Radomir V. Bolgov, Nikolay V. Borisov, Andrei V. Chugunov, Natalya N. Koroleva,
Dmitry E. Prokudin, Leonid V. Smorgunov, Alexander E. Voiskounsky,
Victor P. Zakharov (Editors)

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The International Conference **"Internet and Modern Society"** (IMS-2020) is organized by the ITMO University

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IMS 2020 Editorial

The International Conference “Internet and Modern Society” (IMS-2020) was initially planned to take place in St. Petersburg, Russia. Due to the spread of COVID-19 and the ban on public events, the conference was held during 17-20 June 2020 in the format of online sessions with a discussion of papers and presentations uploaded in advance. The conference was organized by the ITMO University during the Information Society Week. The important events of IMS-2020, focused on specific aspects of information society and digital transformation, were International Workshop **“Information Systems for Science and Education”,** International Workshop **“Internet Psychology” (IntPsy2020),** International Workshop **“Computational Linguistics” (CompLing2020)** and International Workshop **“Electronic Governance” (E-Governance2020).**

Prior to the conference the Program Committee comprising of the recognized researchers from 12 countries had conducted a rigorous peer review, with 32 papers accepted for the publication.

The goal of the **International Workshop “Internet Psychology” (IntPsy-2020)** was to create a platform for experts and researchers’ collaboration and discussion of the issues related to the transformations of human behavior and communication in the network society, the influence of ICTs on the cognitive and personal development of children and adults, as well as related to the methodology of psychological research on the Internet. The workshop IntPsy 2020 was focused on the following topics: Online Cognition, Digital Socialization, Identity & Self-Presentation Online, Psychology of Gaming & Cybersport, The Use of Immersive and Augmented Reality in Psychology, Problematic & Pathological Online Behavior, Psychology of Social Networking & Mobile Interactions, Big Data in Cyberpsychology Studies, Psychological Aspects of Cybersecurity.

The goal of the **E-Governance2020** workshop was to discuss the problems of new forms of interaction between citizens and the state in the digital environment, to develop the idea of digital citizenship, to identify the challenges and risks of digitalization of the public sphere, to determine the role of trust in digital technologies on the part of citizens and public servants. The participants of the workshop discussed the following topics: E-participation, Digital Public Sphere, Digital Citizenship, Trust in Digital Technologies, Participatory Governability, Crowdsourcing, Citizen Sciences in Digital Environment, Big Data, Policy Processes and E-participation.

The goal of the **CompLing2020** workshop was to discuss the actual issues of interaction of linguistics and information technologies – regarding the development of technology solutions on the basis of a natural language, and the influence of information technologies on the language. Target audience are linguists of all profiles, the staff of organizations developing information systems that involve natural language processing, specialists in knowledge representation, higher education teachers, translators. The workshop was focused on the following key topics: Computer modeling of language, Computer analysis of natural language, Corpus linguistics, Digital linguistic resources, Computational and linguistic ontologies, Information extraction, Document

analysis, Information retrieval, Machine translation, Computational lexicography, Speech technologies, Linguistic analysis of social networks.

The goal of the **International Workshop "Information Systems for Science and Education"** was focused on the following topics: e-learning, online education, digital libraries, electronic multimedia collections, and tools for extracting and analyzing contextual knowledge.

The research part of IMS 2020 was structured around paper sessions within three workshops giving the floor for presenting the results of studies.

We would like to thank those who made this event possible and successful. Our gratitude is especially expressed to the Program Committee members for their contribution to the event. We thank the authors for presenting their papers and also the session chairs that led fruitful discussions. We are grateful to all organizers and representatives of institutions, who contributed to the success of this conference; and we are proud to attract a great team of scholars from different countries and disciplines. We will work further to sustain and expand the IMS community through joint research and collaboration. There are the beliefs that the IMS has the good potential to turn into a new important forum for further academic discussion.

We will keep monitoring the evolution of COVID-19. We hope that IMS-2021 will take place in St. Petersburg on time and everyone can safely make it through this global issue.

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Radomir V. Bolgov, St.Petersburg State University;
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Digital Library Metadata Factories

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Abstract. As you know, today the digital economy is understood as an economy based on the processes of production and use of digital technologies. Currently, these processes are largely implemented on the basis of digital platforms organized in various subject areas and fields of activity. Such platforms have their own sets of services and allow solving various sets of tasks for the development and use of digital technologies.
This article discusses the development and use of digital technology in scientific activities based on digital platforms. Such platforms have their own sets of services and allow solving various sets of tasks for the development and use of digital technologies. We have indicated the importance and role of digital libraries in the formation of digital platforms, and also analyzed the problems of ensuring the integration (connectivity) of the extracted information.
The concept of a metadata factory is presented by us as a system of interconnected software tools designed to create, process, store and manage metadata of digital library objects. Such metadata factories make it possible to integrate created electronic collections into digital scientific libraries that will combine these collections.
We have solved a number of problems associated with the construction of the metadata factory of the digital mathematical library named after Lobachevsky-DML. We suggest using this implemented metadata factory as an element of the ecosystem of any scientific digital library.

Keywords: Digital Science Platform, Digital Science Library, Digital Library Ecosystem, Metadata, Metadata Generation, Metadata Extraction, Metadata Normalization, Metadata Factory, Digital Mathematical Library Lobachevskii-DML.

1 Introduction

As you know, at present, the digital economy is understood as an economy based on the processes of production and use of digital technologies (see, for example, [1]). Today, these processes are largely implemented on the basis of digital platforms organized in various subject areas and fields of activity. Such platforms have their own sets of services and allow you to solve a variety of problem sets for the development and use of digital technologies. The very concept of a digital platform and some features

of the current stage of their development are analyzed in [2]. In [3], estimates are given of the current level of development of digital platforms in Russia.
These levels include the following four main components: the definition of multilateral digital platforms, development factors for digital platforms, business models, and competition dynamics. Note that the formation of digital platforms for research and development is provided for by the Digital Economy of the Russian Federation program [4, Ch. 1]. This program emphasizes the need to create digital platforms for basic and applied research, research and development. It is research and development that precisely constitutes the main lines of activity in the field of research and development. As a rule, each created digital platform has a specific organization that acts as a platform operator and forms its own ecosystem around itself.

Another area of development and use of digital technologies in scientific activity provides for the organization of access to the latest scientific results, in particular, scientific publications and scientometric information about them, using modern digital technologies. Historically, this direction is associated with the formation of digital (or electronic) libraries in the world, including scientific ones. Their active development began at the end of the twentieth century (see, for example, [5–7]). In general, digital (electronic) libraries of any orientation (not only scientific) mean models of complex information systems that serve as the basis for creating universal distributed knowledge storages and are equipped with navigation and search tools in the collections of heterogeneous electronic documents included in these storages.

2 Digital Scientific Libraries

Currently, digital scientific libraries exist in all developed countries of the world [7, 8].

2.1 Russian Digital Scientific Libraries

We only note the most famous Russian digital scientific libraries that provide not only access to scientific content, but also services for working with it.

- Socionet (https://socionet.ru, year of organization – 2000). This is a digital library that ensured Russia's participation in the development of an international online scientific and educational infrastructure (initially – in the field of social sciences, now – in all scientific disciplines);
- eLibrary (https://elibrary.ru/, year of organization – 2005). This is the largest Russian digital scientific library integrated with the Russian Science Citation Index (RSCI);
- Cyberleninka (https://cyberleninka.ru, year of organization – 2012). This is a digital scientific library, which is based on the concept of open science (Open Science) and is one of the five largest open scientific archives in the world;
- MathNet.RU (http://www.mathnet.ru/, year of organization – 2006). This is an all-Russian mathematical portal. It contains archives of leading Russian mathematical journals, collections of video lectures, navigation and search tools, as well as an information system for managing editorial processes [9].

In Russia in addition to those listed a large number of various digital libraries have been created related to modern publishing and scientometric services.

Examples of the latters are Mendeley (https://www.mendeley.com, year of organization – 2008) is a tool for managing a personal scientific library and effective collaborative scientific work; ISTINA (https://istina.msu.ru/, year of organization – 2014) is a digital platform for collecting, organizing, storing and analyzing scientometric information for the preparation and adoption of managerial decisions.

2.2 International Digital Science Libraries

The largest international digital scientific libraries are scientometric databases:

- Web of Science (until 2014 – Web of Knowledge) (https://clarivate.com/webofsciencegroup/solutions/web-of-science/). It arose in 1961 as a product of the American company ISI (Institute for Scientific Information), later belonged to the Thomson Reuters media corporation and became digital, since 2016 it belongs to Clarivate Analytics; its main product is Web of Science Core Collection;
- Scopus (https://www.scopus.com/, founded in 2004). This is the largest citation database for peer-reviewed scientific literature.

These digital libraries (as well as a large number of others) play a huge role in accelerating the circulation of existing knowledge and access to it. But without the Internet, which today has become a comprehensive integrated information environment, extracting information from various kinds of information sources (databases), which are a variety of digital libraries, would be impossible. At the same time, a number of serious problems arise in ensuring the integration (connectivity) of the extracted information. From this point of view, the narrowing of the entire space of available information makes it possible to more accurately specify information and, therefore, provide better access to and use of it. Such a narrowing is provided in the framework of specialized digital scientific libraries, which are organized in specific subject areas. For example, mathematical digital libraries have reached a high level of organization. The history of their origin and development is presented, for example, in [8, 10]. Digital libraries such as MathNet [9], Numdam [11], dml-cz [12] provide services that take into account the peculiarities of mathematical content. Within the framework of the project The European Digital Mathematics Library (EuDML, https://initiative.eudml.org/), methods for integrating European digital mathematical collections are being developed.

Thus, at present, in the field of science and scientific research, on the one hand, a significant number of different digital scientific libraries have been formed. They implement a wide range of search services. Each digital library has its own ecosystem. On the other hand, there are currently no examples of digital scientific platforms that are created and in accordance with the basic definitions [2, 3] successfully implement their own functions and user interaction services, as well as their own business models. We believe that digital scientific libraries can serve as the basis for building such digital platforms. At the same time, existing (not all) ecosystems must be improved. In the absence of such ecosystems, they simply need to be created. Below we discuss one area of such improvement.

3 Metadata and Navigation in the Scientific Information Space

Currently, digital scientific libraries exist in all developed countries of the world [7, 8]. It is well known that today navigation in the information space is largely provided by the availability and completeness of the set of metadata (data about data) of documents presented on the network (for example, [13–16]). There are currently quite a few different metadata standards. These standards should provide opportunities for interoperability with the external environment, identification and integration of information, its search in a distributed environment. Metadata should be open and extensible, oriented to modern semantic and digital technologies. But even with such standards, it is very difficult to really provide the necessary metadata properties for various documents. It is much easier to standardize metadata in relation to a specific subject area and on the basis of those digital libraries that are created in this area. An example is the field of mathematical and computer sciences, where a significant number of digital libraries have been created that perform various functions of integrating mathematical knowledge. Features of the presentation of document metadata in various digital mathematical libraries are described in [10, 11].

3.1 Digital Library Metadata Factory

We believe that a metadata factory should become an essential element of the ecosystem of any digital library. We use the term "metadata factory of digital library" in the following sense: a metadata factory is a system of interconnected software tools aimed at creating, processing, storing and managing metadata of digital library objects and allowing integrating created electronic collections into aggregating digital scientific libraries. The use of these tools, mainly in the automatic mode, will ensure the performance of operations such as selecting objects and their relationships, extracting metadata from various sources and specific documents, checking, refining, improving, normalizing in various formats, and matching metadata (using manual editing or automatic agents), as well as storing and linking metadata to external databases. In the case of the digital mathematical library, a number of specialized ones are added to the listed tools. For example, this is a conversion to the MathML format, markup of mathematical formulas and organization of a search on them [11, 17–19].

We indicate the main tasks that must be solved within the framework of the digital library metadata factory.

When working with digital libraries, one of the important tasks is the automated integration of the repositories of relevant documents with other information systems. Such a process is based on a model of aggregation and dissemination of metadata. The OAI Protocol for Metadata Harvesting model (http://www.openarchives.org/OAI/openarchivesprotocol.html, hereinafter OAI-PMH) is supported by most systems designed to store information resources. To organize work with OAI-PMH it is necessary to use a digital storage support system. The most famous of these are DSpace, Eprints, Fedora, and Greenstone. Some libraries have specialized methods for harvesting metadata from other repositories. In this case, it is necessary that the data providers have tools and services that allow the dissemination of metadata.

To organize the interaction of services both within the digital library and with external libraries and databases, it is necessary to take into account the metadata formats that are used in them. Even in one digital library, software tools work with multiple metadata formats. This is due both to the features of the formation of digital content, and to the requirements of aggregating digital libraries and scientometric databases. We mention only the most common metadata formats that you have to deal with when organizing the interaction of services in digital libraries (their full descriptions are available on the Internet).

First of all, this is the Dublin Core format and its extensions, the MARC cataloging format, RIS (Research Information Systems) bibliographic link formats, AMSBib, and the Russian Science Citation Index (RSCI) XML format.

Separately, we note the XML schemes of the Journal Archiving and Interchange Tag Suite (NISO JATS), which are designed to meta-describe articles in scientific journals [20, 21]. The significance of these schemes for digital mathematical libraries is determined by the fact that the mandatory and fundamental metadata sets for The European Digital Mathematics Library (EuDML) [22] are based on the NISO JATS v.1.0 scheme.

Many of the tasks mentioned above were solved by us when constructing the metadata factory of the digital mathematical library Lobachevskii-DML (https://lobachevskii-dml.ru/). As in the case of any digital scientific library, the formation of the Lobachevsky-DML library and the corresponding metadata factory required the use of technological solutions to manage scientific content, both previously created and those that were newly developed by us.

The formation of metadata of digital mathematical collections in the metadata factory of the digital library Lobachevskii-DML is carried out in several stages.

At the stage of preprocessing, the collection of documents is processed by software tools in order to bring it to a form suitable for further automatic processing [10]. For this, clustering of documents by stylistic similarity is performed, and then the stylized constructions used in the document are reduced to the template form. For example, .tex collections may contain documents that use not only the `\title{}`command, but also `\tit{}`, `\ArticleNAME{}` and others to design the article title. Lists of authors, keywords, codes of subject classifiers and other information necessary for the formation of a set of metadata are recorded using tex-commands, which differ significantly in the style files of various journals.

Moreover, the title of the article, the list of authors, keywords and other blocks necessary for inclusion in the metadata may not be executed by teams. In this case, they simply differ in font selection, for example, `{\bf Paper Title}`. In these cases, an attempt is made to automatically find such blocks by location in the text and font design. This approach applies to most collections of documents created in office formats [23]. In [24–26], algorithms for extracting metadata from scientific articles are presented. These algorithms are based on the study of the structure of documents and ontologies for describing the structure of documents.

At the preprocessing stage, part of the files cannot be processed automatically. For example, this situation occurs when processing a tex-document, when there is no style file or a file with author macro definitions that are referenced in the processed document. From such files a set is formed, which is adjusted by semi-automatic tools or

manually. After that, preprocessing is repeated. Files rejected at this stage several times are manually corrected.

The next step is the formation of a set of basic metadata. Strings with the title of the article and the list of authors are extracted from the documents. Next, the search is carried out and the text of codes of subject classification, a block of keywords, affiliation of authors and abstracts to the article, if they are given in the document, are extracted. Also, the metadata of each document includes its URL-link in the digital library collection. The generated metadata is stored in the xml-file in accordance with the DTD-rules and XML-schemes, which are installed in the digital library.

At the stage of improvement and refinement of metadata, software tools are used, with which simple spelling errors and typos are corrected in the title of the article, list of authors and keywords. Metadata is being improved, in particular, transliteration of article titles, addition of abbreviations with full titles ("SPb" –"Saint Petersburg", "LJM" – "Lobachevskii J. Math.", "Lobachevskii Journal of Mathematics").

URLs are checked using existing refinement services. Then, the metadata includes the date the web resource was accessed. Formula fragments in article titles and annotations are converted to MathML code.

Not all metadata can be obtained by searching for the corresponding blocks in the document and then extracting it from the text. Keywords, classifier codes, and other data are determined only as the result of textual and semantic analysis of the document [18, 24]. In the metadata factory, these operations are performed at the stage of generating additional metadata. As part of the project to create a digital mathematical library, we have developed tools to automate a number of operations at this stage.

3.2 Normalization of Metadata

We use the term normalization [10] to refer to the methods for generating and converting document metadata in accordance with the rules and XML schemes of digital libraries and scientometric databases.

One of the functions of the metadata factory is the normalization of metadata in accordance with the formats of other aggregating libraries. For example, the OAI-PMH protocol requires the inclusion of a metadata set in the resource description in the oai_dc notation, which is based on Dublin Core.

In the metadata factory of the digital mathematical library Lobachevskii-DML, a method has been developed for normalizing metadata into the format of the Russian Science Citation Index [27]. This method is implemented as a plugin of the journal platform Open Journal System and is used to generate metadata of the digital journal "Russian Digital Libraries Journal" (https://elbib.ru/). Methods have also been created to normalize the metadata of the collection of articles of this journal into formats of the bibliographic database on computer sciences "dblp computer science bibliography" (DBLP, https://dblp.uni-trier.de/) [28]. Methods have been created for the formation of mandatory and fundamental sets of metadata using XML schemes of the EuDML European Mathematical Library (https://initiative.eudml.org/) [10, 28].

Tools of the metadata factory of the Lobachevskii-DML library, already implemented by us, are described in detail in [10].

4 Conclusion

So, as a result of the development of the metadata factory of the digital scientific library Lobachevskii-DML:

- a system of services has been proposed for the automated generation of metadata of electronic mathematical collections;
- developed an xml-language for the presentation of metadata, based on the Journal Archiving and Interchange Tag Suite (NISO JATS);
- software tools have been created to normalize metadata of electronic collections of scientific documents in formats developed by international organizations - aggregators of resources in mathematics and Computer Science;
- an algorithm has been developed for converting metadata to the oai_dc format and generating the archive structure for import into DSpace digital storage;
- methods for integrating electronic mathematical collections of Kazan University into domestic and foreign digital mathematical libraries have been proposed and implemented.

The metadata factory model presented above was implemented in a specific digital mathematical library. Naturally, this model takes into account the specifics of the processed content. At the same time, it can be used as an element of the ecosystem of any scientific digital library.

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Study of Conceptual Bases of Software Functioning for the Representation of Deliberative Argumentation

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Abstract. Deliberative reasoning is widely used in various fields of human activity. In the modern information society, the use of methods of deliberative argumentation is associated with the development and use of appropriate application software, which is intended for visualization and modeling of intellectual activity to solve various types of practical problems, as well as argumentation. At the same time, various software designed for modeling and representation of argumentation explicitly or implicitly contains its conceptual grounds for argumentation. In this study, based on the identification of software intended for the simulation of deliberative reasoning, analysis of its purpose and main functions, the conceptual foundations of their functioning are determined, which is the initial stage for the formulation of a body of criteria for evaluating this software and its subsequent classification. The authors propose two preliminary independent classifications based on conceptual grounds, which are significant characteristics for the classification of the corresponding software.

Keywords: Deliberative Reasoning, Conceptual Bases, Software, Modeling, Representation.

1 Introduction

Deliberative argumentation is a kind of practical argumentation about actions. In contrast to the theoretical argumentation with its objective to prove the truthfulness of a proposition, the deliberative argumentation focuses on the rationale for what has to be done or what we should do in a given situation. Along with the actions which the deliberative argumentation aims at justifying and the propositions by means of which it intends to justify those actions, it also involves norms, goals and values as the atomic elements of the deliberative arguments. For that reason, it finds wide application in various fields of human social practices, including political, legal, moral, religious and everyday life.

In the context of creating of the software for the representation of deliberative argumentation, its main difference from the theoretical argumentation consists in two aspects, technical and conceptual. The technical difference amounts to the fact that for the modelling of the deliberative argumentation, there is a need for a wider expressive power of the formal languages and ontologies in order to take into account the intentions, goals, norms, values, etc., in addition to the descriptive propositions conveying

facts, which exhaust the atomic elements of the theoretical arguments [16]. The conceptual difference lies in the distinction between the argumentation as a competition among justifications, which belongs to the field of modeling reasoning in general, manipulating knowledge bases and information that make up the cognitive direction in the computer science where information reliability and truthfulness if the key criteria for wining that competition, and the decision- making as a strategy and tactics of behavior belonging to the field of psychology and management where the key criteria for wining is effectiveness in terms of means-ends or resources-ends relations.

The selection and classification of the software based on these aspects is the final goal of our study. At its initial pilot stage, we conducted a preliminary selection of the software for the representation of the argumentation and reasoning in general by separating it from the software used for manipulating knowledge bases and information. At the second stage, we set the task of selecting and classifying the software for modeling the deliberative argumentation. The outcomes of those two stages of our study will be incorporated into the final classification of the software. Here we talk about general approaches in the second stage.

In the contemporary information society, modeling of the deliberative argumentation is connected to the development and use of the special software applications, which is designed to visualize the intellectual activity in solving the practical questions of various kinds by means of reasoning and argumentation. This means that most software applications abstract from the above conceptual distinctions and embrace the reasoning and the decision-making altogether. Decision-making support methods for the intellectual activity with the elements of deliberation using the information and communication technologies find their application in various fields of the human activity: medicine [19], public policy and e-democracy [5, 13], scientific or academic argumentation (including technical, medical and humanities) [22], education, business and other fields [24, 27].

The contemporary research varies in considering different aspects of the software application. Analysts and practitioners have developed the techniques for the application of such software, which is reflected in numerous publications, for example [9, 10, 12, 13, 24, 27].

As a rule, when analysts focus on the software products for determining the possibilities of their application for modelling argumentation, they seldom correlate them with the concepts of argumentation. At the same time, the rationale for analysts to look for the software of that kind refers mostly to training the critical thinking and other soft skills, and to a lesser extent to its use in business analytics, law, management of complex social systems – to the key areas of practical application of the software in question, where conducting evidence-based reasoning based on knowledge and argumentation is at stake. Although some analysts examine the aspects of using such software in the applied fields [7], the theoretical foundations implemented in the software for modeling argumentation, deliberative reasoning and mind mapping are considered superficially. In addition, the available results of those studies cover restricted amount of the existing software, and no reasons are given for the selection they make. Most of the existing classifications are based on the experience of applying the software rather than on the examining the conceptual foundations of the software, and they mainly consider

the methodology of their application in various educational practices. Therefore, in the contemporary studies, there is a challenge for the theoretically substantiated body of the software evaluation criteria with respect to modeling arguments, deliberative reasoning in a broad sense and for the mind mapping.

Many Russian authors focus on creating the software for modeling the plausible reasoning rather than on modeling reasoning in general, which seems to be a more promising approach to solving the problem of the adequacy of modeling of the software. This problem amounts to selecting the software appropriate to the objectives of its application which implies taking into account the conceptual foundations of the software at issue, contrary to selecting it on the basis of the software availability and IT-brand fashion. An influential contribution to the development of the concept of argumentation as plausible reasoning was made by the school of Viktor Finn [1], whose research group created several algorithms for the automated solution of problems through non-deductive, probable and abductive, reasoning [8]. Russian researchers are developing concepts of plausible reasoning as applied to the intellectual and expert systems, including the deliberative systems (decision making), as well as databases, within the framework of which the argumentative reasoning functions as a special competence of highly intelligent agents [25]. They develop the bodies of the methods for discourse analysis of the Internet discussions on socially significant topics, and propose to study them in one of the aspects of the deliberative reasoning - from the perspective of agreement or disagreement with values, norms, etc. [21].

The software designed to model and represent the argumentation is based on diverse conceptual foundations of the argumentation which are visible in the software explicitly or implicitly. Our study aims at determining the conceptual foundations of how such software functions, which is the initial stage for formulating of a body of the evaluation criteria for this software and its subsequent comprehensive classification. We intend to determine those foundations by means of identifying the software designed to model deliberative argumentation, analyzing its purpose and basic functions.

In the development of such a classification we confine ourselves to the following objectives:

- the development of proposals for solving the problem of the theoretical gap between the concepts of argumentation formulated as a result of its research studies and the concepts explicitly or implicitly implied in a number of the software systems and the software applications designed for the modeling and representation of argumentation. Most of those systems and applications have descriptive character: they are limited to the visualization of argumentative dialogs (disputes) and offer no mechanisms for their solutions which highlights the relevance of establishing those particular aspects of deliberation the definite software visualizes;
- to draw the conceptual borderlines between the three approaches: the modeling of argumentation as kind of intellectual cognitive activity aimed at identifying the consistency or soundness of the views of the parties on the issue at stake; visualization of the critical and deliberative reasoning by applied methods of the mind mapping, and the mind mapping as the sets of graphical tools of representing information, including reasoning, using associative diagrams;

- to provide the academic, research and educational community with a tool for the effective selection of the software systems and applications for use in research and educational activities where the deliberative argumentation plays significant role;
- to suggest the methodological support by formulating recommendations for the creation of the domestic software systems and applications for modeling arguments which would respond to the local needs in an adequate linguistic and dialectical setting.

2 Identification of the conceptual foundations of the software for deliberative reasoning and argumentation

In the earlier pilot study, we selected the software designed for modeling, analysis and teaching of argumentation and critical thinking skills [17, 18]. We considered the purpose and the aspects of the application of the software for formulating meaningful criteria for distributing the software into the following categories: the type of reasoning or interactions modelled by the software; the kind of interactions – monological, or agentless, dialogical with two or more agents; whether the software takes into account the logical correctness of reasoning; whether it discriminates between the descriptive and non-descriptive information; whether it has the functions of heuristic search of solutions. With respect to the software application for solving practical tasks, taking those aspects into account allows to separate the software into the following three groups: modeling arguments in a broad sense; analysis and visualization of the processes of generating and evaluating the argumentative discourse - this software can be effectively used for teaching academic writing skills; solving practical tasks based on the use of argumentation, for example, in the field of legal or moral argumentation. Accordingly, the selected software was divided into several main categories in accordance with its following purpose:

- modeling of argumentation;
- visualization of critical and deliberative reasoning;
- mind mapping.

After that we grouped the selected software systems and applications into several categories according to the following methods:

- we have used some of the software for a long time in the educational process and determined some of its conceptual foundations;
- some of the software systems and applications are widely used and their characteristics are described in the educational and research publications;
- developers of some software give their own descriptions of its functional properties.

For example, *Carneades* and *Rationale* software applications that we widely use in the educational process have clear descriptive objective of representing argumentation in a definite way, although many researchers view those applications as based on the argu-

mentation model of S. Toulmin, which has normative character with respect to constructing arguments and their performance in the dialogs. Moreover, the concepts of argumentation implemented in *Carneades* and *Rationale* are different from each other albeit both are descriptive. *Carneades* software supplements Toulmin's argumentation model with some types of defeasible reasoning which the original model lacks. *Rationale* adds to the model two kinds of evaluations of the arguments, the quantitative estimates of the argument strength (poor, good, undefined) and the qualitative estimates of the arguments based on the establishment of their meaningful sources (data, statistics, expert opinions, etc.), as well as the templates for generating arguments in the text. Recently, *Rationale* developers have proposed a new application for modeling decision-making *b'cisive*, which is based on the concept of deliberative protocol [4]. *b'cisive* developers position it for visualization of arguments in the deliberations and decision making altogether, by which with they explicitly avoid drawing distinctions between them.

Some software programs are no longer supported or developed. These include, for example, *Araucaria* software, which we classified for use for the purpose of modeling arguments and deliberative reasoning, but in 2006 the developers stopped supporting it and switched to developing their new web-based software OVA (http://ova.arg-tech.org), designed for argumentation mapping for the analysis and modeling of argumentation in the text. Contrary to *Araucaria*, OVA discriminates the sorts of arguments in terms of their kinds, strength and functions in the dialog. The discrimination is realized by the sets of argumentation schemes available at user's choice (for example, Walton presumptive inference, Rutgers SALTS, Cornell, Dundee illocutionary, Second order illocutionary, Basic conflict, Extended Conflict, Deductive inference). Those sets have been proposed by the research groups and can be used for mapping the argumentation in texts originating from various subject areas. In terms of logic, the sets of the argumentative schemes include deductive and a variety of non-deductive arguments. Users may choose to identify the arguments they are mapping by other criteria like speech acts, dialectical role, rhetorical shape, etc.

From what was said above we conclude that the software designed for modelling argumentation sensitively varies in the degrees and the ways of implementation of the concepts of argumentation on which it is based, including the cases when the software products differently implement the same concepts. For example, *Rationale* software users need no prerequisite knowledge about the analysis or structure of the argument is for starting to work with it. The visualization of argumentation by *Rationale* is close to its intuitive mapping and reflect the basics of the theories which are normally given in standard textbooks on argumentation. *Rationale* supports generating argumentative texts in the vein of design thinking, as well as the multivariate assessment of the effectiveness of argumentation. OVA does not support the latter two options. In contrast, in OVA software, the users have to choose the argumentation schemes themselves, and they have to be aware of the dialectical concept of argumentation implemented in OVA for being able to construct their maps with OVA.

As a part of our study, we single out into a separate group the software systems and platforms used to support the deliberative democracy such DemocracyOS, Democracy

2.1, Loomio, OpaVote, Delib, Decidim [2, 11], which promote deliberations as a necessary tool for generating and shaping public opinion as well as for formulating of the political agenda and observing the controversial issues in the political decision-making. Those systems are the social online platforms or forums, they provide the digital and technical tools for polls, opinion exchange, debates and discussions, statistical analysis and visual representation of its results.

They are designed for supporting decision-making for state and municipal management and are often employed for similar governmental purposes. In those systems the decisive analytical function is assigned to humans who, however, may choose rely on the systems' AI analytical potential, too. Enhancing that potential of AI in the vein of substituting humans at the analytical chair of those software platforms is a relevant subject of concern for many apologists of wider implementation of AI and the natural language processing (NLP) technologies in the deliberative democracy for analyzing public discourse and decision making [20]. The platforms for the deliberative democracy pay no special attention to the kinds and sorts of argumentation performed there, and it is impossible to identify the conceptual grounds of argumentation implemented in them.

We propose two preliminary classifications of the software and give the theoretical descriptions of the aspects of argumentation for creating such software. At the first step, we divide the software into two groups, depending on whether they are descriptive formalisms, platforms, protocols, or ontologies, that visualize the argumentative reasoning of their users, or normative systems that simulate what conclusions should be drawn, what assumptions are recommended to accept or what decisions have to be taken given the rationale visualized by the software (Table 1).

Note that we call the platforms, protocols, or ontologies altogether formalisms and place them into one group with respect to their functional capability to represent discussions where argumentation is used as one of the tools, which means that for this classification we abstract from their diverse functional capabilities in how those representations are realized in each of them. At the second step, we identify two groups of theoretical concepts laid down by their developers in the corresponding software, depending on whether it supports the visualization of the modifiable (defeasible) reasoning or not (Table 2).

Note that the criteria we have chosen for the two groupings give the independent groups despite the fact that they overlap, and we see it impractical to create a generalized classification, since we propose to use those criteria and groupings for different practical purpose. The descriptive vs normative groups are meant for guiding the users in finding an appropriate software for their tasks regarding reasoning in general; the modifiable vs non-modifiable groups are meant for doing so with respect to argumentation of the definite kinds. Perhaps, the only purpose those two groups of the criteria are both equally suitable is their further development, and generally the development of the software and its classification, since those criteria and groupings make explicit some of the software essential properties.

Table 1. Descriptive and normative software applications

Protocols \ ontologies \ platforms	Normative software applications
Software applications for vizualising argumentation (Carneades, Rationale, b'cisive)	modelling of the defeasible reasoning (DeLP, DefLog)
Platform for deliberations and informal discussions (D-BAS)	modelling argumentation with AI systems (ArgTools, Dung-O-Matic)
Platform for collective problem finding and solving	Modelling of probable inferences with modifiable assumptions PITA
Ontology of argumentation for some kinds of reasoning	Modelling of cognitive reasoning for rational agents OSCAR
Protocol for argumentation about actions ATR	Modelling argumentation in dialog by a two-agent game Convince Me
System of plausible argumentation	

Table 2. Software applications for modifiable and non-modifiable reasoning

Non-modifiable (monotonous)	Modifiable (non-monotonous)
St. Toulmin descriptive model of argumentation (Carneades, Rationale, b'cisive)	modelling of defeasible reasoning (defeasible reasoning) (DeLP, DefLog)
Formalised model for informal dialogs with implicit arguments D-BAS	Modelling of argumentation with the AI-systems (ArgTools, Dung-O-Matic)
IBIS (Issue-Based Information System) an approach to explanatory argumentation proposed by V. Kunz and H. Rittel for cjlltctive problem finding and solving (QuestMap, Compendium)	Modelling of probable inferences with modifiable assumptions PITA
Ontology of argumentation for some kinds of reasoning	Modelling of cognitive reasoning for rational agents OSCAR
Modelling argumentation in dialog as a two-agent game Convince Me	Protocol for argumentation about actions ATR
	System of plausible argumentation

The relevance of the software classification which we are developing with respect to its conceptual foundations is that it will enable the users to choose the software regarding their practical goals in a more rational way with respect to solving the tasks of argument analysis and its digital mapping. Another aspect of the relevance is that the classification will respond to the new educational challenges in the teaching of skills of practical argumentation and deliberative reasoning in various fields of human activity. For example, at St. Petersburg State University, the Digital Transformations of Argumentation in Science module is included in the general compulsory course 'Digital Culture'. As part of the module, master students study argumentation digital mapping using Rationale and OVA software and apply it to solving the tasks with the help of practical argumentation. In this vein, they develop applied competencies in digital argumentation mapping, deliberative reasoning, defense and criticism of arguments.

Note that along with the software solutions that we have studied and described here, there are other software systems and platforms that implement mechanisms of deliberation, argumentation, and support for intellectual activity. However, they bear theoretical character and are described only in the research papers (for example, ProGraph, ConArg2), or there are no links either to the websites of their developers or to the software itself. Therefore, those software products are most likely ongoing development or test versions, which lack information or functional performance for determining their capabilities and describing their key properties, including the conceptual basis for their construction.

3 Conclusion

At the current stage of the study, we have identified two grounds for classifying the software designed for analyzing reasoning - on the basis of the descriptive or normative approach to modelling deliberations and with respect the modifiable or non-modifiable character of argumentation at issue, which form the foundation of the classification of the software we are intended to develop. Those grounds are independent of each other and are both essential properties of the software we focus on.

In the future, we are going to develop a comprehensive classification of the software designed for modeling and representing argumentation, in which we will identify its key conceptual foundations that will enable us to form large groups of the software. We will consider the differences in the implementation of these concepts in the software as its functional properties and separate them into a special characteristic, which will make users' selection of the software more justified with respect to the tasks they wish to solve by means of it.

For the practical approbation of the results obtained we will conduct an applied study. As part of that study, we plan to select an example of a text with a description of a problem solved by means of practical argumentation. We will model that argumentation first with the help of OVA or OVA+ software, which will be a sample for the further modelling by means of two other software applications for analyzing argumentation. Those applications will be selected on the basis of the alternative conceptual grounds compared to OVA. In the selection of those software applications we will take into account the demand in the research community based on the results of the quantitative analysis of the research publications and accessibility both in terms of licensing and availability for the users. This comparative modelling will enable us to clarify the results obtained by our classification and to verify the recommendations for further development of the software we are intended to formulate as another result of our study.

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Developing a Machine-readable Catalog of Computer Programs and Tools for Extracting and Analyzing Contextual Knowledge

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Abstract. For researchers in modern conditions of development and the total application of information and communication technologies, there is an issue of choosing effective tools for research purposes. A huge amount of the existing software lacks classifications of the software and information systems to consider research task classes. The project implemented by the authors aimed to develop an approach to research the evolution of the thematic and terminological apparatus of interdisciplinary scientific fields. The following methods: search, extraction, clarification, explication, analysis, and presentation of contextual knowledgewith software and information systems were considered and applied. The specifics of the research limits software and information systems to the tasks of contextual scientific knowledge processing. The main types of software and information systems used for these purposes were analyzed, and their main functional characteristics were identified. Based on the typology of contexts and the groups of characteristics identified, an approach is proposed to develop a catalog of software and information systems analysis of contextual knowledge with the functions of allocation, classification, and explication of scientific content. To provide information about software and information systems in the catalog a Dublin Core metadata model is proposed. This model allows not only to describe and structure the main characteristics of software and information systems, but also to present the catalog in a machine-readable form to add new records, efficiently search the necessary software and information systems subject to the research tasks, and integrate it into the scientific information network based on open science principles. A palliative solution for testing the correctness of Dublin Core metadata presentation and metadata exchange via the OAI-PMH Protocol is presented.

Keywords: Software, Classification, Catalog, Contextual Knowledge, Dublin Core, OAI-PMH.

1 Introduction

The variety of software, application environments, and web-oriented services for various purposes makes it difficult for modern researchers to choose tools that can be effectively used in scientific research. They have to focus on the existing approaches

to software classification. Both general approaches that distinguish the common software classes and special approaches that focus on a more detailed description of software subclasses for various applications have been developed. The most common classifications include, for example, the Classifier of programs for computers and databases used by government agencies in Russia [24]. One of the general approaches to classify the Business intelligence (BI) class software is the annually updated analytical report "Infrastructure and Applications Worldwide Software Market Definitions" by Gartner [12], which reflects the general approach of Gartner to assess the software market development [32]. This approach is followed by the International Data Corporation (IDC), one of the world's largest consulting companies, a leading provider of information and consulting services, and an organizer of events in the information technology, telecommunications, and consumer technology markets [2]. The Computing Classification System (developed by the Association for Computing Machinery, the latest version was introduced in 2012) can also be used to classify software and information systems. The system is presented as a single source of categories and concepts that reflect the current state of the fields related to computational engineering, computer science, and information and communication technologies [5]. Other approaches to classification, which have historically been formed from the logic of computer technology and software development, are also widespread [15, 16, 22].

The analysis of approaches to software classification makes it possible to identify the problem of choosing a specific tool with which researchers, as users of software products, can solve research and analytical tasks. This problem arises from the fact that software developers try to integrate the maximum set of functionalities into their systems and thus ensure that a whole range of tasks is performed. Unfortunately, the results obtained are often not equivalent. A specific computer application has its own "specialization", that is, a minimal set of functionalities that ensures the performance of a narrower range of tasks, but most optimally and successfully. There are usually many analogs, their choice by a researcher is based on compliance with certain initial requirements to the system (for example, a particular language support or implementation of certain methods in the software). There are information systems that were not designed by the developers to process scientific information or analyze information for scientific purposes. Although, if there is an introductory, explanatory information or a developed method, they can be efficient for scientific purposes. Even with detailed information about a specific computer program or an information system, it is not always possible to categorize it with the existing classifications. Therefore, both classification and identification of specific functionality can be made or refined only in the process of software application to solve specific research tasks. The presence of analogs initiates creation of software catalogs focused on solving a certain class of research tasks based on the classification developed.

2 Approach to software search and selection

As part of the ongoing project to develop an approach (synthetic method) to In the ongoing project framework,the principle of the synthetic method independence from the specific tools was chosen as the main one.

The research specifics led to the development of a typology of contextual knowledge of textual modality, which must be considered when choosing an appropriate software for processing contexts of certain types (corpus, fragment, paragraph, sentence, term-concept, thesaurus, meta-description, semantic group, thematic collection). The topology allows software application for multi-level structural analysis that increases the research task effectiveness. Focusing on the methods used in the study (search, extraction, explication, analysis, and representation of contextual knowledge), the general classifications revealed a lack in clear division into classes for these methods as enlarged functions. It is also not possible to determine the types of contexts being processed using these classifications.

For example, Gartner identifies the following market segments:

- Data Warehouse;
- On-Line Analytical Processing, OLAP;
- Enterprise Information Systems, EIS and Decision Support Systems, DSS;
- Data Mining;
- Query and Reporting Tools.

In the Computing Classification System, the following subclasses correspond to the systems considered:

- Specialized information retrieval – Structure and multilingual text search;
- Document management and text processing – Document capture – Document searching; Document analysis.

In the Russian Classifier, the following subclasses of software application can be associated to the programs under consideration:

- Search engines – software systems that search for text, graphics, and other information in local, corporate, and other repositories, including consulting and information systems for searching and viewing information in specialized multi-industry databases;
- Linguistic software – parsers and semantic analyzers/systems for natural language text analysis with the selection of syntactic sentence structures or semantic relations between text elements and general text meaning;
- Systems for data sets collection, storage, processing, analyzing, modeling and visualizing – business analysis systems (BI)/programs focused on big unstructured data processing to facilitate their interpretation, including tools for data extraction and transformation (ETL), subject-oriented information databases (EDW), tools for real-time analytical processing (OLAP), data mining, generating reports, graphs, charts and other visual forms, decision support (DSS).

To search and identify a software with the functions of extracting, classifying, and explicating scientific content to support scientific research, both open network sources and scientific publications with similar software were used. The analysis of the identified systems showed that the vast majority are used as text linguistic analysis tools

in linguistics [13, 33], sociology [31], cybersecurity [21], as well as in interdisciplinary fields [4, 10, 18].

Some linguistic software catalogs are presented in the Internet [1, 14, 18, 22, 28, 29, 30]. This software can be used for research purposes.

Catalog analysis allows to identify common areas of software used for the tasks listed above:

- Text Mining;
- Text Analytics/Analysis;
- Information Retrieval/Extraction;
- Text Comparison;
- Topic Clustering/Modelling;
- Text Visualization.

Such catalogs do not have classifiers that consider their main functional purpose and the types of contexts being processed. Therefore, they do not perform the tasks of selecting effective tools for research. It was decided to reject the use of other software classifications widely presented in the network, including those based on the signs "scope of application" and "system functionality", for the same reasons. Such classifications are intended for the business community, operate with business concepts, focus on the range of business tasks of an enterprise, organization, or market analysis.

In this regard, the purpose of this study is to develop a structured description of a software using the main characteristics: software class, main functions, and types of the processed contexts. Based on a structured description, the software catalog development is performed, which allows researchers to solve the problem of effective software selection to meet the research aims and objectives. The creation of the catalog solves the researcher's pragmatic task to make an informed choice of a required software set.

3 Development of a catalog of a software with functions and services for extracting and analyzing contextual knowledge for scientific research

3.1 Defining the main software classes

When forming the structure of a software description for the developed catalog, the general classification was chosen based on the this software applicability for the analysis of contextual knowledge with the functions of extracting, classifying, and explicating scientific content to support scientific research.

The target group of catalog users includes scientists and teachers specializing in interdisciplinary research and working with various sources of information and big data. The following specific task classes for the interdisciplinary studies were set:

- Neural Network;
- Machine Learning;
- Natural Language Processing;

- Information Extraction;
- Ontology;
- Forecasting Systems;
- Creation and Use of Thesauri;
- Topic Clustering/Modelling;
- Full-text Databases;
- Abstract Databases (metadata only).

These classes of tasks in the catalog correspond to the "type of software" characteristic. The latter two types are characterized only by full-text and abstract databases that have their engines for searching, selecting, and analyzing information.

The integrated types of software do not always reflect the diversity of their functional capabilities. Therefore, for a more complete understanding of their capabilities and rational choice for specific research purposes, the main functions of the software are grouped separately. The following main functions of the software are distinguished:

- Classification;
- Forecasting;
- Contextual analysis;
- Selection of data according to various criteria (smart search);
- Automated data/metadata exchange;
- Visualization.

This is a set of basic functions. However, when a specific software application is included in the catalog, its analysis may reveal other specific functions. Therefore, the classification of the functions is extensible.

The proposed classification does not consider some important classes of tasks, such as "scientific communication" and "issues of science management and research coordination", as they go beyond research tasks.

3.2 A typology of contexts for software features

The choice of specific software for research purposes is related to its ability to process certain types of contexts. Within the framework of this research, the concept of context is understood as an independent conceptual unit of the thesauri, used as a basis for classifying scientific texts, as well as for visualizing hierarchical and associative relations between terms. The explication and analysis of contextual knowledge resulted in a typology of contextual knowledge developed in this project [17].

This classification can be further specified for the study of more specific subject areas. The correlation of the software with the types of the processed contexts also allows researchers to choose a software more rationally. Therefore, when classifying a software, it is proposed to use the type of the processed contexts as an essential characteristic.

Based on the types of stored, extracted, and processed (analyzed) contexts and their specification, the software for the catalog can be divided into the following enlarged categories:

- An information search system that processes a large number of unstructured texts and multimedia information, with limitations in the user dialogue with the system, as well as limited graphematic analysis and low reliability of link detection (Yandex, Google);
- Information systems that represent text databases, digital online archives of scientific publications and abstract databases of multidisciplinary areas, that significantly differ in the content analysis functionality (eLibrary, T-Libra, Science Direct, Scopus and WoS);
- Information and analytical systems that have various degrees of completeness of fact detection and self-learning, levels of semantic hierarchy and automatic logical analysis of factual information. These systems also process a large volume of unformalized texts and multimedia information, (Mallet, AskNet, Voyant-Tools, Tropes, Sketch Engine, CLAVIRE, RCO (Russian Context Optimizer));
- Multifunctional mixed-type information systems that have the advantages and disadvantages of the information systems described above: the ability to process a large volume of unformalized texts and multimedia information, reliability of identifying links, a wide range of document formats. These systems have limitations in automatic semantic analysis of various levels, which is a software developer task (ABBYY Intelligent Tagger SDK, ABBYY Smart Classifier SDK; Title: PROMT Analyser).

These enlarged categories are used in the catalog to group software.

3.3 Machine-readable view of the catalog

The description of the software for contextual knowledge processing was analyzed. This leads to the conclusion that such catalogues are mostly static lists or tables, where the software is either grouped by a certain attribute (for example, freely distributed or commercial; belonging to enlarged functional categories) or presented in an unstructured form with a brief description of features and links to relevant sites on the Internet. This presentation of information makes it difficult to quickly search for and effectively select the software necessary for conducting research, considering the main features, functionality, types, and formats of the processed contexts.

For a structured representation of information about the software, it is suggested to use its description, as well as the descriptions of the documents, via the metadata representation. For example, González and van der Meer considered standard metadata representation formats (Dublin Core, EAD, ISAD (G) and MARC) and suggested the Extended Dublin Core for Software Components (XDC-SC) of the Dublin Core scheme, which allows extracting information about a software using standard search engine tools or XML tools [11]. They also suggested that this approach may encourage the creation of environments to present information about a software. Other researchers suggest not to focus on one standard, but develop a Semantic Master Metadata Catalog (SMMC) to ensure interaction between the existing metadata models (such as Dublin Core, UNIMARC, MARC21, RDF/RDA, and BIBFRAME) based on the ontology mapping model [20]. Here, an approach to developing a Semantic enhanced Metadata

Software Ecosystem (SMESE) is proposed. This ecosystem is designed to support specific distributed content management applications. However, the implementation of such a solution is a complex task that can only be solved at a large consortium level.

Based on the generally accepted approaches for software description, it is proposed to use the Dublin Core meta-data representation specification in the catalog. The main characteristics of the presented software are described by the corresponding elements of the main metadata set (Dublin Core Metadata Element Set, DCMES) [6]. In this approach, the combination of element values sufficiently describes the software presented in the catalog, in accordance with the general approach of this specification application to describe various entities [9, 23, 27]. The proposed approach also makes it possible to present the catalog in a machine-readable form in the network information systems with free access for both researchers and automated search and identification by search engines. In this case, the users can search for various metadata elements: classes, software functions, or types of the processed contexts.

Usually, this approach mainly describes various text objects: articles, books, library catalog cards, archive materials, and semantic models [27]. When developing a metadata representation scheme for software description, its specifics is not considered, which is important when choosing a software (for example, the types of contextual knowledge being processed) [3, 11]. Therefore, in connection with the specifics of the software description, in addition to the main metadata elements, qualifiers were used to refine the characteristics, which make the second level of metadata and refine the elements [7, 20].

Also, the most suitable software platform was selected to present the catalog in a machine-readable form. When choosing, the following basic principles were considered:

- availability – open source or non-commercial software;
- popularity – the most well-known and widespread solution;
- flexibility – ability to adjust the metadata description to the task of catalog creation.

Among the systems considered, the most popular at present is DSpace software platform (https://duraspace.org/dspace/). According to the most authoritative aggregator ROAR [26], of the 4,725 open access repositories registered, 1,965 use DSpace. The second place takes EPrints (679). DSpace meets all the above criteria, so this platform was chosen for this study. After reviewing the documentation for metadata presentation in DSpace by the Dublin Core specification [8], and considering the specifics of qualifiers application, the following set of metadata is proposed for each catalog record:

`dc.title` — software title ;
`dc.creator` — developer;
`dc.subject.classification` — main functions (can be added after analyzing the corresponding software);
`dc.subject.other` — type of context to process;
`dc.description.abstract` — software description ;
`dc.publisher` — vendor (copyright holder);

dc.contributor — contributor (people or organizations who also participated in the software development);
dc.date.issued —last release date (year);
dc.type — categories (software classes according to the developed classification);
dc.format.mimetype — formats of the processed files;
dc.identifier.uri — identifier (link on the Internet to the developer's site);
dc.source.uri — source (link to the web application);
dc.language — languages of documents to be processed;
dc.relation.isreferencedby — relations (list of publications on the software);
dc.coverage — supported operating systems;
dc.rights.license — license type.

Based on the proposed approach, more than 50 software items were described. A visual representation of a catalog record by the Dublin Core specification is shown in Figure 1.

dc.title	Voyant-Tools
dc.creator	Stéfan Sinclair, McGill University; Geoffrey Rockwell, University of Alberta
dc.subject.classification	processing of individual documents; processing by a collection of documents (text corpora); classification; analysis of Internet pages; frequency analysis; context analysis; trend contextualization (building trends); data analysis visualization
dc.subject.other	term; paragraph; document; document collection
dc.description	Web-based system for downloading and analyzing digital texts, studying the frequency and distribution of terms in documents, and in a collection of documents (corpora). It is a set of different functional modules. There is a local solution in the form of an application on JETTY
dc.publisher	Voyant-Tools
dc.contributor	Andrew MacDonald; Cyril Briquet; Lisa Goddard; Mark Turcato
dc.date.issued	2018
dc.type	natural language processing
dc.format.mimetype	txt; rtf; doc; docx; pdf; zip; html; xml
dc.identifier.uri	https://voyant-tools.org
dc.source.uri	http://voyeurtools.org/voyant-server/
dc.language	Multilanguage
dc.coverage	Web-based application (Web interface), Mac, Windows, JETTY server, Voyant server
dc.rights	Freeware software
dc.relation. isreferencedby	Laurie J. Sampsel (2018) Voyant Tools, Music Reference Services Quarterly, 21:3, 153-157, DOI: 10.1080/10588167.2018.1496754; Sinclair, Stéfan; Rockwell, Geoffrey (2016). "Voyant Facts". Hermeneutica: Computer-Assisted Interpretation in the Humanities. Stéfan Sinclair & Geoffrey Rockwell. Retrieved 2016-12-20; Using Voyant for Text Analysis: http://voyeurtools.org/using-voyant-for-text-analysis/;

	Rambsy, Kenton (2016). Text-Mining Short Fiction by Zora Neale Hurston and Richard Wright. Using Voyant Tools // CLA Journal. № 59 (3): 251–258; Priestley Alexis. Voyant Tools: A Tutorial for Text Analysis: https://medium.com/@priestleyal/voyant-tools-a-tutorial-for-text-analysis-df265d85d214;
dc.coverage	Multisystem
dc.rights.license	Creative Commons Attribution 4.0 International (CC BY 4.0)

Fig. 1. Description of Voyant-Tools by Dublin Core specification

3.4 The implementation and use of the catalog

Despite the choice of the DSpace software platform for machine implementation, this system installation and configuration is not a trivial task, which did not allow to implement this solution immediately. In this regard, a free and open-source software Open Journal Systems (OJS, https://pkp.sfu.ca/ojs/) was chosen as a palliative solution for initial testing. This system is a full-cycle publishing platform to publish electronic journals. This solution has already been applied to the machine-readable representation of the thesaurus in the framework of the ongoing project. The OJS is easier to install and configure and works on most virtual hosts. This system has all the functionality required: it supports Dublin Core metadata format, allows to search for metadata, provides open access to information, and acts as a provider for OAI-PMH protocol. For experimental purposes in the installed OJS system (http://ojs.iculture.spb.ru/index.php/thesauri), the descriptions of several software units from the selected ones were entered. The Open Harvester Systems (OHS, https://pkp.sfu.ca/ohs/) installation was used to control the correctness of metadata display and verify the operation of OAI-PMH Protocol., which is an OAI-PMH metadata aggregator. The proposed approach to present the software catalog in the machine-readable form also allows to export metadata to other presentation formats for integration in various information systems and metadata aggregators. Using the OAI-PMH metadata exchange protocol makes it possible to integrate the catalog into the information space of scientific research. The researchers can not only search the catalog but also create their information systems and aggregate information from the catalog. A platform like DSpace also allows to use it as an aggregator and collect information about the software application presented in the catalog from various resources using OAI-PMH protocol. For example, these may be scientific publications that consider particular software for specific scientific purposes.

The implementation of such a distributed information environment allows the users to present not only software descriptions but also information about its application in one information space. This provides the researchers with methodological support for a more rational choice and tools efficiency for their scientific purposes.

4 Conclusion

The research has shown that there is no common approach to classifying the software designed for analyzing contextual knowledge with the functions of highlighting, classifying, and explicating scientific content, considering the types of the processed contexts. It was also found that there are no developments in the representation of software catalogs in machine-readable form based on metadata format and considering the specifics of software for contextual knowledge analysis.

The developed approach to present a catalog of a software designed for contextual knowledge analysis with the functions for highlighting, classifying, and explicating scientific content based on Dublin Core provides:

- integration of the developed context typology into the catalog, which is an essential characteristic and the basis for choosing a software for conducting specific research;
- creation of a machine-readable catalog with standard freeware software (for example, OJS, DSpace);
- efficient search and selection of a specific software for research purposes by the main characteristics described in Dublin Core tags, using standard search engines;
- open access to catalog records for both users and automated indexing;
- automated exchange over OAI-PMH protocol for aggregation of catalog meta descriptions in other information systems.

The proposed palliative solution (OJS) is expected to be replaced in the future with an information system based on the freeware DSpace. In parallel, the work will continue filling the catalog with software descriptions that can be used for contextual knowledge analysis with the functions for extracting, classifying, and explicating scientific content. Scientific publications describing the research results using the software presented in the catalog will also be selected.

There is a great potential to further catalog application in the framework of teaching activities: masters of "Digital smart city technologies" educational program, majoring in "Applied Informatics" will use it to select the technological tools for their research projects. The catalog is one of the components of the educational and methodological complex "Technologies of data extraction and mining in scientific research", aimed at forming research and analytical competencies of undergraduate students. The course "Information technologies in science" will be modified based on the developed educational and methodological complex.

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Data Formats for Electronic Multimedia Collections

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Abstract. The article analyzes data format requirements from collection support services, content owners, and external users, as determined by the presentation, storage, and access characteristics of multimedia elements of electronic collections. Possible reasons for supporting (or not supporting) certain formats utilized for storing collection items are considered, taking into account the authors' experience with the development of an electronic scientific journal publishing platform which allows multimedia materials to be published via a web interface.
The analysis of multimedia data formats enabled the selection of the "technology stack" of libraries and modules, which serves as the basis for creating electronic multimedia collections and is currently under development. The system has been brought to the stage of "out of the box" deployment – both in its version for creating universal collections and in its version oriented toward electronic multimedia magazine publishing. Further support for all formats discussed in the article is planned.

Keywords: digital collections, multimedia content, data formats.

1 Open systems to support electronic collections

Over the past few decades, both the Internet as a whole and its web segment have expanded. Digitizing a large number of cultural and scientific artefacts can potentially make them available to anyone, regardless of their physical location. Consequently, the importance of creating thematic collections of digital resources, with the support of effective ways of access to them (electronic collections), is growing. Services which – to a greater or lesser extent – make it possible, appear in open access. A common goal for this kind of services is that a visitor to a collection not require any effort – or incur any cost – to access the collection. The only pre-requisite, ideally, should be a standard browser on the user's device and access to the network. However, the downside of using such services is the delegation of the rights to use data to the service providers and, possibly, an obligation to view advertising. In some cases, such a compromise may be unacceptable. The creators of electronic collections may then try to implement their own version of the platform with specific functionality; however, the labor costs for creating and maintaining such services may turn out to be unacceptably high.

Web publications are becoming increasingly relevant in the scientific field. To ensure long-term availability of information resources, the exchange of meta-information, etc., a number of systems have been created used by the scientific and educational communities. The following are some of the examples of systems used for electronic scientific publications:

- The support system for digital repositories (institutional repositories) is widely used to build open access archives and electronic libraries to create, store, and distribute digital materials. These include open-source software platforms such as DSpace, EPrints, GreenStone, Fedora, and others. The most reputable platforms are supported by large scientific and technological organizations: for example, DSpace was developed jointly by HewlettPackard and MIT libraries (Massachusetts Institute of Technology) [1, 2].
- Some electronic scientific journals use electronic publishing systems such as Open Journal Systems (OJS). The main advantages of this approach is the implementation of a complete publishing cycle for the preparation of electronic publications. It should be noted that layout itself is done “outside” the system, and ready-made files are loaded into OJS. Also, this system does not provide for displaying multimedia content. At the same time, the format of the scientific publication itself remains very traditional; on the web, content can be presented in two formats - PDF and static HTML.
- New technological and organizational approaches to scientific publications are developing:
- Integration issues are resolved using a metadata exchange technology based on the OAI-PMH protocol.
- The concept of "live publications" is being developed. A “live publication” is a scientific work posted on the Internet, in public domain, which is continually maintained by its author in an up-to-date state [3].
- Since 2014, several Elsevier journals have begun publishing reviewers' reviews along with articles. Such an approach, called the “open review,” leads to an improvement in the quality of articles; additionally, the contribution of the reviewer to the publication process is recognized [4].

Since the early 2000s, online electronic resources, such as electronic journals, have been actively developing. Electronic journals publish articles in both PDF and HTML formats, which provides more opportunities for publication, including of multimedia materials.

Focusing on the analysis of scientific journals, the following observations can be made:

- The receipt of texts of articles and related multimedia materials by the editors is conducted via e-mail. *That is, the process of loading collection items is not by itself technologically advanced*.
- The editorial staff is expected to indicate the place in the text of an article where it is necessary to insert the appropriate multimedia material. *That is, authors do not directly participate in the laying out of the article*.
- Not a single magazine analyzed publishes a full range of multimedia files. The principal published formats are: graphic files of various formats (e.g. JPG, GIF,

PNG), video (e.g. AVI, MPG, MOV), animation (SWF, GIF) [5], audio of various formats, and presentations. There are separate magazines that publish, in addition to the entire range of multimedia formats listed, virtual reality content in the VRML format (e.g. the journal Scientific Visualization, http://sv-journal.org/). *To date, no system supporting a wide range of multimedia formats exists.*

- To display video in articles, various video players are used or cloud video services' code is embedded. *That is, third-party applications are used to display the elements of the collection, whose support is not guaranteed in the future.*
- Magazine sites are either of original designs or else they are built on top of publishers' platforms. The widest range of displayed multimedia materials is published by the journal Scientific Visualization (http://sv-journal.org.). However, even on the pages of this magazine, viewing some of the multimedia objects (for example, 3d, http://sv-journal.org/example/index.html), requires additional software installed on the user's computer. *That is, the user must use additional applications or plug-ins in order to view elements of a collection.*

The authors faced a number of such problems while developing the tool platform of the electronic scientific journal which allows the publication of multimedia materials and provides access to them through a web-based interface [6,7]. One of these problems was the choice of data formats that could be transparently processed within the platform and, if possible, furnish authors with various opportunities to publish multimedia data.

Without claiming the above to be an exhaustive description of the data that can be stored in a wide range of diverse collections, we turn to the range of multimedia formats related to articles in scientific online journals. The above list of the main types of multimedia components can be further expanded with the development of the platform; however, even with the list of types considered, almost any content can be adequately presented.

The main prerequisites that were considered in the selection and analysis of supported data types were the following:

- materials provided by the authors should be efficiently processed on the server, and the journal staff should not be required to perform a large amount of tedious actions and or have to master modern software development environments. For the correct reproduction of a complex object, it is often necessary to preserve the structure of a project containing dozens of directories and hundreds, maybe thousands of separate files. Moreover, the project may retain absolute paths to the resources used, so that even when copying the entire project tree to another location, the correct reproduction of the object may be compromised. Embedding such an object in a document may require the use of highly specialized skills from the staff of the journal (the team of software and technical support for the collection);
- the user must have access to the article and its individual components (individual elements of the collection) without installing specialized software. Ideally, is should be enough to have access to the Internet and have a standard browser installed on the user's computer. The use of specialized, and sometimes proprietary, extensions by the article authors can lead to making the reproduction

of the object impossible on the computer of the reader (an external user trying to access the elements of the collection).
- the selected limited set of supported formats should, if possible, provide wide-ranging opportunities for the use of multimedia resources.

Currently, the types of supported multimedia components and the types that will be supported in the future include the following:
- text fragments, quantitative data;
- raster and vector images;
- audio data;
- video of various formats, including Video 360 format;
- 3D models;
- virtual and augmented reality scenes;
- map data;
- charts;
- formulas, etc.

Along with the presentation of multimedia objects, an important aspect is the storage method. It should be noted that the element of the multimedia collection can be not only a mere arbitrary fragment of data acceptable for the platform of types, but also an arbitrary aggregate including fragments of data of different types. Please note that the first paragraph of a section or subsection is not indented. The first paragraphs that follows a table, figure, equation etc. does not have an indent, either.

2 Some aspects of preparing multimedia materials for online magazines. Three formats and three contexts

Essentially, for each multimedia element of an online article, at least three formats are relevant:
- the format intended for an end user viewing an online article in a browser;
- the format of internal storage;
- the format in which the author of the article submits materials to the editor.

When considering issues related to the formats of multimedia elements of online articles, we take into account three groups of factors:
- the efficiency of users in various roles;
- aspects of technological implementation and support capabilities at different stages of the life cycle of an information system;
- the need to ensure the preservation of the source data, without any data loss associated with the formats and parameters relevant at the time of publication.

We would venture to say that the third of the factors mentioned above often remains outside the discussion scope of discussion when considering current and prospective technology solutions. Converting data to the actual formats of the final presentation in the browser can result in future data losses.

As an obvious example, let us consider the archived versions of web sites created 10-15 years ago. Small images and low-quality video (in the SWF format) were specially prepared for publication, but the originals have, in most cases, already been lost.

Requirements for the formats of multimedia elements are largely determined by the tasks and by the specifics of the work of users playing different roles within the information system.

The end user (or "Reader") should be able to adequately view multimedia articles on a wide range of devices. The playback of multimedia elements must be accurate on all current operating systems and in all modern browsers. Moreover, a significant trend of the last decade has been the desire to implement the required functionality exclusively within the browser, and without third-party plug-ins. We would dare say, for example, that at present, any suggestion to install a plug-in for viewing video will be perceived negatively by the user.

The "Author" user, on the other hand, uses familiar applications or online services to prepare multimedia elements. As a result, he or she receives the multimedia elements of a future article in one of the formats that are "exported" by the application. What should be the online magazine's policy? Several approaches can be considered, of which we will mention only two. The first approach involves a severe restriction: the author is required to prepare a multimedia element in one of the formats that can be directly displayed in the browser. The second approach would allow the author to submit materials in a range of formats that are to be further converted before publication. Ths conversion can be carried out either manually by the content manager, or by the corresponding software module of the information system.

The content manager loads the material prepared by the author into the system. The stricter the requirements for the formats of the multimedia elements prepared by the author, the less effort the technical aspects associated with the publication will require. The scenario in which the content manager only needs to copy the text of the article into the appropriate fields and download the multimedia files, without performing any preliminary processing, requires only minimal qualifications on the content manager's part. However, in any non-trivial case, the author's work would be more complicated due to the need for the conversion of the source data into the required formats.

Note that today's ideas about the "current OS" and the "modern browsers" may take on a completely different meaning in the near future, as devices, communication channels, stylistic trends and technological capabilities will change. That is why the main format of internal storage, as a rule, involves a certain redundancy.

3 Types of components for multimedia collections

3.1 Text data

It may seem obvious, but it's worth pointing out that any article will contain fragments of text. These text fragments can be very small, e.g. the contents of fields in a questionnaire, or they can be of considerable size.

The use of text implies the use of language. A written language is associated with a possible set of symbols used - the alphabet. It is easy to imagine a situation in which several languages can be used in one text fragment, and accordingly, several character sets. This situation may have some consequences. For example, when forming lists, the owners of a collection may need appropriate lexicographic ordering rules.

There are other nuances in the use of text fragments. In our developed platform, two main languages – Russian and English – are supposed to be used. It is not intended to be used with texts which utilize the "from right to left" writing direction, as Arabic does, or the "top to bottom" direct, as does Japanese. On the other hand, a number of characters in the text, which are used in some subject areas, can be found in the texts presented, but not in the character set of Russian or Latin (or Greek, often used in mathematical formulas) character sets. In addition, the use of advanced text formatting (italics, boldness, underline, size and color of text and background, the use of various fonts, structural elements such as headings, paragraphs, etc.) are understood as standard text properties.

Thus, to represent text fragments, UNICODE can be used to adequately display a wide range of characters – the TXT format for simple text fragments and the RTF (RichTextFormat) for complex ones, both public and open. Their possibilities for presenting text fragments in journal articles seem to be sufficient.

Text tagged with HTML tags associated with stylesheets may have similar capabilities to RTF; however, using the names entered by the markup author may conflict with the markup created when the collection item is displayed in the browser, which can lead to conversion difficulties.

Storing text fragments as separate files or as text fields on database servers does not pose a problem.

3.2 Quantitative data

Many characteristics of collection elements can be expressed quantitatively. Moreover, a number of characteristics, even not of an explicit quantitative nature, can be expressed in quantitative values when digitized. For example, a color, along with its description (e.g., "red"), can be described by the numerical RGB-palette value (e.g., #FF0000).

There currently exist enough standard options for storing and presenting quantitative data. However, for text fragments as for quantitative data, various forms can be used – e.g. "Arabic" or "Roman" spelling; binary, decimal or hexadecimal representation, rational fraction form. Therefore, for the purposes of platform support, appropriate storage and display capabilities must be provided.

In those special cases when the standard means of storage or representation do not suffice (for example, for representing the value of Pi to the hundredth decimal place), one can use textual string representation. In any case, quantitative data can be stored either as standard numeric fields or as text. To represent related groups of numbers, special objects, such as tables, graphs, charts, and formulas, can be used.

3.3 Bitmap images

With the advent of a wide range of digital cameras and digital image editing software, storing, transmitting and displaying images has become as common and widespread as handling text data. Along with the proliferation of images, the number of different image storage formats has expanded. These formats provide specialized capabilities for presentation and use.

Raster images are characterized by the size of their pixel matrix –raster (width x height), their pixel color depth, and their storage format. The first two characteristics determine what the image looks like when displayed without conversion, while the storage format determines the actions that must be performed before the pixel matrix is formed, which will be displayed. The size of the displayed pixel matrix may differ from a non-converted one, and modern software tools allow you to perform such conversions so quickly that users who do not think about the technical aspects of storing and displaying images may receive a false impression of the trivial nature of such actions. However, automatic conversion of the original image size to the size specified by the characteristics of the document where the image is to be placed can have negative repercussions: for example, when zooming in on the image, the image may not be clear, and when reducing its size, fine details can be lost. In addition, transferring an image that is higher in resolution than that one displayed to the user's computer consumes additional network traffic. While such a state of affairs can be considered satisfactory for everyday use, and distortions thus introduced ignored as insignificant, in some professional areas – for example, in medicine – it may be unacceptable.

Special formats are developed to solve specific problems. Thus, many camera manufacturers can provide images in RAW format - i.e. in the form of raw measurements taken directly from the sensor, which representation allows for advanced photo editing. However, one can only process such files using special programs, and for different manufacturers the programs are often not compatible. Developers of new graphic raster formats, such as JPEG200, WebP, BPG, WBMP, FLIF demonstrated the advantages that their formats afford, but so far, there has been no support for them in modern browsers, and in some cases, a special license may even be required. In view of the current situation, it was decided to use only graphic raster formats in collections that are supported directly by browsers for now, since article images are illustrative rather than documentary.

For browsers, the standard bitmap formats are JPG (Joint Photograph Expert Group), other extension suffixes in the file name are .jpeg, .jpe), PNG (Portable Network Graphics) and GIF (Graphic Interchange Format). All of the above formats are automatically recognized and processed by browsers and are based on open standards.

Thus, we can formulate the following recommendations for presenting bitmap images:

- image format is .JPG, .PNG or .GIF;
- image size - corresponds to the size of the image displayed on the user's computer.

Particularly important is the sizing of images used as a group and uploaded to a "slider" or "gallery".

3.4 Vector graphics

In some situations, vector images may be used instead of bitmaps. In this case, the image is stored not as matrix of pixels but as a description of an algorithm that can construct it. For such images, scaling without the loss of quality can be performed at much larger scale than for raster ones. The best-known vector graphic formats are WMF

(Windows Meta File), CDR (CorelDRaw Document), AI (Adobe Illustrator), EPS (Encapsulated PostScript), but as for direct support of these formats in the browsers, it leaves much to be desired. We recommend using the SVG (Scalable Vector Graphics) format, promoted by the W3C consortium and having support in all common web browsers as the default vector format for all image files.

3.5 Audio

Audio fragments are also represented by a component that should be supported in a multimedia article. Audio files are characterized by the following characteristics: container file format, codec (an algorithm for compressing audio data), sampling frequency (in terms of time and amplitude), and the number of playback channels. Currently, there are several container file formats: .WAV, .AAC, .OGG, .MP3, .M4A, .AIFF, .FLAC and others. Typically, the format of the container file determines the codec that compresses the stored data. Based on the requirement of wide availability, the data formats are played without additional user actions should be prioritized. Thus, on the WINDOWS platform in the standard distribution, codecs are installed that correspond to the containers .WAV, .MP3, .WMA; on iOS this would be .MP3, .M4A, .AIFF, .WAV; on LINUX (including the ANDROID OS) - .WAV,. .OGG, .MP3. In addition, the vast majority of computers are equipped only with dual-channel speakers, so, sound in DOLBY SURROUND 7.1 format, for example, will not be played on them.

Another aspect to consider is the length of audio fragments. For a fragment whose duration is limited to a few seconds, the file containing it can be stored directly on the server and transmitted to the user via a direct link. If the fragment's duration is reaches a minute or more, streaming should be used, which may require a separate streaming server. In this situation, it is possible to use external file storage on media servers: the file is placed on a special media server (for example, YouTube.com), and a link to the resource is received from the server's support service and, if necessary, a piece of program code that can be embedded in a web document that allows access from a web document to the resource and ensure the fulfillment of a number of conditions. In such a storage architecture, the media server, interacting with the user, analyzes the composition of the software and hardware and transmits the data in a suitable format, even if they were placed in a different format on the server.

To summarize, we can formulate the following recommendations for the presentation of audio files:

- container file formats: .MP3, .WAV, or .OGG (browsers that support the HTML5 standard can play them independently), MIDI files can be stored separately: support for MIDI was introduced in browsers from HTML 3.2;
- number of channels: 1 or 2;
- sampling frequencies in amplitude and time: it makes sense to choose from the most standard: 22 050 Hz, 32 000 Hz, 44 100 Hz, 48 000 Hz, with the sampling depth of up to 16 bits, but at the discretion of the author (since it may make sense to use higher resolution parameters for certain collections).

3.6 Video

Video files are also represented by a component that should be supported in a multimedia article. Video files are characterized by the following characteristics: container file format, codec (an algorithm for compressing audio and video data), frame rate, and size. Currently, there are several container file formats, including .AVI, .WMV, .FLV, .MP4, .MPEG, .MOV, .MKV and others. Typically, the format of the container file determines the audio and video codecs that compress the stored data. For progressive streaming formats, a characteristic such as bit rate can also be considered, which represents the amount of data that must be transmitted to play one second of video.

Problems with the amount of data transfer for video playback are somewhat similar to those already mentioned for audio files. For a fragment whose duration is limited to a few seconds, the file containing it can be stored directly on the server and transmitted to the user via a direct link.

If the fragment duration is around a minute or more, then streaming should be utilized, which may require the use of a separate streaming server. In this case, it is possible to use external file storage on media servers, where the file is placed on a special media server (for example, YouTube.com), a link to the resource is received from the server support service, and, if necessary, a piece of program code that is embedded in a web document that allows access from a web document to the resource and ensures the fulfillment of certain conditions. When using such a storage architecture, the media server, in interaction with the user, analyzes the composition of the software and hardware on the user's computer, the required playback parameters, and transfers the data in a suitable format, even if it was stored in a different format on the server. Furthermore, if during the playback process, the conditions of file transfer and playback are changed, the media server, using special adaptive algorithms, changes the parameters of the transmitted media stream so that the file is played back at the user side with the best possible quality.

Thus, we can formulate the following recommendations for the presentation of video files:

- container file format: MP4, OGG (browsers that support the HTML5 standard can play them independently);
- The frame size (width x height) should correspond one of the common ratios of 4x3, 16x9, etc.

3.7 360 degree video

Recently, various specialized forms of video playback have appeared. A noticeable phenomenon was the appearance of 360º video, in which the image is captured in the video file from all directions. Playback can be carried out on a spherical screen, and the user, from the ‘inside’, chooses the direction of view independently.

Thus, it is possible to increase the level of immersion. Taking advantage of the fact that the real user’s actual angle of view is substantially less than 360 degrees, playback devices (virtual helmets) were developed that provide almost the same sense of presence without creating real spherical screens, and it is possible to create individual video streams for each user’s eye. The file containers and codecs used for encoding of 360

video are no different from those used for traditional video. The emergence of this new type of multimedia resource (360 degree video) at first involved the creation of specialized players that allow users to view the immersive content in a specialized application (browser), using special virtual reality headsets, on mobile devices. Later, it became possible to view it in universal players, by specifying the type of resource as a parameter. Embedding metadata in the resource file, which allows players to automatically recognize the type of resource and form viewing controls suitable for the situation, now allows one to play 360º video.

One characteristic of the use of this type of media resource is the high demand it places on the throughput of the communication medium. At the current stage of software development, the media server sends the user a full spherical image, and the player selects for demonstration a fragment (approximately 10% of the area of the sphere), determined by the angle of view and the direction of the user's "gaze". This results in a situation where for an acceptable video display quality of 360 video, the minimum frame size requirements are 4K (whereas the common Full HD television format corresponds to the 2K format). The support of such media streams places high demands on the media server (particularly if the resource in question is popular). Therefore, it is more preferable to store resources in the 360 video format on third-party streaming servers, such as YouTube, and use embedded code to access the server.

In summary, the following recommendations can be formulated for the presentation of video files in 360 video format:

- container file format: .MP4, .OGG;
- the frame size (width x height): at least 2x1, with at least 4K resolution;
- when placing resources on external streaming servers, meta-information is introduced into the video file indicating that the file should be played in 360 video format.

3.8 3D models, scenes of virtual and augmented reality

The use of 3D models and interactive 3D scenes for meaningful illustrations in documents has led to the emergence of autonomous means of displaying such objects, including via the Internet. However, the complexity and variety of tools for creating such resources make it their use as elements of multimedia collections difficult. The need to install specialized software on the user's computer, in general, does not solve the problem of displaying a resource. Thus, a scene created in 3DS-max can be exported to various formats (including those designed for exchanging 3D models); however, when exporting, many features of the model will be lost, since specific modifiers of the development environment are not supported by all formats. Moreover, when using special plugins – especially commercial ones – it may not be possible to play the scene back on the user's computer. In addition, for correct scene reproduction, it is necessary to preserve the project’s structure, which, for the more complex scenes, may contains tens of directories and hundreds–maybe even thousands–separate files. In such cases, the project may retain absolute paths for the resources used, and upon copying the project tree to another location, correct scene reproduction may be impossible.

The authors are of the opinion that the solution to the problem of the full use of multimedia resources such as 3D models and interactive 3D scenes as elements of a multimedia collection can be found, in one of the following ways:

- Using specialized web services that allow the author to upload his or her project to the server; if necessary, edit and check the adequacy of its playback, and submit code for its implementation in a web page (as done, for example, on youtube.com). SketchFab can play be used as such a service. The disadvantage of this solution is that the resource is stored on an external service. Any problem with the owner's account may render the resource itself inaccessible.
- Exporting the project in WebGL format. Recently, browser support for this format has been improving. In addition, there are now development environments that allow one to implement or edit a 3D project directly in WebGL. A 3D project prepared with this technology can be presented directly on web pages using only a web browser. As a development environment, for example, one can use an environment supported by the ThreeJS community.

3.9 Use of cartographic information

In a number of electronic collections, information is tied to an existing or existing landscape. The development of modern cartographic systems on the Internet allows each user to embed a small code into a web document, ensurig the embedding of the desired map fragment with a set of functional elements. They can be provided either by the owners of the map service, or added by the user himself using the open API. Such services are provided both by Russian platforms, such as Yandex, or Mail.Ru, and global services, such as Google, Microsoft, Apple, etc. Moreover, to insert a map fragment into a document, the geographical coordinates are required and, if the map is to have additional functionality, a JavaScript library, developed on the basis of the open API of the chosen map service, has be to be included by the author. A JavaScript library is a text file that can be stored as a text fragment in the database of the log server (the collection's support server).

In summary, the following recommendations can be formulated for the presentation of cartographic data:

A snippet of code that displays the desired fragment of the map (usually generated on the web page of the corresponding map service), embedded in the web document.

JavaScript library implementing the necessary functionality, developed on the basis of an open API of the selected map service (if the map is to have additional functionality).

3.10 Formulas and Charts

Along with individual pieces of quantitative data used, arrays of such data are often used. This may require authors to demonstrate the nature of relationships between different elements of the array. One common way to achieve this is through data visualization. The functionality of pre-formed raster images of graphs and diagrams currently used in printing seems to be insufficient for online display. To solve this problem, a component is being developed that allows the user to enter a tabular array of data

and their descriptions and select a display style from the palette. The prototype of the quantitative data visualization component is currently being tested.

An important and popular component of scientific articles is the availability of mathematical content. When including mathematical notation in the text, two aspects must be taken into account - the writing of the formula and its further display.

The de facto standard for entering mathematical equations is TeX, which is most often used as its LaTeX extension.

The second challenge of using formulas in articles published in a scientific online journals is their correct display in the browser. There are several approaches to solving this problem:

- displaying formulas as bitmap (GIF or PNG). While this is the simplest approach, it completely erases the meaning of formulas and precludes their further analysis. A slight improvement on this is the publication of LaTeX formulas as alternative text, along with the image;
- converting LaTeX formulas to SVG vector format;
- using the specialized mathematical markup language, MathML. MathML was designed to facilitate the use and exchange of mathematical notation data over the Internet (for more information on MathML see, for example, Wikipedia). MathML is an XML application and can be processed and displayed within the browser. However, not all browsers today offer MathML support, a fact that necessitates the use of additional libraries. MathJAX, a cross-browser JavaScript library, deserves special mention.

Automatic conversion from LaTeX to MathML is a relevant topic for discussion.

One of the options for solving the problem of the full use of formulas in an online magazine with multimedia content, in the author's opinion, may be the following combined approach:

- use the TeX / LaTeX format for formulas;
- encourage article authors to prepare formulas for publication using powerful third-party tools such as Overleaf, Authorea, Papeeria, or Lyx;
- display formulas in a browser using MathML; as a tool for cross-browser display and an automatic conversion tool from LaTeX to MathML, using MathJAX is recommended.

Currently, a platform component responsible for loading and visualizing formulas is under development.

4 Conclusion

This present analysis has shown that at the current stage of software (both serve and client), developing a platform for creating and supporting digital multimedia collections is feasible. Such a platform will provide the formation, editing, and storage of digital collections, with acceptable requirements for the operational support service. It will also provide access to the collection via the Internet using a browser to a wide range of users, without the need to install additional software on the client.

The system developed by the authors thus far has support mechanisms for publishing a limited set of components, such as single images, collections of images with visualization in the slider version and a set of thumbnails, and videos and 360º videos published on the YouTube service.

The introduction of more complex multimedia data required an analysis and evaluation of the technologies for their creation, storage, and visualization. The analysis of the data format has enabled the selection of the technology stack – i.e. libraries and modules on the basis of which the platform for electronic multimedia collections continues to be developed. The development of additional functionality continues along several paths:

- Development of modules for publishing 3D models and interactive 3D sketches based on the ScetchFab service using WebGL. The choice of publication option will depend on the format of the data submitted by the author.
- Implementation of a solution allowing full use of formulas in a magazine with multimedia content has begun. Authors are encouraged to submit formulas in TeX / LaTeX format and prepare them on one of the external resources, such as Overleaf, Authorea, Papeeria, or Lyx. A module allowing to display formulas in a browser and automatically convert from (La)TeX to MathML will use the MathJAX JavaScript library.
- The range of multimedia formats that do not require additional processing and can be directly displayed by browsers is constantly expanding. Examples include audio in the MP3 format and vector graphics in the SVG format.
- The information system is being developed in two directions:
- the creation and support of multimedia collections;
- online multimedia science journal.

Moreover, it is implemented on the basis of a single core, with slightly different functionality for the types of resources mentioned above.

The integrated development approach along both directions is accompanied by the creation of installers allowing to deploy the system "out of the box," using any standard modern shared hosting service. The development still planned is aimed at increasing of the supported multimedia formats and also at developing metadata export modules in the electronic journal branch. At the same time, authors of individual elements of the collection may be provided with tools for downloading and online editing. The set of data formats supported by the system can provide storage for a wide range of multimedia resources used.

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Computational Linguistics

Investigating the Use of Lexical Bundles and Keyness in B2 and C1 ESL Learners' Academic Writing

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Abstract. This research investigates whether there is a relationship between the use of three- and four-word Lexical bundles and language proficiency. The study conducts both quantitative and qualitative analyses to see whether learners from different CEFR levels groups exhibit the same behaviour in the use of Lexical bundles. Therefore, in the first stage, it compares between two different levels B2 and C1 in terms of frequency, structures and functions of Lexical bundles to give an overview of some of the linguistic features to differentiate between the levels. In the second stage, a longitudinal study investigated the development of ESL learners use of Lexical bundles across the levels to give a picture of the increases of the proficiency levels. A major finding from the analysis shows that generally, ESL learners favoured using more signalling bundles in their writing, three-word bundles turned out to be the most frequent bundles in ESL sub-corpora. Moreover, significant progress has been found in the variability of the structures and functions of Lexical bundles, C1 writers are found to have used various structures and functions as professional writers in their academic writing. For the development of Lexical bundles in relation to the CEFR levels, the findings clearly indicate that there is no significant relationship between the increased use of Lexical bundles and academic performance. However, multiple regression analysis revealed that there is a direct proportionality between variations of the use of Lexical bundles and the CEFR levels, as (C1) students act as professional writers and used variant structures and functions than (B2) Students.

Keywords: Academic writing, Lexical bundles, ESL Learners, Corpus-based.

Introduction

Lexical bundles are word combinations that can be defined as continuous multiword sequences that recur frequently to satisfy specified frequency and dispersion thresholds; for example, occurring at least 20-40 times per million words in five texts, or in at least 10% of texts [4, 8]. Lexical bundles have captured the attention of many linguists since Biber et al. (1999) first introduced the notion in Longman Grammar of Spoken and Written English. Considerable attention has been given to lexical bundles within the area of corpus linguistics, and interest has increased since being widely agreed that lexical bundles are widespread in spoken and written registers, serving a “building blocks of discourse," where “frequent use of these bundles is indicative

of fluency in linguistic production" [4]. These bundles have been found to be used by both native and non-native speakers of a language to fulfill specific discourse functions within a particular context [5, 9].

The bundles are important elements by which to measure learners' language development, and both native and non-native speakers indicate their language proficiency by using lexical bundles in their academic writing; the absence of these bundles signals a novice writer. This idea has been supported with empirical evidence showing that the competent use of lexical bundles contributes to fluent language production. [6, 12] For example, Biber et al. (1999) investigation of lexical bundles in conversation and academic prose found that bundles constituted approximately 21% of the written discourse. Cortes [11] agrees that using lexical bundles is an indication of a competent language user, and Ellis et al. 2008 argue that use of lexical bundles frequently results in native-like language use.

However, many studies have investigated the use of lexical bundles by non-native speakers of different levels across a range of registers and academic disciplines. According to the previous studies, although there has been an increase in the use of lexical bundles by non-native speakers, their use is limited to specific bundles causing them to overuse some expressions compared to others, making their writing appear non-native [17]. Some studies have argued that experts writers use lexical bundles in a way that is functionally different from novice authors and, in general, that lexical bundles are used much more frequently by experts than novice writers [1, 11]. Römer (2009) states that experts are more important than nativeness and the distinction between novices and experts is more important than L1 andL2 distinction. Similarly, Staples et al. (2013) [21] investigated idiomaticity through the use of lexical bundles in written response across three proficiency levels in the Test of English as a Foreign Language Internet-Based Test TOEFL iBT, in a controlled environment. The study found an increase in the number of lexical bundles used as proficiency level increased.

To the best of the researcher's knowledge, while most previous studies have paid considerable attention to the use of lexical bundles across different registers and a number of disciplines, little research has been done to investigate whether learners from different proficiency level groups exhibit the same behaviour in their use (or not) of lexical bundles. This research investigates whether there is a relationship between the use of three- and four-word lexical bundles and language competence. The study utilises both quantitative and qualitative analyses to determine whether learners from different CEFR (Common European Framework of Reference) level groups exhibit the same behaviour in the use of lexical bundles. Additionally, this study examines the development of lexical bundles across proficiency levels. Specifically, it compares between two different levels, B2 and C1, in terms of the frequency, structures, and functions of lexical bundles to give an overview of some of the linguistic features that differentiate between the levels. This study addresses the following questions:

– What are the most frequently used three- and four-word lexical bundles in the B2 and C1 sub-corpora?

– –What does a keyness analysis reveal about lexical bundles identified in theB2 and C1 sub-corpora?
– –How do lexical bundles in the B2 sub-corpus differ from C1 in terms of structure and function?
– Is there any growth in the lexical bundles identified in the study between B2and C1 learners?

1 Methodology

1.1 Data

This study is first interested in the relationship between the use of lexical bundles and academic performance; thus, the author compared B2 and C1 sub-corpora (for the frequency, structures, and functions of lexical bundle) of ESL learners and then compared them with a reference corpus. The data used came from written essays equivalent to the IELTS test in terms of the title, written by 42intermediate and advanced ESL learners from different mother tongue who have studied in the UK who contributing 130 essays. These learners write academic essays to test their progress and place them at new levels if they meet the requirements at the English Language Centre (ELC). Only argumentative or expository pieces written by L2 learners were chosen for the sub-corpora. The decision to use learners' sub-corpora was based on the assumption that they are useful to explore and identify the similarities and differences in the use of recurrent word combinations across L2 proficiencies of "actual language in use" [2].
The second stage of the study consisted of second language development research, which compares learners' language across proficiency levels (CEFR levels). A longitudinal study investigated the development over three months of two ESL learners use of lexical bundles in their academic essays across the levels to trace the increases in proficiency level. The participants were two ESL students (one male and one female) at the upper intermediate level that moved to advanced level after two months who contributed 36 essays to be used for the investigation.

1.2 Determination of CEFR levels

The procedure for determining the CEFR level originates from the manual for Relating Language Examinations to the CEFR for Languages [22]. Using the manual helps to choose the appropriate samples – for standardisation purposes – from the collected essays, which are considered representative of the B2 and C1 levels [9]. Three experienced examiners working at the British Council and teaching IELTS preparation were trained to rate the essays using a Writing Assessment Scale developed by the CEFR. The essays were marked by two raters independently; if any essays were given different scores, they were then re-rated by a third rater. Therefore, they received three ratings rather than two. If an essay received three different ratings, it was excluded. If raters agreed, the inter-rater reliability for the two raters was calculated to determine the percentage of agreement among the raters, following [18] which used by (Chen

and Baker [9] as a statistic to measure inter-rater reliability between the raters. After the rating step, the total number of words in the ESL learner's corpus forming 15488 in B1 sub-corpus and 12752 as described in Table 1.

Table 1. An overview of B1 and B2 ESL learners sub-corpora

Modules	B2 Corpus	C1 corpus
Number of texts	49	35
Average length of the essays	314	364
Total number of words	15488	12752
Total type of words	2723	2513

For the longitudinal study, 35 essays were rerated to be used in the investigation; 15 essays were incorporated into the B2 sub-corpus, totaling 5,007 words, by contrast, the C1 sub-corpus consisted of 20 essays totaling 10,597 words.

1.3 Reference corpus

The reference corpus used in this study was taken from the British Academic Writing English (BAWE) corpus, which contains 2,761 texts of proficient assessed academic works written at universities in the UK (6,506,995 words), ranging in length from around 500 words to approximately 5,000 words. However, since the target sub-corpora used argumentative essays (equivalent to the IELTS task 2)written by ESL learners, it was decided to use BAWE (linguistics and English disciplines) as a reference corpus to avoid skewing the sample heavily toward one discipline. These two disciplines are big enough to be used as a reference corpus as well as include relative language that ESL learners use in their academic essays, using other disciplines such as Philosophy or Biochemistry might effect the results. Therefore, linguistics and English disciplines are suited to the goal of this study as they provide a wide range of language representative of ESL students writing in an authentic academic context.
As stated by Leech [16] 'A Reference Corpus is designed to provide comprehensive information about the language which has to be a general Corpus of wide coverage of the language". To ensure comparability, only 65 short texts of the BAWE corpus (linguistics and English disciplines) were selected for the investigation. This was sufficient number for a reference corpus and was used in this study, comprising 163,091 words – this is more than five times greater than the target sub-corpora (B2 and C1), having 15,488 and 12,752 words, respectively.

1.4 Analysis

The analysis used to answer the above research questions was carried out using Wordsmith computer software. [20] Due to the smaller sub-corpora size in this study, the low-frequency cut-off point of four times per 100,000 (40times per million words) was selected to include highly used lexical bundles in the analysis and eliminate low-frequency parameters. In addition to frequency cut-off, dispersion criteria were ap-

plied where a bundle had to be found in at least three to five texts [4, 8, 11] or in at least 10% of the texts [12] to avoid focusing on idiosyncratic uses by the individual authors of the texts.

After retrieving the corpus and applying the frequency and distribution criteria, Wordsmith provided lists of three- and four-word lexical bundles for both sub-corpora. Hyponyms were checked and cleared from all the bundles found. In order to narrow down the included lexical bundles, all content-based bundles were discarded, as they do not reflect the use of general academic language, such as The United Kingdom or The University of Liverpool. In addition, overlap-ping bundles were combined as one bundle to avoid duplication in the counting of high-frequency bundles. For example, the bundle can be used to and it can be used to were counted as one bundle, adding a word between the brackets such as, (it) can be used to [8].

2 Finding and discussion

2.1 Frequency of lexical bundles

The results revealed that the B2 sub-corpus accounted for 102 (type) three- and four-word lexical bundles, which occurred 458 times, making up 9.2 % of the total number of words in the sub-corpus. The C1 essays contained 45 (type) three-and four-word lexical bundles, which occurred 204 times in the sub-corpus and made up 5 % of the total words in the sub-corpus. What stands out is that the lower-level students used a larger stock of lexical bundles than the higher-level students as presented in table 2.

Table 2. Bundles (type) and frequency (occurrences) found in the sub-corpora

Sub-corpora	Frequency	type	%	(Frequency) Per 100,000
B2 (3-word)	388	86	7.50%	2505
C1 (3-word)	169	38	4.00%	1325
BAWE (3-word)	4220	32	7.70%	2587
B2 (4-word)	66	16	1.70%	426
C1 (4-word)	35	07	1.00%	274
BAWE (4-word)	400	37	0.98%	245

In addition, the three-word bundles were revealed to be the most common bundles at both levels. Therefore, it can be concluded that ESL learners have a tendency to employ a higher number of three-word than four-word bundles with an increase in low-level students. A possible explanation might be related to the complexity of their production, which language learners avoid in their writing, as it requires more effort and time for students to produce longer sequences than shorter ones. The result was not surprising; Biber et al. [4] states that three-word Lexical bundles are extremely common because they are “a kind of extended collocational association”, while longer bundles are “more phrasal in nature and correspondingly less common”. Another finding to note is that the bundle *on the other hand* was the most frequently appearing

bundle in the B2 and C1 sub-corpora. This bundle is common and important in academic discourse; most ESL learners are familiar with it and know how to use it both structurally and functionally.

Surprisingly, few of the most frequent bundles in the BAWE corpus were found in the ESL learners' corpora: only eight out of the 50 most frequent lexical bundles in B2 and C1 sub-corpora were identified in the BAWE corpus. According to that, although the B2 level students used more lexical bundles than C1 students, certain bundles were new and used by only a few learners with repeated the same bundle more than once in their essays. For example, the bundle on the other was identified 19 times in the B2 sub-corpora (although one student used it three times in one text). A possible explanation for this might be that ESL learners tend to use certain lexical bundles more frequently to reflect a high level of formality and demonstrate their language competence; alternatively, they may still be in the process of learning additional lexical bundles. This result conflicts with those presented by Chen and Baker [7], who found many shared lexical bundles across both native and non-native academic writing.

2.2 Keyness analysis

To determine the 'key' bundles in B2 and C1,WordSmithsoftware was used to generate a list of 'key' bundles that occur unusually frequently in the target sub-corpora when compared with a reference corpus (i.e. BAWE) by means of statistical tests (e.g. chi-square or log-likelihood). A 'keyness' value is given for each bundle that has statistically significant, the higher the keyness score, the more the key bundle is statistically significant. The *WordSmith* software provides a list of lexical bundles which are positively and negatively key. However, as the main focus only on the positive keyness, the *WordSmith* tool was sitting to ignore all the negative results as provided in Table 3 and 4.

Table 3. Key lexical bundles in the B2 sub-corpus with a significantly different frequency from those in the BAWE corpus

Lexical bundles	Frequency in B2	Frequency in RC	Keyness
Point is that	14	0	68.69
First of all	14	02	57.00
To sum up	07	0	34.34
On the other	19	16	34
I will discuss	06	0	29.44
Are very different	05	0	24.53
I believe that	05	0	24.53
Seem to be	05	0	24.53
On the other hand	17	25	31.22

Table 4. Key bundles in the C1 sub-corpus with a significantly different frequency from those in the BAWE corpus

Lexical bundles	Frequency in C1	Frequency in RC	Keyness
Can choose to	05	0	26.52
On the other (hand)	14	29	24.23

The results provided some evidence for the common assertion in the previous studies that ESL learners favour particular bundles and overuse them in their writing [12, 15, 19]. The keyness analysis of the sub-corpora revealed that L2 learners overuse some signaling words in their writing. In general, therefore, it seems that low-level students are more likely to rely on the use of lexical bundles than C1 students, and accounted for more instances: nine significant key bundles were identified at the B2 level, whereas only two key bundles were found in the C1 sub-corpus. This result might be affected by the corpus size for this study, as the C1 sub-corpus consisted of only 12752 words.

2.3 Structures and functions in B2 and C1 sub-corpora

Structurally, Biber et al. [6] structural taxonomies were adopted, which have been used in various research studies in this area [3, 10, 12]. However, they were modified and developed for this study, using Biber et al. (2004) classification to place the identified bundles that did not fall under Biber et al. [6] structural taxonomy, as provided in the table 5.

Table 5. Structural taxonomy of lexical bundle types (F= Frequency)

Types	Sub-types	B2		C1		BAWE	
		(F)	%	(F)	%	(F)	%
Verb-based	Anticipatory it + verb / adjective phrase	01	1.0	04	9.0	29	8.12
	be + noun /adjective phrase	03	3.0	02	4.4	09	2.52
	Pronoun/NP + be	13	12.7	08	17.8	18	5.04
	1st person pronoun + dependent clause	09	9.0	01	2.2	01	0.28
	(verb/adjective +) to-clause	12	11.8	09	20	36	10.08
	Other Verb-phrase	03	3.0	0	0	30	8.4
	Total verb-based bundles	41	40.5	24	53.4	123	34.44
Noun-based	NP with of-phrase	10	9.8	05	11.1	95	26.61
	NP with other post-modifier	06	5.5	03	6.66	18	5.04
	Other noun phrases	04	4.0	0	0	12	3.36
	Total noun-based bundles	20	19.3	08	17.8	125	35.01
Preposition-based	Prepositional phrase with embedded of-phrase	02	2.0	0	0	11	3.08
	Other prepositional phrase expressions	16	15.7	07	15.5	55	15.7
	Total preposition-based bundles	18	17.7	07	15.5	66	19.1
Other	Other structures	23	22.5	06	13.3	43	12.04
Overall	12	102	100	45	100	357	100

Although B2 and C1 writers showed variation in the use of lexical bundles according to the structural classification, there were differences in the use of lexical bundles between EFL sub-corpora and the RC. The results showed that EFL learners used more phrase bundles than clausal bundles in their writing. More specifically, verb-based bundles were the most frequent three- and four-word bundles found in the B2 and C1 sub-corpora. Among the two CEFR levels, the C1 level had the highest proportions of verb-based bundles, at 53.4%, while the B2 level had a lower percentage, 40.5%. These results conflict with the idea of the rarity of verb-based bundles in academic discourse [6]. The results of the present study suggest that the language of EFL writing contains more conversational bundles. By contrast, the reference corpus clearly represents the formal writing genre, as it contains more noun-based bundles, which is a sign of academic writing.

It can be concluded that the three groups employed a different percentage of most of the structural sub-categories, except the 'preposition-based' category. The chi-square test results of the correlational analysis revealed a significant difference among the corpora. The standardised residuals in a chi-square contingency table for the distribution of structural types revealed that greater differences occurred in the 'verb-based', 'noun-based' and 'other' categories. For instance, the test shows that C1 writers overused verb-based bundles compared to B2writers, which supports the idea that C1 students rely more on spoken language in their writing. In regard to Noun-based, it appeared that B2 students underused these bundles in their writing. On the other hand, B2 writers overused 'other' bundles not related to any sub-category (e.g., as adverbial or modal bundles).

As the standardised residuals in a chi-square did not show any significant difference in the use of 'prepositions-based' bundles, the result reflects the similarity of the proportion of preposition-based bundles in both levels and BAWE, at 15% of total bundles. The 'PP expressions' subcategory is typically used to show the logical relationship between prepositional elements, which means that EFL learners could use this type of lexical bundle to link between the ideas of the argumentation. The difference in frequency of the use of different structural categories across the levels suggests that as their level increases the students are able to recognise and use the adverbial meaning of the bundles.

Functionally, Hyland's taxonomy was adopted, since the data used in the this study was mainly academic prose (see Table 6) [12].

In order to be able to classify bundles into the correct sub-categories, it was important to look at the concordance line to see the bundles in their context and to tackle the issue of multi-functionality of the target bundles. There was similarity in the use of functional categories between the levels. The most frequent functions of the identified bundles across the levels were research-oriented followed by participant-oriented, and then text-oriented. The increase in use of research-oriented bundles in the B2 and C1 sub-corpora might be due to the fact that in argumentative essays, students need to describe various aspects and provide different justifications of their ideas to the reader. Bundles of this function accounted for more than 40% of all bundles identified in the corpora. This result is similar to previous studies, which have found that academic writing is dominated by research-oriented bundles over other categories [6, 7, 14].

A consequence of the high proportion of research-oriented bundles might be a focus on describing the problems in the argumentative essay rather than its presentation.

Table 6. Distribution of the functional sub-categories across the groups

types	Sub-types	B2		C1		BAWE	
		(F)	%	(F)	%	(F)	%
Research-oriented	Location	07	6.8	03	7.0	18	5.0
	Procedure	05	5.0	03	7.0	18	5.0
	Quantification	18	17.6	09	20	29	8.0
	Description	19	18.6	06	13	91	25
	Topic	0	0	0	0	0	0
	Total	49	48.0	21	47	156	43
Text-oriented	Transition signals	07	6.8	05	11	12	3.0
	Regulative signals	02	2.0	01	2	13	4.0
	Structuring signals	12	11.7	05	11	0	0
	Framing signals	03	3.0	0	0	63	18
	Total text-oriented	24	23.5	11	24	88	25
Partici-pant-oriented	Stance features	24	23.5	10	22	73	21
	Engagement fea-tures	05	5.0	03	7	40	11
	Total participant-oriented	29	28.5	13	29	113	32
Overall	10	102	100	45	100	357	100

In the comparison between the levels, it was seen that B2 writers used research-oriented bundles more often than C1 writers. By contrast, C1 writers employed more text-based and participant-based bundles than B2 writers. The study found a direct proportionality between the percentage of text-oriented and participant-oriented bundles as the level increased. In addition, chi-square unstandardized residuals statistical methods were used in the analysis of structural and functional type, to further support arguments in this study. Statistically, the study has failed to demonstrate any statistically significant difference in functional distributions between the levels.

2.4 Longitudinal study

For the development of lexical bundles across the levels in the second stage, the results were similar to the first stage, where three-word bundles were found to be the most frequent bundles in the EFL sub-corpora. However, the results provide some evidence that suggests there may be development of the use of lexical bundles across the levels, but not to a statistically significant degree. This might be due to the number of collected essays that made up the sub-corpus and the short period of time the learners were tracked over.

Structurally, there was much variability in terms of the structures and functions of lexical bundles across the levels. High-level EFL learners used a greater variety

of structures and functions in their writing than low-level learners. The results showed that there were distinctive differences in terms of the greater use of 'noun–based', 'preposition-based' and 'verb-based' bundles by both levels and in the reference corpus. It should be noted that, across the four categories, the percentage of three structural categories in the C1 level seem closer to those in the reference corpus than did those at the B2 level. The B2 levels students used six out of 12 subcategories, while C1 and reference corpus students used 10 out of 12 subcategories. The chi-square revealed significant differences between the levels and the reference corpus, and the standardised residuals (R), which compared observed and expected counts in each cell, showed that greater differences occurred in all the categories, as the C1 and reference corpus used significantly more 'verb-based' and 'noun-based' bundles and fewer 'preposition-based' bundles than B2, except in the 'other' category, which did not show any significant difference between the levels, which reflected the frequent use of bundles such as *I want to*, *a lot of*, the *fact that (the)*, and *the development of*.

By contrast, the overuse of preposition-based bundles in the B2 sub-corpus reflected the frequent use of bundles such as in order to and as well as. Functionally, while the density of text-oriented bundles appeared almost identical in the B2 sub-corpus, the use of research-oriented and participant-oriented bundles in the C1 sub-corpus seems to be more aligned with the reference corpus.

Further analysis of the functional sub-categories revealed the same results as for the structural sub-categories: the C1 level seemed closer to the reference corpus than the B2 level. The result of the chi-square test revealed a significant difference among the three groups. The standardised residuals (R), which compare observed and expected counts in each cell, showed that the greatest differences between the groups occurred in the 'text-oriented' and 'participant-oriented 'categories, as the C1 and reference corpora used significantly more participant-oriented bundles but fewer text-oriented than the B2 level. This might be due to the wide range of topics that argumentative and expository essays covered.

3 Conclusion and Limitations

3.1 Summary of findings

A major finding from the analysis was that, generally, EFL learners favoured using more signaling bundles in their writing; three-word bundles were found to be the most frequent bundles in EFL sub-corpora. Moreover, significant progress was identified in terms of the variability of the structures and functions of lexical bundles, C1 writers were found to have used various structures and functions as professional writers in their academic writing. In terms of the development of lexical bundles in relation to CEFR level, the findings clearly indicated that there was no significant relationship between the increased use of lexical bundles and academic performance. However, multiple regression analysis revealed that there is a direct proportionality between variations in the use of lexical bundles and CEFR level, as higher-level students (C1)

acted as professional writers and used more variant structures and functions than lower-level students (B2).

The results of this study show that there are specific lexical bundles that maybe considered to be the building blocks of ESL learners academic essays. These results might be interesting for English language teachers and instructors because it provides insights into the ESL learners community preferences in academic writing.

3.2 Limitation

Like many other studies, the present investigation has its limitations. One of which is the small corpora size. However, small corpora size can produce more lexical bundles than the big corpus. [13] To avoid biased results, the frequency cut-off point and dispersion criteria were set at 40 occurrences per million words to include highly used lexical bundles in the analysis and eliminate low-frequency parameters. In addition to frequency cut-off, dispersion criteria were also applying in at least three texts.

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Web-Academic Impact on Terminology: A Corpus-Based Study

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Abstract. The article presents a study of some key issues of borrowed terminology in Russian scientific texts. The study presumes that global web academic intercourse and professional bilingualism of actively publishing Russian authors facilitate the process of borrowing new terminology of English origin. The problem addressed is the manner and methods Russian authors accept and use new terms in their research papers. The research methodology applied is that of corpus technologies. The study is based on corpus findings in two original research corpora. It aims at developing a procedure of detecting and describing new English terminology and its presentation in recent Russian scientific texts of a restricted knowledge domain, namely web and linguistic technologies. Section 1 presents an overview of factors influencing the quality of Russian academic writing. Section 2 describes the research corpora and a corpus-based procedure of detecting and extracting loan words. Section 3 focuses on analysis of loan terms interpretation by Russian authors. Section 4 summarizes the preliminary results.

Keywords: Russian Scientific Text, Borrowed Terminology, Corpus-based Analysis.

1 Introduction

Scientific communication today actively involves international sources of information and data, including abstract and citation databases such as Scopus and Web of Science, and web search engines like Google Scholar, that help to widespread research results in global web academic society ("web academy"). Since "web academics" read and publish their research preferably in English, the core lexical component of scientific texts – terminology – is picked up and accepted easily (with much aid of global technologies in use). Unlike publications in international English scientific journals and conference proceedings scientific papers in national languages that are designed for publication in national scientific journals and conference proceedings demonstrate a terminological battle between national terminology and loan terms, the outcome is seldom in favor of the former. Nationally published materials of various reliability have a substantial representation in the web, too, which adds to the resulting diversity of term presentation and interpretation.

As text remains (and it always will) the main source of data and knowledge mining, no matter what its language (natural or artificial) and its addressee (a person or a system) are [1; 2; 3] data requirements of modern information society ("Information 4.0") concern every aspect of how a text is created, structured and used, how texts or their structural parts are shared in various technological and humanitarian systems.

The process of Russian scientific text creation today is complicated by "professional" bilingualism of active Russian scientists, which is natural and almost mandatory under the circumstances, and which influences their performance in writing for Russian journals and conferences [4; 5].

In fact, modern scientific communication reflects the internationalization process of scientific domains, however the insufficient academic literacy in native language is exactly that stumbling-block, which interferes with training professional communication in English [6; 7] and Russian languages. Our observations show that even basic philological education does not guarantee textual competences in academic and scientific writing [8]. The problem redoubles as novice researchers are not trained to present information of their research projects in different textual forms in Russian and actually fall out of Russian academic style tradition.

Terminology is one of the key points on the way to master academic style for research publications. In spite of fast developing terminology management systems an active bilingual researcher proves faster: they pick up and transfer new English terminology, and coin new Russian terms in a voluntary manner. Partly they do so, because translating an English term (or text as a whole) has become a redundant and lost practice, though it was professional translation of foreign texts that not only most adequately introduced new terms, but established parity of accepted Russian terminology and the new borrowings (loans) [9; 10]. Such were the famous issues of "Новое в зарубежной лингвистике" with professionally translated linguistic texts and subject indexes that fixed the new terminology.

Considering time necessary for a proper equivalent choice when translating a scientific or technical text (75% of the time needed for text translation as a whole [11]), labor-intensive procedure of a translation equivalent formation and description is dropped out of the academic writing process. Thus, in national Russian scientific spheres, the result of this incomplete terminology knowledge is generation of pseudo-Russian texts in a bizarre mixture of languages, a sort of new Volapük. We doubt whether the text fragments (1-2) below may be considered as a proper scientific style in Russian, where (1) is a definition of "социально-сетевой дискурс" [social network discourse], abounding in complex terms including prefixes of different origin: *макро-, пара-, гео-* [*macro-, para-, geo-*], *много-, разно-, одно-, меж-* [mnogo-, razno-, odno-, mezh-] and hyphenated constructions, which makes the definition incomprehensible; and (2) is a typical example of borrowing new terms in every manner possible – translating (*энвайронментализм, экологическое искусство, арт-практики*) , transliterating (*ленд-арт, био-арт, арте повера*) and taking "as it is" (*art&science*), which reduces the text addressee to those in the know:

(1) Представленное исследование направлено на выявление вербальной , и ***пара****вербальной специфики формирования и функционирования в мировой электронной медийной среде социально-сетевого дискурса (ССД), опреде-*

*ляемого нами как дистантный опосредованный, **много**векторно-**разно**направленный, **одно**временно-**разно**временный в реальном времени (on-line) и отложенный (off-line), **много**тематический электронный **макро**полилог, который отражает **меж**личностные, **меж**этнические, **меж**конфессиональные, социально-экономические, **гео**политические и т. д. типы отношений, что находит непосредственное выражение в специфике вербальных и **пара**вербальных коррелятов письменных и устных дискурсивных высказываний*

(2) *Это справедливо, например, для **энвайронментализма** который, в свою очередь, был тесно связан с другими **арт-практиками**, в частности. **ленд-артом**, экологическим искусством, **арте повера**, **био-артом**, **art&science**.*

The fact of the matter is that in bilingual web academic environment there is no need of translating scientific texts into Russian, which results in ignoring and, hence, failing to correctly use any dictionary, including electronic ones, that, in its turn, adds to introduction of new terms into a Russian text, even if their official equivalents are already set and dictionary-fixed. Thus, for example, the word *perceptual* in the universal translation dictionary of ABBY LINGVO system (English-Russian) has the following description:

***perceptual** [pə'septʃuəl]*
относящийся к восприятию; перцепционный
perceptual [pə(r)sɐptʃuəl]
ADJ; ADJ n
Perceptual means relating to the way people interpret and understand what they see or notice.
[FORMAL]
Some children have more finely trained perceptual skills than others.
***perceptual** [pə'septʃuəl]*
перцептивный
perceptual per|cep¦tual
adjective relating to the ability to interpret or become aware of something through the senses
A patient with perceptual problems who cannot judge distances

The dictionary information assumes that a Russian writer shall use translations *перцептивный* or *перцепционный* that are registered as terms in the Russian language, and introducing the adjective *перцептуальный* as offered in (3) is absolutely redundant:

(3) *Личное (или личностное) присутствие (англ. - personal presence), и близкие к нему понятия «физического присутствия», «пространственного присутствия», «**перцептуального** погружения» можно было бы назвать присутствием в чистом виде…*

Reading and processing information from a vast number of scientific texts in global English to support personal research and international communication brings a Russian author to active use of borrowed lexicon. This is not only Russian specific, one can spot similar use in other scientific cultures, for example, in the materials of

tekom-Jahrestagung and Tcworld conferences, where texts written in German include terms in English, see, for example (4):

(4) Am Standort Rorschacherberg (Schweiz) setzen die hauseigenen Technischen Redakteure für die Dokumentenerstellung ein ***Content-Management-System*** *ein – anschließend werden die fertigen Dokumente an den Übersetzungsdienstleister geschickt, der die Daten in einem-****Translation Memory-System*** *weiter verarbeitet.*

This way of including loan terminology into a native text is permitted due to common alphabet systems, which in case of a Russian text seems hardly possible.

The use and borrowing of English terminology in web-academic society is a natural process, the spread of terminological loans in published Russian texts is uncontrolled and the author's choice of presenting a new borrowed item is absolutely voluntary. Thus, we consider that discussion of the linguistic peculiarities of new term introduction is relevant and pertinent. **The purpose** of this study is to suggest and develop a procedure of detecting and describing actual English terminology and its presentation in recent Russian scientific texts of a restricted knowledge domain, namely web and linguistic technologies [12].

2 Methodology and Material under Study

In principle the methods of determining words with no translation could be divided into two groups.

One group is usually applied to a specific set of new data, using such language resources as word lists and linguistic models. It is noteworthy that modern lexicological studies rely on analysis of research and national text corpora and, respectively, on automated word lists, which units (tokens) are automatically defined as sequences of symbols between two spaces. Naturally, such tokens are not always words. When detecting non-translated words, the word lists are usually generated from the existing lexicographic paper and web resources, dictionaries or texts corpora, and are then edited with special filters eliminating surplus tokens, such as sets of symbols but not natural language words (dates, URL, formulaic elements), misprints and errors (cf *awaraness, abyssin, ajudicated*), named entities (personal names, organization names, geolocations, time intervals). To assist detecting new words the procedure may apply linguistic models, such as markers of lexical novelty: punctuation marks (different quotation marks, diacritical marks and subscript), application of italics and/or boldface font, etc., they can signal, that the word is a new one (neologism) or is used in a new meaning (see [13]).

The other group of methods, usually applied to multiple data sets, is oriented to statistical evaluation or machine training which are necessary to calculate and evaluate the growth of usage or change of meaning, arisen in due course of time or in various registers [14]. Within this approach one can use national text corpora or specially created corpora (see, for example, Chambers Harrap International Corpus (CHIC), which was specially created for new word extraction and includes more than 500 million words from global English texts, it represents a static, balanced resource [13],

see as well a specially created reference texts corpus in [15]. Naturally, web sources as a whole can be used as a corpus with application of various computer programs of scanning and search, the so-called crawlers. One of such facilities is the extensible program Heritrix with open original texts, the program performs scanning and search in the web archives [14].

The majority of modern studies of new words relies on such automatic scanning of text archives for new words and automatic tracking of their persistent occurrence, which requires to create a list of their formal features in each special domain language, to introduce special timeline for such analysis (weekly, monthly and so forth). In Russia, unfortunately, such methods are not practiced widely, if at all. The analysis of new words that have no translation equivalents, is traditionally performed on a bound material of published translation dictionaries and the absence of a fixed translation is taken as a ground for detecting a new word.

Terminology of web and linguistic technologies domain can't be based on the units already fixed in dictionaries in principle. In this case a most reliable language source is a specialized research corpus.

The present research is based on two original research text corpora including texts recently published on the domain issues. The first one includes representative conference materials published in English: tekom-Jahrestagung und tcworld conference (2013 and 2014), 19th Conference on Computational Language Learning (2015), Annual Meeting of the Association for Computational Linguistics and the 7th International Joint Conference on Natural Language Processing (2015), EURALEX International Congress (2018), Workshop on Natural Legal Language Processing (NAACL HLT, 2015, 2019). The corpus includes 372 papers, written in global English by researchers from Europe, North and South America, Southeast Asia, Australia and New Zealand. The corpus volume is 3 468 000 tokens, dictionary volume is 71 000 word-forms.

For detecting and extracting loan words in Russian scientific texts we built a corpus of papers published in proceedings of two international conferences "Internet and Modern society", namely IMS-2017 and IMS-2018. The research corpus volume is 226301 tokens (34833 word forms), it includes papers, relating to the following conference topics: computer linguistics, applied linguistics, electronic training and online educational technologies, information systems for science and education, cyberpsychology, state and society interaction in digital age, communicative culture of digital age, culture and technologies, information technologies and systems.

Before the papers were added to the corpus they underwent the necessary normalization procedures: formulae and meta information (about authors) were manually removed. References to explicit bibliographic sources were left for the sake of terminology in the texts, though, therefore in the alphabetic-frequency dictionaries (word lists) received with the help of AntConc corpus manager a lot of units are proper names, which then were manually removed from these word lists.

To provide comparability of the English and Russian corpora the English corpus was reduced to a sample of 275056 tokens (13699 word forms), this procedure makes it possible to compare frequencies of new words in both languages that shows prevailing quantity of new or occasional abbreviations in the English corpora (see Table 1)

and comparable quantity of abstract nouns in both corpora. In the studies that will follow this one, we are going to compare new lexical item frequencies in both corpora in order to set the really dominant translation modes for Russian.

The next step in identifying candidates for new terms was translating every item of the automatically produced and manually edited word lists (English and Russian) with the aid of WORD^{+} machine translation system. Translated words were removed from the word lists, the words, which received no translation, were checked in ABBY LINGVO lexical system and consequently removed in case their translation was already fixed there. The words remaining without translation after this check were considered candidates for new lexis, possibly, new terms.

3 Results and Discussion

The procedures described in section 2 resulted in obtaining two dictionaries of new words based on alphabetic-frequency principle: English and Russian. The new words in the dictionaries are supplied with frequency index and illustration of their use in the context provided by corpus search. For new English words some additional information casting light on their actual meaning was added from their web definitions and description. The dictionary fragments are presented in Tables 1 and 2.

The obtained dictionaries allow to fix neologisms in the subject domain in question, describe productive word-building technics, analyze the attempts to adapt the loans to a Russian text, they may be used as a source information for translation dictionaries as well.

Thus, preliminary observation of dictionary items and their morphological structure marks similar derivation technics in both languages:

- the use of Latin and Greek components (*hypernymhyponym*, *mereological*, cinephotomacrography, *гиперпараметр*, *дискурсология*, *интерактив*, *квазикультурный*, etc);
- the use of English (-ness, -hood, -icity, etc.) and Russian (-ство, -сть, истика etc.) affixes for words which mean properties and characteristics, inherent to new entities (aboutness, termhood, formulaicity, гуманитаристика, дистантность, коммуникационность);
- the use of complex hyphenated constructions in English (-based, -driven, -formed, etc.) and Russian (–коммуникативный, -поисковый, -ориентированный, etc.)
- the use of abbreviation (AAsum - a very complex MDS method which fully exploits the advantages of clustering and the flexibility of matrix factorization; ACT-PTQ - Adding the adjectives (modifiers) and settings to the subject, verb and object, which we will called parse tree quintet (ACT-PTQ); ММО - многопользовательские онлайн игры; НБИК – Ипотечное бюро независимого кредитования).

Table 1. Fragment of English new word dictionary

Frequency	Word	Context in the corpus, web description or definition
1	aboutness	determining the aboutness of conversations
1	ABox	The non-generic sentence (lb) roughly speaking provides ABox content for a machine-readable knowledge base, i.e., knowledge about particular instances.
50	ABS	The abbreviations c.c., ABS and TLC have various meanings in and out of the field of science. ABS: absolutive case (can be subject or object depending on transitivity). ERG: ergative (subject with transitive verbs). INE: inesive. INS: instrumental. DAT: dative. Absolute evaluation (called ABS in Fig. 1) therefore is required to determine the quality of a given translation.
1	abstractive-based	The abstractive-based approaches gather information across sentence boundary, and hence have the potential to cover more content in a more concise manner.
7	Abs-Cl	The first classifier (Comprehensive Classifier / Comp-Cl) is intended to cover dialectal statistics, token statistics, and writing style while the second one (Abstract Classifier / Abs-Cl) covers semantic and syntactic relations between words.
96	AdaGrad	AdaGrad - An adaptive learning rate method. AdaGrad algorithm (Duchi et al., 201 1) with mini-batch is adopted for optimization.
8	AdaGradUpdate	Note that AdaGradUpdate (x, g) is a procedure which updates the vector x with the respect to the gradient g.
5	B-ADDR	mainly common first names, such as John; such names are frequently labeled as B - ADDR across movies.
9	w.addSVD	We will compare to two other previously studied composition methods: weighted addition (w.addSVD), and lexfunc (Baroni and Zamparelli, 2010). w.addSVD is weighted addition of SVD vectors
1	add-one-approach	the add-one_approach returned the combination of the three features FORM, PLACE and FREQ_10PSadd-one-approach

As far as the research focus is borrowed terminology in a Russian scientific text let us consider the ways the loans are treated by Russian authors.

While the recognized methods of new words introduction into a Russian text are tracing (loan translation), transliteration and transcription, the corpus under study demonstrates a sure preference of transliteration to the other two.

In the aspect of terminological system development and new lexical units generation linguistic technologies are very special, since their active progress results naturally in the origin of new terms and permanent updating of the accepted. Terminology of linguistic technologies has been traditionally developing on the English language base ever since 1947 when practical computer systems and algorithmic languages were created in USA and Great Britain.

English lexical units with transparent morphological structure are well motivated not only for native speakers of English, they are understandable for speakers of other languages, bilingual "web academics", by virtue of knowledge of their components. Providing that translation practice is lost in "web academy" there arises a set of loan terms either transliterated or transcribed lexical units, that are not motivated in the Russian morphological context. If morphological components are either transparent, or correlated with a Russian component (irrespective of their Greek or Latin origin), the loan term is motivated and its use is justified, though such terms permit parallel introduction of specialized translation equivalent, i.e. tracing, see, for example (5):

*(5) "Наука о данных" или "**даталогия**" ("Datalogy"), начиная с 70-х годов прошлого века, рассматривается как академическая дисциплина, а с начала 2010-х годов, во многом благодаря популяризации концепции "больших данных", — и как практическая межотраслевая сфера деятельности.*

At the same time, a transliterated compound borrowing does not always permit to trace over the neologism meaning, as in (6):

*(6) Данный **датасет*** [dataset] *уже был получен готовый с сайта британского проекта Mendeley, направленного на хранение и распространение научных трудов и баз данных по всему миру*

Table 2. Fragment of Russian new word dictionary

Frequency	Word	Context in the corpus
1	агрессивно-девиантный	Наиболее часто на экспертное исследование поступают содержащие лингвистические признаки экстремизма и ксенофобии материалы, опубликованные пользователями социальных сетей «ВКонтакте», «Одноклассники», «Facebook», транслирующие модели агрессивно-девиантного речевого поведения
1	аддикт	Относительно небольшой процент всех геймеров являются аддиктами
1	адъективность	адъективность: отношение числа прилагательных к числу словоформ в тексте;
1	Азиопа	«Азиопа» для обозначения союза Азии и Европы
1	айпад	Такими орудиями являются, к примеру, компьютеры, смартфоны, айпады, гаджеты и виджеты,
1	Аквафон	мобильная компания «Аквафон»
7	аккаунт	регистрация соответствующего *«альтер-эго»,* в виде различных аккаунтов, чтобы исключить возможные недоразумения и возможные комментарии.
1	аксиологичный	Традиционные этические представления аксиологичны и антропоцентричны, то есть они, в основном, описывают взаимоотношения между людьми
1	акторно-сетевой	делает чрезвычайно эвристичным обращение к акторно-сетевой теории Б. Латура, в рамках которой технические устройства получают статус субъектов в совместной деятельности.
1	акустико-тактильный	В настоящее время исследователи выделяют несколько видов синестетической метафоры: слухо-зрительная; <…>, акустико-тактильная; …

The component *set / сет* is actively borrowed by Russian authors, however, it is homonymous to the Russian root morpheme *сет- (сеть, сетевой)* for *network*, which can cause misunderstanding of *сетература* [netliterature], *сетикет* [netiquette], *сетинг* [setting] on the one hand and *синсет* [synset] on the other.

In some cases even the transparent structure of an original English word does not guarantee understanding of a transcribed or transliterated loan, in such cases the loan word is used with a definition to avoid incorrect interpretation (7):

(7) В то же время, пользователи часто указывают, что их сообщение имеет личный, а не официальный характер, это так называемый **«дисклеймер»** *- письменный отказ от ответственности за возможные последствия в результате действий человека (или организации), заявившего данный отказ.*

The English word *disclaimer* is polysemantic, its different meanings are fixed in the ABBY LINGVO system as follows:

1) отказ, отклонение, отречение

2) письменный отказ от ответственности

The company asserts in a disclaimer that it won't be held responsible for the accuracy of information. — В разъяснительном замечании компания предупреждает, что она отказывается нести ответственность за точность информации. Syn: denial, disavowal, rejection, renunciation

3) оговорка о случайном характере совпадений (имён персонажей в книге или фильме с именами реально существующих людей)

4) отказ (от права на что-л.), отречение

The loan word *дисклаймер* [disclaimer-2] is borrowed in only one of these meanings.

A productive word-building model is used in case, when the borrowed word belongs to a different part of speech than the original word, for example, the English word *interactive* is an adjective, while it is borrowed as a noun *интерактив,* obviously due to analogy with *актив, позитив, диминутив, etc.*:

(8) Однако при использовании новых технологий необходимо помнить, что, несмотря на все новации, ***интерактив*** *в цифровом формате не отменяет правила хорошего тона, тем более, что, как уже отмечалось, тема самопрезентации в сети на персональном и корпоративном уровнях - одна из наиболее актуальных тем современной деловой коммуникации.*

Sometimes the adjective to noun conversion is prior to borrowing and the new term is a loan transliteration, for instance *(аффективный) диспозитив* [affective disposition] as a loan term from social science domain:

(9) ***Аффективный идеологический диспозитив*** *не восприимчив к идущим от Просвещения моделям борьбы с идеологией через рациональное (научное) объяснение фактов. <…>* ***В аффективном диспозитиве*** *популистской идеологии герой-одиночка борется с силами, намного превосходящими его, к тому же эти силы никогда не играют честно.*

The list of the examples can be continued, but they only confirm the fact, that Russian scientific texts are overloaded with borrowed terms and their meaning is not always clear even to the author, makes the Russian text inaccurate and precarious.

A suitable way out could be introduction of new terms followed by their working definitions, which permits to avoid possible misunderstanding or incomprehension.

However, interpretations of brand-new terms (even from the standpoint of the text authors) are rarely included into the text, they are rather an exception, as in (10) with the author's orthography and grammar:

(10) Д. Берман и Д. Уэцнер ещё в 1997 году писали о детецентрилизованной структуре Интернета, которая предоставляет выбор из многочисленных ***вебсайт-хостингов (платформ, поддерживающих непрерывную работу сайта)***[site hostings (platforms that support the nonstop operation of the site)], *что тем самым исключает необходимости получения «разрешения со стороны власти»*

At the same time in some cases we can see within the limits of one sentence new term introduction, which is not followed with explanations or interpretation, and introduction of terms interpretation with use of neologisms with no definitions at all, see,

But very often authors fail to introduce new terms correctly, avoiding definitions of loans even if their interpretation is part of research issue, for example, when classifying new objects of study as in (11). In this paragraph one can notice an ineffectual attempt to explain one loan by another one, which proves the assumption made above of authors' incomplete awareness of the loan term meaning: *дигитальный перформанс* [digital performance] could be hardly considered as a definition or equivalent for *медиаперформанс* [media performance]:

(11) При этом культурные трансформации, новые требования к искусству, новая эстетика, социально-культурные потребности стали основаниями появления множества видов искусств. Это «электронное искусство», «цифровое искусство», видео-арт (в том числе, виджеинг, саунд-арт, медиаинсталляция и медиаскульптура), ***медиаперформанс (дигитальный перформанс****), медиаландшафт (или медиасреда), сетевое искусство (интернет-арт или нет-арт, иногда также* ***веб-арт****) и др.*

The paragraph is a happy illustration of the research focus issue since it demonstrates almost every possible way of a loan term presentation in a Russian scientific text: verbal translation (*«электронное искусство»* [electronic art], *«цифровое искусство»* [digital art], *сетевое искусство* [web art]), transliteration (*саунд-арт* [sound art], *интернет-арт* [internet art], *нет-арт* [net art], *веб-арт* [web art]), transcription (*виджеинг, cf.:* VJing) and tracing (*медиаперформанс* [media performance], *дигитальный перформанс* [digital performance]) with a morphological adaptation to Russian word building rules (cf.: *медиаинсталляция, медиаскульптура, медиаландшафт, медиасреда*).

In this paragraph there is an attempt of pointing to new terms synonymy: "*медиаландшафт (или медиасреда), интернет-арт или нет-арт, иногда также веб-арт* [media landscape (or media environment, internet-art or net-art, sometimes even web-art]" that can't be interpreted as sufficient or reliable as the author does not clearly state that *медиаперформанс* and *дигитальный перформанс* are synonymous too. What is more, obviously synonymous *электронное искусство* [electronic art] and *цифровое искусство* [digital art] are introduced as different kinds of art (*множество видов искусств* [many kinds of art]).

4 Conclusion

Contemporary English-oriented web academic intercourse and mandatory, under the circumstances, professional bilingualism of actively publishing Russian authors facilitate the process of borrowing new terminology of English origin. The lost practices of professional (within a particular knowledge domain) term translation and proper academic writing instruction result in a "scientific Volapük" mainly affecting the terminological component of Russian scientific texts published in national journals and conference proceedings.

The research focus being the manner and methods Russian authors accept and use new terms in their research papers, we suggest a corpus-based procedure for compiling dictionaries of new words (terms). The two original research corpora of contemporary English and Russian scientific texts restricted to web and linguistic technologies domain present a reliable material for detecting and describing new English terminology and its presentation in recent Russian scientific texts.

The corpus findings demonstrate that of the three recognized methods of borrowing (tracing or loan translation, transliteration and transcription), Russian authors prefer transliteration to the other two.

Analysis of dictionary items and their morphological structure revealed similar productive technics for new terminology in both languages, such as the use of Latin and Greek components, affixes meaning properties and characteristics, the use of complex hyphenated constructions and abbreviation.

Individual authors' methods of adapting English terms to a Russian text vary from a suitable definition of the borrowed term to a voluntary, often incorrect or erroneous (cf.: *гаждет* instead of *гаджет*) transcription / transliteration or mere borrowing a term "as it is" (*теневой DOM (ShadowDOM), HTML-импорты (HTML-imports), art&science*).

The obtained dictionaries allow to fix neologisms in the subject domain in question. They help to highlight productive word-building technics, which may contribute to lexicographic (terminographic) practices. The dictionaries may be as well used as a reliable source information for specialized translation dictionaries.

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Decisions of Russian Constitutional Court: Lexical Complexity Analysis in Shallow Diachrony

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Abstract. The paper is aimed at studying the texts of Russian Constitutional Court decisions, issued from 1992 to 2018. We analyzed the corpus, consisting of 584 decisions or 3,426,747 tokens (incl. punctuation marks) and tested the hypothesis about increasing lexical complexity of the documents. Using the R package *stylo* and MFW statistics, we got a picture that reflects the differences of the texts by years. The results of cluster analysis show that the texts of the 90s and 2000s are combined into the first large cluster. The second large cluster includes the texts of the 2010s. Using the R package *quanteda*, we obtained the values of 11 lexical diversity measures. We chose the index K (Yule's K) as a basic measure, relatively more reliable and independent of the text length, and then interpreted the values of this measure. In general, the value of K decreases over the years, except for the texts of 2006, in which there is a noticeable increase in the index value, and the texts of 1993, in which the outlier is observed. The calculation hapax proportion shows a picture of a gradual decrease in the share of hapaxes. If we apply the traditional approach to the interpretation of TTR values and derived metrics, we can conclude that, as the lexical diversity decreases and the proportion of hapaxes decreases, the texts become easier to read.

Keywords: Legal Linguistics, Decisions of the Russian Constitutional Court, Stylometric Analysis, Most Frequent Words, Lexical Complexity, Lexical Diversity, TTR, Yule's K, R packages, *stylo*, *quanteda*.

1 Introduction

This paper is aimed at studying the texts of Russian Constitutional Court decisions, issued from 1992 to 2018. The purpose is to verify the hypothesis, according to which the texts became more complex during the specified period (i.e. in shallow diachrony). At the moment, we were primarily interested in the lexical complexity.

The Constitutional Court is one of the youngest legal institutions in Russia. Its appearance in 1991 was associated with large-scale changes in the legal and political system caused by the rejection of Soviet legal and political system and the creation of a new democratic state in Russia.

The Constitutional Court, more than any other courts, was perceived as an "alien body" in the judicial system, since the Court was significantly different from all other judicial bodies in its objectives and duties. The task of the Constitutional Court was neither to solve a specific case, nor to draw conclusions about the rights and obligations of a particular citizen, but to compare the norms of a law challenged by a citizen and the provisions of the Constitution, ensuring the protection and implementation of constitutional principles.

The major function of the Constitutional Court is direct application and appropriate interpretation of the constitutional text. Citizens and legal entities' complaints about the violation of their constitutional rights noticeably prevail among the cases considered by the Russian Constitutional Court. For example, in 2019, out of more than 3,500 judgments and rulings of the Constitutional Court, only three were made at the request of state bodies, about 30 were made at the request of the courts, and all the rest were made on complaints.

At the same time, it cannot be concluded that decisions of the Constitutional Court, initiated by citizens, are addressed specifically to these citizens. Of course, an applicant should understand whether the Constitutional Court supported her arguments as well as the outcome of the case consideration. However, only a small (operative) part of a Constitutional Court decision is devoted to this.

The rest is primarily addresses those bodies that must restore the violated rights, and not only and not so much the citizen who applied directly to the Constitutional Court, as those who find themselves in a similar situation. In this regard, the main addressees of Constitutional Court decisions are the legislative bodies, which should amend corresponding laws, and law-enforcement bodies (both executive and judiciary), which should interpret the legal provisions that they apply in accordance with decisions of the Constitutional Court.

However, it would be wrong to exclude citizens and legal entities from the addressees of the decisions. The Constitutional Court very rarely finds itself concluding the absolute, complete and unconditional contradiction of examined norms of the Constitution. More often, conclusions about unconstitutionality are made in relation to a particular interpretation of the impugned norm. Acts of the Constitutional Court become part of existing law, shall be applied along with statutes, the interpretation of which they strongly influence. Coming to court and demanding application of a provision, for example, establishing a social payment, citizens often must refer not only to the provisions of the law, but also to their constitutional interpretation in the practice of the Constitutional Court. That is why the **decisions of the Constitutional Court should be clear to all citizens**.

On the one hand, the field of activity for the Constitutional Court is an area of refined jurisprudence, free from description of factual circumstances, proving their existence and assessment of such evidence; on the other hand, it is a part of the existing legal regulation, along with statutes. The decisions of the Constitutional Court have the most significant difference with the latter, as these decisions are a result of the work of judges (i. e. professional lawyers). Many of the Constitutional Court judges are professors of law, others were appointed to the Constitutional Court after many years career in other courts. A draft of each decision is prepared by a judge-

rapporteur, while the final text of any decision becomes a result of the collective creativity of all judges and has no authorship.

That is why the assessment of the decisions' complexity is important and indicative. Such an assessment **demonstrates the ability of professional lawyers to be clear**, to write specialized texts addressing to a wide range of citizens, in an accessible manner.

2 This Paper's Structure and Recent Works

To test the hypothesis of texts becoming more complex with time, we used the capabilities of two R software packages (*stylo* and *quanteda*) [1], [2], [3]. Both packages allow to analyze non-structured text data.

Using the *stylo* package, we got a general picture that reflects the differences between the texts by year. Using the *quanteda* package, we received more detailed information about the lexical complexity of texts by different time periods.

The diachronic study of legal documents is the actively developing area. In particular, there are diachronic corpora of legal texts, for example, Corpus of Historical English Law Reports (CHELAR) [4]. A study of the texts of Russian legal documents in dynamics was carried out in [5], [6].

A research on the readability of texts of Constitutional Court is presented in [7]. The corpus of decision was analyzed using a simple readability metric, the Flesch-Kincaid formula, adapted for the Russian by I.V. Oborneva [8].

The Flesch-Kincaid formula for the Russian looks as follows:

$$\mathrm{FRE} = 206{,}836 - 60{,}1 \times \mathrm{ASL} - 1{,}3 \times \mathrm{ASW}, \quad (1)$$

where ASL is the average sentence length in words, and ASW is the average word length in syllables.

However, two points should be emphasized. Firstly, the coefficients of the Oborneva's formula were obtained by calculating the statistical characteristics of about 100 works of famous English-language literary classics (and translating these works into Russian). Thus, the formula **is not quite universal**, but is applicable primarily for the analysis of the complexity of texts of (translated) fiction; about the indicated problem, see [9]. Secondly, recent studies show that "**sentence and word length measures likely do not tap directly into linguistic components related to readability** … nor are they the only linguistic features related to readability" [10].

In this paper to assess the text complexity (lexical complexity) we also use the traditional method of assessing, calculating the TTR (type-token ratio), more precisely, we use a number of derived metrics.

TTR is the ratio of the number of unique tokens (types) to all document tokens. It is known, however, that the values of the TTR measure are not independent of text length, that is, documents of equal length should be compared to obtain relevant results. The solution to this problem can also be the use of derivative measures, see [11], [12]. Such measures are provided in the *quanteda* package.

In addition, to assess the lexical complexity, we use information on hapax richness and hapax proportion (the hapax is a token that appears in a sample once). Hapax richness is a measure that describes text from the same perspective as the TTR measure.

3 Methods for Assessing Text Complexity and Lexical Complexity

There is a rather long tradition of applying methods for assessing complexity (readability) to texts in Russian; for a review, see, for example, [13]. There is, among others, the traditional direction mentioned above, associated with the use of a wide variety of readability formulas. Only 5 or 7 readability formulas were adapted for Russian [14], [15]. So, the following metrics are used on the "LeStCor: Levelled Study Corpus of Russian" resource: Flesch-Kincaid grade level, Coleman Liau Index score, (Gunning) Fog, SMOG index, Automated Readability Index, New Dale Chall Adjusted Grade Level, Powers-Sumner-Kearl Grade Level [16].

To assess the lexical complexity, we can use information on:

- lexical density, the proportion of various content words in the texts;
- lexical richness and lexical diversity, measured by calculating the values of TTR or derived measures;
- number of words with abstract or concrete meaning;
- number of ambiguous words;
- number of function words (particularly prepositions);
- number of abbreviations

etc., see [17], [18], [19] and many others. TTR values well predict Russian text complexity, see [20].

4 Material

We analyzed a collection of judgments, consisting of 584 documents relating to the period since 1992, when the first judgment of the Court appeared. The distribution of decisions by year is described in Table 1.

The full texts of the decisions were taken from the database of the ConsultantPlus information system [21] and from the web-portal of the Constitutional Court [22].

There are no 1994 decisions in the text collection. This is due to the fact that the Constitutional Court suspended work at the end of 1993. The reason was the need to adopt a new law, regulating the Constitutional Court activities. As a result, in 1994 the Federal Constitutional Law "On the Constitutional Court of the Russian Federation" was adopted. The appointment of judges also took some time. In an updated form, the Constitutional Court resumed its work in 1995.

Table 1. The distribution of texts by year

Year	N of texts	Year	N of texts
1992	9	**2006**	10
1993	18	**2007**	14
1995	17	**2008**	11
1996	21	**2009**	20
1997	21	**2010**	21
1998	28	**2011**	30
1999	19	**2012**	34
2000	15	**2013**	30
2001	17	**2014**	33
2002	17	**2015**	34
2003	20	**2016**	28
2004	19	**2017**	40
2005	14	**2018**	44
Total	**584**		

We used the corpus, which contains texts combined by years. Accordingly, the corpus files received names like “1992”, “2003”, “2018”.

The text collection consists of 3,426,747 tokens (including punctuation), see Table 2.

Table 2. The description of text collection

Year	Tokens (incl. punctuation)	Tokens (mean)	Year	Tokens (incl. punctuation)	Tokens (mean)
1992	32489	3609.89	**2006**	62093	6209.30
1993	48072	2670.67	**2007**	93645	6688.93
1995	67961	3997.71	**2008**	56621	5147.36
1996	76767	3655.57	**2009**	97603	4880.15
1997	89138	4244.67	**2010**	145130	6910.95
1998	106561	3805.75	**2011**	185631	6187.70
1999	82536	4344.00	**2012**	229870	6760.88
2000	76945	5129.67	**2013**	239763	7992.10
2001	85747	5043.94	**2014**	217964	6604.97
2002	95908	5641.65	**2015**	239644	7048.35
2003	113715	5685.75	**2016**	214721	7668.61
2004	108004	5684.42	**2017**	293955	7348.88
2005	112454	8032.43	**2018**	253810	5768.41

5 MFW Statistics

5.1 Analysis Procedure in *stylo*

The *stylo* package was created for quantitative studies of writing style and can be used in authorship verification (including forensic linguistics) and diachronic studies, see [2].

We performed unsupervised multivariate analysis. Using the basic functions does not imply preprocessing and markup of the text collection (segmentation into sentences, lemmatization, etc.). We downloaded text data directly from the corpus files. Text metadata were included in the file names. Using the basic `stylo()` function, it is possible to analyze a corpus with the assistance of the following methods.

- Cluster analysis (CA), the results of which are visualized as a dendrogram, or a graph, showing the clustering of texts.
- Multidimensional scaling (MDS), as a result of which texts are displayed as ordered on the basis of several variables, so that similar texts are placed next to each other, and heterogeneous texts are separated, see [23, 19].
- Principal Component Analysis (PCA), which operates on the covariance between features (PCV) [Ibid, 933].
- Principal Component Analysis (PCA), which operates on the correlation coefficient matrix between features (PCR) [Ibid, 933].
- Building a Bootstrap Consensus Tree (BCT), summarizing various cluster analysis results based on the most frequent features occurrences and culling parameter values [2].

So, by means of the package one can find out how much the analyzed texts or text collections differ. As features for the analysis, n-gram sequences of tokens and characters can be used.

5.2 Analysis Results

At the stage of preprocessing, we performed tokenization and removal of stop words. When tokenizing, we used the built-in features of the package. To remove stop words, we took a stop word list from [24].[1]

The corpus size after the removal of stop words was 2,103,608 tokens. We formed a list of 1000 frequent features, then found the features that are used in at least 90% of the texts. In this way, we got a list of 1684 MWF, and then in the analysis we used 100 or from 100 to 1600 of them.

[1] We used a list of stop words to remove units that are not able to characterize the lexical peculiarity of a text or text collection. The list [24] consists of 159 high-frequency words and includes primarily function words, as well as some most common nouns, adverbs and verbs (*человек* ‘person’, *говорил* ‘said’ etc.).

Then we performed cluster analysis, multidimensional scaling, principal component analysis. As a measure of distance, where relevant, we used the **Eder's Delta measure**, which is recommended for highly inflected languages [25].

The results of the PCA, MDS, and CA (see Fig. 1 below) show that the texts of the 90s, 2000s, and 2010s can be described as two separate groups. One can see the following pattern: the texts of the 90s and 2000s are combined into the first large cluster. The second large cluster combines primarily the texts of the 2010s.

Thus, MFW statistics shows, that in general the texts before 2010 and after 2010 are clearly opposed, but the texts of 2005 and 2007 are adjacent to the group of texts of the 2010s. In addition, the texts of 1992 and 1993 are opposed to the rest of the texts written before 2010.

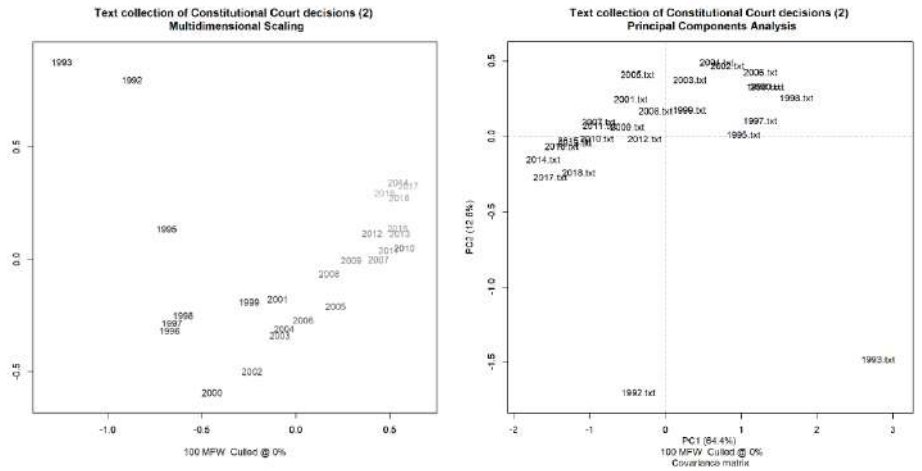

Fig. 1. MDS and PCA analysis results

On the whole, the results of calculating the Euclidean distance on normalized token frequency demonstrate a similar, but non identical patterns, see Fig. 2 (the dendrogram displaying normalized token frequency was obtained using *quanteda* package). The texts of 1992 and 1993 are contrasted with the rest of the texts in the corpus; in addition, the texts of 2012 fell into a large cluster containing the remaining texts of the 1990s and texts of the 2000s.

Finally, BCT allowed us to obtain the combined results of a cluster analysis (see Fig. 3).

6 Measures of Lexical Diversity

6.1 Analysis Procedure in *quanteda*

The *quanteda* package provides tools for a range of natural language processing tasks, see [3], it allows to perform tokenization, stemming, n-grams forming, selection and weighing of features [Ibid].

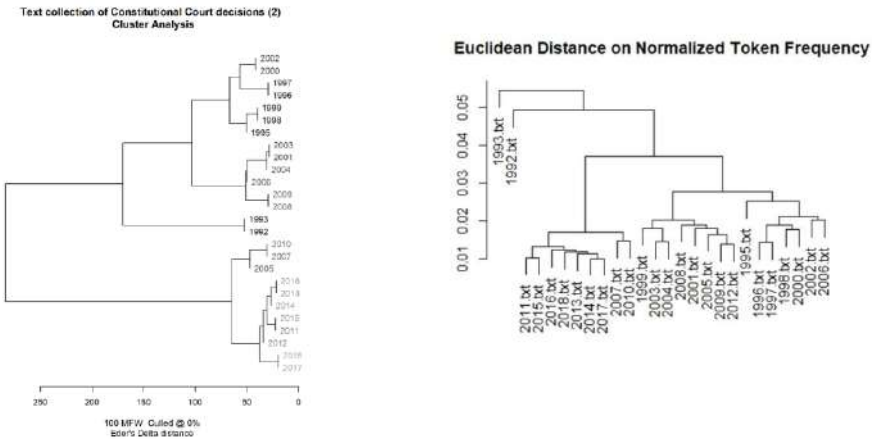

Fig. 2. Dendrogram of the results of CA using 100 MFW and normalized token frequency

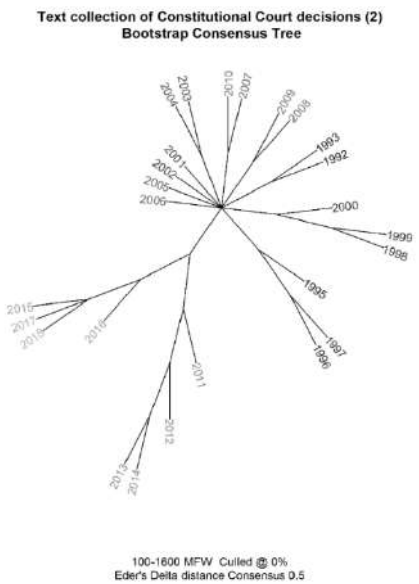

Fig. 3. BCT. We used the package capacities, related to the lexical diversity assessment. More specifically, we used TTR calculation and calculation of derived measures such as Herdan's C (C), Guiraud's Root TTR (R), Carroll's Corrected TTR (CTTR), Dugast's Uber Index (U), Summer's index (S), Yule's K (K), Herdan's Vm (Vm), Maas' indices (Maas, $\log V_0$, $\log_e V_0$). The variables in all formulas are the number of types (V), the number of tokens (N), as well as f_v (i,N), that is, the number of types occurring i times in a sample of length N [Ibid]. In addition, we calculated the amount and proportion of hapaxes.

When forming the corpus, we performed the removal of stop words, numbers and punctuation marks (since by default numbers were considered as tokens). The package uses the "Snowball" list of stop words [24].

6.2 Analysis Results

Using the package, we obtained the values of 11 measures of lexical diversity listed above.

It is well known that the value of a simple TTR is affected by the text (or the sample) length, see for example [26], [27], [28], and many others. This problem can be solved in three ways.

1. It is possible to use samples of the same length.
2. It is possible to apply formulas with logarithms or with other transformations of variables N and V (Herdan's C, Guiraud's Root TTR, Carroll's Corrected TTR, Dugast's Uber Index, Maas' indices).
3. It is possible to apply measures that make use of elements of the frequency spectrum (for example, the "Yule's K" measure), e.g. measures that take into account the number of hapax legomena (as in the "Honoré's R" measure) or hapax dislegomena, see [11], [12] for more details. We used the second and third possibilities, see Table 3.

Table 3. The values of lexical diversity measures

Year	TTR	C	R	CTTR	U	S	K	Vm	Maas	lgV_0
1992	0.21	0.84	30.67	21.69	27.80	0.88	47.29	0.07	0.19	6.81
1993	0.15	0.82	26.44	18.70	24.48	0.87	83.69	0.09	0.20	6.35
1995	0.17	0.83	34.44	24.35	27.64	0.88	49.08	0.07	0.19	6.95
1996	0.15	0.82	32.51	22.98	26.47	0.87	51.66	0.07	0.19	6.78
1997	0.14	0.82	31.77	22.46	25.88	0.87	50.32	0.07	0.20	6.71
1998	0.13	0.81	32.08	22.68	25.73	0.87	58.00	0.08	0.20	6.72
1999	0.15	0.82	33.35	23.58	26.73	0.88	41.15	0.06	0.19	6.84
2000	0.13	0.81	29.03	20.52	25.01	0.87	53.33	0.07	0.20	6.53
2001	0.16	0.83	35.65	25.20	27.64	0.88	32.22	0.06	0.19	7.00
2002	0.13	0.81	30.65	21.67	25.33	0.87	47.11	0.07	0.20	6.63
2003	0.14	0.82	35.70	25.24	27.02	0.87	40.67	0.06	0.19	6.96
2004	0.13	0.82	34.66	24.51	26.69	0.87	44.64	0.07	0.19	6.89
2005	0.14	0.82	37.21	26.31	27.58	0.88	33.63	0.06	0.19	7.05
2006	0.17	0.83	32.77	23.17	27.04	0.88	54.24	0.07	0.19	6.84
2007	0.15	0.83	36.50	25.81	27.70	0.88	29.59	0.05	0.19	7.03
2008	0.18	0.83	32.66	23.10	27.26	0.88	37.94	0.06	0.19	6.85
2009	0.14	0.82	33.82	23.91	26.56	0.87	32.82	0.06	0.19	6.85
2010	0.11	0.81	34.21	24.19	26.03	0.87	31.44	0.06	0.20	6.83
2011	0.11	0.81	36.55	25.85	26.49	0.87	29.70	0.05	0.19	6.96
2012	0.09	0.80	35.34	24.99	25.83	0.86	36.27	0.06	0.20	6.88
2013	0.10	0.80	37.45	26.48	26.44	0.87	26.67	0.05	0.19	7.00
2014	0.10	0.81	38.02	26.88	26.73	0.87	23.40	0.05	0.19	7.04
2015	0.10	0.81	38.25	27.05	26.66	0.87	26.71	0.05	0.19	7.04
2016	0.11	0.81	40.70	28.78	27.59	0.87	25.09	0.05	0.19	7.19
2017	0.09	0.80	39.84	28.17	26.88	0.87	24.46	0.05	0.19	7.12
2018	0.10	0.81	38.37	27.13	26.63	0.87	27.58	0.05	0.19	7.05

The values of the indices TTR, C, S, K, Vm, Maas demonstrate a general decrease in time. The values of the indices R, CTTR, $\log V_0$ demonstrate a general increase in time. In general, the interpretation of the data is quite tricky, since the values of different measures are somewhat contradictory.

Therefore, based on the findings of [11], we chose the **K (Yule's K) index** as a basic measure, relatively more reliable and independent of the text length, and then interpreted the values of this particular measure.

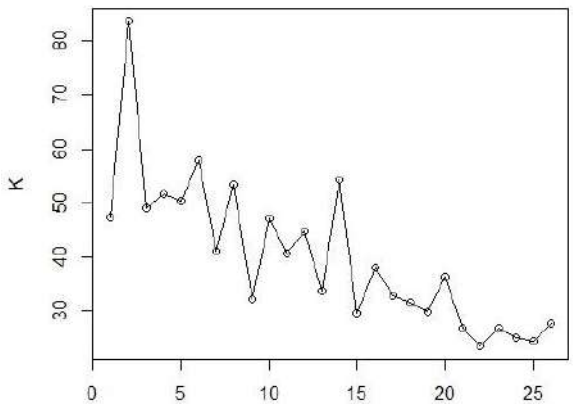

Fig. 4. The changes in the values of Yule's K (for 26 years).

The value of the index K varies in the range from 23.40 to 83.69 (and the value of 83.69 observed in 1993 should be considered an outlier, see Fig. 4 and 5). In general, we can say that the value of K decreases over the years (except 2006 and 1993).

Accordingly, it can be argued that the lexical diversity of the texts of in time is decreasing.

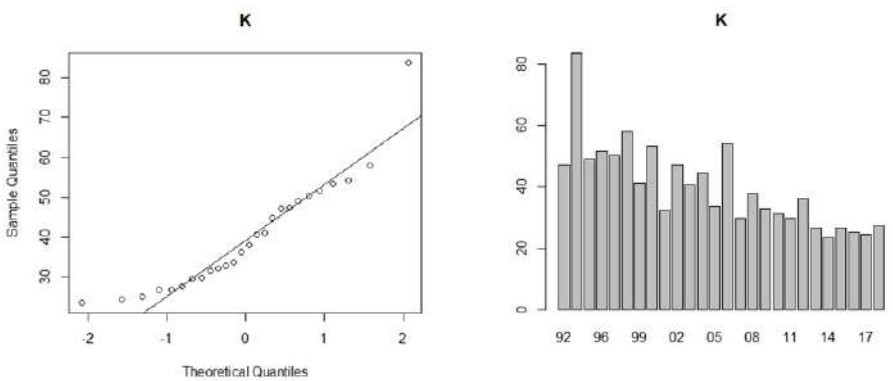

Fig. 5. Yule's K.

The calculation of hapax richness (the number of tokens that appear in the sample only once) and the proportion of hapaxes show that the share of hapaxes gradually

decreases, see Table 4, Fig. 6. However, the texts of 2006, 2008 and, to a lesser extent, 2007, 2005 and 2016 do not correspond to this general scheme.

Table 4. The number of hapaxes.

Year	N of Hapaxes	Year	N of Hapaxes
1992	2451	2006	3095
1993	2237	2007	4053
1995	3651	2008	2884
1996	3365	2009	3664
1997	3465	2010	4518
1998	3590	2011	5410
1999	3433	2012	5717
2000	2749	2013	6195
2001	3816	2014	5941
2002	3314	2015	6310
2003	4254	2016	6696
2004	4034	2017	7323
2005	4574	2018	6553

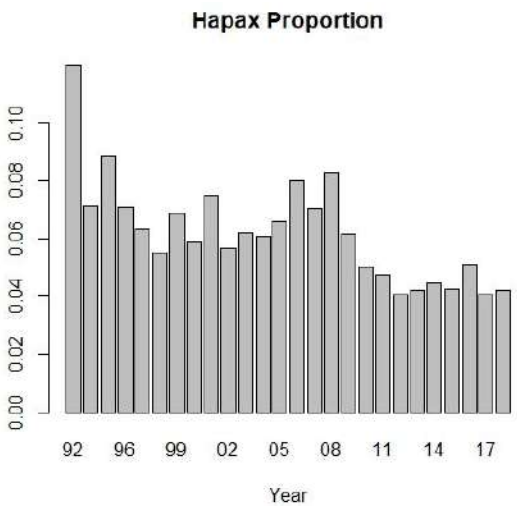

Fig. 6. The share of hapaxes

Thus, the share of hapaxes decreases over the years, the lexical diversity decreases over the years (texts have more and more repeating words). These two text evaluation options are easy to interpret in a consistent manner.

7 Conclusion

As a result of analyzing the corpus of Constitutional Court decisions we found out the following.

- MFW statistics shows that, in general, the texts before 2010 and after 2010 inclusive are clearly opposed.
- The texts of 1992 and 1993 are contrasted with all other texts (see, in particular, the clustering results after calculating the Euclidean distance on normalized token frequency). This can be explained by the fact that in 1994 the composition of the Constitutional Court was updated.
- The hapax proportion decreases over the years, the lexical diversity of texts also decreases.

If we apply the traditional approach to the interpretation of TTR values and derivative metrics, we can make a general conclusion that, since the lexical diversity is reduced and the proportion of hapaxes decreases, the texts become easier to read. Thus, our hypothesis of an increase in lexical complexity has not been confirmed.

There is an opposite approach to the interpretation of TTR values, we quote: "a lot of formal repetitions of the same words denoting legal entities and various legal terms interfere with the perception of the meaning of the sentence. In this case, we can say that reducing diversity not only does not simplify the text, but also causes the opposite effect" [5].

Legal texts use many repetitions. Though the presence of repetitions tires, it also allows to avoid problems with the interpretation of coreferential expressions. In addition, the process of text perception is affected by the priming effect (in particular, lexical priming).

Apparently, for the successful application of vocabulary-based measures for text complexity assessment, it is necessary to take into account at least some words' characteristics, that is, their semantics (first of all, abstractness/concreteness), their belonging to a certain part-of-speech class and general-language frequency.

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Text Complexity and Abstractness: Tools for the Russian Language

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Abstract. The article focuses on two parallel studies aimed at validating an original automatic tool (RusAC) designed to define the level of abstractness of Russian texts. The studies were conducted on: (a) the Russian Academic Corpus (RAC) compiled of the textbooks used in middle and high schools of the Russian Federation and (b) students' recalls of academic texts. The design of RusAC is based on the Russian Dictionary of abstractness / concreteness compiled by the authors in previous studies, which enlists abstractness ratings of over 88.000 tokens. The pilot studies pursued on the Russian Academic Corpus (circa 3 mln tokens) proved that the ratio of abstract words grows in textbooks of all disciplines across grades from 5 to 11. We also confirmed that the share of abstract words in Science textbooks is lower than that in the Humanities textbooks and that abstractness of readers' recalls is typically lower than that of the original text as the respondents tend to omit more abstract words than concrete. The findings of the research may be applied in a wide range of spheres including education, business, PR, medicine etc. as RusAC facilitates leveling texts for different categories of readers.

Keywords: Text Complexity, Abstractness, Concreteness, Textbooks.

1 Introduction

In modern Education leveling and profiling texts is viewed profoundly significant as graduated reading levels of text books build students' confidence and increase comprehension. The latter can be achieved only with the help of automated tools able to discriminate texts for readers of various reading literacy levels. "A computational approach to distinguishing texts offers researchers and educators a number of exciting avenues of interest" [1]. It is especially true about distinguishing abstractness/concreteness ratings of different texts which may serve as good predictors of text complexity [see 2, 3]. However, an automated tool able to compute texts abstractness and correlate it with text complexity has recently been a research niche. In this article we present the study aimed at validating an innovative automated tool RusAC designed and developed to assess a number of linguistic metrics

of Russian texts. The study was organized into three major parts: (1) design and development of a an automated tool (tagging program) that identifies abstract words in the texts; (2) validation of the tool through a computerized abstractness analysis based on the Russian Dictionary of abstractness/ concreteness and the tagging program.

Until now, in the absence of a dictionary of abstract / concrete words, quantitative studies of Russian texts complexity including assessment of abstractness of words have been either limited or impossible. In our previous work we presented the first version of a computer-generated Russian dictionary of concrete/abstract words (RDCA) [33]. The present study is the first research in which the authors apply the Dictionary to assess the complexity of texts. We also view a battery of school textbooks of a particular subject as a good Corpus, since the complexity of textbooks is expected to grow from class to class. The hypothesis of the current study is the following: if the number of abstract words grows from class to class, then the number of abstract words as a metric can be used in assessments of complexity of other text thus extending the sphere of applying RDCA.

2 Literature review

2.1 Psycholinguistic approach to concrete / abstract words

The notion of abstractness/ concreteness (hereinafter A / C) has been a focus of numerous studies [see 4] as the problem of discriminating concrete and abstract words is considered relevant in linguistics, psychology, education, etc. In the modern paradigm, the discrimination of abstractness / concreteness rests on the idea that concrete words denote referents experienced, primarily, through senses, whereas referents nominated with abstract words refer to ideas or concepts [5]. Psycholinguistic studies suggest a number of differences in processing concrete and abstract words [6, 7, 8, 9, 10]. Perception and acquisition of abstract words is hindered by lack of ‘word to world’ mapping, i.e. when comprehending an abstract concept a person may fail to make correspondences to real word phenomena (c.f. learning words ‘a car’ and ‘good’) [11, 12]. The latter argument was also supported in the study of specifics of acquisition and processing of abstract / concrete words by school children [9, 13]. The research shows that children take longer to acquire abstract words as compared to concrete ones even when it comes to high frequency words [14]. Due to this fact, P. Schwanenflugel infers that abstract words are harder for children to understand [14]. Moreover, when tested in a variety of lexical tasks, abstract words are found to exhibit slower reaction time and less accurate responses [15, 16, 17]. Similar conclusions are found in V. Marian’s (2009) studies who claims that concreteness is found to be a property facilitating words acquisition as concrete words are recognised and processed more rapidly [18]. Psycholinguistic experiments also indicate ‘that 75% of the words most frequently produced by school-aged children (6–12 years of age) are concrete and it is not until adolescence that children master the majority of abstract words used by adults’ [13].

2.2 The rating of abstract/concrete words as a text complexity parameter

Abstractness as a text complexity feature has been confirmed by a number of researchers viewing it as a text-related variable contributing to the difficulty of reading comprehension [19]. D. Fisher suggests that the fewer concrete words there are in a text, the higher is the text complexity [20]. While including abstractness into a list of features influencing text complexity, Petrie (1992) argues that 'the degree of abstraction (abstractness) is difficult to determine' [see 21]. Sadoski et. al. (2000) studied concreteness as a text feature that engaged readers' comprehension, interest, and learning in four text types: persuasion, exposition (Science and Maths), literary stories, and narratives (History and Social Studies). In the experimental study, 80 under-graduates read either three concrete or three abstract texts, further wrote an exposition and rated them for familiarity, concreteness, interestingness, and comprehensibility using 7-point bipolar scales. As a result the authors claim that concreteness was 'overwhelmingly the best predictor of overall comprehensibility, interest, and recall' [22].

In applied linguistics, the number of concrete / abstract words in texts is validated to strongly correlate with texts complexity as texts about abstract notions are more difficult to comprehend than texts about concrete notions. The correlation between abstractness and text complexity has been also demonstrated in the research of Russian scholars who conducted the study on separate academic texts [2, 3].

Presenting the results of his study of abstractness of over 20 Russian text-books on biology, geography, physics and chemistry, R. Mayer ranks them based on their complexity [23].

2.3 Methods and tools measuring the degree of word abstractness / concreteness

Many worldwide research aimed at rating words as concrete or abstract involve native speakers who are asked to use a numerical scale as an effective instrument to measure A / C [24, 22, 5, 25]. A well known dictionary of English words registering A / C ratings of 4000 English words, used in the MRC Psycholinguistic Datase, was compiled based on a 7-point bipolar scale [24]. The respondents participating in the study tagged each word with an A / C rating from seven (the highest) to one (the lowest). In such a way every word received a rating from 100 to 700. This dictionary is still used in much research on the English language and in cross-linguistic studies [26, 5, 27, 28, 29].

In another study aimed at defining the A / C ratings of 60,099 English words and 2,940 two word expressions (such as "zebra crossing" and "zoom in") Brysbaert et. al (2014) asked respondents to assess the abstractness/concreteness the meaning of each word is by using a 5-point rating scale designed from abstract to concrete [5]. Using the A/C numerical scale, Wang et. al. (2018) computed the degree of abstractness of Chinese words from the context-sensitive model of word embedding in rich contextual information. Word vectors for word distribution study were trained on Reader Corpus (Chinese Corpus). The authors 'built paradigms of A/C words' in two steps: (1) respondents' evaluation of 200 Chinese words as concrete or abstract using '– 1 / 0 / 1' scale, with '– 1' being the most concrete, '1' – the most abstract. (2) Extending obtained results by classification algorithm based on the corpus [25].

A similar online study was pursued for the Russian language in which respondents were asked to evaluate the C / A ratings of 500 most frequent Russian nouns on a 5-point scale. The C /A ratings of each Russian word were computed as an average of all the assessments received in the range from 1 to 5.

As the Dictionary data [24] and our estimates were computed based on different scales we also processed our estimates with the following formula: f (x) = 100 * (1.5 * ((6-x) - 1)) +1), where x is the value obtained in our survey. After this conversion, the index values range between 100 (the most abstract words) to 700 (the most concrete).

The findings, i.e. lists of words tagged with ratings of abstractness/concreteness are uploaded at https://kpfu.ru/tehnologiya-sozdaniya-semanticheskih-elektronnyh.html and a fragment of the intra-language comparative analysis of the ratings (based on the abovementioned scale) is presented in Figure 1 below [30].

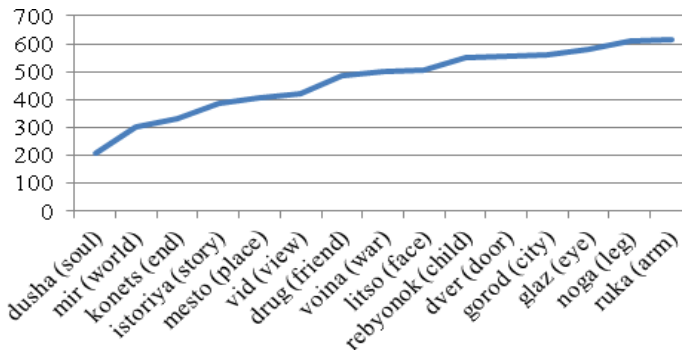

Fig. 1. A / C ratings of Russian nouns

Researchers designed and developed a number of text complexity software able to match texts with lists of abstract words [31, 32]. E.g., Coh-Metrix provides the average A / C ratings for content words in a text thus offering. However, replicating large scale studies aimed at assessing the level of A / C for the Russian language was lately a challenge as there was no automated tool defining rank of abstractness of Russian words. In our latest study we identified it, designed and compiled the Russian Dictionary of abstractness/ concreteness [see 33].

2.4 Russian Dictionary of Abstractness/concreteness

Creating a large dictionary of abstractness by computing interviewees' assessments is time and energy consuming. Therefore, the dictionary was compiled automatically based on a large corpus of texts, i.e. the Google Books Ngram package (https://books.google.com/ngrams). The fundamental ideas of the dictionary are as follows: (A) Abstract words are more often found along with abstract words, while concrete words are used more frequently with concrete words [37]. (B) We define the core comprising a certain set of words that are obviously abstract and another set which is obviously concrete and then expand it to the size of the dictionary selecting the entries based on (A). A detailed description of the method is provided in [33].

As a result we compiled a dictionary of 88.000 words available at https://kpfu.ru/tehnologiya-sozdaniya-semanticheskih-elektronnyh.html. The values of the concreteness / abstract index are in the range from -4.91 to 4.56 for nouns and from -4.01 to 5.33 for adjectives. The A / C index for verbs was not calculated in accordance with the tradition in Russian linguistics not to consider this semantic category for verbs. Fig.2 below shows a fragment of the dictionary.

21	girlyandy	garlands	4,04
22	sanki	sledge	4,04
23	stavni	shutters	4,00
24	polen'ya	logs	4,00
25	kolpachok	cap	3,94
26	rudnik	mine	3,94
27	galstuki	ties	3,89
28	stakanchiki	glasses	3,89
29	shtanga	bar-bell	3,89
30	komad	cabinet	3,89
31	kvadratik	square	3,89

Fig. 2. Russian Dictionary of abstractness/ concreteness (fragment)

The Dictionary provides researchers and testers with an instrument facilitating not only assessment of texts complexity but leveling and profiling texts for different categories of readers as well.

3 Analysis

The current study was pursued to answer three main research questions:

RQ1: How does the rating of abstractness change across the grades from elementary to high schools?

RQ2: How different or similar are the ratings of abstractness of textbooks on Humanities and textbooks on Science?

RQ3: How does the rating of abstractness of recalls differ from the ratings of abstractness of the original texts?

To answer the research questions we used the Russian Academic corpus, the Corpus of Recalls and designed an automatic tool defining abstractness of Russian texts.

3.1 Materials and methods

In this study we used the Russian Academic Corpus (RAC), a corpus of text-books used in elementary, middle and high schools of the Russian Federation [33]. As the corpus builders aim at collecting the best possible representative corpus and the list of school textbooks is non-exhaustive, RAC has been a work in progress for over four

years and by now reached the size of nearly 3 mln. tokens[1] (see Table 1 below). The books included are published between 2006 and 2020 and the body of the Corpus is divided into two sub-corpora: Science Sub-corpus (628920 tokens) and Humanities Sub-corpus (2105058 tokens). Both sub-corpora comprise textbooks specified in the "Federal List of Textbooks Recommended by the Ministry of Education and Science of the Russian Federation to Use in Secondary and High Schools". The choice of these particular textbooks was caused by a number of reasons: (a) the fact that the texts under study use minimum of non alphabetical symbols, graphs, figures etc., (b) the availability on the textbooks on the Internet (School textbooks and manuals, 2017). The detailed information on the size of the corpus is presented in Table 1 (below).

Table 1. The Size of Russian Academic Corpus

Grade	**Tokens**		
	Science	Humanities	TOTAL
1st	21304	4757	26061
2nd	29284	28235	57519
3d	53565	-	53565
4-th	51489	24621	76110
5-th	102467	19527	121994
6-th	-	159664	159664
7-th	75205	111788	186993
8-th	-	273251	273251
9-th	88335	390821	479156
10-th	207271	656072	863343
11-th	-	436322	436322
Total	628920	2105058	2733978

RAC contains 74 documents (textbooks) of all grades and disciplines and as such is considered a representative sample of the population of Russian school textbooks.

3.2 Corpus of Readers' Recalls

The Corpus of Students' Recalls was compiled as a side result of the study aimed at evaluating the impact of cohesion on readers' comprehension [35].

[1] A token is viewed in the work as an instance of a sequence of characters in some particular document that are grouped together as a useful semantic unit for processing. In this article it refers to the total number of words in a text, corpus etc, regardless of how often they are repeated. A type is the class of all tokens containing the same character sequence.

Of 289 respondents participating in the study we selected 65 with the General Knowledge index[2] ranging between 13 and 16. Those were 11-12 year old native Russian speakers. The subjects were individually asked to read one of the informational texts, MT53 (modified text for the 5th Grade #3) and OT53 (original text for the 5th Grade #3), both of about 200 words with which they had no previous experience. The texts were fragments of a Chapter from a textbook on Social Science 5 by Bogolyubov N.F. [36]. The recalls of the respondents were recorded by experts and assessed holistically on its relevance to the task and statistically: we computed the number of tokens and propositions in each recall. The total size of the corpus is 6473 tokens. As the Corpus is presented in 65 separate texts with the average number of words in recalls being 106.4 (MT53) and 92 (OT53) tokens we view the Corpus is representative enough. The statistics on the Corpus of Readers' Recalls and selected samples of recalls are uploaded at the site Technologies of electronic dictionaries' compilation, at https://kpfu.ru/tehnologiya-sozdaniya-semanticheskih-elektronnyh.html, last accessed 2020/17/05.

3.3 RusAC as the automatic tool defining abstractness of Russian texts

Text preprocessing (tokenization, etc.) is carried out with Russian TreeTagger (http://www.cis.uni-muenchen.de/~schmid/tools/TreeTagger/). RusAC processes texts for abstractness/concreteness and readability, which together allow the tool to estimate which of the texts processed is more difficult for comprehension. RusAC ensures the following functions: 1) automatic assessment of text complexity based on two descriptive parameters, i.e. length of words and length of sentences; text complexity is calculated based on the formula proposed in [38]; 2) assigning words in a text with an A/C rating from the dictionary; 3) saving the results of the analysis. RusAC performs the text analysis of texts saved as doc, txt, rtf files.

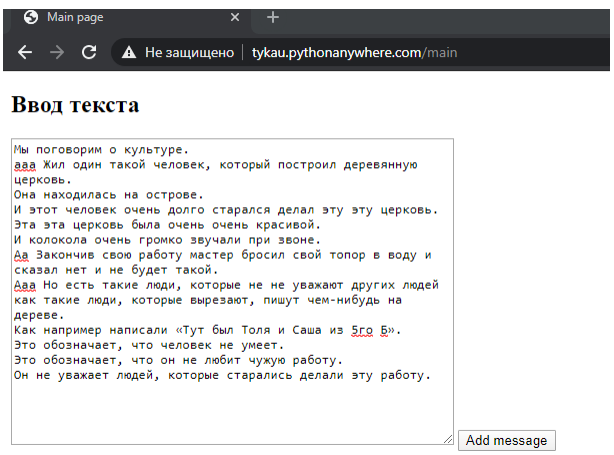

Fig. 3. The RusAC text input box

[2] Wechsler "General knowledge" Subtest for Children (WISC GK) as it is widely used to assess IQ to predict or explain school performance.

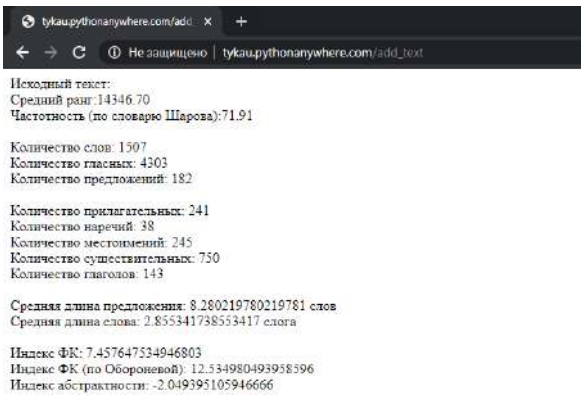

Fig. 4. The RusAC text output data

4 Results

4.1 Abstractness of school textbooks

In this study we performed a systemic study of abstractness of all the text-books in RAC grouped into the following sets: Primary school textbooks (30, grades 1-4), Middle school textbooks (19, grades 5- 8), High school textbooks (25, grades 9-11). The complete set of textbooks for secondary and high schools comprises 21 books on Humanities and 11 books on Science (Biology). The procedure for computing the mean index of concreteness is as follows: (1) we search the texts for the tokens registered in Russian Dictionary of Abstractness; (2) tag each token with the corresponding index from the Dictionary; (3) compute the average either for the book or for a set of textbooks, (a) in the first case the sum of the indices is divided by the number of tagged tokens in the book and (b) for the set of books the sum of the indices is divided by the total number of tagged tokens in those books.

Table 2. The A / C ratings in textbooks

Subject	Number of textbooks	Grade	Mean abstractness index
All Primary school	30	1-4	+0,34
Biology	7	5-7	+0,49
Biology	5	9-10	+0,15
History	7	10-11	0
Social Studies	7	5-8	-0,11
Social Studies	7	9-11	-0,15
Literature	5	6-8	+0,08
Literature	6	9-11	-0,14

The mean abstractness index (see column 4, Table 2) indicates the following: a) the highest index of concreteness is demonstrated by texts in Biology and primary school books: the concreteness of Biology textbooks for middle school is the highest with

+0,49 which is even higher than that of primary school texts which is +0,34 abstractness; b) The index of Social studies textbooks marks the highest level of abstractness of those texts; c) History books are located in the middle of the scale with the "0" score probably due to the fact of an equal incidence of concrete and abstract words. It can be explained by the fact that a pattern of History texts contains descriptions of some artefacts and narration of events which bear a high degree of concreteness.

In general, there is a statistically significant (p-value <0.001) dependence of the abstract index on the Grade level both for the entire collection of textbooks and separately for subcollections of Biology and Literature textbooks. In Social Sciences and History textbooks regularity is not significant.

4.2 Abstractness/Concreteness of Readers' recalls

The texts offered to the participants of the study for recalls, OT53 and MT53, bear similar average indices of A / C (see Tables 3). It was computed in the same way as the index of textbooks: all the words in the texts registered in Russian Dictionary of Abstractness received a corresponding tag with a rating, all the total sum of the ratings was divided into the number of tagged tokens in the text.

Table 3. OT53 and MT53 Data

Code	Word Count	Abst_index
MT53 Text	222	0,12
OT53 Text	210	0,17

Table 4. OT53 and MT53 Recall data analysis (fragment)

	Recall Code	Word Count	Abst_index
	K5P09	31	0.72
	K5P10	38	0,44
	K5P13	127	0,26
	K5P14	109	0,92
	K5P21	172	0,02
...			
61.	KC503	81	0,06
62.	KC506	46	0,29
63.	KC507	91	0,39
64.	KC508	129	0,07
65.	KC510	63	0,28
	MEAN		0,28

The same procedure was implemented for every recall. The results are presented in Table 4 and for the complete data visit the website of Technologies of electronic dictionaries' compilation, at [34].

As the table above demonstrates the average index of A/C for recalls is more than that of the source texts which confirms that respondents tend to omit more abstract words and keep the concrete ones in their recalls. As expected, 5th Grade students' recalls are simpler in terms of traditional metrics and the A / C index. The comparison of A / C indexes of the recalls and the source texts based on Student criterion confirms the hypothesis that the difference is statistically significant as the p-value equals 0.0003.

5 Conclusion

Abstract words as carriers of the notion of abstractness present a special interest for linguistics, psychology and pedagogy. In Natural Language Processing studies the problem is narrowed to designing and developing tools able to tag words in a text with the corresponding ratings of abstractness/concreteness. The tool evaluating the level of abstractness of Russian texts was a research and an engineering niche. The authors of the article created an automated tool, RusAC, performing computation of the index of concreteness/abstractness. The functions of RusAC are supported by the Russian Dictionary of Concrete and Abstract words with its total size of 88000 tokens compiled in our previous study. Implementation of RusAC on two representative corpora, i.e. Russian Academic Corpus and Corpus of Readers' Recalls, verified the hypothesis that the incidence of abstract words in a text impacts its complexity as they are taking longer to be processed by readers.

School textbooks were selected to test the proposed approach, since they are graded by levels of complexity from elementary to advanced. Collections of school textbooks are used in studies of various techniques for assessing text complexity in different languages in a number of works [39–43]. One of the most important issues is to select a battery of classroom books of the same author. This eliminates the influence of the author's style, concept or pedagogical attitudes on the texts of textbooks of different classes and allows to analyze textbooks of the same author for different grades focusing only in complexity.

The study also confirmed the highest index of concreteness of Science books and primary school books. The Humanities textbooks demonstrate the highest level of abstractness. The index of abstractness grows across grades one through 11. The findings are consistent with the earlier published hypothesis on the impact of abstract terms on text complexity and validate the designed tool. RusAC is freely available for all categories of users.

Currently, the index of abstractness is typically interpreted as a separate parameter calculated for texts but not included in the existing formulas of text complexity. In this way the index of abstractness compares various texts in this aspect without marking the level of text complexity.

The perspective of the study is viewed as extending the number of entries in RDCA and improving its quality. In the next stage of research, we plan to pursue a survey and text recall experiments with students of Grades 9-10 (15-17 years old), thus expanding the database and providing foundation to compare the level of abstractness of texts generated by schoolchildren of different grades.

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A Corpus-Based Study of Adjectives that Describe People

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Abstract. The computer methods were used in this article to study attributive constructions, namely, Russian adjectives that combine with the words *chelovek, muzhchina, zhenshchina*. The research was based on the Google Books text corpus. Besides, the Open Corpora morphological dictionary was used to automatically determine parts of speech of the words that contain in the obtained word combinations. Approximately 17 thousand adjectives were identified and classified into five groups. The center and periphery of the colour palette of the studied colour adjectives were identified. The analysis of the adjectives describing appearance and physical parameters of a person revealed the most significant body parts. The obtained data also allowed making a frequency portrait of a typical man and woman of the 19th and 20th centuries. It was also revealed how age is represented by adjectives in the Russian texts. Analysis of the opinion adjectives showed the most significant traits of character attributed to the words under study. Adjectives that describe physical condition, emotional state and social status demonstrated the most typical ones for Russian written culture. All the adjectives were analysed in terms of frequency. It was shown that most often the adjectives combine with the generic word *person*. As for the nouns *man* and *woman*, there are adjectives that combine more often with *woman* and never with *man* and vice versa. The diachronic analysis of the adjectives showed how their use in combination with the nouns under study can change with time and how it can respond to significant historical events.

Keywords: adjectives, attributive constructions, Google Books Ngram.

1 Introduction

Computational methods have been widely used in linguistics for the last several decades. This happens due to different factors. One of them is big data. Creation of extra-large text corpora such as Google Books or COHA allows one to use computational methods for linguistic studies. In this paper, these methods are used to study word combinability.

The problem of word combinability has been studied in linguistics for a long time. There are different views on the nature of combinability and the degree of its idiomaticity [1,2,3]. However, word combinability is semantically determined [4] and reflects how people perceive the surrounding reality. By studying lexeme combinability, one can reconstruct individual fragments of the linguistic worldview.

The issue of lexeme combinability has been investigated in various scientific papers. For example, attributive constructions are studied in [4,5]. Studies of colour terms have been also a productive field of research in terms of combinability [6,7].

This article studies attributive constructions, namely, Russian adjectives that describe the words *chelovek*, *muzhchina*, *zhenshchina* (person, man, woman). It was decided to study these constructions for the following reasons. Firstly, the fact of the anthropocentricity of the linguistic worldview has been known for a long time. However, it seems interesting to understand how a person perceives himself in the framework of this worldview and how this perception can change over time. Secondly, the word *chelovek* is a generic category and the words *muzhchina* and *zhenshchina* are basic categories. The basic level of categorization is the most significant one for the language since it is most fully reflected in the linguistic worldview [8]. Therefore, specific categories (e.g., names of professions and occupations, names of kinship, etc.) were not considered in the article.

Two Russian text corpora served as a study material. The first one is Google Books [9], the famous electronic library which contains millions of diachronically marked texts. The Russian sub-corpus of Google Books Ngram is based on the texts of 591 thousand books and includes more than 67 billion of words. This corpus is the largest one among other diachronic Russian text corpora. It contains data for the period 1607-2009. However, most of the texts were written within the last two centuries [9]. Google Books was used to identify attributive constructions and study the dynamics of their use. The second one is an electronic morphological dictionary Open Corpora [10]. Currently, this dictionary includes 391,268 lemmas containing 5,128,422 inflectional forms. Thus, it is one of the largest dictionaries of the Russian language. The second one is an electronic morphological dictionary Open Corpora [10]. Open Corpora was applied to automatically determine parts of speech of the words contained in these constructions. The LC system was used in the article to perform transliteration.

2 Method

The GBN corpus (the version of 2012) was used to find 2-grams of the *Adj+Noun* type. The nouns that combined with the adjectives were presented by forms of the words *person*, *man* and *woman* (there are 36 of such word forms, according to Open Corpora, including the suppletive form *liudi*). Since the POS mark-up of the GBN corpus contains a lot of errors [11], the Open Corpora morphological dictionary was used to verify parts of speech (adjectives). This also allowed us to exclude word forms with the ORC errors which often occur in the GBN corpus. Thus, 24504 2-grams were selected. These 2-grams contain 17183 adjectives of 3613 different lemmas. Lemmatization was performed based on the Open Corpora dictionary.

After that, data on frequencies of the selected 2-grams were extracted from the GBN corpus and total frequencies for each lemma were calculated. To present the graphs of the time series of the frequencies, smoothing was used with a Kaiser window (with the parameter β equal to 3.5) with a half-width of 3 years. The selected adjectives were analysed and classified manually.

3 Results

The automatic analysis allowed us to identify approximately 17 thousand forms of adjectives. In other words, different case-forms of the nouns *chelovek, zhenshchina* and *muzhchina* are described by 3613 adjectives (without considering the case-forms of the adjectives). Major part of the relative adjectives was not considered in the article and qualitative adjectives and the rest smaller part of the relative adjectives were classified (according to their semantics) for a more detailed description. There are various approaches to classifications of adjectives [12,13,14,15,16]. Based on these classifications and the obtained data, the adjectives were divided into five groups:

1. Colour adjectives (*belyi, raznotsvetnyi*).
2. Adjectives describing appearance and stature of a person (*kosmatyi, vysokoroslyi*).
3. Adjectives describing age and "temporal relevance" of a person (*molodoi, sovremennyi*).
4. Opinion adjectives (including adjectives denoting traits of character and abilities: *vydaiushchiisia, milyi, luchshii*).
5. Adjectives describing emotional and physical state of a person, his social status (*ustalyi, peshii, odinokii, bezdetnyi*).

However, it should be noted that the proposed classification is not strict, since the same adjective can belong to different groups depending on the context. The main objective of this work is not to analyse semantics detailly but to reveal language patterns and trends.

3.1 Colour

The first group included adjectives that denote colour and combine with the nouns under study. Most of them have a figurative meaning (including idioms), and not just name a colour of a person. If talking about colours, any object of reality has its colour. However, people talk about the colour of a particular object if its colour can change and is significant for a person [4]. The amount of colour adjectives combined with the considered words are relatively small. The analysis revealed the following adjectives: *chernyi, belyi, seryi, ryzhii, krasnyi, tsvetnoi, zheltyi, ryzhevatyi, zelenyi, goluboi, korichnevyi, sinii, rozovyi, raznotsvetnyi, chernen'kii, zolotistyi, prozrachnyi, bagrovyi* (they are presented in the frequency descending order).

The basic colours are at the top of the colour frequency list. *Belyi* (white) and *chernyi* (black) are used in 68 and 56 thousand of word combinations, respectively. They dominate over the other colours in the stated combinations making the centre of the colour palette. Moreover, if a comparison is made by gender, it is seen that these adjectives are more often used with the word *zhenshchina*. The adjective *seryi* (grey) follows white and black in the frequency list. However, it combines with the words under study only in 6300 cases. The word combination *seryi chelovek* (grey person) in its generic sense is used more often than the other combinations. *Seryi* (grey) combines with the word *zhenshchina* only in 187 cases and the combination *seriy muzhcjina* (grey man) was not found in the corpus. The adjective *ryzhii* (ginger) traditionally used to describe people was found in 6000 cases.

The adjectives *krasnyi* (red) and *tsvetnoi* (coloured) are used in 2559 and 2446 cases, respectively. It should be noted that sometimes the word *krasnyi* means beautiful and there is a word combination *tsvetnaia zhenshchina* but there is no combination *tsvetnoi muzhchina* (coloured man) in the Russian corpus. *Zheltyi* (yellow) occurs in 1200 cases and does not combine with the word *muzhchina*. Starting from *zelenyi* (green), the use of colours in the studied word combinations significantly decreases. *Zelenyi* is used in 766 cases, mostly with the word *chelovek* and never with the word *muzhchina*. *Goluboi* ((light blue) (663 cases)), *korichnevyi* ((brown) (487 cases)) and *sinii* ((blue (409 cases)) can combine with a *person* but not with *man* or *woman*. The adjective *rozovyi* (pink) is used in 344 cases and can combine with all the words under study. *Raznotsvetnyi* ((multicoloured (328 cases)) and *chernen'kii* ((blackish (196 cases)) combine with *chelovek* (person) and *zhenshchina* but not with *muzhchina*. There is no word combination *nebelyi chelovek* (not white person) in the corpus.

Without going into details of semantics, it can be concluded that the core of the colour palette in this context is represented by the basic colours *chernyi* and *belyi* (black and white), closer to the center are *seryi* and *ryzhii* (grey and ginger). *Krasnyi*, *tsvetnoi* and *zheltyi* (red, color and yellow) are the periphery of the palette, and the remaining colours are the periphery of the periphery. Moreover, colour adjectives are more often used with the generic word *chelovek* than with the other words under study. The use of colour adjectives is influenced by the gender of the nouns they combine with. This is due to word semantics and perception of the world.

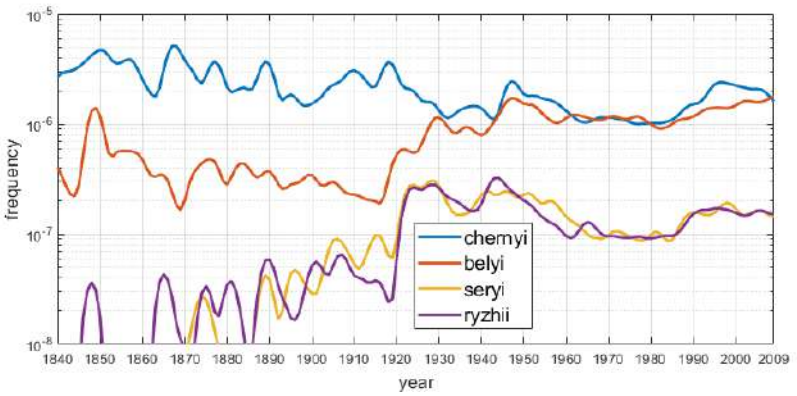

Fig. 1. Frequency dynamics of the colour adjectives

The dynamics of the most frequent colours combining with the studied words was analysed. It was shown that conventional colours are naturally appear at earlier time intervals. The black colour always dominate over the rest ones. However, a small decrease of its frequency is observed. Frequency of *belyi* (white) has been growing after 1920. A smooth growth of *seryi* (grey) with a peak in the 30s of the 20th century is observed, then it decreases slightly and stabilizes. The word *ryzhii* (ginger) that describe the nouns under study, appeared later than the other frequently used colours.

Its use grows until the 40s of the 20th century and only slightly decreases by modern time. Dynamics of the most frequent colour adjectives is shown in Figure 1.

3.2 Appearance and stature

The corpus contains approximately 400 adjectives that describe appearance and stature of *person*, *man* and *woman*. *Person* is essentially an object name. Therefore, it is not surprising that the list of 100 most frequent words of this group included adjectives that describe a person`s stature (*tolstyi, khudoi, sutulyi*), size and height (*nebol'shoi, prizemistyi*) and colour of body parts (*chernokozhii, chernoglazyi*).

The analysis of this group of words showed that it includes a list of adjectives that describe a person`s body parts or indirectly relate to them (for example, *lysyi* (bold) means a person who lacks hair).

One of the tasks was to reveal which part of the human body is the most productive one for the adjectives that describe the studied nouns. It was found that the most significant part of the human body in this case was hair, its color, condition and its presence/absence. *Sedoi* (grey-haired) and *lysyi* (bold) were the most frequently used adjectives. They are followed by the adjectives that include the word *boroda* (beard) and describe its presence/absence and colour.

It is interesting that the word *sedoi* (grey-haired) is used twice as frequently with *zhenshchina* (woman) than with *muzhchina* (man). *Lysaia zhenshchina* (bold woman) were not found in the corpus but the combination *borodataya zhenshchina* occurs in 540 cases. Human eyes are the second "productive" body part. The eye colour is the most relevant feature. The list of eye adjectives includes words that denote the number of eyes (*odnoglazyi, bezglazyi*), their form and shape (*pucheglazyi, uzkoglazyi, kosoglazyi*). It should be noted that the group of adjectives that has the word *eye* included some adjectives with figurative meaning such as *ostroglazy* and *bystroglazyi*.

There are also many adjectives describing a person`s skin and face. Complexion is described more often (*blednyi, rumianyi, zheltolitsyi*). The face itself is most often described in terms of form and shape (*shirokolitsyi, uzkolitsyi*). There are 11 adjectives including the word *nose*. The most frequent of them are *gorbonosyi, nosatyi, kurnosyi, dlinnonosyi*. The list also included the words describing moustache, shoulders, legs, head, cheeks, cheekbones, chest, forehead, eyebrows, teeth, stomach, arms, lips, color, hips, and even tail and balls.

A person`s appearance can be described using different language means and constructions. One can say *bol'sheglazyaya zhenshchina* (a big-eyed woman) or *u zhenshchina bol'shie glaza* (the woman has big eyes). However, the analysis of the given attributive structures showed that hair, eyes, skin, complexion and nose are the most significant when describing people.

If one takes into account the frequency of the given attributive constructions, the prototypical man and woman will look as follows in the 19th and 20th centuries (see Table 1). The numbers in Table 1 denote the percentage from the total number of word combinations that include the words *man* and *woman* and one of the adjectives from the “appearance and statute” group.

Table 1. Frequency portraits of *man* and *woman* in the 19th and 20th centuries

Man	XIX, %	XX, %	Woman	XIX, %	XX, %
Sedoi	1,04	4,39	Sedaja	0,65	9,26
Tolstyi	7,80	3,59	Golaja	11,18	8,58
Khudoi	2,30	3,04	Tolstaja	14,92	8,58
Krepkii	0,15	6,87	Hudaja	6,60	4,73
Borodatyi	9,51	8,83	Krupnaja	0,42	2,61
Krupnyi	0,97	5,20	Hudoshhavaja	6,60	2,63
Khudoshchavyi	8,77	4,51	Smuglaja	2,01	2,45
Plotnyi	20,80	6,78	Blednaja	6,76	2,90
Smuglyi	4,23	1,56	Nizkaja	2,73	0,32
Lysyi	0,37	2,65	Chernovolosaja	1,82	2,67
Tuchnyi	2,15	1,73	Belokuraja	3,31	3,12
Chernovolosyi	2,97	1,49			
Usatyi	0,30	3,00			
Plechistyi	3,79	2,29			
Zdorovennyi	4,53	2,50			

3.3 Age and "temporal relevance"

Age and time are important categories for human beings since perception of the world is limited to certain time periods. The third group included adjectives denoting specific age of a person (*deviatiletnii* (nine years old)) and adjectives that indicate a person's position on the timescale (*drevnii, sovremennyi, molodoi, pozhiloi, vzroslyi* - ancient, modern, young, old, adult). The most frequent adjectives were *molodoi, pozhiloi, vzroslyi, sovremennyi, staryi, drevnii, nemolodoi, prestarelyi.* If not considering the words *molodoi/pozhiloi* (young/elderly), the scale of a person`s perception in Russian culture is shifted to an older age (according to this list).

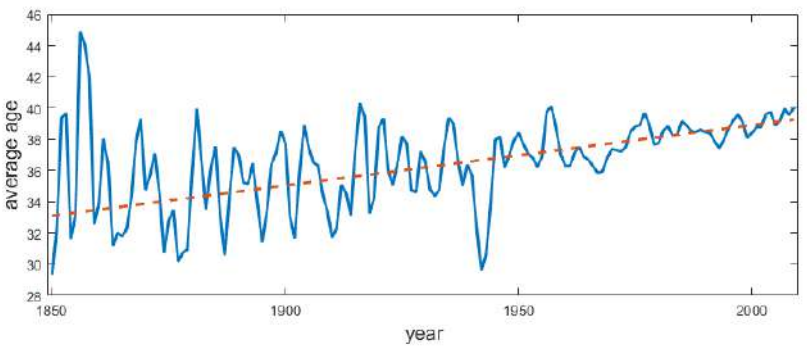

Fig. 2. Dynamics of the average age described by the adjectives

The most frequent and, therefore, most significant age adjectives attributed to the nouns under study were *sorokaletnii* (40 years), 30 *tridtsatiletnii* (30 years), shesti-

desiatiletnii (60 years), *piatidesiatiletnii* (50 years) and *dvadtsatiletnii* (20 years). The following ages are mentioned in the frequency descending order 70, 45, 25, 10, 80, 26, 22, 27, 7, 5, 19, 12, 18, 90, 23, 42, 24, 28, 4, 3, 15 and 9.

Age adjectives dynamics was analysed from quantitative and qualitative point of view. The frequency use of adjectives describing a specific age of a person was quantified (see Fig.2). It was shown that a person`s average age increases in the texts. This can be due to the increasing life expectancy and general changes in perception of human age.

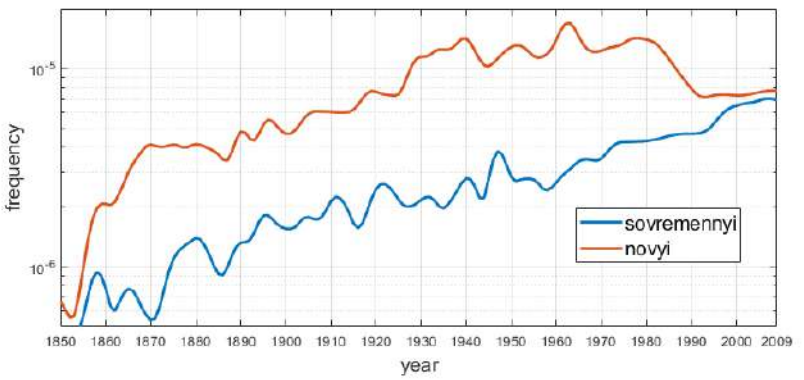

Fig. 3. Frequency dynamics of the time adjectives

If talking about qualitative dynamics of the adjectives, the graphs of the adjectives *sovremennyi*, *novyi*, *griadushchyi* seem to be interesting (see Fig.3). The frequency of the adjective *sovremennyi* has been increasing since 1850. This may indicate that modern people who live in the time of constant modernisation do not evaluate the progress as something unconditional and clearly contrapose themselves to the past generations on the timescale. The adjective *novyi* (new) has a general tendency to increase and shows a peak in the mid-1960s, slightly decreasing since that time and reaching a plateau in the early 1990s. Such dynamics can probably be due to political trends in the country. The idea of a new man (person) is widely discussed in the time of the abolition of serfage, the October revolution, the Great Patriotic War and the Reconstruction. However, this idea becomes less acute after the Reconstruction. The adjective *griadushchii* (upcoming) came into use after the revolution. It is less frequent than the two previously discussed adjectives of this group. However, its dynamics clearly responds to political events in the country. The peaks are observed after the revolution and after the end of the Great Patriotic War. Its smooth growth has been observed since 1980s, the time of new political trends in the USSR.

3.4 Opinion adjectives

Opinion adjectives is the largest group of words that combine with the nouns under study. Opinion adjectives can have either positive or negative connotation and de-

scribe different aspects of a person. For example, his mental abilities, ability to percept new information, inner world, attitude to other people and others. The group of opinion adjectives included adjectives reflecting subjective opinion about a person and describing a person`s traits of character.

The most frequent opinion adjectives are *dobryi, khoroshii, umnyi, zamechatel'nyi, poriadochnyi, sil'nyi*. All of them denote positive traits of character. The word *dobryi* (kind) heads the list of a person`s traits of character. It combines with the word person approximately 260 thousand times. It seems interesting to mention that the combination *dobraia zhenshchina* (kind woman) was found in 17 thousand cases but the word *dobryi* combines with the word *muzhchina* only in 843 cases. In other words, kindness as a trait of character is typical of Russian people (in general sense). However, kind man is not a typical word combination in Russian. The same situation is observed with the adjective *khoroshii* (good) which is also at the top of the list.

The most frequent adjectives with negative connotations are *zloi* (malicious), *plokhoi* (bad) and *glupyi* (silly). Moreover, these adjectives combine with the word *zhenshchina* several times more often than with the word *muzhchina*.

In general, opinion adjectives combine with the word *zhenshchina* more frequently. However, a short list of opinion adjectives which combine only (or more often) with the word *muzhchina* were extracted from the corpus. They are *sil'nyi, chestnyi, trudosposobnyi, vidnyi, rabotosposobnyi, strastnyi, stepennyi, respektabel'nyi, zhelchnyi, impozantnyi, bravyi, razviaznyi, galantnyi, frantovatyi* etc.

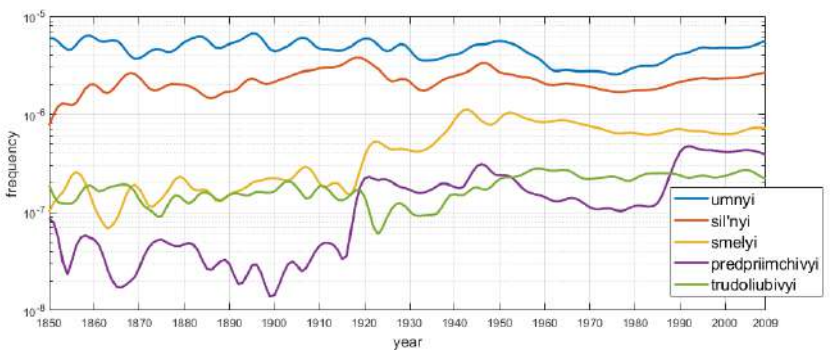

Fig. 4. Frequency dynamics of the opinion adjectives

The following results were obtained during the diachronic analysis of the opinion adjectives (see Fig. 4, 5). The general trend of the words *umnyi* (clever) and *sil'nyi* (strong) does not show high peaks. However slight growth of their use is observed in the war and post-war times when strength and ingenuity are relevant.

The frequency of the word *smelyi* shows sharp increase after the October revolution, reaches the peak in the time of the Great Patriotic war, slightly decreases and reaches the plateau. In other words, its frequency grew during significant political events and is still high today. The adjective *trudoliubivyi* (hard-working) is most frequently used in the war and post-war times when the destroyed country had to be

restored by all means. This word is still frequent at the beginning of the 21st century because the idea of personal success becomes very important at this time and no success can be achieved without one's own efforts.

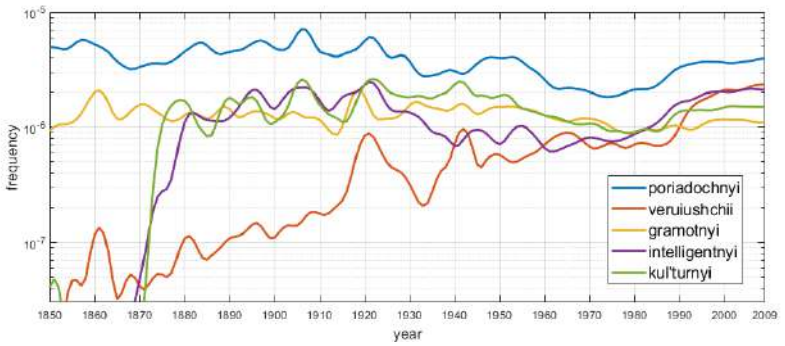

Fig. 5. Frequency dynamics of the opinion adjectives

The rapid growth of the word *predpriimchivyi* (enterprising) is observed after the revolution and has two large peaks - in the post-war period and the beginning of the 1990s, responding to social events in the country.

The graph of the word *veruiushchii* (believer) is also interesting. In general, its frequency grows. The peaks are observed in the post-revolutionary period and during the Great Patriotic War. Its frequency has been growing rapidly since the 1990s of the 20th century. In other words, the issues of belief are very acute in the period of social cataclysms and after the collapse of the USSR.

According to the corpus, the words *intelligentnyi* (genteel) and *kul'turnyi* (cultured) appeared in the Russian texts at the end of the 19th century. After the 30s of the 20th century, there is some decrease in the frequency of the adjective *intelligenthyi* which can probably be due to bourgeois perception of intelligence. However, its frequency starts growing after the 1980s. The word *kul'turnyi* has a similar graph. The adjective *gramotnyi* (literate) has a peak after the revolution since this issue becomes relevant in connection with the fight against illiteracy. The frequent word *poriadochnyi* (trustworthy) shows increase in the years of the October revolution, post-revolution and the wartime. Then, there has been some decrease since the 60s and the frequency has been growing since the 90s of the 20th century.

Summing up, it should be said that significant social and political events can influence the presentation of a person`s traits of character and his perception in written texts.

3.5 Emotional and physical condition/social status

Adjectives that describe emotional and physical condition of a person and his social status were included in this group. The most frequent adjectives were *zdorovyi, svobodnyi, bol'noi, odinokii, semeinyi, mertvyi, p'ianyi, bezdetnyi* etc.

The adjectives *schastlivyi/neschastnyi* (happy/unhappy) are also among them. At that, *schastlivyi* is used almost twice as much as *neschastnyi.* It is also interesting to mention *that schastlivyi/neschastnyi* combine with *woman* several folds more often than with *man*. There are 8 derivatives of the word *schastlivyi*, three with positive and five with negative connotations. However, total frequency of the words with positive connotation is higher.

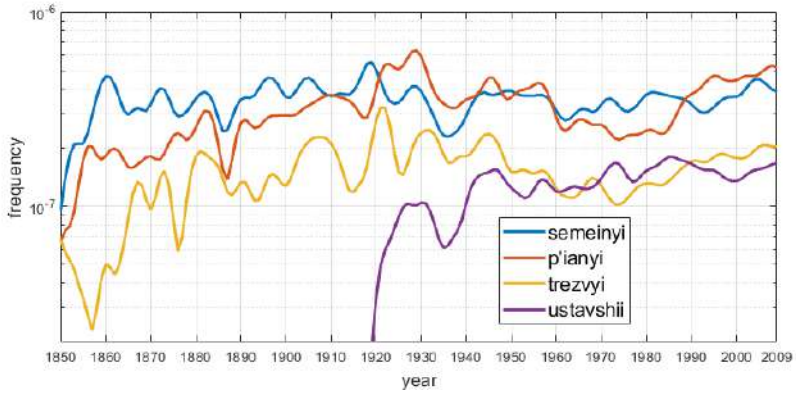

Fig. 6. Frequency dynamic of the emotional/physical condition and social status adjectives

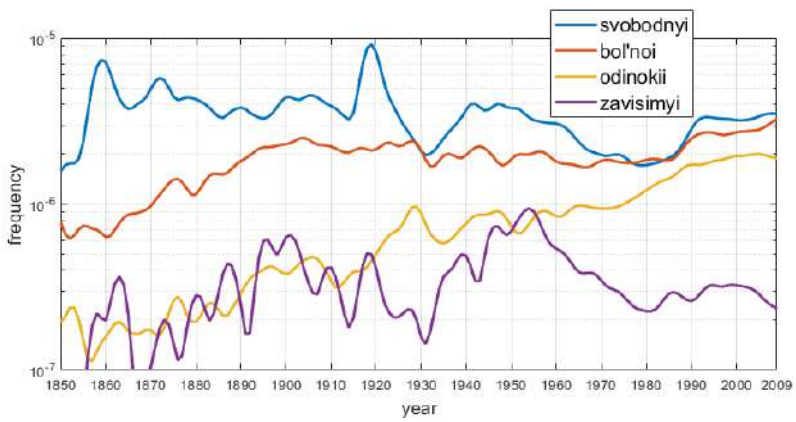

Fig. 7. Frequency dynamics of the emotional/physical condition and social status adjectives

The diachronic analysis of the most frequent and interesting (in our opinion) adjectives (see Fig. 6, 7) allowed us to obtain the following results. The issue of drunkenness has always been acute in Russia. Since 1980, there has been a consistently high use of the word *p'ianyi* (drunken). One frequency peak of this adjective is observed in the late 20s of the 20th century and two peaks are observed in the post-war period. The frequency of *p'ianyi* decreases between the 60s and 80s of the 20th century when the government struggles against alcoholism in the USSR. However, the frequency tends to grow after this period.

The graph shape of the antonym *trezvyi* (sober) resembles the one of *p'ianyi* but it differs at the end of the 1920s. In other words, the amount of *trezvyi* becomes less with the growth of *p'ianyi*. Besides, it should be noted that *trezvyi* can have figurative meaning. The adjective *semeinyi* (married) has always been acute for Russia. However, there is a gap in the mid-30s of the 20th century. The adjective *ustavshii* (tired) describes a person`s physical state. It has appeared in the corpus since 1920 and its frequency tends to grow. Thus, men and women become more tired in the texts.

The adjective *svobodnyi* (free) often combines with the given nouns. Its frequency peaks are observed in the late 50s and early 60s of the 19th century (when the issue of the abolition of serfage was acute), during the revolution of 1917 and the Great Patriotic War, as well as in the early 1990s when human rights and freedoms were widely discussed in the USSR. The frequency of the adjective *bol'noi* (ill) tends to grow in the combination with the given nouns. After the 1990s, it increases even more. It is also interesting to mention that frequency of the word *odinokii* (lonely) has a general trend to grow. The frequency peak is observed at the end of the 1920s and a its steady growth has begun since 1970s. The graph of the adjective *zavisimyi* (dependent) is heterogeneous and shows peaks in different years. The highest of them are observed in the period of the October revolution and the mid-1950s.

4 Discussion

The article is based on a computer method of processing big data which has been widely used for the analysis of text corpus data. The problem of combinability was studied in [4] and [7]. Studies of collocability of specific words was performed in [17]. This article studies a combination of the *Adj.+Noun* (man, woman, person) type.

Adjectives have always been interesting for linguists. Different semantic classifications of adjectives have been introduced in [14, 16]. The obtained adjectives were divided into 5 groups in this work. However, it should be noted that any classifications can`t be strict as the language itself.

The obtained data show us one of the facets of linguistic perception of a person in Russian culture. Moreover, this perception is associated with gender differences. Some adjectives combine only with man and (or) woman. Reflecting the realty, the use of the studied constructions can correlate with significant social or political events which happen in the country.

5 Conclusion

The article studied attributive constructions using computational methods. Namely, Russian adjectives that combine with the word forms of *person*, *man* and *woman* were considered. The Google Books text corpus served as a study material. The Open Corpora morphological dictionary was used to verify parts of speech.

There were approximately 17 thousand adjectives obtained during the analysis which were divided into 5 groups. The center and periphery of the colour palette of the studied colour adjectives were identified.

The analysis of adjectives describing appearance and physical parameters of a person showed that hair, eyes, complexion, body skin, face and nose are significant for the Russian culture while describing a person`s appearance. The obtained data allowed us to make a frequency portrait of a typical man and woman of the 19th and 20th centuries.

Dynamics of the age and time adjectives was analysed and showed increase in person`s average age, in other words the timeline of human perception shifts to the right in the Russian culture.

The largest group was opinion adjectives. Adjectives with positive connotation were at the top of the frequency list. According to the corpus texts, the perception of a person in Russian culture is positive. The adjective *dobryi* (kind) is the most frequent one in this group. Some gender differences in the use of the adjectives were revealed.

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Topic Modelling of the Russian Corpus of Pikabu Posts: Author-Topic Distribution and Topic Labelling

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Abstract. The paper discusses development of a corpus of Russian posts with hash tags based on Pikabu social network. We developed a balanced and representative corpus as regards the impact of certain authors, the amount and size of their posts. Our study is aimed at the development of probabilistic topic models revealing the authors' interests and preferences, as well as correlation of topics within the corpus. We performed a series of experiments including standard LDA topic modelling and Author-Topic modelling. In course of topic modelling we used algorithms from Python libraries. Experiments allowed to extract groups of authors with similar and related interests. We used topic label assignment based on manually introduced hash tags and labels automatically extracted from the lexical database RuWordNet. That facilitates linguistic interpretation of results.

Keywords: Social Networks, Pikabu, Russian, Topic Modelling, LDA, ATM, Topic Label Assignment

1 Introduction

Information environment gradually penetrated into our daily life, and the growth of network devices gave rise to a peculiar virtual world with its own rules of digital discourse. Communication within the virtual world is governed by technical equipment of «speakers» and «listeners», the texts created by the digital discourse exhibit the features of various types and forms of speech, the roles of «speakers» and «listeners» turn out to be diversified, communication in itself becomes spectacular, it requires reinforcement by visual content. Therefore, the study of digital discourse should combine methods of cognitive linguistics, content analysis, computational linguistics, sociology and adjacent fields of knowledge.

At present the attention of computational linguists and sociologists is focused on multilevel analysis of social media texts, the core tasks to be solved in empirical stud-

ies being author profiling [1, 2, 3] and topical analysis of online communities [4, 5, 6]. These tasks require corpora collection from web-sources and software elaboration. Proper linguistic processing of social media corpora opens wide opportunities for studies of social opinion and Russian web discourse, cf. recent publications of E. Koltsova and colleagues, LINIS HSE [4] and SCILA [5]; T. Litvinova and colleagues, RusProfiling Lab [6]; S. Bodrunova, I. Blekanov and colleagues, Web-Metrics Research group, SPbSU [7], etc.

Our present study is devoted to the creation and processing of the social media corpus containing posts of various authors from the social network Pikabu [8] which has not been properly investigated. Pikabu is a Russian language community founded in 2009 which is considered as an elaborated analogue to Reddit [9]. The rise of attention to Pikabu was caused by the famous meme Zhdun which flooded social media in 2017. The attractiveness of Pikabu as a source of linguistic data is explained by the medium size of posts (they are not so brief as in Twitter) and by the abundance of the users' hash tags indicating the subject matter of the posts.

Most corpora developed for Russian social networks use Twitter, LiveJournal, Facebook, VKontakte as sources of textual data, e.g., Taiga social network segment [10], GICR [11], Twitter sentiment corpus [12] and the like. Such social media corpora are used for elaboration and evaluation for NLP algorithms, models and tools, cf. Dialogue Evaluation Competition [13]. Social media provide a huge platform for studying topics, opinions, discourse structure of web-communication, that requires corpus-based linguistic resources: lexical databases, sentiment lexicons, formal ontologies, etc. Nowadays predictive distributed word representations are in great demand for text classification, collocation and construction analysis, that's why research community welcomes access to word2vec embedding models pretrained on various text corpora, and social media corpora as well (cf. RusVectōrēs [14]). In the previous work we described and evaluated word2vec models for Pikabu [15] which prove to be useful for further studies of the given source.

In course of experiments we process a newly developed dataset of the Russian Pikabu corpus by means of state-of-the-art algorithms and NLP tools. That gives us the opportunity to form a baseline for further elaboration of our methodology. For the first time we carry out experiments on author-topic modelling of the corpus and obtain data on thematic coherence of posts and on authors' covert clusters. The novelty of our study consists in thorough linguistic interpretation of topic models strengthened by topic label assignment which takes into account hash tags introduced by the authors as well as labels automatically extracted from RuWordNet [16] lexical database. Thereby, our research fills in the gaps existing in contemporary Russian corpus linguistics and social media analysis.

2 Topic Modelling

In recent years we witness the rise of interest in the development and application of topic modelling as a research procedure for data mining and content analysis [17, 18, 19]. In fact, topic modelling is a variety of fuzzy clustering performed for words and

documents, latent semantic relations within a corpus in this case being described in terms of a family of probability distributions over a set of topics [20, 21, 22].

Early versions of topic models were based on algebraic transformations, e.g. classical Vector Space Model (VSM) and Latent Semantic Analysis (LSA), which take into account term-document distribution, term co-occurrence frequency, and may be expanded with dimensionality reduction techniques, e.g. Singular Value Decomposition (SVM). Gradually these models gave way to probabilistic topic models, the most notable of them being Probabilistic Latent Semantic Analysis (PLSA), Latent Dirichlet Allocation (LDA), Expectation-Maximization (EM) Algorithm, etc.

Probabilistic topic models are based on the assumptions that ordering of words within documents and documents within a corpus may be ignored; frequent and rare words do not affect the quality of the topic model; a topic t should be considered as a discrete distribution over a set of words w, and a separate document d as a discrete distribution over a set of topics t; the occurrence of words in a document d is determined by a particular distribution $p(w|t)$.

In our study we use a topic model which is based on Latent Dirichlet Allocation, our choice is explained by the advantages of LDA compared with previously developed methods, as well as its availability in a set of libraries, including gensim [23] and scikit-learn [24] for Python.

Topic modelling allows to build multimodal models which include metadata alongside with intrinsic features of a corpus, e.g., polylingual models for information retrieval, temporal models taking into account the time of document creation, author-topic models which include authorship parameter. The latter type of topic models satisfies the conditions of our experiments.

The Author-Topic model (ATM) [25] may be considered as a refined extension of LDA, combines a topic model reproducing relations between words, documents and topics, and an author model describing relations between documents and authors. In recent years ATM is often used in linguistic and sociological studies, especially in the tasks of user profiling (age and gender detection [26, 27]) and authorship attribution [28, 29, 30].

3 Development of a corpus of Pikabu Russian posts

3.1 Corpus collection

The corpus of Pikabu Russian posts includes texts downloaded from Pikabu social network. Collection of posts was carried out with the help of Pikabu parser adapted from [31]. The parser was developed for Python 3.7 [32] and maintained with lxml [33] and requests [34] libraries.

We improved the original parser by adding the option of arranging posts as regards their authorship. We also added an option of post filtering: deletion of non-Russian texts, images, media-content, punctuation marks, etc. Html-pages parsing was performed by means of BeautifulSoup library [35]. We parsed no less than 100 posts for each author, so preliminary selection of the most productive authors was necessary. We took into account productivity ratings [36] which were published in 2017−2018

but still preserved their actuality in 2019. The parsed posts were ordered from the latest (2019 – end of 2018) to the earliest (middle 2018 and further). Each post was saved in a *.txt file, its name containing the author's ID. Joint data about the authors being saved in a separate document. After preprocessing the corpus size turned out to be 2 161 681 tokens, the total number of texts being 3 059, maximum number of texts for a single author – 100, minimal number of texts for a single author – 16. Some of the authors fell out of the final list of Pikabu users as they posted texts in the image format, e.g. *Oblomoff* (cooking recipes in JPEG) и *IriskaVRF* (comics/pictures).

3.2 Corpus processing

Corpus processing included tokenization, lemmatization and stop-word removal was performed by means of spaCy [37] and pymorphy2 [38] libraries. We modified standard stop-word list by adding Wiktionary data [39] which was parsed by means of BeautifulSoup library [35] in order to extract interjections, pronouns, particles, prepositions, parenthetic expressions, numerals. We added proper names and pejoratives into a stop-word list. All in all, the size of a stop-word list is 1400 items. After stop-word removal the corpus size reduced to 1 144 812 tokens which constitutes about 53% of the initial corpus size.

Before topic modelling we detected bigrams and trigrams in the corpus. In most cases topic models are designed as unigram models which don't take into account regular syntagmatic relations in contexts. At the same time such models may fail to reflect lexical constructions (collocations and idioms) which are broken into separate lemmata, the content of the whole phrase being lost [40, 41]. That's why we came to a conclusion that in the process of topic model development bigrams and trigrams with frequency more than 20 should be added into the dictionary of the model. In our case retrieved n-grams turned out to be frequent functional set expressions, e.g. *любой_случай, всякий_случай 'any_case'*, etc., that's why only a few of them occurred among top 10 topic words in the output.

We also compressed the dictionary by omitting high- and low-frequency items, so that the final size of the corpus turned out to be 8320 tokens in 3059 documents of 39 authors.

3.3 Hash tag analysis

Alongside with posts we parsed users' hash tags which could facilitate linguistic interpretation of the topics generated by our models. We selected three most frequent hash tags for each author, e.g. *видео 'video'*, *мое 'my'*, *длинностекст 'long-text'*, *длиннопост 'long-post'*, etc.; hash tags duplicating users' names: *varlamov, mtd, goodmix*, etc.

While processing frequent hash tags we joined semantically correlated hash tags which could possibly introduce a single topic, e.g.: *авторский рассказ 'author story' → рассказ 'story'; строительная история 'building story' → строительство 'building'; кулинария, рецепт 'cooking, recipe'→ кулинария 'cooking'*, etc. In cases of low interpretability of hash tags we borrowed topic labels from the community titles: e.g. the user *Region89* [42] uses the hash tag *bash im* as the most frequent one,

instead of it we labeled his posts by group names *Истории из жизни 'Life stories'*, *Лига диетологов 'League of nutritionists'*, etc. In some cases hash tags admitted generalization: e.g. country → continent: *США, Канада 'USA, Canada'* → *Северная Америка 'North America'*; *Бразилия, Латинская Америка 'Brazil, Latin America'* → *Латинская Америка 'Latin America'*; *Уганда, Руанда 'Uganda, Rwanda'* → *Африка 'Africa'*, etc.: hyponym → hypernym: *андроид 'android'*, *ios* → *телефон* '*telephone'*; *супергерой, комиксы 'superhero, comics'* → *комиксы 'comics'*, etc. The given hash tag transformations were necessary for evasion of false diversity of topics which could complicate data analysis. Resulting correspondencies are illustrated in Table 1.

Table 1. Examples of authors' hash tags

Author	Number of posts	Hash tags
MadTillDead	100	*Рассказ, офис 'Story, office'*
smile2	100	*История, жизнь 'Story, life'*
CreepyStory	100	*Крипота, страшные истории 'Creep, horror stories'*
AnnrR	96	*Строительство, работа 'Building, work'*
dr. Doctor	22	*Женский бред, форум 'Women's raving, forum'*
Brahmanden	100	*Кулинария, Одесса 'Cooking, Odessa'*
alekseev77	70	*Автосервис 'Car service'*
DoctorLobanov	100	*Медицина, рассказ, война 'Medicine, story, war'*
findeler	95	*Записки строителя, люди 'Builder's notes, people'*
upitko	100	*Фильмы 'Films'*

4 Topic Modelling of a corpus of Pikabu Russian posts

4.1 LDA topic model

LDA topic models were developed for the whole corpus and for its subcorpora. We used gensim library [23] to train the models and pyLDAvis library [43] for Python to visualize topic distributions. The procedure includes 3 stages:

1) LDA parameter choice and model training;
2) evaluation of topic coherence with UMass-measure [44];
3) topic visualization.

For LDA development we split the corpus to segments including representing posts of particular authors. Parameter choice was performed taking into account the variety of author's hash tags which envisages a set of expected topics, and UMass measure as it reflects the level of topic coherence which is treated as a level of human interpretability of the model based on relatedness of words and documents within a topic:

$$\mathrm{UMass}\,(v_i\,,\,v_j) = \log \frac{D(v_i\,,\,v_j) + 1}{D(v_j)}, \qquad (1)$$

where $(v_i\,,\,v_j)$ corresponds to the number of documents containing words v_i and v_j, while $D(v_j)$ shows the number of documents contains v_j [44].

UMass measure was calculated for each author's subcorpus, thus, the most appropriate number of topics in LDA models for different authors was established ad hoc (ranging from 3 to 30). In all cases the topic size was settled as 10 lemmata per topic. Visualization allows to view the most significant lemmata characterizing author's subcorpora and word-topic distributions. Below we present topic distributions and their visualizations for posts of random authors *BadVadim*, *CometovArt*, *FrancoDictator* and *Griffel* (cf. Fig. 1 – 4).

Username ID: BadVadim; hash tags: Оружие 'Weapon'

Topic 1: *оружие, нож, холодное, бабочка, тема, ножевой, видео, ждать, сложный, признать… 'weapon, knife, cold, butterfly, topic, blade, video, wait, complex, recognize…'*

Topic 2: *нож, клинок, оружие, холодное, длина, рукоять, изделие, обух, должный, бабочка… 'knife, blade, weapon, cold, length, handle, product, butt, necessary, butterfly…'*

Topic 3: *нож, пункт, ГОСТ, клинок, рукоять, общий, технический, шкуросъёмный, условие, разделочный… 'knife, point, GOST, blade, handle, general, technical, skinning, condition, cutting…'*

Topic 4: *нож, самооборона, средство, применение, оружие, метр, эффект, случай, дистанция, шокер… 'knife, self-defence, means, application, weapon, metre, effect, case, distance, shocker…'*

Topic 5: *нож, видео, оружие, Россия, сегодня, тема, минута, полиция, сообщество, пневматика … 'knife, video, weapon, Russia, today, topic, minute, police, society, pneumatics…'*

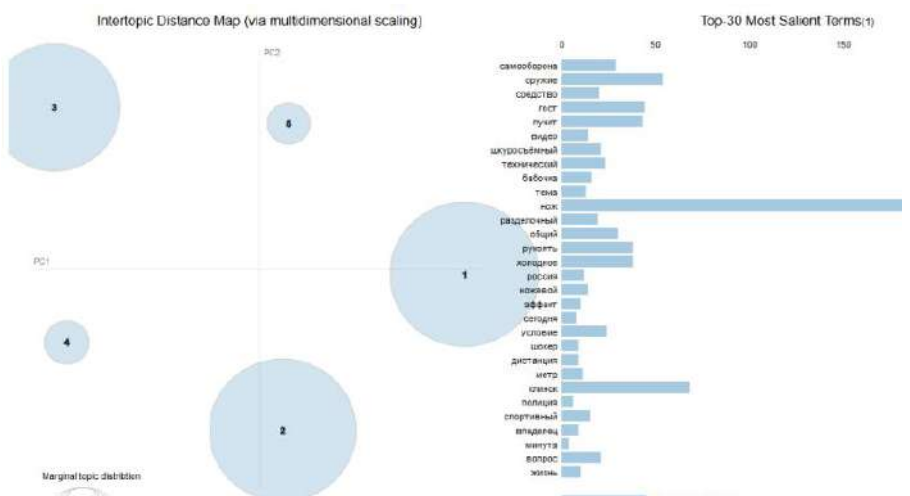

Fig. 1. User *BadVadim*: topic distribution

Username ID: CometovArt; hash tags: Игры 'Plays'

Topic 1: *игра, ролик, фракция, парад, террана, делать, карта, являться, нормальный, хороший… 'play, roller, fraction, parade, terran, make, card, be, normal, good…'*

Topic 2: *проект, скорость, работа, Бог, проблема, древние, Зот, идея, эфир, хороший… 'project, speed, work, God, problem, ancient, Thot, idea, airing, good…'*
Topic 3: *сделать, игра, сезон, серия, момент, играть, трейлер, хороший, увидеть, делать… 'make, play, season, episode, moment, play, trailer, good, see, make…'*
Topic 4: *день, проект, колода, получить, эльф, система, игра, работа, праздник, подборка… 'day, project, block, get, elf, system, play, work, holiday, collection…'*
Topic 5: *орда, альянс, сила, фракция, победить, герой, игра, убить, объединить, зачистить… 'horde, alliance, force, fraction, win, hero, play, kill, join, clean…'*

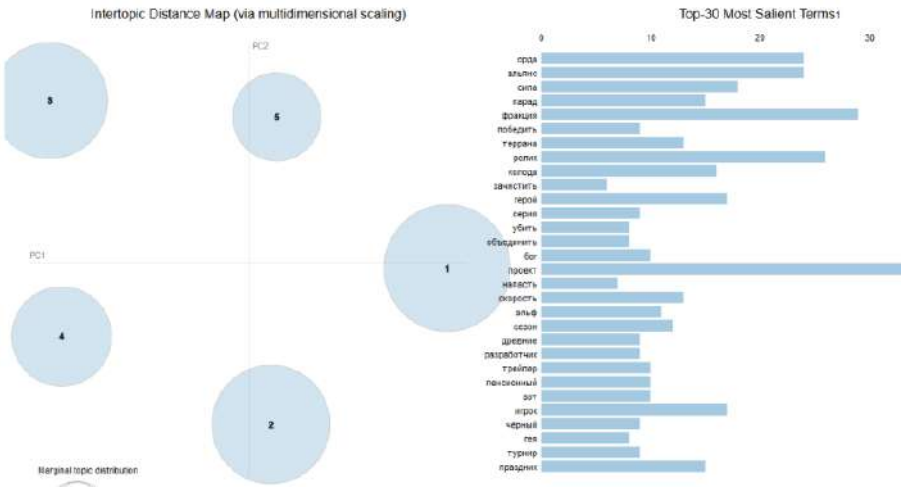

Fig. 2. User *CometovArt*: topic distribution

Username ID: FrancoDictador; hash tags: Политика, Испания 'Politics, Spain'
Topic 1: *страна, беженец, город, евро, Мадрид, Испания, статус, привет, Франко, момент… 'country, refugee, city, Euro, Madrid, Spain, status, salutation, Franco, moment…'*
Topic 2: *страна, Россия, Украина, власть, митинг, посмотреть, действующий, государство, понять, следующий… 'country, Russia, Ukraine, power, meeting, look, active, state, understand, next…'*
Topic 3: *клиент, адвокат, бизнес, суд, процесс, работать, страна, Испания, сделать, право… 'client, lawyer, business, court, process, work, country, Spain, make, law…'*
Topic 4: *деньга, рынок, банка, экономика, банк, государство, кот, дать, валюта, иметь… 'money, market, pot, economy, bank, state, cat, give, currency, have…'*
Topic 5: *страна, дать, Испания, Россия, беженец, деньга, клиент, Швейцария, момент, Франко… 'country, give, Spain, Russia, refugee, money, client, Switzerland, moment, Franco…'*

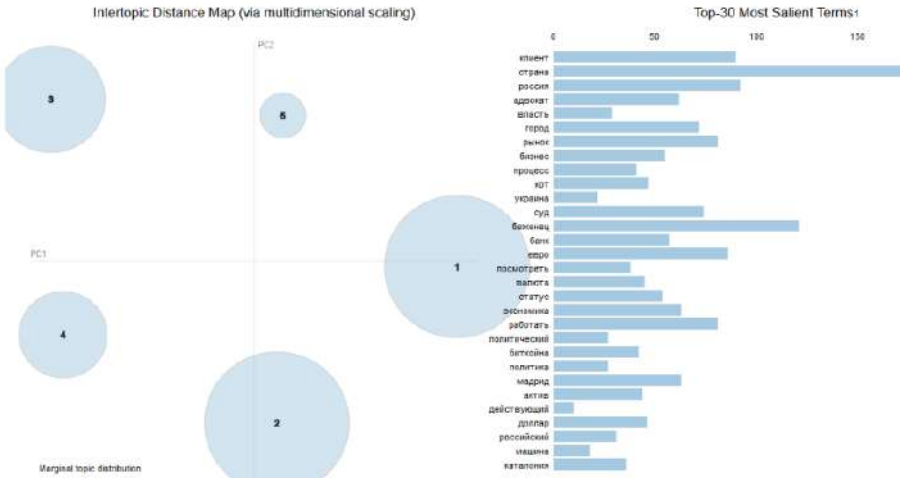

Fig. 3. User *FrancoDictator*: topic distribution

Username ID: Griffel; hash tags: Северная Америка 'North America'

Topic 1: *Канада, страна, химиотрасса, большой, компания, работа, США, находиться, фторид, фтор… 'Canada, country, chemtrail, big, company, work, USA, be, fluoride, fluor…'*

Topic 2: *Канада, США, мир, миллион, два, стать, Торонто, право, арестованный, место… 'Canada, USA, world, million, two, become, Toronto, law, arrested, place…'*

Topic 3: *кофе, Канада, язык, рубль, США, канадский, девушка, слово, Америка, страна… 'coffee, Canada, language, ruble, USA, Canadian, girl, word, America, country…'*

Topic 4: *Канада, русский, канадец, жизнь, жить, страна, уехать, Торонто, гусь, женщина… 'Canada, russian, Canadian, life, live, country, leave, Toronto, goose, woman…'*

Topic 5: *код, валюта, дать, рубль, балл, том, Россия, машина, метр, русский… 'code, currency, give, ruble, score, volume, Russia, car, metre, russian…'*

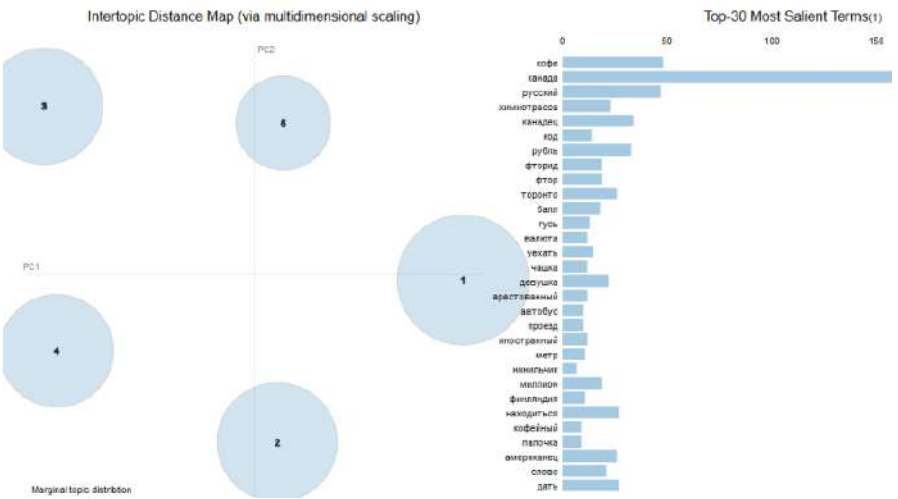

Fig. 4. User *Griffel*: topic distribution

Subcorpora preparation was strengthened by stylometric analysis performed with JGAAP toolkit [45]. Data processing gives evidence in favour of stylometric parameter diversity between subcorpora and their unity within sets of documents written by particular authors.

4.2 ATM Topic Model

ATM was built by means of gensim library [23]. The procedure includes 4 stages:
1) ATM parameter choice and model training;
2) evaluation of topic coherence with UMass-measure;
3) authors' posts similarity estimation by means of Hellinger distance [46];
4) modelling of authors' clusters as regards similarity of their posts.

A series of experiments was carried out to choose the appropriate number of topics for the whole corpus, this number was changed from 10 up to 40 with step 5, the constant size of topics being 10 lemmata. UMass measure was used to define the best experimental settings. The highest UMass values corresponded to topic modelling with 25, 30 and 40 topics. We took into account lowest scores of lemmata repetitions between topics, that were characteristic of the model with 30 topics, this value was selected as the best for the tasks of our study. For each author we selected the most relevant topics generated by ATM and matched them with hash tags. After ATM constructions we evaluated similarity of authors' posts by Hellinger distance [46] which estimates the distance between probability distributions describing topic variety for the authors, thus, author clusters were formed within our model. Examples of such clusters for users *BadVadim*, *CometovArt*, *FrancoDictator* and *Griffel* are given in Table 2.

Author clusters proved to be consistently interpretable with respect to the content of their posts. The user *Griffel* [47] is a participant of the society «Pikabu Users of North America», his associates within a cluster being immigrants and/or travelers, e.g. *Varlamov.ru*, a well-known blogger writing on urbanistics and adventures [48]; the user *goodmix* is a businessman and sauna proprietor, and his associates turn out to be builders and repairmen (*AnnrR*, *alekseev77*, *Scrypto*), etc.

Table 2. Author clusters for users *BadVadim*, *CometovArt*, *FrancoDictator* and *Griffel*

Author	Hash tags	Author cluster	Similarity measure	Hash tags
BadVadim	*Оружие 'Weapon'*	dr.Doctor	0,71	*Женский бред, видеоигры 'Women's raving, video-plays'*
		evilcame	0,64	*Телефон, игры 'Telephone, plays'*
		alekseev77	0,63	*Автосервис 'Car service'*
		AlexGyver	0,60	*Своими руками 'With my hands'*
		goodmix	0,59	*Сауна, истории 'Sauna, stories'*

CometovArt	*Игры 'Plays'*	L4rever	0,75	*Германия, Бонусы'Germany, bonuses'*
		AlexGyver	0,70	*Своими руками 'With my hands'*
		Scrypto	0,69	*Ремонт техники 'Equipment repair'*
		Varlamov.ru	0,68	*Городская среда, архитектура 'Urban environment, architecture'*
		Griffel	0,68	*Северная Америка 'North America'*
Griffel	*Северная Америка 'North America'*	Varlamov.ru	0,99	*Городская среда, архитектура 'Urban environment, architecture'*
		ShamovD	0,98	*Япония 'Japan'*
		FrancoDictador	0,97	*Политика, Испания 'Politics, Spain'*
		L4rever	0,79	*Германия, Бонусы'Germany, bonuses'*
		Esmys	0,78	*Латинская Америка, кулинария 'Latin America, cooking'*
Franco-Dictador	*Политика, Испания 'Politics, Spain'*	Varlamov.ru	0,99	*Городская среда, архитектура 'Urban environment, architecture'*
		ShamovD	0,98	*Япония 'Japan'*
		Griffel	0,97	*Северная Америка 'North America'*
		L4rever	0,79	*Германия, Бонусы'Germany, bonuses'*
		CometovArt	0,68	*Игры 'Plays'*

ATM allows to distribute users over certain groups in accordance with the major topics discussed in the posts. We will mention only a few examples: user group of travelling (*Griffel*, *ShamovD*, *FrancoDictador*, *L4rever*, *Esmys*, etc. describe different cities and countries), user group of narrators (*MadTillDead*, *smile2*, *CreepyStory*, *DoktorLobanov*, *denisslavin*, *ozymandia*, *femme.kira*, *svoemnenie*, *889900*, *Region89*, etc. write short stories), user group of builders and repairmen (*alekseev77*, *AnnrR*, *BadVadim*, *Scrypto*, *AlexGyver*, etc.).

4.3 Topic Label Assignment

There are certain approaches to the improvement of topic models. Traditional topic modelling algorithms, LDA being among them, do not include label assignment as an internal procedure.

At the same time, topic labelling allows to improve informativeness of the models. Labels are considered as single terms or phrases generalizing the topic content. From the semantic point of view, such labels are expected to be either strict hypernyms, holonyms, or at least more abstract lexical items covering the meaning of separate topic words. By default one can choose the first word of a topic as a label, but such labels often turn out to be unconvincing. Although topic words are ranked within a topic and may be related to each other by various syntagmatic and paradigmatic relations [49], such ordering is not obligatorily hierarchical. Labels can be assigned manually in course of human expertise, but in this case they may reflect subjective treatment of topics. Thus, it is necessary to find a tradeoff solution to the problem. Consequently, NLP researches proposed several ways of automatic label assignment [50, 51, 52] which differ in the source of labels (intrinsic data extracted from corpora or extrinsic information from external resources – lexical databases (WordNet, Wikipedia, etc.) or search engines (Google, Yandex, etc.). In our previous studies experiments on automatic label assignment were performed using such external resources as Russian Wikipedia distributional model accessible via ESA (Explicit Semantic Analysis) and Yandex search engine output with morphosyntactic parsing and statistical ranking [53, 54]. Taking into account stylistic peculiarities of social media (Pikabu corpus representing one of them), we expect that labels extracted from encyclopaedic texts (Wikipedia) and news headings (Yandex) may fail to match with the content of Pikabu topics. Therefore, in this study we chose a lexical database RuWordNet [16, 55] suitable for experiments with social media data of mixed stylistic character.

The procedure of label assignment implemented in our project implies a hybrid approach combining human expertise and automatic data processing, involving internal and external sources of candidate labels. On the one hand, we use manually assigned hash tags extracted from Pikabu as topic labels. As hash tags are consciously introduced by the authors, they may be considered more reliable than the first topical words. On the other hand, we extract hypernyms for topic words as candidate labels from RuWordNet. The idea to use lexical hierarchy as a source of topic labels keeps close to the task of automatic extraction of «IS-A» relations and corpus-based taxonomy enrichment. The procedure used in our study implied selection of hypernyms for each topic word which were united in a list and ranked. Both hash tags and hypernyms are ranked in accordance with ipm frequencies from A Frequency Dictionary of Contemporary Russian (based on the Russian National Corpus) by O.N.Lashevskaya and S.A.Sharoff [56].

Samples from our dataset are described in Table 3. As expected, in all four cases the users' hash tags provide the best fit. It should be noted that throughout the corpus hash tags are repeated among top 10 topical words, but not necessarily at the head part. This gives us the reasons to consider them as a solid baseline dataset in further experiments.

As regards the first topical words, in our example they are suitable as topic labels for the topics extracted from the posts of the users *Brahmanden* and *yulianovsemen*, but it is not the case as regards the users *upitko* and *Malfar*: although the words *готовить 'prepare'* и *дело 'case'* have abstract meanings, they turn out to be too ambiguous and vague for being topic labels. As for the corpus in general, the set of top one /

three topical words is rather heterogeneous in meaning, so we may consider them as a tentative – less reliable as hash tags – dataset for evaluation procedure.

Table 3. Examples of topic labels

Author	Topic example	Topic labels = ranked hash tags	Topic labels = ranked RuWordNet hypernyms
Brahmanden	*готовить, добавить, мясо, перец, минута, масло, соус, вкус, лук, бульон… 'cook, add, meat, pepper, sauce, taste, onion, broth…'*	*кулинария, Одесса, рецепт… 'cooking, Odessa, recipe…'*	*продукт, блюдо, кулинария… 'foodstuff, meal, cooking…'*
upitko	*фильм, режиссер, рейтинг, известный, кино, роль, кинолента, известно, история, хороший… 'film, producer, rating, famous, cinema, role, filmstrip, known, story, good…'*	*фильм, рецензия, кино… 'film, review, cinema…'*	*передача, фильм, кино… 'broadcast, film, cinema…'*
yulianovsemen	*дело, случай, сотрудник, следователь, место, райотдел, прокуратура, МВД, орган, розыск... 'case, accident, officer, detective…'*	*милиция, прокуратура, убийство… 'police, procuracy, murder…'*	*политика, право, преступление… 'politics, law, crime…'*
Malfar	*комикс, Бэтмэн, Флэш, фонарь, стать, Икс, вселенная, выпуск, читать, Марвел … 'comics, Batman, Flash, flashlight, become, X, universe, issue, read, Marvel'*	*комикс, супергерой, суперзлодей…. 'comics, superhero, supervillain…'*	*издание, печать, рубрикация… 'edition, print, rubrication…'*

Labels extracted from RuWordNet and assigned to the main topics of the users *Brahmanden* and *upitko* correspond to the content of the topics and partially intersect with hash tags on the lexical level (repetitions are marked in bold: *кулинария*, *фильм*, *рецензия 'cooking, film, review'*). That doesn't hold true for the users *yulianovsemen* and *Malfar*: RuWordNet labels turn out to be rather more general than users' hash tags and topical words (*преступление*, *право*, *издание 'crime, law, edition'*). All in all, according to our observations, RuWordNet topic labels, being semantically correlated with the topics, seem to be rather generalized in comparison with label candidates selected by other methods. In order to improve the results we upgraded the procedure of hypernym selection by using word2vec embeddings extracted from the pretrained corpus model: we assumed that possible label vectors may be similar to averaged topic vectors, but our expectations were partially fulfilled as candidate labels enhanced by word2vec data remained general by meaning. That inspires further

experiments with combination of topic labeling with distributed vector representations.

However, three types of labels constitute a scale of acceptability which is limited by the first topical words as formal labels and RuWordNet labels as the most general ones, the golden mean being the users' hash tags. The combination of expert-based and knowledge-based approaches to topic label assignment requires further quantitative analysis and evaluation, but even in the qualitative aspects it seems to be fruitful as it provides data for topic expansion and may be useful in text rubrication.

5 Summary

In the given study we managed to create an author-topic model for the corpus of Pikabu Russian posts.

We worked out a procedure for corpora development suitable for processing mixed data from social media: texts and metadata (author's usernames and hash tags). A multilevel analysis of our corpus was performed.

We developed standard LDA models with visualization for subcorpora containing posts of separate authors, that provides data on their interests. A complex Author-Topic model was constructed for the whole corpus, which allows to detect clusters of authors writing on similar topics.

Finally, we carried out experiments on topic label assignment, topic labels being obtained from two sources: manually assigned users' hash tags and hypernyms for topical words automatically extracted from RuWordNet lexical database.

Results achieved by now allow to expand our studies and put forward the next set of tasks: development and processing of various social media corpora, elaboration of the procedure for latent community detection, enhancement of the procedure of hypernym extraction and ranking for automatic label assignment.

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Thematic Tagging of Literary Fiction: The Case of Early 20th Century Russian Short Stories

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Abstract. The paper deals with the problem of thematic tagging in works of fiction, Russian short stories of the early 20th century (1900-1930) serving as research data. The very concept of discourse theme, or topic, is argued to be fuzzy and ambivalent, all the more so in the case of literary prose. In the present study, theme is conceived as a set of keywords basically (but by no means exhaustively) defining the story's plot. A list of 89 themes was empirically formed, embracing a wide range of topics. A sample corpus of 310 stories was manually tagged, with each story being mapped onto a set of themes. This corpus was divided into three parts corresponding to three periods, 1900-1913, 1914-1922, 1923-1930. These periods of Russian history being radically different, the stories' content varies greatly, too, not only in what concerns political and social themes, but also in quite personal and mundane matters. The paper traces the themes' frequency rates across the three periods, accounting for their change dynamics in terms of sociopolitical context. The sample corpus will be further used as training data in devising computational techniques for automated thematic tagging of literary fiction.

Keywords: literary corpus, thematic tagging, discourse theme, Russian literature, short stories

1 Introduction

Thematic tagging is an essential kind of annotation used in digital libraries and large national corpora. Thus, in Russian National Corpus non-fiction texts are assigned tags roughly corresponding to manifold spheres of human life, e.g. *politics, economics, law, religion, medicine, business, art,* etc. Fiction texts, however, are provided solely with tags indicating their genre and chronotope.

This is by no means accidental. The concept of topic, or theme, in literary prose is an under-studied and problematic issue. The lack of a practicable definition has a negative effect on developing literary text corpora. In large-scale corpora, texts have to be thematically annotated but the very principles guiding such annotation are not clear. There is no agreement on what constitutes a theme in works of fiction, or whether a text should have a single theme or may be assigned a few of them. Nor is there a fixed list of themes to choose from. Progress in digital humanities (and artificial intelligence, in general), though, crucially depends on semantic text processing.

In what follows, an individual attempt at manual thematic tagging of a literary texts sample is presented. It will be further tested against similar annotations performed by other researchers on the same data, to check out similarities and differences and together work out a final annotation of the sample.

The resulting tagged sample will be used twofold. First, it will serve as training data for a learning model to be used in annotating a larger corpus of Russian short stories dated between 1900-1930. Second, it will be set against the automatic topic modeling results, to assess the latter's adequacy and thus the prospects of using standard topic modeling algorithms for annotating the above-mentioned corpus. Once a reliable thematic tagging procedure is found, it can be extended to other literary corpora and text collections.

2 Russian Short Stories Corpus (1900-1930)

The paper deals with recent research within the ongoing project "The Russian language on the edge of radical historical changes: the study of language and style in pre-revolutionary, revolutionary and post-revolutionary artistic prose by the methods of mathematical and computer linguistics (a corpus-based research on Russian short stories)" [1;2]. The project aims to give a comprehensive account of early 20th century Russian short stories from the viewpoint of genre theory which presupposes their thematic, structural, and linguistic analysis [3: 237]. Although the project's particular emphasis is on language and style, it seems impossible to research into them without taking account of the short stories' themes and plot structure.

The first three decades of the 20th century in Russia were a tumultuous time marked by a series of dramatic historical events (Russo-Japanese war, World War I, February and October revolutions, the Civil War) that radically changed the course of Russian history and made an impact on Russian literature and language style. Thus, in a closer perspective, the project's goal is to trace the way all the three aspects (themes, narrative structure and language style) kept changing over time by comparing different chronological periods [4].

To accomplish this, a text corpus was created, containing several thousands of short stories written in Russia and later, the Soviet Union, from 1900 to 1930 and published in literary journals or story books. This timespan is divided into 3 parts, 1900–1913, 1914–1922 and 1923–1930, the first covering the time before the great cataclysms, the second embracing World War I, February and October revolutions and the Civil War, and the third corresponding to the post-war socialist period. Thus there are peace periods at the beginning and at the end linked by an intermediate wartime period.

Each author is represented by a single, randomly selected, story per period. To ensure robustness of the results, the project aims to account for as many professional writers as possible, both famous (e.g. Anton Chekhov, Leo Tolstoy, Ivan Bunin, Maxim Gorky) and lesser-known ones, metropolitan and provincial alike [5].

From the text corpus, a random sample was taken, containing 310 stories by 300 authors (some writers featuring in more than one period, this accounts for a slight

discrepancy in numbers) [6]. This sample serves as an initial testbed for linguists and literary scholars enabling them to put forward and prove (or disprove) preliminary conceptions concerning Russian short stories of the early 20th century as a special genre, with its specific themes, plot structure and stylistic features.

3 Themes and Their Dynamics of Change

3.1 Mapping Short Stories onto Sets of Themes

Identifying themes in works of literature is a challenging job. Theme, or topic, is a fuzzy concept allowing for an array of interpretations. This holds for any discourse type, but it is in fiction that the theme notion is most ambivalent. The main problem is that literary texts are often heavily laden with implicit meanings, or subtext. A short story theme may never manifest itself in a particular word or phrase and remain an unspoken message, thus being quite different from the so-called "word themes" [7: 30-31].

In this respect, literary prose is opposed to both academic and mass media discourse [8]. It is no accident that the merits of various information extraction and data mining techniques are demonstrated on these discourse types rather than on works of fiction. Thematic content of literary texts by and large defies automatic detection although certain noteworthy advances have been made in recent years [9;10].

Another difficulty concerning the thematic content of a literary text is that it normally contains a handful of themes, like *love*, *war*, *death* and *desolation*, or, say, *art*, *poverty*, and *suicide*. In fiction, unlike some other text types, themes are not hierarchically arranged, so that one cannot confidently tag one of them as dominant, or global, and others as subsidiary, or local. Rather, themes may come in a bunch or be consequentially arranged, being linked by causal relations.

In theory, a story's themes can all be put together in a single proposition, as suggested for discourse topics in general [11: 134ff], e.g. *A poverty-stricken artist desperately needs money and, unable to sell his paintings, commits suicide*. Obviously enough, each story then will have an individual topic and there will be little chance for finding regularities.

In the present paper, thematic tagging presupposes the identification of all semantic components that contribute to the plot, determine the protagonist's motives and actions and directly bear on the conflict and its resolution. Themes are considered akin to keywords [12], so that each story is mapped onto a clustering of themes. A parallel can be drawn here with componential analysis that aims to present word meaning in a bundle of semantic features. The difference, though, is that while componential analysis tries its best to bring out the total semantic content of a word, a set of themes is not meant to fully define the short story plot.

As there are no universally accepted algorithms of themes detection in works of fiction, a careful qualitative analysis is needed at the outset. Topic modelling techniques [13; 14] will be considered later, once there is a certain amount of data at hand. Thematic tagging discussed in the present paper was done manually on the above-

mentioned sample comprising 310 stories which will be later used as training data for a learning model.

We proceeded as follows. A rough set of themes was drawn from the 1st period stories. It was subsequently tested against the short stories of the two other periods, with inevitable corrections, deletions and additions. The final set for the whole sample currently numbers 89 themes, ranging from political to personal, and from philosophical to mundane.

In the next sections, groups of themes are identified and figures are presented showing their frequency rates over the three periods. One should be aware that the figures in the tables below show the absolute frequencies of themes, i.e. the actual number of stories in which a particular theme occurs. However, as the total number of stories per period is close to 100, these figures can be roughly viewed as percentage.

3.2 Political Themes: Wars and Revolutions

The initial three decades of the 20th century proved a difficult time in Russian history. Defeat in the Russo-Japanese war (1904–1905), the subsequent political and social unrest, World War I, February and October revolutions of 1917, resulting in a radical transformation of economic, political and social life, and finally the Civil War (1917–1922) with its long aftermath period could not fail to affect Russian literature. It is but natural that these events are used in many stories as settings. We treat such political events as themes if they play a key role in the plot. This is often the case with the war themes. With the revolutions, however, things are different. In a sense, almost all stories of the third period and some of the second one could be marked by such tag since their plot would be deemed unrealistic had not the revolutions taken place. Nevertheless, we think it completely unnecessary to introduce a special tag for the February bourgeois democratic revolution as it was but a prelude to a much more radical socialist revolution in October. As for the latter, only a couple of stories, specifically highlighting the role of this event for the plot, are tagged accordingly.

It is important to note that themes pertaining to the political context are likely to be evoked in fiction long after the events concerned. Thus, the Civil War is a theme in twice as many stories of the third period as those of the second one. The greater the event, the stronger the postponed effect. One should remember this when comparing the figures.

Together with wars and revolutions are listed themes directly bearing on them, including pre-revolutionary unrest (strikes, military mutinies, peasant riots), political activities which ultimately led to the revolution (revolutionary movement), death in the war and execution (Table 1).

The disastrous Russo-Japanese war failed to get a wide coverage in fiction, probably because of its local character, or the shame of the defeat. It was largely forgotten by the time a new war broke out. World War I dragged inconclusively for three and a half years, causing heavy losses in the Russian Army. Soon after the October revolution Russia signed Brest-Litovsk Treaty and emerged from the war. World War I is a frequent theme in the 2nd period stories, but seems no longer significant in the 3rd period ones.

The October revolution had brought about so fundamental transformations in all spheres of life that World War I began to look like a remote and much less topical event. This accounts for a sharp drop in frequency rate, from 21 to 1. The number of stories about pre-revolutionary activities also declined.

Table 1. Political themes

Themes	1900-1913	1914-1922	1923-1930
Russo-Japanese war	3	1	0
Pre-revolutionary unrest	7	3	0
Revolutionary movement	12	6	5
World War I	0	21	1
October revolution	0	2	1
Civil war	0	12	24
Death in the war	6	13	5
Execution	3	5	8

The impact of the Civil War, in contrast, is on the rise, from 12 during the war to 24 after the end. This is by no means surprising. The war's outcome was crucial for the socialist regime, determining the future life of the whole country. In the decades to come, the Red Army victory would be praised and glorified in numerous works of fiction, movies, etc.

The death-in-the-war theme reaches its peak in the 2nd period stories, which is but natural, given that wars went on over the whole period, and then decreases. The execution theme, however, gradually goes up, probably due to an increase in the number of stories dealing with the Civil War.

3.3 Economic and Social Developments

A thematic block associated with the country's industrial and social policy became particularly prominent after the end of the Civil War, during the third period (1923–1930). Below, in Table 2, major issues are covered.

The construction of Trans-Siberian railway between 1891 and 1916 was a strong impetus toward migration over the Ural mountains into Siberia. At the turn of the 20th century, resettlement was promoted and sponsored by the Russian government. However, the process was by no means easy and smooth. Disappointment, frustration and desperation plagued many settlers who found it difficult to survive in the new lands and were on the verge of giving up the whole idea and going back. These attitudes appear in three stories of the first period. During World War I, the resettlement program was dropped. After the end of the Civil war, it was subsumed by larger-scale projects aimed at the total reconstruction of the country's life.

In economics, such large-scale projects were meant to promote technical modernization and inventions. Hence, a noticeable rise in the number of stories tackling these issues during the third period.

Table 2. Economic and social themes

Themes	1900-1913	1914-1922	1923-1930
New lands development	3	0	0
Industrial advance	1	0	6
Explorations and inventions	1	1	5
Mass education	0	0	3
Women's emancipation	2	3	7
New social order	1	9	38
The old vs. the new	1	1	17
Bright future	3	0	5
Young people	2	4	9

In the social sphere, the same period is marked by the policy of mass education and women's emancipation, the corresponding figures being higher than previously. The concept of bright future is gaining ground due both to the Soviet propaganda efforts and the universal human need to believe in a better tomorrow which was particularly acute after the end the Civil war. The 3rd period stories tend to focus on the young, active and romantic people, architects of the future happy society.

The October revolution totally destroyed the former structure of the Russian society and its old ways of life. The process of instituting a new social order is a key theme of the third period, hitting a record 38 stories. Sometimes the new order is explicitly set against the old one, with the former always evaluated positively and the latter, negatively. Such a neat divide is due to the fact that people disapproving of the October revolution and the subsequent transformations either had to leave the country or keep silent. It was impossible for writers denying the new ideas and values to get their work published.

Changes inflicted by the revolution affected every person and every family (Table 3). In particular, they totally eliminated the familiar pre-revolutionary pattern of the well-to-do families dwelling in the large cities in winter and moving to their countryside estates in summer. The opposition of city and country life is no longer relevant. Instead, the characters of the 3rd period stories either reside in the city (workers, clerks) or, most often, are to be found in the rural settlements. There they are trying to survive in the absence of food, cattle, seeds, agricultural implements, horses or any other facilities. The peasant life was undergoing major transformations, perhaps the greatest of all, hence the skyrocketing frequency of this theme in the third period.

The concept of land is central to the third period, too, as one of the first Bolshevik decrees, Decree on Land, abolished private property and proclaimed that peasants should divide up rural land among themselves. This decree led to a split between the poorer farmers who supported the revolution and sided with the Red Army in the Civil War and the wealthier ones, who did their best to retain the traditional lifestyle. The two groups fought over land and the new ways of things in general, sometimes with violence. The latter theme is increasingly present in short stories across the three decades.

Table 3. Social structure and lifestyle

Themesë	1900-1913	1914-1922	1923-1930
Country vs. city life	9	2	2
Peasant life	3	2	24
Land as property	1	2	3
Violence	5	7	10
Non-peasant work	4	4	11
Working class	1	2	2
Country life	4	3	12
Pets and animals	4	4	13

The number of stories about the non-peasant work and the working class (another target audience of the early Bolshevik decrees) also grows, the dynamics, though, being less spectacular than with the peasantry.

Surprisingly, quite a number of stories in the second and particularly the third period are about country life, pets and animals (embracing the love of nature, the unity of man and nature, and hunting). This bunch of themes seems to have been a last resort for writers hating to praise the Soviet State's new policies and eager to step aside.

3.4 Religion

As the Bolsheviks explicitly pursued to eliminate religion with the goal of establishing state atheism, noticeable change can be seen in the relative frequency of such themes as Christian God (incorporating the concepts of faith, saints, sin and even devil) and religion as a social institution across the second and third periods (Table 4).

Table 4. God and religion

Themes	1900-1913	1914-1922	1923-1930
Christian God	10	16	4
Religion as a social institution	3	7	7

In the wartime period from 1914 to 1922, the concept of God, quite naturally, was quite prominent. After the ultimate victory of the Red Army, a peace time ensued, marked by an active anti-religious campaign launched by the Soviet government. Spiritual issues are seldom mentioned in the literature of the third period. This is not the case, however, with religion as a social institution. Although from the quantitative viewpoint the third period looks exactly as the second one, the situation is different in two respects. First, in the 3rd period stories, the Christian church no longer enjoyed the monopoly and had to make room for the Jewish and Buddhist religions. Second, the references to the church, priests, worshippers, etc. became outright derogatory or ironic, at best. This fact, incidentally, warrants an interpretative, rather than a purely quantitative, approach to the semantic analysis of literary fiction.

3.5 Personal matters

One might think that there are timeless, core values in the human life, unlikely to be affected by political whirlpools and social-life transformations. This may well be so as regards individual lives, but in the literature, the impact of dramatic public events prevails. As a result, strictly personal themes like love, marriage, unfaithfulness, jealousy, children, parental love in the second period shifted out of focus and gradually declined, becoming less prominent and frequent (Table 5).

Interestingly, the sexual aspect of love and, more broadly, the body life (including accidental affair, sexual desire and lust) is on the rise. The same holds for rape. Prostitution theme vanished from the 3rd period stories following the attempts of the Soviet government to combat and repress this social practice.

Table 5. Personal themes

Themes	1900-1913	1914-1922	1923-1930
Romantic love	22	19	17
Unrequited love	1	2	1
Marriage	28	12	13
Unfaithfulness	14	7	6
Jealousy	10	9	8
Children	17	14	11
Parental love	8	6	4
Mutual heterosexual love	6	2	9
Body life	3	11	14
Rape	1	3	3
Prostitution	4	2	0

Other human relationships embrace fraternity and solidarity, friendship, mentorship, and rivalry. Together with them are listed ill effects of interpersonal dealings, including envy, greed, deceit, treachery, and revenge (Table 6).

The dynamics of the fraternity and friendship themes reaching their maximum in the 2nd period stories is quite understandable. In a war, mutual help and reliability are greatly appreciated and needed and thus it is but natural that stories written during the war should profile these aspects of human life.

Revenge-theme frequencies display an opposite pattern with an absolute minimum in the second period. Rivalry slightly increases over time, while envy, greed and deceit stay roughly at the same level. Treachery (not to be confused with treason!) steeply goes up in the 2nd period stories and remains at the same point in the 3rd period ones. Figures for the mentorship theme rise, reaching roughly 5% in the 3rd period stories. Their rather high frequency rate may be due to the fact that in Soviet times this type of relationship was actively promoted in professional and ideological domains.

Poverty and hunger plagued people's life more or less steadily. In the wartime period, hardships obviously increased. They did not end after the Civil War as the country was exhausted and near ruin. The economy was devastated, people were starving and dying from epidemics and lack of health-care. The number of stories highlighting

the contrast between the rich and the poor and the crucial role of money went down in the 3rd period stories, as there no longer remained wealthy people (Table 7).

Table 6. Interpersonal relations

Themes	1900-1913	1914-1922	1923-1930
Fraternity, solidarity	5	14	11
Friendship	2	5	3
Mentorship	1	4	5
Rivalry	1	3	3
Envy	1	1	2
Greed	1	1	2
Deceit	6	6	5
Treachery	0	7	7
Revenge	4	0	5

The alcoholism theme gradually declines over decades which must be due to prohibition introduced in Russia at the beginning of World War I. It carried on through the turmoil of the revolutions and the Civil War until 1925.

The difference between the times of war and peace is most obviously reflected in the figures related to the death-in-the-war theme (see Table 1 above). Surprisingly, there is yet another thematic marker of peace times, and that is boredom. In the epoch of cataclysms, people do not have the luxury of monotonous everyday life.

Table 7. Mundane aspects of life

Themes	1900-1913	1914-1922	1923-1930
Poverty, hunger, hardships	9	12	14
The rich vs. the poor; money	12	8	9
Alcoholism	5	3	1
Death from natural causes	10	6	6
Sudden and accidental death	6	3	2
Suicide	6	8	4
Monotonous life; boredom	12	7	11

Some stories touch on the characters' inner life (Table 8). The frequency rates of such themes across the periods can be accounted for by two factors. One is the Soviet ideology that fundamentally "reformatted" the former social structure, overturning the system of norms and values and abolishing charity institutions and philanthropy on the false pretext of an all-sufficient state.

Another is the above-mentioned shift of focus, both in real life and fiction. In the aftermath of the Civil War, people haunted by poverty, starvation, homeliness, and misery could not afford to brood over being lonely, but rather had to survive. The same applies to hopes and illusions.

Table 8. Inner life

Themes	1900-1913	1914-1922	1923-1930
Willingness to help, be of use, philanthropy	4	2	0
Nobility of character, magnanimity, self-sacrifice	8	5	1
Readiness to forgive, spiritual rebirth	2	6	2
Loneliness	7	8	3
Mysticism, hallucinations, presentiments	9	12	5
Dreams vs. reality	9	9	4
Frustrated hopes, disillusionment	9	1	1
Insanity	4	2	2
Shame	1	1	0
Remorse	1	1	1
Passion for life	1	1	1

The mysticism theme enjoys a rise during the war and drops sharply in the Soviet period, stories of spiritual experience being unwelcome by the new regime. The insanity theme also diminishes. Shame, remorse and passion for life get their small but steady numbers.

4 Conclusion

In this paper, early 20th century Russian short stories are analyzed from a thematic viewpoint. Drawing on a large corpus currently containing a few thousand stories, a sample of 310 stories was randomly taken to serve as a testbed for a pilot study. It was further divided into three periods, 1900-1913, 1914-1922, and 1923-1930.

To detect themes typical of the whole timespan (1900-1930), an empirical approach was used. Themes were identified manually in a bottom-up fashion (starting from individual stories) and then tested against the whole sample. In the end, a set of 89 themes was formed, most of them featuring in the tables above. Tagging was also done manually, to ensure the reliability of results. Each story thus is mapped onto a set of themes deemed essential for its content.

For each theme, its occurrences were calculated in the stories of particular periods and then the frequency rates were compared. The figures vary greatly across periods almost for every theme, which is not surprising given the turbulent time the country was going through. Fundamental transformations affected all spheres of life, from public to private.

Short stories published in the third period are quite different from those of the first period. New themes emerged while some old ones dropped in priority, vanished, or radically changed in evaluation. However, the 2nd period stories cannot be viewed as a "bridge" between the literature of the two peace periods. They have a distinct character of their own shaped by the large-scale political and military events.

Future research into the Russian short stories thematic tagging will run along several lines. First, a few annotators will perform independent tagging of the sample, to test the degree of subjectivity, pinpoint controversial issues and work out guidelines

for tackling them. Second, each theme will be provisionally linked to a set of semantically associated lexical items (words or collocations). It will be then checked to what extent each theme manifests itself explicitly via such words (it may be presumed that themes will vary greatly in this respect). The results will determine the prospects for their automatic detection in literary texts.

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Russian Literature Around the October Revolution: A Quantitative Exploratory Study of Literary Themes and Narrative Structure in Russian Short Stories of 1900–1930

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Abstract. The paper reveals the thematic content and plot structure of the Russian short stories written in the 20th century's first three decades. It presents part of the ongoing project aimed at a comprehensive study of the Russian short stories of this period, encompassing their thematic, structural and linguistic features. This particular period is targeted because it was marked by a series of dramatic historical events (Russo-Japanese war, World War I, February and October revolutions, the Civil War, formation of the Soviet Union) that could not but affect Russian literature and language style. Within the project, a corresponding text corpus has been created, currently containing several thousands stories and thus allowing for a wide coverage of texts and their computer processing. On its basis, a random sample has been selected, serving as a testbed to probe preliminary observations and hypotheses. It is used in the paper to identify prevailing themes, both major and minor, manifest and latent, as well as characteristic narrative structures and to trace the way they kept changing over the three decades. This helps to pinpoint certain features and tendencies which may be of interest to literary theorists and other scholars.

Keywords: digital humanities, Russian literature, Russian short stories, literary themes, revolution, social changes, literary history, narrative structure, literary corpus.

1 Introduction

In this paper, we present recent results obtained within the ongoing project "The Russian language on the edge of radical historical changes: the study of language and style in pre-revolutionary, revolutionary and post-revolutionary artistic prose by the methods of mathematical and computer linguistics (a corpus-based research on Russian short stories)" [1; 2]. The project's overall goal is to give a comprehensive account of the early 20th century Russian short stories from the thematic, structural and linguistic perspectives [3].

This particular period is targeted because it was marked by a series of dramatic historical events (Russo-Japanese war, World War I, February and October revolutions, the Civil War, formation of the Soviet Union) that could not but affect Russian literature and language style. In particular, the October Revolution of 1917 is known to be one of the key topics of Russian literature of the XX century [4]. However, the literary scholars have usually approached this topic from a purely qualitative viewpoint [5; 6; 7]. In our research, we set a goal to obtain preliminary quantitative assessment of literary changes in 1900–1930 in terms of themes distributions and narrative structure modifications by dynamically comparing different chronological periods [8].

To accomplish this, a text corpus was created, containing several thousands of short stories written in Russia and later, the Soviet Union, and published in the timespan from 1900 to 1930 in literary journals or story books. This timespan is divided into 3 parts, 1900–1913, 1914–1922 and 1923–1930, the first covering the time before the great cataclysms, the second embracing World War I, February and October revolutions and the Civil War, and the third accounting for the post-war socialist period. Each author may be represented by a single, randomly selected, story per period. To ensure robustness of the results, the corpus aims to take account of as many professional writers as possible, both famous (e.g. Anton Chekhov, Leo Tolstoy, Ivan Bunin, Maxim Gorky) and lesser-known ones, metropolitan and provincial alike [3].

From this corpus, a random sample was taken, containing 310 stories by 300 authors (some writers featuring in more than one period, this accounts for a slight discrepancy in numbers) [ibid.]. This sample serves as an initial testbed for linguists and literary scholars enabling them to put forward and prove (or disprove) preliminary conceptions concerning the Russian short stories of the early 20th century as a special genre, with its specific themes, plot structure and stylistic features.

2 Thematic Tagging

2.1 General Approach

Identifying themes in works of literature is a rather difficult and controversial issue [9; 10]. First and foremost, the problem is that literary texts are often heavily laden with implicit meanings, as opposed, say, to academic or mass media discourse [11]. Thus there are no common statistical or computational techniques to be used for such a goal. Instead, a careful qualitative analysis and interpretation are needed, at least, initially. Automatic theme extraction procedures [12; 13] could be considered or devised later, once there is a certain amount of data at hand, but still it would be futile to fully rely on them. Thematic tagging which we are going to discuss here was done manually.

Another difficulty concerning the thematic content of a literary text is that it normally contains a handful of themes, like *love*, *war*, *death* and *desolation*, or, say, *art*, *poverty*, and *suicide*. In fiction, unlike other text types, themes are not hierarchically arranged, so that one cannot definitely tag one of them as dominant, or global, and others as subordinate, or local.

In theory, they can all be brought together in a single proposition, as suggested by Teun van Dijk [14: 134ff] for discourse topics in general, e.g. *A poverty-stricken artist desperately needs money and, unable to sell his paintings, commits suicide*. Obviously enough, each story then will have an individual topic and there will be little chance for checking out regularities.

We take a different approach. The basic idea is that thematic tagging of short stories presupposes the identification of all semantic components that contribute to the plot, determine the protagonist's motives and actions and directly bear on the conflict and its resolution. Each story thus is provided with a set of themes, similarly to the way componential analysis presents word meaning as a bundle of semantic features. The difference, though, is that while componential analysis aims to bring out the complete semantic content of a word, the set of themes does not fully define the short story plot.

We proceeded as follows. A rough set of themes was drawn from the first period stories. It was subsequently tested against the short stories of the two other periods, with inevitable corrections, deletions and additions. The final set for the whole sample currently numbers 89 themes, ranging from political to personal, and from philosophical to mundane.

In the next section, we briefly touch upon some of them and comment on the frequency rates over the three periods. It is important to note that themes pertaining to socio-political agenda are likely to be evoked in fiction long after the events concerned. Thus, the Civil War is a theme in twice as many stories of the third period as those of the second one. The greater the event, the stronger the postponed effect. One should be aware of it when comparing the figures.

2.2 Theme Rates over Three Periods

The initial three decades of the 20th century proved a difficult time in the Russian history. Defeat in the *Russo-Japanese war* (1904–1905), the subsequent political and social unrest, *World War I*, *February and October revolutions* of 1917, resulting in a radical transformation of economic, political and social life, and finally the *Civil War* (1917–1922) with its aftermath period could not fail to affect the Russian literature. It is but natural that these events are used in many stories as settings. We treat such political events as themes in case they play a key role in the plot. This is often the case with the war themes. With the revolutions, however, things are different. In a sense, almost all stories of the third period and some of the second could be marked by this tag since their contents would be deemed unrealistic had not the revolutions taken place. Nevertheless, we think it completely unnecessary to introduce a February revolution theme. As for the October revolution theme, only a couple of stories, specifically highlighting the role of this event for the plot, are tagged with it (Fig. 1).

Another thematic block closely associated with the sociopolitical context comprises issues dealing with the country's development policy adopted after the October revolution, such as *technical progress*, *mass education*, *women's emancipation*, *explorations and inventions*. They became particularly relevant after the end of the Civil War, during the third period (1923–1930) (Fig. 2).

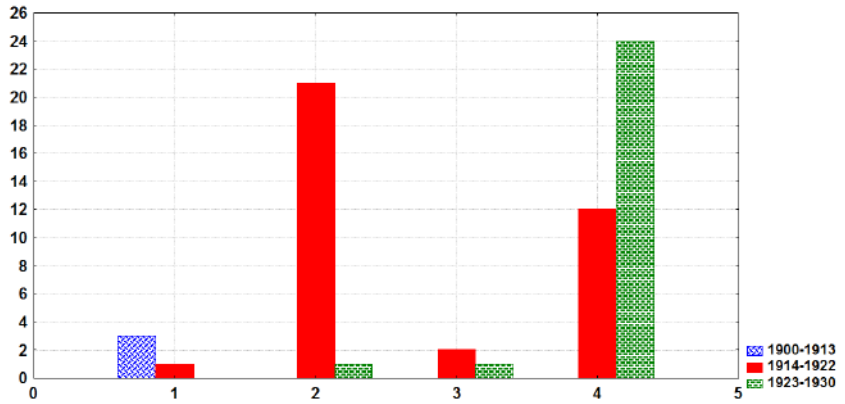

Fig. 1. 1 – Russo-Japanese war, 2 – World War I, 3 – October revolution, 4 – Civil War

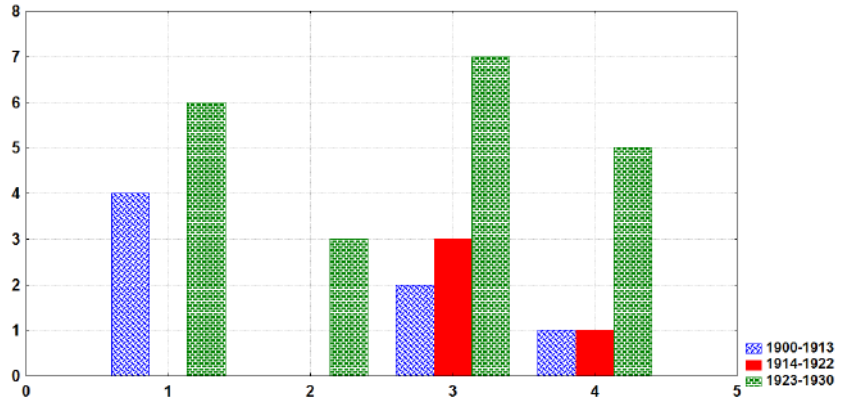

Fig. 2. 1 – Technical progress, 2 – Mass education, 3 – Women's emancipation, 4 – Explorations and inventions

The process of instituting a *new social order* is a key theme in many stories of the third period. Sometimes the new order is explicitly set against the old one, with the former always evaluated positively and the latter, negatively. Such a neat divide is due to the fact that people disapproving of the October revolution and the subsequent transformations either had to leave the country or keep silent. It was impossible for authors denying new ideas and values to get their work published (Fig. 3).

It was perhaps the *peasant life* that underwent the greatest transformations at this time. The October revolution totally eliminated the familiar pre-revolutionary pattern of the well-to-do families dwelling in large cities during the winter and moving to their countryside estates in the summer (where they naturally may have met peasants, but such encounters did not normally constitute a story theme). Instead, the protagonists of the third-period stories either reside *in the city* (workers, clerks) or, most often, are to be found in the rural settlements. There they are trying to survive in the absence of food, cattle, seeds, agricultural implements, horses or any other facilities.

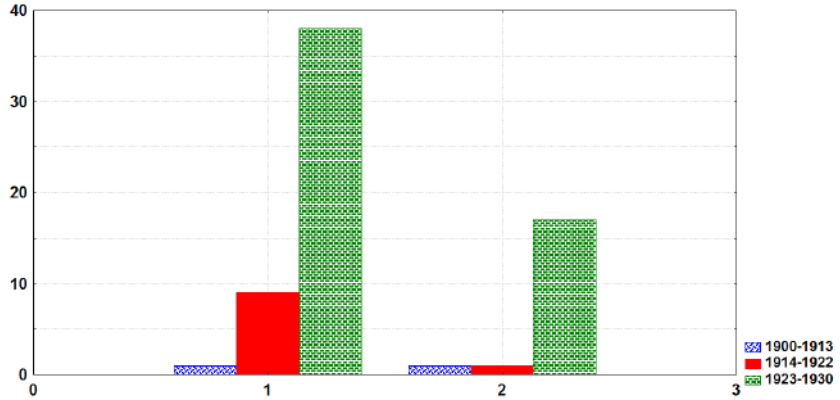

Fig. 3. 1 – New ways of life, 2 – The old and the new

Besides, there is a split between the poorer farmers who supported the revolution and sided with the Red Army during the Civil War and the wealthier ones, who do their best to retain the traditional lifestyle. The two groups fight over land and the new ways of things in general, sometimes with *violence* (Fig. 4).

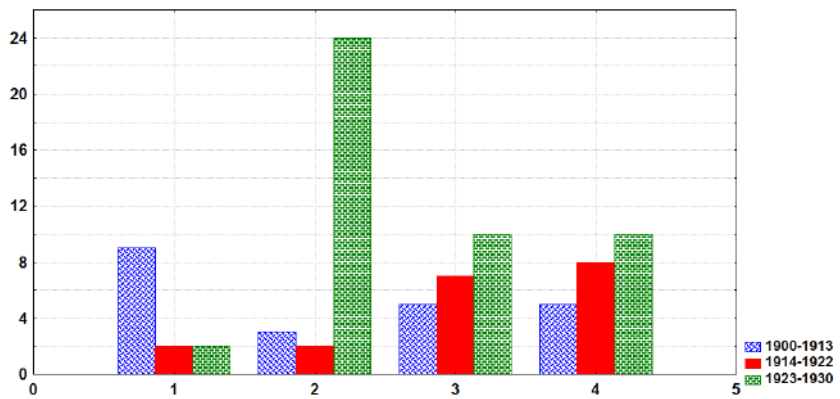

Fig. 4. 1 – Rural life vs. city life, 2 – Peasants life, 3 – Violence, 4 – Murder

A major change can be seen in the relative frequency of such themes as *Christian God* (incorporating the concepts of *faith*, *saints*, *sin* and even *devil*) and *religion* as a social institution across the second and third periods. During the "military" period from 1914 to 1922, the concept of God, quite naturally, was among the key ones. After the ultimate victory of the Red Army, a peace time ensued, marked by an active anti-religious policy of the Soviet government. Spiritual issues are seldom (if ever) mentioned in the literature of the third period. This is not the case, however, with religion as a social institution. Although from the quantitative viewpoint the third period looks exactly as the second one, the situation is different in two respects. First, in the third-period stories, the Christian church no longer enjoys the monopoly and has to make room for the Jewish and Buddhist religions. Second, the references to the church, priests, worshippers, etc. are outright derogatory or ironic, at best (Fig. 5).

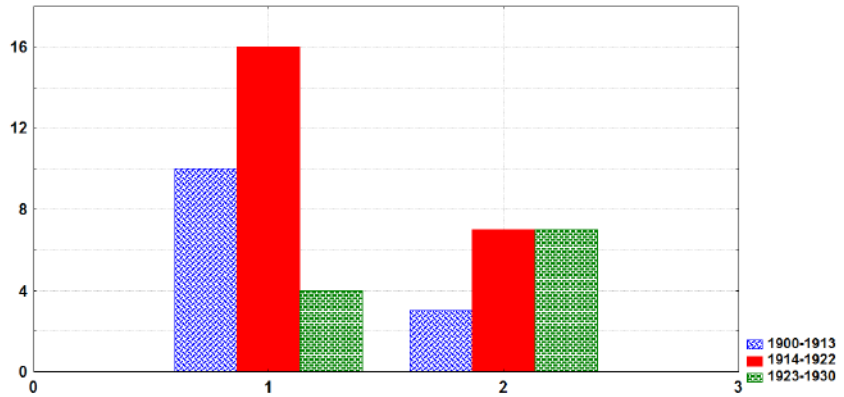

Fig. 5. 1 – Christian God, 2 – Religion as a social institution

One might think that there are timeless, core values in the human life, unlikely to be affected by political whirlpools and social life transformations. This may well be so as regards individual lives, but in the literature of tumultuous periods the focus is shifted towards large-scale public events. As a result, strictly personal topics like *marriage*, *romantic love*, *unfaithfulness*, *jealousy*, *children*, *parental love* gradually decline, becoming less prominent and frequent (Fig. 6).

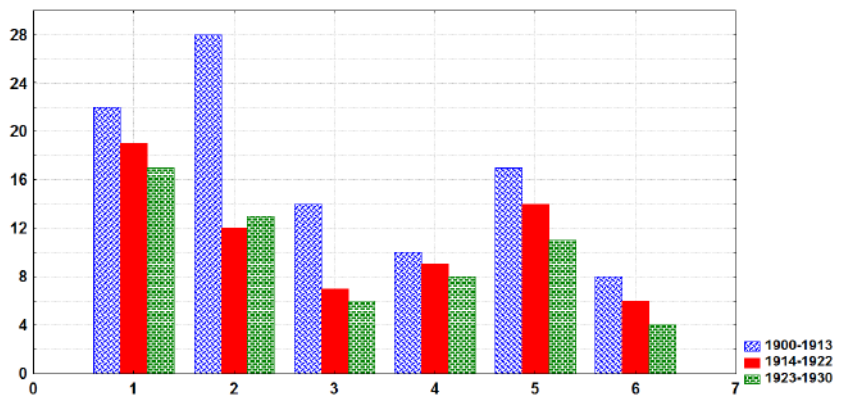

Fig. 6. 1 – Romantic love, 2 – Marriage, 3 – Unfaithfulness, 4 – Jealousy, 5 – Children, 6 – Parental love

Interestingly, the *sexual aspect of love* and, more broadly, *the body life* over the three periods is on the rise (Fig. 7).

Poverty, *hunger*, *lack of money* plagued people's life more or less steadily. During the war the hardships obviously increased. They did not diminish after the end of the Civil War as the country was exhausted and near ruin. The economy was devastated, people were starving and dying from epidemics and lack of health-care. The number of stories highlighting the contrast between *the rich and the poor* and the crucial role of *money* after the revolution slightly went down, as there were no more wealthy people (Fig. 8).

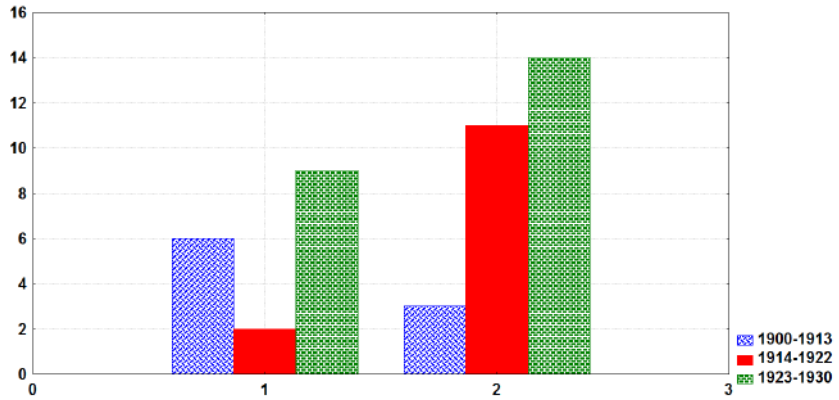

Fig. 7. 1 – Mutual sexual love, 2 – Body life

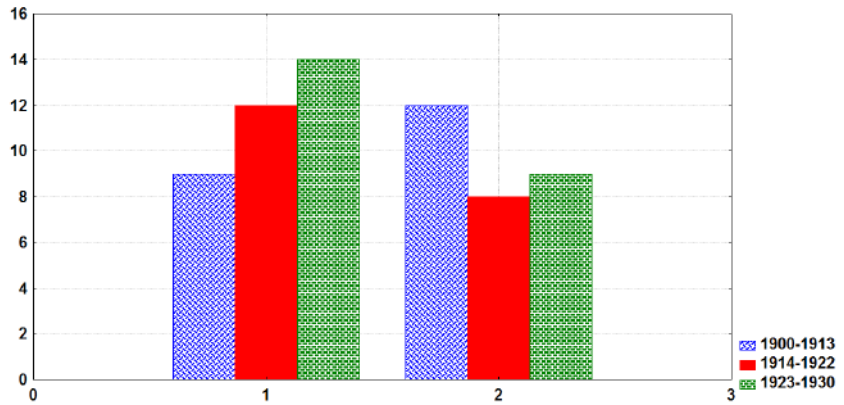

Fig. 8. 1 – Poverty, hardships, 2 – The rich and the poor, money

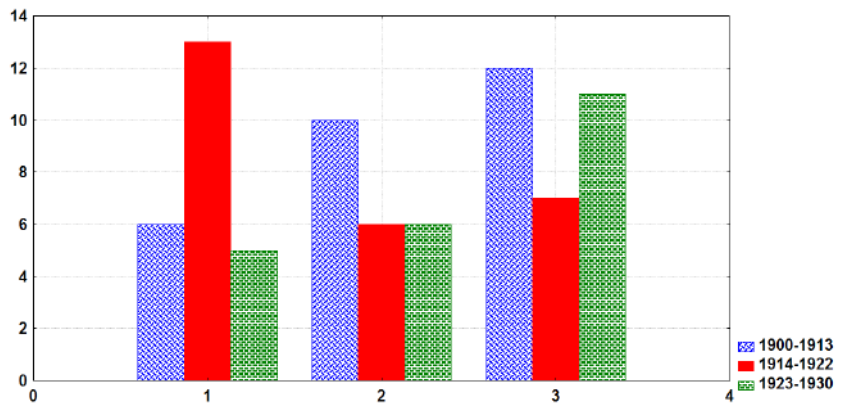

Fig. 9. 1 – Death in the war, 2 – Natural death, 3 – Monotonous everyday life, boredom

The difference between the times of war and peace is most obviously reflected in the figures related to the *death-in-the-war* theme. An increase in this theme runs parallel to the decrease in the number of stories involving *death from natural causes*. Surprisingly, there is yet another thematic marker of peace times, and that is *boredom*. In the epoch of cataclysms, people do not have the luxury of *monotonous everyday life* (Fig. 9).

3 Narrative Structure

3.1 Conflict and Resolution

It is commonly believed that works of fiction, in particular short stories, are bound to have a standard plot structure consisting of 5 parts: exposition, rising action, conflict, falling action, resolution [15]. Complications signaled at the beginning tend to increase and reach a climax, a turning point after which the main conflict unravels and is finally resolved [ibid.]. Curiously enough, this classical framework is rather often breached in short stories of all the three periods [16].

The non-canonical cases can be roughly divided into two groups. One contains stories with no or little action, intentionally devoid of changes in the protagonist's fate. The other embraces stories filled with small-scale events and local conflicts which, however, do not translate into a conclusive climax bringing about a new state of affairs in the protagonist's life. Most often, this is done on purpose, but in some cases the deficient structure may result from the author's poor writing skills. The total number of stories in the two groups is about 30% for the first and second periods, in the third period it drops to roughly 25%.

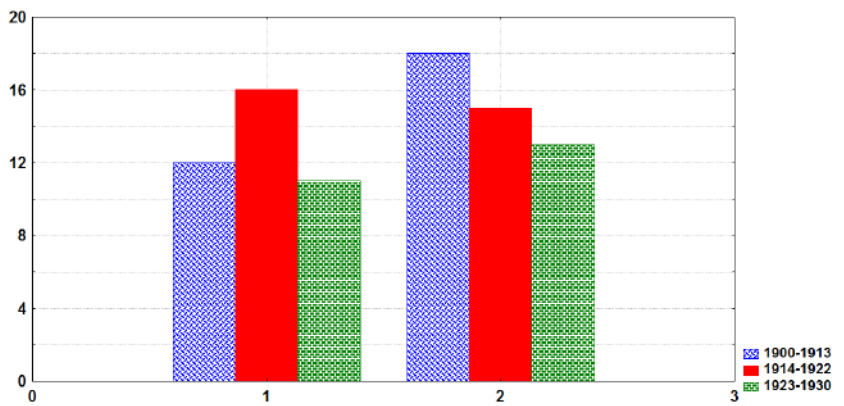

Fig. 10. Features of the composition: 1 – No climax, 2 – A number of small climaxes

The short stories marked by a non-standard composition cannot be safely linked to particular themes. For example, quite often stories about poverty and hardships have no conflict and thus no resolution. This helps to highlight the protagonist's hopeless position. If there were a conflict, it would be followed by a resolution bringing im-

portant change in the protagonist's life, which would run counter to the author's intentions. The same applies to such themes as *monotonous everyday life*, *boredom*, *hard work*. But such correlations are by no means a rule.

The deficient structure is regularly found in short stories involving *thoughts*, *reminiscences*, *dreams*, *fantasies*, *mysticism*, and *supernatural*. A whimsical temporal structure and a general lack of coherence characteristic of the phenomena concerned is reflected in the narrative, preventing a progressive unraveling of the plot.

Many stories dealing with *the new social order* established after the October revolution have no obvious conflict or a conclusive resolution, either. The writers simply depicted the new order because it was novel and unusual, sometimes opposing it to *the old way of things*.

What may seem strange at first sight is that quite a number of stories about political events also lack the canonical narrative structure. This is usually done on purpose to underline *ineffective leadership*, *hesitation*, *stalemate*, *overall confusion* or *individual futile efforts* and *despair*. Such literary stories about *hopeless*, *non-heroic situations* actually exhibit similar effects to the everyday stories about ethnic minorities that were shown to lack resolution more often than not [17].

Another conspicuous factor at work accounting for a loose narrative structure without a salient conflict and resolution, especially in what regards the short stories of the second and the third periods, is quite trivial. The October revolution and the subsequent radical transformations resulted in the emigration of many talented Russian writers, the vacancies being filled by lesser-known or unexperienced young authors whose professional competence or talent left much to be desired. Short stories by Dmitri Furmanov and Zinaida Richter mixing up fiction prose with documentary writing are glaring examples of this sort. Indicative of the tendency are also numerous third-period stories pervaded by ideological evaluations which bring them close to newspaper articles of that time.

Finally, it might be presumed that the strength of the short stories' conflict and resolution is partly determined by the national literature periods. Thus, it was shown in [18] that American 19th century stories tend toward greater resolution on the level of the plot than those of the 20th century. Closural states referred to in the 19th century-stories' terminal sentences deal mostly with objective events (*death*, *parting*, *marriage*, *an obstacle removed*, *a problem solved*, *a goal achieved*) while in the 20th century there is a noticeable shift toward subjective and minor things like *satisfaction* [ibid.]. Naturally, literature periodization is not the same for different national traditions, still the overall trend seems clear enough.

3.2 Narrative Modes

Traditionally, third-person narration is the most commonly used narrative mode in literature. The first-person point of view is rather frequent in short stories, too. This holds for our sample. However, a few interesting details are worth mentioning Fig. 11).

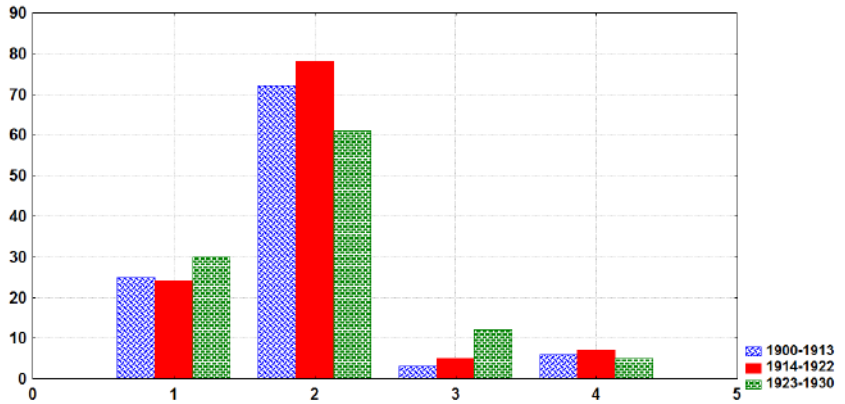

Fig. 11. Narrative modes: 1 – 1st person narration, 2 – 3rd person narration, 3 – Alternating-person narration, 4 – Embedded story

To begin with, the ratio of first-person narration to third-person narration is not the same over the three periods. In the stories written from 1923 to1930, there is an increase by roughly 5% in the former. The narrator thus is placed close to the reader and the unfolding story, making the latter seem more personal and subjective.

The sense of subjectivity is even stronger felt in alternating-person narration, which was constantly on the rise starting with 3 for the pre-war stories to 5 in the war period and then up to 12 in the post-war period. Why such an increase?

In the 1923–1930 period, with the communist control of the country well-assured, there arose a need to promote the alleged advantages of the new order. In many stories an ideological component was made explicit by narrator's first-person comment, usually placed at the end of the story and separated from the body text by asterisks or even marked as "Afterword" (e.g. stories by Sivachov and Zorich). In such cases, the reader initially takes it to be third-person narration, and all of a sudden at the end of the story comes across a first-person evaluation of the plot. Such structure is not found in the stories of the other two periods.

Thus, what is most peculiar about the grown number of stories involving alternating narration, is not the numbers as such but rather the purpose. While this narration type is generally used mostly to impart a personal note, in the socialist period it often served to introduce ideology. It may be said that the relatively high percentage of stories involving alternating narration are due to the need (perceived by the writers) to express an explicit evaluation of the new order. This is yet one more aspect which enables to draw a parallel between the literary prose of the 1923–1930 period and everyday stories (see also above).

A classical way to combine different points of view in narration is embedded narrative, or a story within a story. The number of such cases is more or less stable across all the three periods. As a rule, it is the embedded story that has a canonical structure while the frame story lacks conflict and resolution. The only exception found in the sample is Vladimir Korolenko's *Frost* which has a full-fledged composition in both

frame and embedded stories. Leonid Leonov's *Tramp* is another interesting case in point as it has two subsequently embedded stories.

4 Conclusion

In this paper we have touched upon two of the three aspects defining a genre, to wit, themes and composition. Although the linguistic aspect has been deliberately left out, the overall picture is clear. The short stories published in the third period are quite different from those of the first period in both thematic and structural aspects. New themes emerged while some of the old ones dropped in frequency or radically changed in evaluation (e.g. religion as a social institution). The latter in particular illustrates the need for qualitative rather than purely statistical analysis.

Some stories of the third period exhibit a quite special structure, marked by the narrator's explicit comment on the ideological gist of the plot. Such weird component, untypical of the fiction prose in general, was prompted by external factors discussed above. It is totally absent from the stories of the previous periods and, it might well be assumed, will be seldom, if ever, found in more recent literature.

The second-period stories cannot be viewed as a "bridge" between the literature of the two peace periods. They have a distinct character of their own shaped by the large-scale political and military events. As concerns the composition, however, these short stories pick up and continue the traditions of the classical Russian literature and as such are closer to the first-period ones. Due to inertia, this is true for the post-revolution years as well, including the Civil War. Thus, the above-mentioned postponed effect holds not only for the stories' thematic content but also for their structure.

The quantitative data obtained should be judged as preliminary, since we have examined only a small portion of Russian literature of the designated period. The proposed methodology seems promising for the analysis of literary corpora in general, the number of which is constantly on the rise in the digital humanities research [20; 21].

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Pragmatic Markers and Parts of Speech: on the Problems of Annotation of the Speech Corpus

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Abstract. The article considers the range of possibilities of pragmatic markers (PM) annotation: from the speaker's code to the speaker's commentaries for all difficult cases. The research is based on the material of two corpora of everyday Russian speech – "One Day of Speech" (ORD; dialogues / polylogues) and "Balanced Annotated Text Collection" (SAT; monologues). Two main annotation levels have become the objects of research in this paper: the part of speech of the original lexical unit, from which the basic version of the PM had derived (POS), and the model of formation of the PM which consist of more than one word (Model). The research shows the low feasibility of trying to fit PM into the system of traditional parts of speech, and, conversely, the importance and role of defining a model of formation of PM for their systematic description. In any case, the automatic annotation of corpus material turns out to be considerably difficult.

Keywords: Spoken Speech, Speech Corpus, Pragmatic Marker, Pragmaticalization, Part of Speech, Model of Formation.

1 Introduction

A speech corpus, by definition, should include not only a set of texts, but also their annotation [Zakharov 2005: 4; Plungian 2005: 6]. Two corpora of everyday Russian speech, which became the sources of observations for this research, are annotated: "One Day of Speech" (ORD; dialogues / polylogues) (see about that: [Russkij yazyk … 2016; Bogdanova-Beglarian et al. 2016 a, b) and "Balanced Annotated Text Collection" (SAT; monologues) (see: [Zvukovoj korpus … 2013]). The corpus "One Day of Speech" was formed using the method of long hours monitoring. This method is traditionally used in Japanese field linguistics studies (see: [Shibata 1983; Campbell 2004]), and, furthermore, was implemented during data collection for the spoken language part of the British National Corpus [Burnard 2020]. The advantage of this method lies in the receiving for the analysis such spoken material which is the closest to the natural everyday speech. During the process of the corpus development, this method has been first-time used as applied to the Russian language. The specificity of the corpus "Balanced Annotated Text Collection" is that it includes monologues received from the socially balanced groups of native speakers. The monologues follow 4 most common communicative scenarios: reading of a text, retelling of a text, de-

scription of a picture and a story. This balancing allows comparing monologues of one speaker, produced in different communicative situations, and monologues of different speakers, produced in similar communicative situations.

Apart from other types of annotation, in both corpora the pragmatic markers (PM) were annotated. PM constitute a significant part of structural units of any oral text: 2,77 % in the whole material, 2,83 and 2,57 % in dialogue and monologue, respectively.

2 Annotation of PM: Literature Background

In this paper, the term "pragmatic markers" describes particular discourse units (words, expressions, and phrases) with a weakened (sometimes even vanished) referential meaning, which have a variety of functions in the discourse: marking the start and the end of the speech, pause-filling, speech-reflection, etc. The term "pragmatic marker" was developed by B. Fraser who defined them as a class of words that signal some important for the speaker messages towards the speech [Fraser 1996]. The majority of the researchers more often use the term "discourse markers" (DM), referring to a group of discourse units which structure the text or label different kinds of relations between its parts. [Baranov et al. 1993; Shiffrin 1996; Lenk 1998; Kiseleva, Paillard 1998, 2003; Schourup 1999].

However, there are some important differences between discourse and pragmatic markers as the objects of the investigation [Bogdanova-Beglarian 2018]: DM are put in the text consciously by the speaker, and PM are inserted unconsciously as speech automatisms; DM in some cases have lexical and grammatical meanings, and PM usually lose both lexical meaning and grammatical properties completely; DM, in general, convey speaker's attitude toward the speech, and PM express speaker's relation to the speech process itself and verbalize difficulties in speech production; moreover, most of DM can be found in the language dictionaries, while PM are left out of the lexicographic description.

Thus, the meanings of the terms PM and DM do not fully coincide. However, the specificity of their annotation in the corpus material is similar in many respects. This paper presents several results of the first attempt of pragmatic markers annotation understood as specific elements of merely oral speech. The annotation of discourse markers, a wider range of units, as shown, was carried out in the different corpora.

D. Verdonik, M. Rojc, and M. Stabej annotated DMs in the corpus of Slovenian telephone conversations TURDIS and analyzed as DM, among the DM in the conventional understanding, hesitations and backchannel expressions. For most cases, as the researchers noticed, "it is not possible to say that a discourse marker performs only one of <…> pragmatic functions" [Verdonik, Rojc, Stabej 2007: 162]. The authors suggest manual annotation of markers since even if the development of an algorithm, trained on the manually annotated data, is possible, subsequent manual correction is needed because of the existing ambiguation of markers and content words.

L. Crible and S. Zufferey implemented the annotation of DM in French and English spoken speech and written texts using the structure of four domains — ideational,

rhetorical, sequential, and interpersonal [Crible, Zufferey 2015]. The researchers stated that the inter-annotator agreement of manual annotation was from 34% (for English texts) to 52% (for French speech). Several issues of such annotation arose: e.g., the distinction of similar DM functions, the discovery of new functions and their clustering, and the ambiguation of markers and other words.

L. Crible and M.-J. Cuenca [Crible, Cuenca 2017] reported that most annotation models of DMs were developed for annotation of written discourse: the Rhetorical Structure Theory (RST) [Mann, Thompson 1988], the Penn Discourse Treebank [Prasad et al. 2007], and the Cognitive approach to Cognitive Relations (CCR) [Sanders et al. 1992]. The researchers annotated discourse markers in the French-English corpus DisFrEn without applying the prescribed DM list [Ibid.]. The following problems appeared during the annotation: the presence of truncated structures in spoken speech, the ambiguity of some DM, and the multifunctionality of markers. Therefore, the authors concluded that the automatic annotation of DM is not possible.

Regarding the semi-automatic annotation of pragmatic units, the EXMARaLDA annotation tools, for instance, should be mentioned. It allows marking two or more functions for each discourse marker in different contexts manually or semi-automatically, using prescribed list of discourse functions, but does not allow the process of annotation being completely automatic [Crible 2018]. The automatic tool for the annotation of discourse markers is provided in the MDMA (Model for Discourse Marker Annotation) project, which uses the methodology named "back-and-forth from theory to data" [Université catholique… 2020]. Within this project, manual selection of DM in the spoken speech and their further semantic, syntactic and pragmatic annotation is made for the NLP-tasks. The results of the research showed that only the initial position of the marker in the sentence let the algorithm based on statistical modeling identify the marker and its particular function [Bolly et al. 2017].

PRAGMATEXT model of annotation includes the list of tagged pragmatic functions, e.g., labelling emotional language, discourse relations, discourse modality, speech act, etc. The researchers used this model for the first attempt of discourse markers annotation in the multilingual parallel corpus (Arabic-Spanish-English) [Samy, Gonzalez-Ledesma 2008]. At the first stage, the Spanish part of the corpus was annotated at the discourse markers level. At the second stage, the comparison with the DM in texts in another two languages was made using a bilingual dictionary. Non-ambiguous DM in Arabic and English texts were automatically tagged the same way as in the Spanish texts. The ambiguous markers were disambiguated manually considering their prosodic features and position within the sentence. The authors intend to develop the automatic disambiguation tool for the purposes of the DM annotation; however, it is prevented by such factors as DM categorical, syntactic, and discursive ambiguity, as well as the absence of the clear distinction between DMs and idiomatic expressions since the DM tend to form the lasts.

Thus, as it was shown above, pragmatic markers annotation of corpus spoken speech data can be performed manually and semi-automatically with necessary checking.

3 Annotation of PM and Types of Pragmatic Markers

The annotation was implemented at the several levels: the particular usage of PM (PM); its functions in this particular usage (Function PM); the commentaries for introducing the optional information and marking the difficult cases which show the troubles in the detection of PM and their functions (Comment PM); the basic version of PM (excluding its structural versions and/or inflectional paradigm) (Standard); the parts-of-speech tagging of the source lexical unit, from which the basic version of the PM derived (POS); the model of formation of the PM which consist of more than one word (Model); the speaker's code (Speaker PM); and phrase commentary (Phrase) [Bogdanova-Beglarian et al. 2018, 2019b].

The main functional types of PM in oral discourse turned to be the following: A – marker-approximator (*vrode 'like', kak by 'kinda'*), G – boundary marker (starting, final, and navigational), D – deictic marker (*vot (...) vot 'like ... this'*), Z – all types of replacement markers (for someone else's speech, whole set or its parts: *bla-bla-bla, i vse dela 'and all that', i vs'o takoe prochee 'and all that stuff'*), K – "xeno" marker (*tipa (togo chto) 'sort of', takoj 'like'*), M – meta-communicative marker (*da 'yeah', (ja) ne znaju '(I) don't know', znaesh' 'you know', smotri 'look'*), F – reflexive marker (*skazhem tak 'let's say', ili kak tam? 'or whatever'*), H – hesitation marker (*eto 'what', tam 'em', eto samoe 'whatchamacallit'*) [Ibid.].

The automatic annotation of such material seems almost impossible: the very specificity of oral spontaneous speech, which is difficult to any systematization, cause too many problems. For instance, the syntagmatic division of spontaneous speech itself is problematic, which is relevant for the distinction of various boundary PM (G): starting, navigational, and final. It is also difficult to establish a distinction between the formally similar PM and meaningful units of discourse, that are pragmaticalized in the speech and sometimes are at the different stages of the pragmaticalization from the lexemes to the pragmatemes (*on prishol, a **tam** nikogo net 'he came but no one was there'* (adverb of place) – *on **tam** prishol **tam**, a nikogo net 'he em came em but no one was there'* (two PM used in hesitative and rhythm-forming functions)).

The most PM of Russian speech are polyfunctional, which leads to the necessity of identifying the main and additional functions of each marker in every particular case (*on **tam** prishol **tam** 'he em came em'* – HR). At last, spontaneous speech reveals such feature of PM as their "magnetism", attraction of one PM to another if they have one common (synonymous) function. Consequently, the need to distinguish different PM which consist of more than one word, on the one side, and a chain of markers, on the other side, appears: *eto kak jego 'what whatchamacallit'* (one marker) or *eto + kak jego 'er + whatchamacallit'* (a chain of markers) [Bogdanova-Beglarian et al. 2019a].

4 Pragmatic Markers and Parts of Speech

The set of the PM revealed in the material shows that PM have different "origins" in the field of parts of speech: particles (*vot 'here', von 'there'*), verbs (*znat' 'to know', govorit' 'to speak', smotret' 'to look', dumat' 'to think'*), including gerund (*govor'a*

'speaking'), adverbs (*tam 'there', tak 'that way', kuda 'where'*), pronouns (*etot 'this', samyj 'the most', on 'he', ona 'she'*), conjunctions/prepositions (*tipa 'kind of', vrode 'like'*).

The parts-of-speech tagging of corpus data was initially made automatically with the software "MyStem" (Yandex Technologies) and then checked manually. Only particular usages of PM were annotated. In the table 1, the results of this annotation in the ORD-corpus for the top of the frequency list of PM (first 20 ranks) are demonstrated. It can be already seen that certain difficulties during the automatic annotation with a help of "MyStem" software application arise, as well as insignificant divergence of two annotation types.

Thus, the program does not identify the integrity of the unit *kak by 'kinda'*, marking it as "adverbial pronoun + particle" (ADVPRO&PART), while, during the manual annotation, the experts choose the option which is closer to the nature of this unit – "particle / conjunction".

The software attributes to the marker *znachit 'well'* the tag "adverb and parenthesis" (ADV, parenth), whereas the manual annotation gives a variant "verb / parenthesis". The element *eto 'what'* in all PM (*eto 'what'* and *eto samoe 'whatchamacallit'*) is marked by the software as the "subject pronoun" (SPRO), although the traditional grammar, which became a base of manual annotation, treats this unit as the "adjective pronoun", that nominalized in the particular cases. The adjective nature of this unit is supported, for instance, by the ability of gender inflection (*eta 'what (fem.)', eto 'what (neutr.)', etot 'what (masc.)'*). The marker *tipa 'kind of'* in the automatic annotation is merely the "particle" (PART), although in the manual annotation it is "noun / preposition", which is required by the dictionaries in the first place.

However, even considering revealed inaccuracy of the automatic POS annotation of material, it is clear that the information about the POS of the original units, which have pragmaticalized and became pragmatic markers in oral speech, is rather a historical background which does not really describe new discourse units. For instance, the markers *tam* and *tak* as a PM lose all the adverbial properties [Turchanenko 2018], the word *da* as a meta-communicative marker falls into category of neither particle, nor conjunction [Shershneva 2015].

The verbal meta-communicative markers similarly lose the majority of their verbal characteristics in their new usage: verbs in indicative mood like *znaesh'/znaete 'you know', vidish'/vidite 'you see', ponimaesh'/ponimaete 'you know'* and verbs in imperative mood as *slushaj/slushajte 'listen', predstav'/predstav'te 'imagine'* leave merely formal number inflection [Bogdanova-Beglarian, Maslova 2019], the markers *(ja) ne znaju '(I) don't know'* и *znachit 'well'* completely lose any grammatical inflection and are used only in one fixed form [Bogdanova-Beglarian 2019], and the pragmatic "xeno" marker *govorit 'says'* is presented in the spoken speech solely in the present tense forms, more often phonetically reduced (*grit, gyt, gr'u, grim*, etc.) [Stojka 2019].

Table 1. The top of the frequency list of PM cases in the ORD-corpus: frequencies and POS tagging (for 300,000 tokens)

Rank	PM	Frequency	IPM	POS (aut.)	POS (man.)
1.	*vot 'er'*	1205	4017	PART	particle
2.	*tam 'em'*	657	2190	ADVPRO	adverbial pronoun
3.	*da 'yeah'*	353	1177	PART	particle / conjunction
4.	*tak 'this way'*	271	903	ADVPRO	adverbial pronoun
5.	*kak by 'kinda'*	270	900	ADVPRO&PART	particle / conjunction
6.	*govorit 'says'*	230	767	V	verb
7.	*znaesh' 'you know'*	164	547	V	verb
8.	*slushaj 'listen'*	160	533	V	verb
9.	*znachit 'well'*	158	527	ADV, parenth	verb / parenthesis
10.	*eto 'what'*	158	527	SPRO	adjective pronoun
11.	*nu vot 'well er'*	137	457	PART&PART	particle + particle
12.	*eto samoe 'whatchamacallit'*	109	363	SPRO&APRO	adjective pronoun + adjective pronoun
13.	*koroche 'in short'*	97	323	ADV, parenth	adverb / parenthesis
14.	*ponimaesh' 'you know'*	90	300	V	verb
15.	*takoj 'like'*	89	297	APRO	adjective pronoun
16.	*tipa 'sort of'*	84	280	PART	noun / preposition
17.	*govor'u 'I say'*	75	250	V	verb
18.	*ne znaju '(I) don't know'*	71	237	PART&V	particle + verb
19.	*voobshche 'generally'*	55	183	ADV, parenth	adverb / parenthesis
20.	*takie 'like'*	53	177	APRO	adjective pronoun

It could hardly be correct to refer all these pragmaticalized forms to the certain traditional POS categories.

5 Basic Versions of PM and Parts of Speech

The top of the frequency list of basic (standard) versions of PM seems slightly different than the one of particular usages of PM in the table (the data from the two corpora altogether):

(...) vot '(…) er' (IPM here and hereinafter – 7119),
(...) tam '(…) em' (2970),
(…) eto, eta, eti… (…) '(…) what… (…)' (1827),
(...) da/da da da '(…) yeah/ yeah yeah yeah' (1572),
(...) tak/tak tak tak '(…) well/well well well (1357),

(...) kak by '(…) kinda' (1353),
govorit/govor'u/govorim... 'says/say…' (1337),
znachit (...) 'well (…)' (1062),
takoj/takaja, takie 'like' (1033),
eto samoe/eti samye, etot samyj… 'whatchamacallit…' (879),
(...) znaesh' (...)/(...) znaete (...) '(…) you know (…)' (839),
vot (...) vot 'like (…) this' (778),
(...) (po)slushaj /(...) (po)slushajte '(…) listen' (750),
(...) ne znaju '(…) don't know' (498),
(...) koroche govor'a '(…) long story short' (462),
(...) tipa/tipa togo/tipa togo chto '(…) sort of' (458),
(...) ponimaesh' / (...) ponimaete '(…) you know (…)' (405),
(...) vs'o 'that's all' (357),
(...) vidish' (...) / vidite '(…) you see (…)' (255),
voobshche 'generally' (231),
(...) dumaju (...) '(…) think (…)' (223),
(...) skazhem (...) '(…) let's say (…)' (211),
(...) v principe '(…) basically' (207),
vrode (...) 'like (…)' (150),
(...) v obshchem '(…) anyway' (130),
smotri/smotrite 'look' (122),
na samom dele 'actually' (122),
(ty) predstavlyaesh' 'you know' (113),
shchas/shchas shchas shchas 'one moment' (93),
(…) tak dalee '(…) so on' (89).

One could see that the majority of markers has only generalized structure of basic version, with potential extension or restricted grammatical flexibility, cf.: VOT – *i vot 'and er', da vot 'well er'*; ZNAESH – *ty znaesh' 'you know', vot znaes'h 'er you know', nu znajete 'well you know'*, etc.; GOVORIT – *govor'u 'I say', govorish' 'you say', govorim 'we say'*, etc.; VRODE – *nu vrode 'well like', vrode kak 'like as', vrode by 'like well'*. Rare PM from the whole list of PM, annotated in the material, do not show such structural variability: *von 'err', prikin' 'guess', i tak dalee 'and so on', po idee 'normally'* and a few others. However, the deictic marker VOT (…) VOT *'like … this'* exists merely as a structural model, which is filled by a new unit each time: *vot **tak** vot 'like this', vot **takoj** vot 'like this', vot **ots'uda** vot 'like this'*, etc. In fact, this marker does not have some single basic (standard) form. The automatic parts-of-speech tagging of such material not only seems difficult, but also has rather inaccurate results since it cannot consider the specificity of possible extensions.

6 Models of Formation of PM

The annotation of corpus material at the level of models of formation of the PM, which consist of more than one word (Model), is supposed to be the most informative and scientifically valuable. At least 12 such models have been identified:

1. PM, which initially consist from more than one word, that are basic versions (but not the source "lexicographic" version): *eto samoe 'whatchamacallit', kak jego (jejo, ikh) 'whatchamacallit', kak eto? 'whatchamacallit?' kak skazat'? 'how can I say?' kak eto nazyvaets'a? 'what am I call it?' chto jeshcho? 'what else?' kak (by) skazat'? 'how can I say it?'*
2. combination of two or more PM, which consist from one word*: nu vot 'well er', nu tam 'well em', nu tak 'well um', vot tak 'er um', nu znaesh' 'well you know', tak skazhem 'let's say', skazhem tak 'let's say', skazhem tam 'let's say em', vot skazhem 'er let's say', znaesh' tam 'you know em', vot kak by 'er kinda', vot skazhem tak 'er let's say', nu ne znaju 'well don't know', tam tipa 'em sort of', nu koroche 'well in short', znachit vot 'well er', v principe vs'o 'basically that's all'*;
3. combination of PM, which consist of one and more than one word: *nu kak skazat'? 'well how can I say?' kak jego tam? 'em whatchamacallit?' nu vot eti vot 'well these ones', nu (ja) ne znaju tam 'well (I) don't know em'*;
4. addition of the personal pronoun with a weakened lexical and grammatical meaning: *(ja) ne znaju '(I) don't know'; (ja) (ne) dumaju (chto) '(I) don't think (that)'; (ty) znaesh', ponimaesh', vidish'… '(you) know'; (ty) predstav', prikin'… '(you) imagine'; chto (tebe) jeshchyo skazat'? 'what else can I say (to you)?'*
5. addition of emphatic particles/conjunctions: *i vse dela 'and all that', i vs'o takoe 'and all that', a vot 'and er', nu i vs'o 'well that's all', i to i s'o 'this and that', ja uzh ne znaju tam 'I even don't know em', ty zh ponimaesh' 'you really know'*;
6. addition of non-personal pronoun: *vs'o takoe prochee 'all that stuff', tipa togo/etogo 'sort of', vrode togo 'like', takoj kakoj-to 'like that one', kak (by) eto skazat'? 'how can I say that?'*
7. addition of the conjunction CHTO (CHEGO) 'that': *dumaju chto 'think that', bojus' chto 'am afraid that', tipa togo chto 'sort of that', vrode togo chto 'like that', znaesh' chto/chego 'you know that'*;
8. addition of parentheses: *vs'o navernoe 'that's all probably', vs'o pozhaluj 'that's all perhaps'*;
9. addition of interjection: *oj slushaj 'ooh listen'*;
10. loss of the gerund GOVORYA 'speaking': *koroche 'in short', sobstvenno 'strictly', voobshche 'generally'*;
11. reduplication: *da-da-da 'yeah-yeah-yeah', na-na-na, shchas-shchas-shchas 'one moment-one moment-one moment', te-te-te, op-op-op, bla-bla-bla, tak-tak-tak 'em-em-em', eto-eto-eto 'what-what-what'*;
12. ILI 'or' + (more often) the rhetorical question: *ili kak jego? 'or whatchamacallit?' ili kak tam? 'or whatchamacallit?' ili chto? 'or what?' ili kak skazat'? 'or how to say?' ili etot? 'or what?' nu ili ne znaju 'well or I don't know'*.

7 Conclusion

Previous works have shown that in the speech recognition process POS-tagging of some markers (excluding multi-word markers and phrases) can be useful for the task of prediction of the following words [Heemant et al. 1998].

However, the automatically derived classification algorithm of DM POS-tagging showed an error rate of 37,3%, in comparison to, for instance, the error rate of 45,3% for the algorithm of J. Hirschberg and D. Litman [Hirschberg, Litman 1993]. In other words, using this automatic algorithm (decision tree), only for 4 from 10 particular pragmatic markers the correct tag could be assigned. Presumably, this POS-tagging heuristic may be improved by the expansion of data, and only after implemented for the objectives of this investigation.

Our paper provides the theoretical basis of the relevant PM POS-tagging and the classification of PM-models for further linguistic elaboration. Anyway, the result of speech corpora annotation at the level of pragmatic markers can become a systematic description of PM as the inherent structural components of oral discourse. The description should be done considering PM functions, polyfunctionality, and possible "synonymic" relations, their formal grammar (and not only at the parts-of-speech level, but also, for example, at the level of predicative units [Bogdanova-Beglarian, Zaides 2019]), the specificity of their usage, and the possible correlation with speaker's characteristics, type of speech (monologue/dialogue) or communicative situation.

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Challenges of Building an Intelligent Chatbot

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Abstract. There can be no doubt that the way of human-computer interaction has changed drastically over the last decade. Dialogue systems (or conversational agents) including voice control interfaces, personal digital assistants and chatbots are examples of industrial applications developed to interact with customers in a human-like way using natural language. With continued growth in messaging applications and increasing demand for machine-based communications, conversational chatbot is likely to play a large part in companies' customer experience strategy. As systems designed for personalized interaction with users, conversational chatbots are becoming increasingly sophisticated in an attempt to mimic human dialogue. However, building an intelligent chatbot is challenging as it requires spoken language understanding, dialogue context awareness and human-like aspects demonstration. In this paper, we present the results of data-driven chatbot implementation in order to better understand the challenges of building an intelligent agent capable of replying to users with coherent and engaging responses in conversation. Developed chatbot demonstrates the balance between domain-specific responding and users' need for a comprehensive dialogue experience. The retrieval-based model, which achieved the best dialogue performance, is proposed. Furthermore, we present the datasets collected for the purpose of this paper. In addition, natural language understanding issues and aspects of human-machine dialogue quality are discussed in detail. And finally, the further studies are described.

Keywords: Natural Language Processing, Dialogue Systems, Conversational AI, Intelligent Chatbot, Retrieval-Based Chatbot, Word Embeddings, Text Vectorization.

1 Introduction

Intelligent dialogue agents are designed to conduct a coherent and emotionally engaging conversation with users. Chatbots became a basis of modern personal assistants which help users to perform everyday tasks. Among the most popular are Apple Siri, Google Assistant, Microsoft Cortana, Amazon Alexa and Yandex.Alice.

There are two major types of dialogue systems: goal-oriented (closed-domain) and open domain (i.e., chatbots or chitchats). Goal-oriented dialog systems are primarily

* Equal contribution to the work

built to understand the user request within a finite number of pre-defined agent skills (e.g., play music or set a reminder). Chatbots are to involve users in some kind of intelligent conversation in order to improve their engaging experience.

Building an intelligent conversational agent interacting with people in a human-like way is an extremely challenging task complex task, meanwhile it is a perspective and promising research direction of the field dialogue systems [1, 14].

Modern dialogue system architecture includes three main modules: natural language processing (NLP), dialogue manager, and natural language generation (NLG). The core of a dialogue system is analysis of user utterance inputted in NLP module [5]. Typically, in this module, the utterance is mapped to text vector representation (i.e., embeddings) [17]. Then vector representations are then used by the internal model to provide a response to the user. Chatbot could be considered intelligent if its responses are coherent and meaningful to the user. This behavior is highly dependent on the chatbot architecture and text vectorization methods.

The goal of this paper is analysis of modern approaches to the development of chatbots which could provide the user with emotionally satisfying and meaningful responses. First, we describe the historical background of conversational agents and consider the main data-driven architectures; in particular, we focus on the retrieval-based approach. Next, we briefly review the state-of-the-art text vectorization models and present the results of comparative analysis. Then we describe our experiment of building a retrieval-based chatbot, starting with the process of train dataset collection that provides a wide range of chatbot about a specific topic. The topic of film/analogue photography has been chosen as an example. The basic implementation of chatbot and its improvements are proposed. Finally, the main challenges of building an intelligent conversational agent and future work are discussed.

2 Chatbot Architectures

Chatbots can be roughly divided into the following three categories based on the response generation architectures [4, 27]:

- rule-based chatbots, which analyze key characteristics of the input utterance and response to the user relying on a set of pre-defined hand-crafted templates;
- retrieval-based (IR-based) chatbots, which select response from a large pre-collected dataset and choose the best potential response from the top-k ranked candidates;
- generative-based chatbots, which produce a new text sequence as a response instead of selecting if from pre-defined set of candidates.

One of the most influential examples of conversational programs is ELIZA [42], the early dialogue system, which was designed at the MIT Artificial Intelligence Laboratory by Joseph Weizenbaum, simulated a human-like conversation as a psychologist. ELIZA is the rule-based chatbot that responds to the user combining complex heuristics and "if-then-else"-rules from the set of hand-crafted templates developed for the system specific domain. All early rule-based chatbots, including ELIZA, required much manual human effort and experts' knowledge to build, enhance and maintain such systems [41].

Thankfully, as a result of the recent progress in internet technology and data science, full data-driven architectures were proposed. Divided by machine learning approaches, there are two chatbot architectures using massive text collection analysis and natural language processing: generative-based and retrieval-based.

Generative-based chatbots reply to users applying natural language generation (NLG). They produce new responses from scratch word by word: given a previous conversation history, predict the most likely next utterance. The early response generative model proposed by Ritter in 2011 was inspired by Statistical Machine Translation (SMT) techniques [21]. Nowadays, the state-of-the-art in the NLG are Encoder-Decoder Sequence-to-Sequence (seq2seq) architectures [37] based on deep recurrent LSTM/GRU neural networks [7] with attention mechanism [33, 39]. The first adaptation of seq2seq architecture to the task of building a conversational agent was presented by [40]. Unquestionably, the fundamental advantage of generative-based chatbots is that they do not rely neither on a pre-defined set of rules nor on a responses repository. Thus, generative models tend to be more sustainable to new unseen input utterances and, as a result, to seem more coherent to the user. However, due to specificity of learning procedure, there are also some weaknesses of generative models: the problem of short informative responses (e.g. "I don't know", "okay") [35]; text generation grammatical and semantic mistakes that humans would never make; and dialogue inconsistency, where the model analyzes only the current user utterance without the previous context ("context-blindness"). The above mentioned problems are still unresolved despite attempts of researchers to handle them [18, 34].

Latest works [1] show researchers' high interest in generative-based chatbot architectures, thus rapid progress in this area can be expected. However, it is worth noting that generative models require a huge amount of training data and computational resources while they are still likely to respond unpredictably. Therefore, today, most of the industrial production solutions still remained retrieval-based [9].

In this paper we focused on the features of retrieval-based architecture. Retrieval-based chatbots do not generate new utterances but they select an appropriate grammatically correct response from a large set of pre-collected *Utterance-Response* pairs. Given a dialogue context, both input utterance and responses pairs are encoded into some vector space representation, then the system counting semantic similarity score for each pair (i.e. dot product or cosine similarity) selects the best response from high-matched candidates. This approach based on information retrieval paradigm [13] became quite popular in the area of conversational agents [12, 25, 26, 15]. Considering the learning process, there are two approaches for best response selection by retrieval-based model: supporting a single-turn conversation, matching current user utterance with candidate pairs without any context information, or conduct a multi-turn conversation, taking into account the previous utterances, which are typically defined as a dialogue context. Building a retrieval-based chatbot supporting a multi-turn conversation is a promising and challenging problem. In recent years, there has been growing interest in this research area [32, 45, 38].

In the next chapter we consider the concept of text similarity in detail and briefly review various vectorization models relevant for the task of retrieval-based chatbot implementation.

3 Text Vectorization Models

Text vectorization models that are popular today are based on the ideas of distribution semantics [10, 24]. According to the hypothesis of distributional semantics, words that occur in similar contexts with a similar frequency are considered semantically close. Corresponding dense vector representations which dimensions are much smaller than the dictionary's dimension (i.e., embeddings) are close to each other by the cosine measure in a word vector space.

One of the most basic vectorization methods is the statistical measure TF-IDF [22], it determines the word importance to the document in a text collection. The TF-IDF is the product of the frequency of words in the text and the inverse frequency of the word in the collection of documents. So the value of TF-IDF increases proportionally to the number of times a word appears in the document. TF-IDF vectors have size equal to the dictionary size, and it can turn out to be quite large. TF-IDF vectors will be close only for those documents which contain the matching words [2].

Text vectorization models gained a wide popularity in 2013 after Tomas Mikolov publication [23] on the approach known as Word2Vec. This approach has two implementations: CBOW (continuous bag of words) and Skip-Gram. CBOW model predicts the probability of each word of text in a particular context, while the Skip-Gram model calculates the probability of a context around a particular word. Word2Vec embeddings capture semantic similarity of words, that is semantically close words will have high cosine similarity in the model vector space.

However, extension of Word2Vec vector space with new word embedding requires retraining the model. The solution of the missing words problem was proposed in fastText model [16, 6]. This model is Word2Vec modification, which produces character n-gram embeddings. Also, it is worth mentioning GloVe model [30] proposed by Stanford NLP Group at Stanford University. GloVe combines ideas of matrix factorization and Word2Vec approach.

Text vector representations described above are commonly referred to as "static word embeddings". One of the problems of static models is polysemy. The same words in different contexts will have the same embedding. The recent progress in approaches to text vector representation is contextualized (dynamic) language model. Contextualized models calculate word embeddings depending on its context. Thus, released in late 2018 BERT model, which helped researchers to reach a new state-of-the-art in most NLP problems, became, undoubtedly, the key achievement of the last years in the field of NLP. With regard to other successful contextualized language models, ELMO [31], XLNet [43] and GPT-2 [28] are particularly to be noted.

People often use foreign words or whole phrases in the spoken language [11]. Thus, multilingualism could be one of the challenges in building chatbots. Contextualized models allow a multilingual format, but separately trained models should be required for each language. There is another approach to multilingualism, which transfers NLP models from one language to scores of others by preparing a model that is able to generalize different languages in a common vector space. Then the vectors of the same statement in any language will end up in the same neighborhood closely placed. Developed by a group of Facebook researchers LASER embedding model [3] is the promising method which implements this idea.

The model maps entire sentences into the vector space, and that is the advantage in creating embeddings for retrieval-based chatbots. In the next section, we describe the steps of the retrieval-based chatbot implementation and present the results of comparison between the considered text vector models applied for this task.

4 Experiments and Results

4.1 Data Sources

Regardless of chatbot architecture, it requires a large dataset of natural language dialogs for training. Such a dataset should include all topics that are supposed to be discussed with the bot. Additional meta-information about the dialogs (i.e. author name and age, message date and time, or response links) can improve chatbot responses. The most notable conversational open data sources for Russian are the following:

- Movies and TV Series Subtitles. Subtitles can be a source of general conversation topics. However, the movie genre introduces the main theme of dialogs, thus the collected dataset must be analyzed for peculiar vocabulary. Another subtitles drawback is the lack of clear separation between dialogues.
- Twitter. Twitter messages in threads contain information about authors and reply details and conversations have clear boundaries. But Twitter users tend to discuss multimedia content, which makes the dialogue lexically and semantically narrow.
- Public Group Chats (i.e. Telegram, Slack). Public chats can provide a rich source of dialogues on specific topics (programming, history, photography, etc). However, it is necessary to remember that poorly moderated public group messages likely contain hate speech, political statements and obscene language.
- Other Web Sources. There are many other sources of conversational data that could be used for chatbots training: social networks discussions, forum threads, movie transcripts, fiction (i.e. plays), etc.

Depending on a practical goal, several data sources can be used for training a retrieval-based chatbot, but it still may not be enough for supporting a coherent conversation. Here it is also worth paying attention to ethical issues and removing offensive utterances and obscene language from the data.

The key idea of our experiment is creating a chatbot that could seem intelligent enough, responding to the input utterance coherently, which could make a good impression on users. The bot should behave that way both within small talk and within some pre-selected narrow topics, which users are interested in. As a subject of a specific topic we decided to choose analogue/film photography. Two public Telegram chats[1] and open set of subtitles[2] have been chosen as the data sources. Thus, the overall text collection consists of 358,545 records with the following columns: message identifier, reply message identifier, author, addressee and utterance.

[1] https://t.me/filmpublic, https://t.me/plenkachat

[2] http://opus.nlpl.eu/OpenSubtitles.php

4.2 Data Preprocessing

When users interact with a retrieval-based chatbot, they usually input a phrase that does not appear in predefined responses word-to-word.

Therefore, relevant responses could be selected only by the semantic similarity between the user's input and conversation context of candidate utterances. In the area of retrieval-based chatbots, various methods for defining the context have been proposed in many research papers [36, 20, 44, 21]. Since the chat-specific conversational data (i.e., Telegram chats) contains information about the authors and *reply_to* links, our dataset can be splitted into many short conversations of the form such as *start_utterance->response->...->response->last_utterance*. Figure 1 demonstrates multi-turn conversations of the dataset. The structure is a directed graph, where each node corresponds to the utterance labeled by message identifier and each edge corresponds to the relationship "is reply to" between messages.

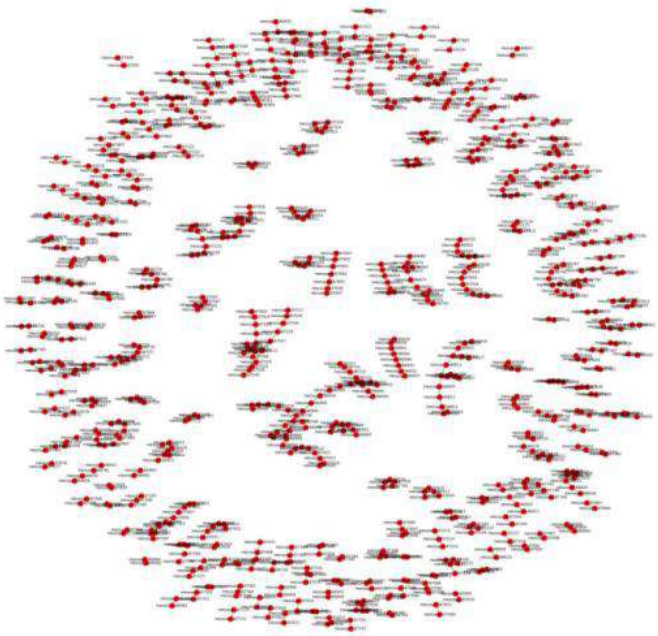

Fig. 1. Illustrated multi-turn conversations of training data.

After multi-turns extraction, the initial dataset was transformed into the Context-Response form, where the Response is the last utterance of the turn and Context is all previous responses of that turn.

Further, the text data was pre-processed according to the following steps:

1. tokenization;
2. removal of special characters, links and punctuation;
3. removal of stop-words;
4. tokens normalization.

After the last step of data preprocessing, the final training dataset contained 134307 *Context-Response* pairs. The average *Context* length is 11 tokens

and the average *Response* length is 9 tokens, which is, in fact, quite short for this kind of the retrieval-based task.

4.3 Results

Vector representation of text could be calculated by averaging its word embeddings. In particular, for the Word2Vec text vectors calculations two averaging word methods were used: simple averaging (Averaged Word2Vec) and weighted averaging W2V over TF-IDF (TF-IDF-weighted W2V).

For evaluation of chatbot responses based on the various text vectorization models, we use *Recall@k* metric. $Recall_n@k$ (denoted $R_n@k$ below) measures the percentage of relevant utterances among the top-*k* ranked *n* candidate responses [8]. This kind of metric is often applied to retrieval tasks and could be calculated automatically, but requires a validation set structured differently from training dataset. Concretely, we have created the dataset with 134307 records, where each record corresponds to three following columns: context, the ground truth response and the list of 9 false responses of training *Context-Response* pairs which have been chosen randomly. Thus, during the evaluation process, various $R_{10}@1$, $R_{10}@2$ *and* $R_{10}@5$ measures have been calculated. Each model should select *1*, *2* and *5* best responses among *10* possible candidates. Thus, the model's choice should be marked as correct if the ground truth utterance is ranked in top-*k*. Our experimental results are shown in Table 1.

It is worth noting that as a retrieval metric $R_n@k$ has a significant drawback: in practice, there could exist more than one relevant response that could be marked as the ground truth. The appropriate responses thereby could be regarded as incorrect.

Table 1. Evaluation of chatbot performance based on various text vectorization models using R10@k measure

Model Metric	TF-IDF	Averaged W2V	FastText	TF-IDF-weighted W2V	LASER
R10 @ 1	0.229	0.186	0.179	0.212	0.195
R10 @ 2	0.277	0.289	0.283	0.318	0.308
R10 @ 5	0.328	0.544	0.543	0.564	0.577

According to Table 1, the different results for each text vectorization method have been demonstrated by the chatbot. For $R_{10}@1$ the baseline TF-IDF has the highest score, for $R_{10}@2$ - TF-IDF-weighted W2V and for $R_{10}@5$ - LASER. TF-IDF-weighted W2V and LASER could be considered as the best overall models on the retrieval metrics. Even so, the model that performs well on the chosen retrieval metrics is not guaranteed to achieve good performance on a new response generation. Our assumption is that improvements on a model with regards to the $R_n@k$ metric will eventually lead to improvements for the generation task. One the other hand, the human evaluation of conversational agents is still the most accurate and preferable approach [19]. Therefore, we evaluated the quality of two highly performed methods by human judgement (TF-IDF-weighted W2V and LASER). Finally, on the generation task, the chatbot based on LASER embeddings seemed significantly

coherent, thus it has been considered as the best text vectorization model in our experiments.

5 Conclusions and Future Work

One of the most rapidly developing subfields of dialogue systems is an area of conversational agents (i.e. chatbots). Building an intelligent chatbot is a major issue of current business and research interests.

A strong product hypothesis is that the more conversational product interface is humanlike and intelligent, the more customers' digital experience is engaging and satisfactory. In this paper three main chatbot architectures have been briefly reviewed: rule-based approach and the fully data-driven retrieval-based and generative models. The advantages and disadvantages of the architectures have been also described. Nowadays, retrieval-based chatbots are the most commonly used conversational models which are built into business production solutions. Typically, retrieval-based models learn faster compared to generative models. They are less likely to have the problem of short general responses and more controllable for filtering grammatical mistakes and inappropriate language.

In this paper, the main challenges of data-driven conversational agents have been considered. We present the results of retrieval-based chatbot implementation, which keeps both a small talk conversation and conversation within a narrow topic of analogue photography in Russian. Semantic relations between context and potential responses are captured by text vector representation (word embeddings). It is a crucial technique for building a retrieval-based intelligent model of chatbot. In order to create a chatbot replying to users coherently and engagingly enough, the state-of-the-art text vectorization models have been compared and applied for our experiment. The LASER sentence embedding model has performed the best. The programming code and datasets have been shared in public repository[3].

Furthermore, we have analyzed current open web-sources of conversational data and outlined its main problems and features. It is essential to underline the critical need of high-quality dataset for training a retrieval-based chatbot. It is necessary to remember that poorly moderated conversational data likely contains offensive, toxic and noisy utterances, which must be removed from the dataset. This issue is one of the future research directions we plan to focus on.

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Using Polyadic Formal Contexts for Information Extraction from Natural Language Texts

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Abstract. The paper considers the use of elements of Formal Concept Analysis – multidimensional or polyadic formal contexts – to extract information from natural language texts. We propose the method for constructing polyadic formal contexts by means of Semantic Role Labeling and Abstract Meaning Representation (AMR) of texts. Using semantic role labeling, a conceptual graph is created for each sentence of the text, and a specific scheme of abstract meaning representation of the sentence is developed based on its elements. The polyadic formal context is a multidimensional tensor, whose points are elements of an AMR scheme. To extract information from a polyadic formal context, data associations as sub-contexts of the original context are built. Each such subcontext is associated with a specific element of the AMR scheme. Queries to associations return responses that preserve the meaning of the phrases according to the AMR scheme. The method was tested in the task of finding dependencies between texts on the corpus of abstracts of scientific articles on biomedical subjects of the PubMed system.

Keywords: Information retrieval, Polyadic formal context, Abstract Meaning Representation.

1 Introduction

The current state of the Computational Linguistics is characterized by the active involvement of mathematical methods of Data Analysis: methods of machine learning, algebraic methods, and methods of graph theory. Such synthesis is doubly useful. On the one hand, it allows in some cases to define objects used in computational linguistics in a new way and also to offer new solutions in Natural Language Processing. On the other hand, the applications of these methods in specific tasks enrich the methods themselves, opening up new areas of development in them. These observations prove to be true in relation to experimental material involved in our study. In it we apply the Formal Concept Analysis (FCA), a mathematically rigorous theory of conceptual modeling, and its main object, the formal context, which in some sense generalizes the concept of context in linguistics. In this paper we prove that clustering used in the Formal Concept Analysis (FCA-clustering) is ineffective in the tasks of extracting information from our specific formal contexts built on texts.

The paper proposes another approach to the clustering of formal context data, based on the construction of data associations with a specific AMR scheme. Information Extraction (IE) from data is effective when the data models used for this purpose are sufficiently informative by themselves. This is especially true for information extraction from natural language texts. To extract information from text data, a common scheme «model + resource» is used.

The model reflects the structure and parameters of the information retrieval target. Forms of models are various. This can be a lexical-grammatical template in a fact extraction problem, or a matrix or graph in procedures based on mathematical models. Linguistic resources are used to train models: text corpora, ontologies, and thesauri. The peculiarity of multidimensional formal contexts used in this work is that they can simultaneously be models of objects, for example, in thesauri development, and information resources in question answering systems. In this paper, formal contexts are constructed using an abstract meaning representation of the text. This ensures that they are informative as models: the semantics of AMR schemes are preserved in the model and in the query results it delivers.

The method developed in this paper is tested on the texts of the AGAC corpus (Active Gene Annotation Corpus) which contains abstracts of scientific articles on biomedical topics of the PubMed system [42]. The efficiency of our approach applied to the task of information extraction is due to the preservation of sentence semantics in a multidimensional formal context.

2 Formal Concept Analysis and Polyadic Formal Contexts

Formal Concept Analysis (FCA) [1] is mathematically rigorous theory which formalizes the notion of concept and studies how concepts may be hierarchically organized. FCA has been applied in many modern areas of knowledge discovery, machine learning and information retrieval [2]. There are also increasing number of FCA applications in text mining and linguistics, bioinformatics and medicine, software engineering and databases [3].

Briefly consider the main issues of the FCA. Classical FCA deals with two basic notions: *formal context* and *concept lattice*. Formal context is a triple $\mathbf{K} = (G, M, I)$ where G is a set of objects, M – set of their attributes, $I \subseteq G \times M$ – binary relation which represents facts of belonging attributes to objects. Formal context may be represented by [0, 1] - matrix $\mathbf{K} = \{k_{i,j}\}$ in which units mark correspondence between objects $g_i \in G$ and attributes $m_j \in M$. The concepts in the formal context have been determined by the following way. If for subsets of objects $A \subseteq G$ and attributes $B \subseteq M$ there are exist mappings (which may be a functions also) $A' : A \to B$ and $B' : B \to A$ with the properties of $A' := \{m \in M \mid < g, m > \in I \ \forall g \in A\}$ and $B' := \{g \in G \mid < g, m > \in I \ \forall m \in B\}$ then the pair (A, B) that $A' = B$, $B' = A$ is named as *formal concept*. The composition of mappings demonstrates following properties of A and B

: $A'' = A,\ B'' = B$; A and B is called the *extent* and the *intent* of a formal context $\mathbf{K} = (G, M, I)$ respectively.

By other words, a formal concept is a pair (A, B) of subsets of objects and attributes which are connected so that every object in A has every attribute in B, for every object in G that is not in A, there is an attribute in B that the object does not have and for every attribute in M that is not in B, there is an object in A that does not have that attribute.

If for formal concepts (A_1, B_1) and (A_2, B_2), $\mathrm{A}_1 \phi\ \mathrm{A}_2$ and $\mathrm{B}_2\ \mathrm{P}\ \mathrm{B}_1$ then (A_1, B_1) ≤ (A_2, B_2) and formal concept (A_1, B_1) is less general than (A_2, B_2). This order is represented by *concept lattice.* A lattice consists of a partially ordered set in which every two elements have a unique *supremum* (also called a least upper bound or *join*) and a unique *infimum* (also called a greatest lower bound or *meet*).

2.1 Applications FCA in Text Mining and Linguistics

First of all, it is necessary to define correlation between the notions of formal and linguistic contexts, the former being substantiated in algebraic theories, the latter being part of language representations.

Linguistic theories provide a variety of context types. In general, a context is regarded as an obligatory condition for actualization of basic relations within a language system, namely, syntagmatic and paradigmatic relations considered on morphological, syntactic and semantic levels. On the one hand, there are approaches which take into account the scope and size of linguistic contexts. This view is characteristic for distributional semantics based on the assumption that semantic similarity of lexical items arises from their contextual similarity. This assumption is well-grounded in the works of L. Wittgenstein, Z. Harris, J. Firth, etc. who are considered to be the founders of this trend in contemporary linguistics (cf. the survey [5]). The ideas of distributional semantics lay the foundations of the rules governing collocability of lexical items in non-compositional phrases (cf. the analysis given in [6]). In various distributional semantic models (from the early word space models – HAL, LSA, COALS, etc. – to contemporary count-based and predictive models – Distributional Memory, Word2Vec, Doc2Vec, etc., cf. the overview of the works in [7, 8, 9]) context window size is a crucial parameter for vector space model development and word embeddings training. On the other hand, cognitive interpretation of contextual relations constitute a basis of theories focused on construction analysis (Construction Grammar, Cognitive Grammar, Corpus Pattern Analysis, etc. [10, 11, 12, 13]).

Inspite of external differences, particular contexts considered in linguistic theories can be generalized as instances of formal contexts. Let's consider a certain class of context relations described as verbal constructions, or valency frames [11, 14, 15] thoroughly described in lexical databases, such as VerbNet, FrameNet, etc. for English, Lexicograph, FrameBank for Russian. Verbal valency frames are commonly treated in terms of syntactic relations: type of governance in pairs «head verb + dependencies»: cf. V(*prove*) → NP(*hypothesis*), V(*prove*) → PP(*in experiments*); and argument structures (Rel – *prove*; Arg0 – subject/agent (*researcher*); Arg1 – object/patient (*hypothesis*); Arg_M – modifier (*in experiments*)).

In Abstract Meaning Representation theory the given frame is considered as an AMR scheme, a unified structural representation of AMR schemata set being a formal context. In Formal Concept Analysis distribution of formal context elements and their features over texts is visualized as an attribute-value matrix similar to term-document matrix in count-based vector space models. Parallel treatment of the notion of context in linguistic and algebraic theories proves the possibility of consistent combinations of contextual semantic approaches (frame analysis and distributional semantics) with FCA and AMR.

Interpretability of the basic notions of FCA from linguistic point of view explains its effectiveness in a wide range of applications in Text Mining [3, 4]. Being a competitive approach to representation of contextual relations, FCA is used in verb frame extraction and clustering [16], structuring lexical resources (thesauri and formal ontologies) [17], ontology development [18, 19], social network analysis and studying social communities organization [20, 21], fact extraction [22], named entity recognition [23], text clustering [24], duplicate detection [25], recommendation systems [26, 27], etc. In most cases FCA forms an ensemble with traditional NLP techniques: morphosyntactic annotation of corpora, collocation analysis, keyword extraction, common clustering and classification algorithms, similarity measures. In recent decades researchers witness a strong tendency to consider FCA as a theoretical platform for experiments within the framework of machine learning.

2.2 Multimodal Clustering in FCA

Formal Concept Analysis may be defined as «the paradigm of conceptual modeling which studies how objects can be hierarchically grouped together according to their common attributes» [2]. Such grouping of objects is really clustering of them. More accurately, this is biclustering: clustering of two sets simultaneously, the set of objects and the set of attributes. The output of FCA algorithms is concept lattice which contains hierarchically linked formal concepts which are biclusters.

Among the advanced issues of FCA there is the study of multidimensional formal contexts which can be represented as *n*-ary relations $R \subseteq D_1 \times D_2 \times \ldots \times D_n$ on data domains $D_1, D_2, \ldots, D_n$. For $n = 3$ these domains have the meanings of «objects», «attributes» and «conditions» and FCA on formal contexts of this dimension has been distinguished as Triadic Formal Concept Analysis [29]. Multidimensional formal contexts also generate corresponding lattices of concepts. Practical applications of polyadic formal contexts in FCA are limited to two- and three-dimensional formal contexts. At the same time, the transition from dimension two to dimension three with the subsequent finding of formal concepts is not a simple scaling, but is associated with the introduction of additional operators and analysis tools [30]. However, already starting from dimension three, their construction is a much more complicated task than in the classical two-dimensional case. The three-dimensional version of FCA is best studied, which allows us to distinguish the Triadic Formal Concept Analysis as a separate area of FCA [29]. The subject of research here is multimodal, in this case, three-dimensional clusters − triclusters.

An important result was obtained here, consisting in the fact that every three-dimensional concept of a conceptual lattice belongs to some tricluster. According to multimodal clustering, for any dimension of formal context, the purpose of its processing is to find *n*-sets $H = < X_1, X_2, ..., X_n >$ which have the closure property [30]:

$$"u = (x_1, x_2, ..., x_n) \text{ O } X_1, X_2, ..., X_n, u \text{ O } R, \quad (1)$$

$"j = 1,2,...,n, "x_j \text{ O } D_j \setminus X_j < X_1, ..., X_j И\{x_j\}, ..., X_n >$ does not satisfy (1). The sets $H = < X_1, X_2, ..., X_n >$ constitute *multimodal clusters*.

As two-dimensional biclusters are built formally, as for the dimension $n \geq 3$ clustering is performed with the use of various measures of proximity. Accordingly, the problem of interpretation of multimodal clusters in the context of the selected proximity measure arises.

3 Constructing Polyadic Formal Contexts on Natural Language Texts

The central notion of Formal Concept Analysis, the notion of formal concept seems very attractive for applying it in the areas where the term «concept» is used naturally. Natural Language Processing (NLP) is just that area. The cherished goal in the NLP is computerized understanding of texts. One a way of such understanding is using concepts being acquired from texts. Formal contexts potentially contain concepts but it is evident that expressiveness of standard two-dimensional formal contexts is not enough for modeling all peculiarities of natural language texts. So we apply multidimensional or polyadic formal contexts constructed on texts.

Consider in general the process of constructing polyadic formal contexts on natural language texts. It includes the following steps.

Establishing the problems to solve. Determining the range of tasks that the developed model is oriented towards in the form of a multidimensional formal context. In a general setting, these are the tasks of extracting information. They come down to extracting named entities from the text, extracting relationships, facts, and events. These may be the results of a query to a system that uses formal contexts.

Choosing a semantic text model. There should be an intermediate link between the text and the formal context the link as semantic model which is the data source for the formal context. As such a model, we chose the abstract-semantic representation of the text. To construct AMR-schemes, conceptual graphs are used.

Formal context construction. At this stage, it is necessary to choose the dimension of the context, the composition of the sets, $D_1, D_2, ..., D_n$ and build the relation $R \text{ H } D_1 \text{ r } D_2 \text{ r } ... \text{r } D_n$. The constructed multidimensional formal context should be implemented as a storage object, for example, in a database in such a way as to ensure work with context by executing queries to it.

3.1 Conceptual Modeling Text Semantics

We apply conceptual graphs (CGs) [31] for modeling text semantics. There are several methods of acquiring conceptual graphs from natural language texts [32, 33]. Among them, the method based on Semantic Role Labeling [34] is most suitable for building formal contexts. Some peculiarities of conceptual graphs created with this method, and examples of applications CGs in knowledge discovery are illustrated in [35].

Certain problems arise when using conceptual graphs as input to formal contexts. Among them there is the problem of *redundancy of conceptual graphs*. A conceptual graph acquired from quite a long sentence may contain many various semantic roles, and it is difficult to represent the variants of connections they specify in the formal context, even when the dimension of a context is greater than two. The solution to this problem is to aggregate conceptual graphs. An aggregated conceptual graph is a smaller graph that summarizes the information contained in the original graph [36].

The method of aggregation that we apply is based on the construction of an Abstract Meaning Representation (AMR) on each conceptual graph.

AMR [37] «*is a rooted, directed acyclic graph that captures the certain notion in text, in a way that sentences that have the same basic meaning often have the same AMR*». The nodes in the AMR graph map to words in the sentence and the edges map to relations between the words. This definition of AMR graph demonstrates the similarity AMR graphs and conceptual graphs.

Let's call the *AMR schema* a template $\boldsymbol{T}(C, S)$ where C is a set of concepts, S is a set of semantic roles, they both are from conceptual graph. Concrete content of AMR schema is defined by certain values (meanings) of C and S and it has a certain meaning too. For example, the template

$$\boldsymbol{T}(C, S) = < Concept\_1 > \leftarrow (\textbf{“Agent”}) \leftarrow <\textbf{Verb}> \rightarrow (\textbf{“Patient”}) \rightarrow <Concept\_2> \quad (2)$$

specifies the AMR schema with the meaning «*who did what to whom*». The template (2) defines a conceptual graph in which «Agent» and «Patient» are the names of semantic roles, *Concept_1*, *Concept_2* – words being its concepts, «Verb» are concept-verb from conceptual graph.

Figure 1 demonstrates an example of interpreting AMR schema as sub graph of conceptual graph.

Conceptual graph on the Fig. 1 derives AMR schema «who did what to whom» with the content «*SHP-2 attenuates function*» according with the template (2). This AMR schema represents the meaning of the whole sentence and, certainly, represents it very broadly. Using AMR schemes, semantic compression of text sentences is performed.

There are two propositions which we can formulate based on the analysis of works [37 - 39] and the essence of conceptual graphs.

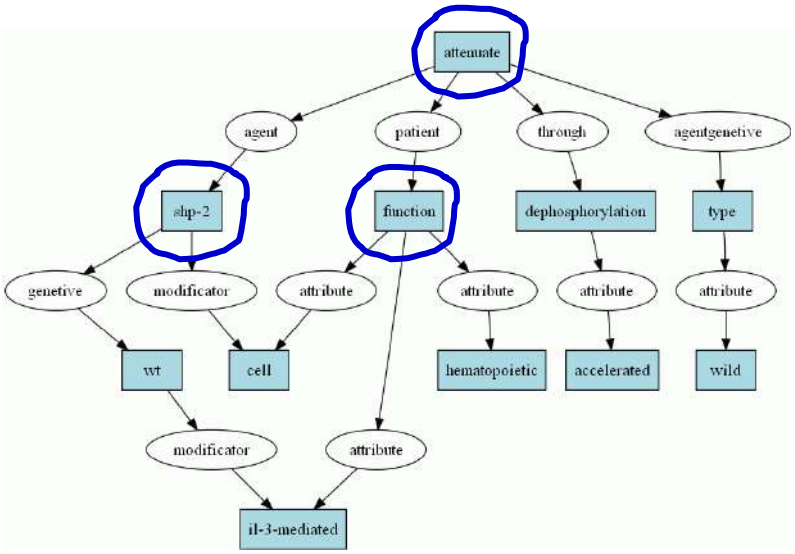


Fig. 1. Fragment of conceptual graph for the sentence «*SHP-2 attenuates IL-3-mediated hematopoietic cell function through accelerated dephosphorylation of STAT5*»

1. In many applications, particularly in the field of Bioinformatics, the expressiveness of AMR schemata is sufficient to represent the meaning of sentences.
2. Conceptual graphs allow implementing a variety of AMR schemata, including more complex ones that reflect the meaning of the sentence more fully.

Based on these propositions, consider the method for constructing formal contexts on a set of conceptual graphs.

3.2 Acquiring Polyadic Formal Contexts

The polyadic formal context is constructed as follows. By semantic role labeling for each sentence of the text, a conceptual graph is constructed, on the elements of which a concrete AMR scheme is created. The formal context $\mathbf{K}\,\mathrm{H}\,D_1\mathrm{r}\;D_2\mathrm{r}\;\ldots\mathrm{r}\;D_n$ is a multidimensional tensor whose points are the elements of the AMR scheme for each representation, $k_{i,j,\ldots,n} = \{c_i, c_j, \ldots, c_n\}$ where c_k, k = 1, 2,..., N are the concepts of the concept graphs, N is the total number of concepts obtained on the processed text. The number of points in the formal context matches the number of AMR schemata found in the text. The vast majority of points in a formal context are meaningful phrases, for example, the phrase «*SHP-2 attenuates function*» from figure 1 is a point <SHP-2, attach, function> in a three-dimensional context.

Query Support on Polyadic Formal Context. After creating a polyadic formal context, it is necessary to organize its storage and access to its content in order to solve the problems of extracting information. Information is extracted by querying a polyadic formal context.

There is the following idea concerned with Conceptual Modeling. If a query to a conceptual model can be represented as an element of this model itself − for example, as its concept, then the refinement of this query or even the answer to it is contained in concepts adjacent to the concept-query. This idea also holds for concept lattices and has been tested in several papers [40]. In general, selecting data that matches the query is a solution to the clustering problem. On polyadic formal contexts, solving the clustering problem requires determining the proximity measure for the points that make up the context. When using clustering algorithms used in FCA [29], a Boolean value is used as the proximity measure − the fact that clustering objects fall into a relation $R \subseteq D_1 \times D_2 \times \ldots \times D_n$ that sets the context. When using this measure in a context consisting of AMR schema points, clustering will result in subsets containing subsets of words $< X_1, X_2, \ldots, X_n >$ found according to the *R* relation. For example, the point considered in Figure 1 may appear in the following cluster of three points (the maximum number of elements is three; they are in the first subset):

<{SHP-2, val174del, ephrin-b2}, {attenuate, cause}, {function, dysplasia}>.

Although this cluster can be useful by demonstrating the relationship of objects from the first subset through words from the second and third subset, it is impossible to extract information from it, for example, about what exactly causes dysplasia. It turns out that individual elements of multidimensional formal context, its points, contain specific information in the form of an AMR scheme, but after processing the context this information is lost.

Thus, in order to extract information from multidimensional formal contexts based on AMR schemes, a different than FCA-clustering method is needed.

In our method, specific clusters − *associations* are built on formal contexts. An Association is a set of points ordered relative to the selected word position in the AMR scheme for a point. This corresponds to the logic of the AMR scheme: certain semantic elements are selected in it. The Association includes all words in the selected position of the AMR scheme. Therefore, an Association is a cluster built on the basis of the proximity measure «belong to a certain position of the AMR scheme». On the other hand, the Association is a function $A(x_1,\ldots, x_p)$ whose argument can be a given word or a set of *p* words belonging to the *k*-th position of the AMR scheme.

The meaning of highlighting such associations is closely related to the logic of queries to the formal context. These queries usually correspond to the structures of the AMR charts.

4 Applications in Information Extraction

4.1 State of the Art

Let's discuss an example of applying FCA to data analysis in a specific area. One of the areas where NLP applications become more in demand is Bioinformatics. The Biomedical Natural Language Processing (BioNLP) [38] is the new area of research

in Bioinformatics which appearance was due to the avalanche-like growth of publications in the field of biomedicine. The main purpose of BioNLP is to obtain new knowledge from published texts, not completely contained in each individual publication. Initially, the main area of application of BioNLP methods was genomic studies. Over time, the subject matter of texts processed by BioNLP has expanded to other areas and BioNLP was formed as a research area with its own data, tasks and methods [37-39]. All the BioNLP tasks may be classified as more or less general. The general tasks of fact extraction and event extraction usually transform to the standard tasks of Named Entity Recognition (NER) and Relation Extraction (RE). NER consists in automatically identifying occurrences of biological or medical terms in unstructured text. As named entities, there are the names of genes, proteins, living organisms or diseases – it depends on the domain to which processed text belongs to.

RE is another standard task of BioNLP. Relations are associations among biomedical entities. The simplest relations are binary, involving only the pair-wise associations between two entities. But biomedical relationships can involve more than just two entities. This kind of relationship is actual in the task of event extraction. In our time, named as genomic era, much of BioNLP work has focused on automatically extracting interactions between genes and proteins. Other associations include interactions between proteins and mutations, proteins and their binding sites, genes and diseases, genes and phenotypic context.

Leading BioNLP research groups are mainly interested in processing English data, although Russian biomedical texts attract growing attention.

Researchers collected and prepared for distribution a great amount of textual data. BioNLP competitions inspired creation of richly annotated corpora for NER, RE, Semantic Role Labeling (SRL), etc. The given empirical data is a great asset to computational linguists working in the field of Bioinformatics.

4.2 Experimental Data

Experiments aimed at the empirical verification of our approach were carried out for texts of the AGAC corpus (Active Gene Annotation Corpus) which contains abstracts of scientific articles on biomedical topics of the PubMed system. The corpus was created for BioNLP Shared Tasks 2019 competition [42] and was proposed as a dataset for NER and RE tasks. The corpus contains 250 annotated abstracts and 1000 raw abstracts, it size being about 300 000 tokens. Conceptual graphs were built for separate sentences from annotated abstracts; experiments with distributional semantic models were carried out for the whole dataset.

4.3 Finding Dependencies Between Texts

The problem of finding the relationships of texts is well known in the field of IE and has a variety of options. In our experiments, we studied a variant in which it is not known in advance by what attributes the links between texts are established. These attributes, which are ultimately reduced to subsets of words, are determined by ana-

lyzing the contents of texts, which in this case are replaced by a formal context built on them.

In our experiments, we compared the informativeness of two formal contexts built on texts in accordance with 3 and 5 element AMR schemes. The three-element scheme has the form (2), and the five-element AMR scheme has the following form:

$$< \textit{Concept\_1} > \leftarrow (\text{«}\textbf{Agent}\text{»}) \leftarrow <\textbf{Verb}> \rightarrow (\text{«}\textbf{Patient}\text{»}) \rightarrow <\textit{Concept\_2}>$$
$$\downarrow \quad \downarrow$$
$$(\text{«}\textbf{Attribute}\text{»}) \; (\text{«}\textbf{Attribute}\text{»}) \quad (3)$$
$$\downarrow\downarrow$$
$$< \textit{Concept\_3} > \; < \textit{Concept\_4} >$$

An additional dimension was included in each context to fix the number of the text to which this point belongs. As a result, contexts of dimensions 4 and 6 were subject to processing.

Obviously, multi-element AMR schemata allow more detailed modeling of the semantics of a sentence. Formal contexts built on their basis are more informative. This position was checked in experiments. The experiments included the following steps.

1. Building associations on selected positions of the AMR-scheme of the formal context.
2. Generating queries for associations based on query words
3. Obtaining query results in the form of clusters containing formal context points.
4. Interpretation of clusters.

Consider some experimental results. Associations were created on both formal contexts regarding the position of the subject of the action − the first position for the three-element AMR scheme and the second position for the five-element one. Next, the size and content of each association were estimated.

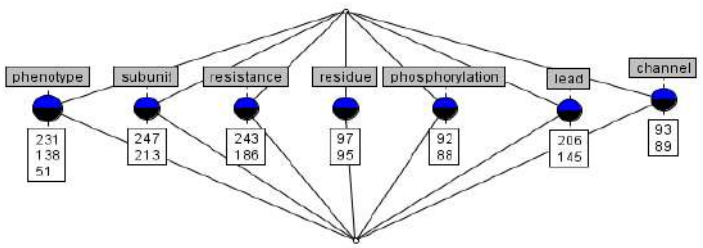
Domain terms were highlighted in the corpus. The term «mutation» has extensive connections, it organizes one of the most voluminous associations. Indeed, most of the texts of the corpus are devoted to the study of various manifestations of mutation and its influence on organisms. Therefore, our queries to associations were performed using the keyword «mutation». The results of the query are clusters. The question that determines further actions with the resulting clusters is: «What does the mutation manifest itself on? » The implementation of this request on clusters was carried out by building associations with respect to the position of the action object − the third position for the three-element AMR scheme and the fourth position for the five-element one. The query words obtained in the constructed associations were compared with text numbers and then presented for analysis.

Responses to association requests are generated in tabular form. If the result of a two-element query to associations is presented as a cross-table, it is interpreted as a two-dimensional formal context. In this case, it can be visualized as a concept lattice according to the classical version of FCA.

Fig. 2 (a) shows the sub context as a cross-table of the four-dimensional formal context constructed for three-element AMR scheme (2), Fig. 2 (b) shows concept lattice.

	phenotype	channel	lead	phosphorylation	residue	resistance	subunit
51	X						
88				X			
89		X					
92				X			
93		X					
95					X		
97					X		
138	X						
145			X				
186						X	
206			X				
213							X
231	X						
243						X	
247							X

(a)



(b)

Fig. 2. The subcontext of the formal context built for the three-element AMR-scheme and its visualization in the form of concept lattice

The query that generates the result in Fig. 2, can be made in the form of «How are texts related in the context of the word «mutation» through its manifestations?» Texts with numbers in the left column of the sub context on Fig. 2 a) are linked in the context of the word «mutation» by means of the words indicated in grey rectangles in the concept lattice.

The lattice in Fig. 2 (b) is trivial. It has only one layer and all concepts are independent. The three-element AMR scheme does not reveal the connections of texts in sufficient detail. For comparison, the same request was processed on a formal context built for the five-element AMR scheme (3).

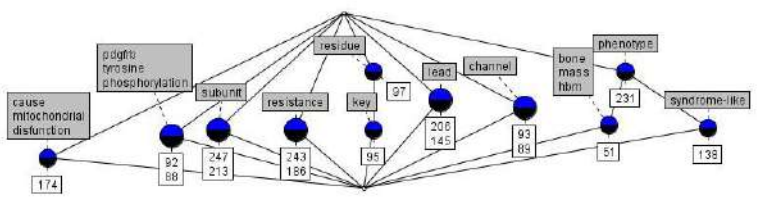
Fig. 3 shows the fragment of the association built on the «mutation» cluster for the fifth element of the five-element AMR scheme. The numbers of occurrences of certain words in context points are shown in the summary table in Fig. 3 a). So the word «phenotype» occurs in 5 points and in some documents, including document No 51.

Processing a query in a six-dimensional context reveals a larger number of words that link texts. The corresponding two-dimensional formal sub-context has a larger

size and its concept lattice shown in Fig. 3 b), is not trivial: it has a hierarchy of concepts.

phenotype	gain–of–function	mutation	exhibit	hbm	phenotype	51
	gain–of–function	mutation	exhibit	mass	phenotype	51
	5 total ›					
cause	gof	mutation	encode	bo	cause	73
	gof	mutation	encode	io	cause	73
	4 total ›					
form	gof	mutation	encode	ad	form	73
	germline	mutation	encode	ad	form	73
polyposis	lof	mutation	be	adenomatous	polyposis	82
apc	lof	mutation	be	coli	apc	82
phosphorylation	n666h	mutation	show	tyrosine	phosphorylation	88
	n666h	mutation	show	pdgfrb	phosphorylation	88
	4 total ›					

a)



b)

Fig. 3. A fragment of association built on the «mutation» cluster the five-element AMR scheme and its concept lattice

Comparing the lattices in Fig.2 (b) and Fig. 3 (b), we see that, for example, in Fig. 2 (b) texts 231, 138, 51 are included in the same concept with the word «phenotype» combining them, and in the lattice in Fig. 3 these texts form three different concepts with a large number of unifying words.

At the same time, the concept that includes text 231 is more general for the concepts that include texts 51 and 138. The lattice in Fig. 3 b) can be named as "What is affected by mutation in different texts".

Based on these results, the following conclusions can be drawn.

1. The problem of finding dependencies between texts can be solved by clustering data of polyadic formal context using data associations.

2. The informativeness of a five-element AMR scheme is qualitatively higher than that of a three-element AMR scheme.

It is obvious that due to the universality of this text analysis tool, it can be used in various other tasks of relation extraction.

5 Conclusion

In this paper, we propose a method for constructing and applying polyadic formal contexts on natural language tests. The method uses conceptual graphs acquired from texts and, together with AMR-schemata, these graphs constitute a data source for polyadic formal contexts.

Polyadic formal contexts constructed by this way may be used as a tool for multi-modal clustering. This tool was tested here on the problem of finding dependencies between texts.

It should be noted that the use of conceptual graphs makes it possible to construct AMR schemata of greater length than those considered in this paper. This will allow for the implementation of polyadic formal contexts that reflect the content of the modeled text more fully and, accordingly, to extract more complete information from it. The method can be applied in Question-answering systems, in which natural language queries correspond to the logic of AMR schemes.

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Subject Area Study: Keywords in Scholarly Article Abstracts Graph Analysis

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Abstract. This paper presents an approach to subject area study based on keywords extracted from scholarly article abstracts graph analysis. Initial case study – Digital Humanities, data source – Google Scholar, time interval – 2013–2019. The study is in two parts. First, keywords and key phrases extraction algorithm based on the combination of four existing methods is proposed. The accuracy is up to 77% as we apply strict restrictions to the algorithm thus obtaining better results than other existing solutions provide when are being applied to such short texts as abstracts. Second, keywords graph is created, and its analysis is performed. Applied here graph theory gave an opportunity to detect the most valuable nodes – keywords – along with subareas and closely related areas, showed some trends in Digital Humanities development. Further research proved our approach applicability to other subject areas and data sources.

Keywords: Computational Linguistics, Keywords Extraction, Graph Theory, Subject Area Study, Digital Humanities.

1 Introduction

Digital Humanities is a new, rapidly developing field, which is gradually becoming a subject of interest for Russian scientists and researchers. So far, this area of knowledge is believed to be represented mostly by natural language processing and data visualization. However, the full range of areas covered by or closely related to Digital Humanities, is not specified [1]. The original idea was to study Digital Humanities as a subject area by extracting and analyzing keywords from Google Scholar scientific data.

Keywords graph represents the approximate subject area structure and makes it possible to work out curriculums, to expand them in accordance with the most relevant scientific trends. As a result, to come up with the research ideas within the field of interest and figure out some directions the subject area is going on thus providing researches with fresh ideas and pointing out out-of-date or already studied enough topics. In addition, the creation of such a graph makes it possible to track the dynamics of the subject area development and, in the future, even predict it.

The paper is structured as follows. Section 2 reviews related works. Section 3 provides an overview of the keywords extraction process and algorithm proposed in this

paper. Section 4 emphasizes on keywords graph creation and analysis. Section 5 describes subject area study approach, the highlight of the paper. Finally, Section 6 discusses the achieved results and concludes the work.

2 Related Work

Subject area analysis methods based on graph theory and keywords extraction has been studied previously and there are similar solutions applicable under specific conditions. L. Weston et al. describe an approach to materials science analysis. They apply text mining with named entity recognition (NER) for large-scale information extraction from the published materials science literature. The NER model is trained to extract summary-level information from materials science documents. The result is represented in a structured format, usually graph-structured [2].

Jefferson de J. Costa et al. propose a way to represent undergraduate programs as a directed acyclic graph (DAG), in which each course is represented as a node, and relations between courses are represented as edges. They proposes methods for mining DAGs using statistical analysis and apriori-based concepts, to identify retention patterns in undergraduate programs [3].

O. Faust made a review on promoting the use of computing machinery by the *Computers in Biology and Medicine* journal in the fields of bioscience and medicine. Analysis of the author supplied keywords was carried out. Keywords clustering showed the statistical connection between them and helped to identify the most popular topics and trends. The results were visualized with graphs [4].

H. Sekiguchi et al. analyzed the guidelines of the American Heart Association Basic Life Support using data mining methods to identify and characterize the changes in keywords and key points. They also built and analyzed a co-occurrence network to classify the words into major topics on one step of the research [5].

Y. Solomonova and M. Khlopotov present an approach to Russian text vectorization based on SRSTI classifier. They use keywords extraction to define SRSTI categories as lists of keywords. The keywords selection process is described, and vector calculation and comparison algorithm are applied to marked-up SRSTI texts [6].

Sharma et al. propose a topic network analysis approach using topic modeling and network analysis. They carried out an experiment on the field of Machine Learning and detected main topics and trends in the area along with interrelationships [7].

Subject area keywords graph creation appears to be a one-size-fits-all solution for the formal subject area analysis, which gives an opportunity to understand its structure. Existing methods and approaches for analyzing subject areas are often field-specific and are not applicable outside of one or more subject areas. It is worth mentioning that in some of them the use of graph theory for the subject area analysis is proposed. However, it differs radically from the approach proposed in this paper. A more thorough review of the methods for subject area analysis showed, on the one hand, their general non-universality, and on the other, the need to engage an expert.

3 Keywords Extraction

To analyze subject area in terms of its structure its elements and subareas should be determined. It can be done by analyzing the scientific literature (in this study, it was decided to work with articles) and identifying keywords.

There are two ways to extract keywords from text:

1. With the engagement of specialists in the studied area.
2. Using algorithms for automatic keywords extraction.

In this research, both methods were discussed, and a conclusion was drawn on the inappropriateness of applying the expert approach, which determined the main stages of the study.

The implementation of the study was carried out in the Python programming language using:

1. scholarly, a Python-based module that allows to retrieve author and publication information from Google Scholar [8].
2. PKE, an open source Python-based key phrase extraction toolkit. It provides an end-to-end keyphrase extraction pipeline in which each component can be easily modified or extended to develop new models [9].
3. Yandex.Translate, a Python module for Yandex.Translate API [10].
4. NLTK, Natural Language Toolkit, a platform for building Python programs to work with human language data [11].
5. Scikit-learn, efficient Python-based tool for data analysis and machine learning [12].

3.1 Source Selection

Google Scholar, a part of the Google search engine, was chosen as a source of scientific materials. Unlike other sources such as Scopus, Web of Science and IEEE, it provides free access to the highest possible number of scientific papers from all over the world in different languages from peer-reviewed journals.

In addition to scientific works, with the help of Google Scholar information about researchers, their scientific interests, authors' citations, and publications can be retrieved. This study is focused on information on scientific articles and their authors, as it is possible to form an idea of the subject area itself according to the leading researchers' lists of interests. The only significant Google Scholar's drawback is that it does not provide access to the author's keywords to the article, which makes it necessary to extract keywords from the abstract body.

3.2 Data Collection

In the view of data collection from Google Scholar peculiarities and the needs of the study, it was decided to collect the following data about the authors:

- Name.
- Affiliation.
- Citations.

– Scientific interests.

Data was collected on the profiles of 1,106 authors – all who put Digital Humanities in the list of their research interests.

With respect to the publications, it was decided to collect the following data:

– Author(s).
– Title.
– Publication year.
– Journal where the article was published.
– Abstract.

Data was collected on 13,847 publications.

3.3 Data Pre-processing

Firstly, authors' list of interests pre-processing was performed. It contained 4,535 terms. To analyze keywords successfully, it was necessary to solve the following problems:

Authors write down their interests in different languages, therefore, they need to be translated into one language, for convenience – English, as 11,907 articles are in English (79% of the total number of articles). 42 different languages were detected within the collected data.

One term can be written down in different ways (abbreviations or in full, include typos, etc.), for example, "data visualization" was detected written down in nine different ways:

1. Data visualization.
2. Visualisation.
3. Visualization.
4. Data visualisation.
5. Information visualization.
6. Information visualisation.
7. Metadata visualization.
8. Metadata visualisation.
9. Datavis.

Thus, the list of keywords was pre-processed in seven steps. The examples illustrate keywords from authors' interests pre-processing.

1. Automatic keywords translation into English. Figure 1 shows the results of several words translations.

2. Automatic translation errors manual correction.

Example: el siglo de oro (Spanish) → century of gold → golden age.

There were 135 non-English unique terms, 27 were translated incorrectly.

3. Terms writing standardization.

Example: vr, virtual world, virtual reality → virtual reality.

4. Separation of different terms united by "and / &".

Example: augmented and virtual reality → augmented reality, virtual reality.

5. "The" and "a" removal.

6. Removal of “interests” that do not make sense for this study, for example “coping with life stress”, “I research”.

7. Encoding bugs removal.

As a result of processing, a list of 4,445 words was obtained.

Similar keywords pre-processing was performed on the list of words extracted from abstracts using regular expressions.

visualisierung	de	visualization
topologie	cs	topology
geschichte	de	history
gender	de	gender
menschenrechte	de	human rights
linguistica italiana	it	the Italian language
letteratura italiana	it	Italian literature
storia della linguistica	it	the history of linguistics
nietzsche	de	nietzsche
francisco de quevedo	es	francisco de quevedo
lingüística computacional	es	computational linguistics
humanidades digitales	es	digital humanities
история русского языка	ru	history of the Russian language
палеославистика	ru	paleoslavistics
слово и вещь	ru	the word and the thing
linguistica computazionale	it	computational linguistics
annotazione	it	annotation

Fig. 1. Automatic translation example

3.4 Keywords Extraction Algorithm

First, existing algorithms for automatic keywords extraction analysis was carried out. More than 19 algorithms were discussed, nine tested. During testing, algorithm requirements were defined:

- Mainly nouns or phrases where the main word is a noun, and the definitive - adjectives, participles or less often adverbs, should represent keywords (TF-IDF [13]: “labeled”, “using”).
- A pronoun cannot be a part of a key phrase (PositionRank [14]: “our method”).
- Single adjective cannot be considered a keyword, adjectives can only be a part of a key phrase where the main word is noun (KP-Miner [15]: “efficient”, “beautiful”).
- Long phrases and whole sentences cannot be key phrases.
- A key phrase should not be incomplete (Rake: “efficiently map text”, “online procedure used”, YAKE [16]: “classification of multi”).
- List of key terms should not be represented only by single keywords or only by composite key phrases.

Finally, we have selected four algorithms, all implemented by NLTK and PKE libraries:

- TF-IDF.
- TextRank [17].
- PositionRank.

– MultipartiteRank [18].

These four algorithms were used as a basis for our algorithm, which demonstrated higher keywords extraction accuracy in terms of our task and conditions.

Algorithm development. To describe an algorithm which meets the requirements and is based on the tested and optimized combination of four mentioned above, set theory is used.

$$A = PositionRank \cap MultipartiteRank \quad (1)$$

Such an intersection gives a stable set of key phrases. As PositionRank and MultipartiteRank tend to extract key phrases, not keywords, single keywords are potentially lost, so other algorithms results should be considered. Nevertheless, *A* may include set of single keywords *S*, so

$$A = S \cap F, \quad (2)$$

where *F* is a set of key phrases.

$$B = TF\text{-}IDF \cap TextRank \quad (3)$$

It was experimentally established that TF-IDF and TextRank algorithms (3), highlighting mostly single keywords, tend to select incomplete phrases and verb constructions as key phrases, most of which are lost after intersection

$$B = S1 \cap F1, \quad (4)$$

where *F1* and *S1* are sets of keywords and key phrases of set *B*, respectively.

$$C = (B \setminus S) \cup (B \setminus F1) \quad (5)$$

In (5) filtering out the set obtained in (3) is performed.

$$C1 = B \setminus S \quad (5.1)$$

In (5.1) single keywords occasionally included into *A* are excluded from *B*.

$$C2 = B \setminus F1 \quad (5.2)$$

In (5.2) all key phrases are excluded from *B*. In (6) sets of keywords and key phrases are being united.

$$D = A \cup C \quad (6)$$

The algorithm is configured so that verbs and adjectives cannot be single keywords, and PositionRank and MultipartiteRank key phrases does not include verbs

due to part of speech constraints. Despite these facts, due to English words ambiguity verb still may be considered a keyword.

The problem of extracting key phrases containing pronouns was solved by expanding the list of stop words.

Testing results evaluation. Table 1 shows the results of nine selected algorithms testing in comparison with the developed one, where KW – keywords, KP – key phrases, IP – incomplete phrases, SA – single adjectives, V – verbs, P – pronouns. Testing was carried out on a 100 randomly selected abstracts previously marked up by experts. Here, numbers represent the percentage of words for each category compared to the total number of keywords and key phrases extracted from each abstract; the average values by the 100 abstracts are given.

The table shows that it was not possible to eliminate the inclusion of verbs and adjectives, as well as incomplete phrases in the list of article abstract keywords, although their number was significantly reduced. Precision, recall and F-measure for a set of 100 random abstracts equal 76.3%, 52.6% and 62.27%, respectively. The precision of keywords extraction is of higher importance than its recall, which was acceptable within the study. In addition, too many keywords might negatively affect the resulting graph.

Diagram in the Figure 2 illustrates the accuracy of nine algorithms that showed the best results during testing, as well as the algorithm we developed. Here, we note that 76.3% is a low accuracy for a keyword extraction algorithm under normal conditions, and most of the tested algorithms demonstrate better results when larger texts are being processed.

However, given the small size of abstracts (3–6 sentences), the low frequency of keywords within the abstract body, and the non-semantic approach of automatic algorithms, the obtained accuracy is considered high.

Table 1. Keywords extraction performed by our and 9 other algorithms

Algorithm	KW	KP	IP	SA	V	P
TF-IDF, %	80	20	12.6	16	34	0
KP-Miner, %	69	31	11	15.3	31.2	5.6
Rake, %	19	81	46.4	8	28.6	0.4
YAKE, %	67	33	13.7	40.8	6	0
TopicRank, %	67	33	4.7	37	7.8	0.9
TopicalPageRank, %	14.3	85.7	15.7	12.1	13.2	13.4
PositionRank, %	27	73	0	0.9	0.9	14.8
MultipartiteRank, %	47	53	0	6	0	10.4
TextRank, %	53	47	7	0	3.4	0
Our method, %	28	72	0.7	3.7	2.9	0

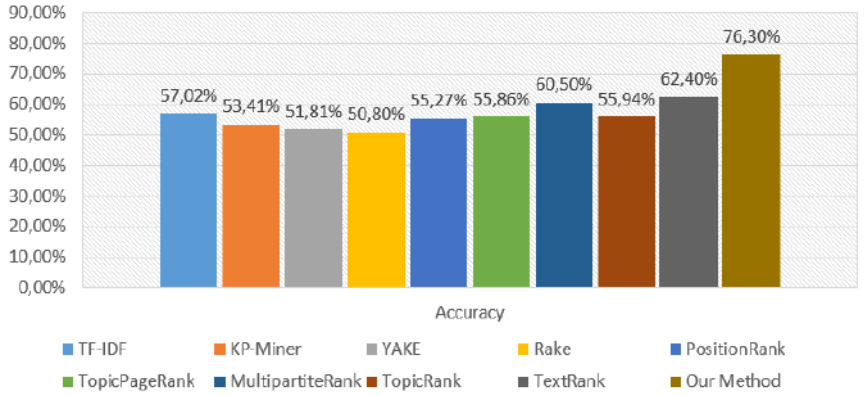

Fig. 2. Algorithms' accuracy

The developed algorithm has been tested on scientific publications abstracts, news articles abstracts, and full-text scientific and news articles. Keywords extraction from essays, fiction and conversational texts was not carried out.

The extraction of keywords from news articles abstracts was performed with no less accuracy than when working with scientific data, while keywords extraction from full-text papers turned out to be almost inapplicable. The results obtained indicate that the developed algorithm is field-focused. This can be explained by the fact that in our task it was decided that extracted keywords' quality prevails over their number and the length of processed texts usually does not exceed 1,500 characters – the approximate size of an abstract. The developed algorithm has strict constraints and is not optimal for other tasks.

4 Keywords Graph Creation and Analysis

91,447 words were extracted from the abstracts; 50,962 of them are unique, which is approximately 56% of the total number of extracted keywords. Top-20 keywords are presented in Table 2.

Keywords graphs were created and analyzed both for the researchers' scientific interests and for keywords extracted from abstracts. Each keyword or key phrase is a node. If two keywords are extracted from one abstract, we consider there is a connection of unknown type between the keywords and create an edge. The same goes for keywords from the researchers' scientific interests.

In the study, a graph of keywords obtained from abstracts' keywords is of greater interest. Its size (in terms of the number of nodes and edges) is comparable to the size of a social graph, so it made sense to use similar approaches to its analysis.

The intersection of the central nodes sets obtained by calculating betweenness centrality, eigenvector centrality and degree for each node gives a stable set of central and most significant nodes of the keywords graph that determines the subareas of the subject area.

Table 2. Top-20 Digital Humanities keywords based on its occurrence

№	Keyword	Occ.	№	Keyword	Occ.
1	natural language processing	**57**	11	archaeology	**24**
2	data visualization	**49**	12	information retrieval	**21**
3	computational linguistics	**41**	13	artificial intelligence	**21**
4	librarianship	**34**	14	text mining	**20**
5	information technologies	**34**	15	book history	**20**
6	history	**29**	16	cultural heritage	**20**
7	digital library	**29**	17	geographic information system	**20**
8	media studies	**28**	18	library	**19**
9	literature	**27**	19	human-computer interaction	**19**
10	machine learning	**27**	20	scholarly communication	**19**

After that, community detection is performed. This type of clustering refers to the procedure of identifying groups of interacting nodes in a graph depending upon their structural properties [19]. Community detection in graphs allows to combine keywords related to one subarea. Further, centralities calculation performed for each community shows which nodes determine the main topic of the cluster and which neighboring subareas are the most closely related to the one of interest.

Due to the substantial number of nodes (50,961) and edges (217,438), and the importance of each node rather than a group of nodes, clustering was carried out in the first place. Resulting graph was of 89 communities, considered separately later.

Figure 3 shows the cluster of Natural Language Processing (in English), and Figure 4 shows the graph of all Digital Humanities subareas (in Russian), obtained by analyzing 89 selected communities.

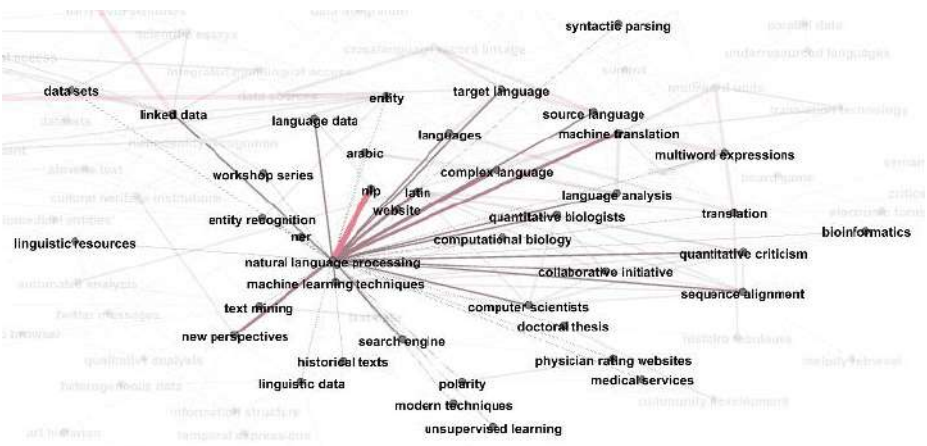

Fig. 3. Natural language processing cluster (neighboring keywords)

The subareas graph has 75 nodes and 118 edges. Due to the uneven clustering of the graph, it would be incorrect to draw conclusions about the nodes' centralities, however, the graph shows connections between the Digital Humanities subareas, and clearly identifies nodes that have the greatest number of connections with others, namely:

- History.
- Text Analysis.
- Machine Learning.
- Natural Language Processing.
- Data Analysis.
- Information Technologies.

According to the graphs created separately for each of the past three years, changes in the research areas in the field of Digital Humanities can be traced. At first, only the humanities were in the foreground, such as Linguistics, History, Archeology and Data Visualization. By 2019, Information Technologies, Machine Learning, Databases are of greater importance, and here appears a large cluster associated with Medical research. This indicates a rapid expansion of the subject area, as well as it shows that scientists of various fields are rapidly becoming interested in Digital Humanities.

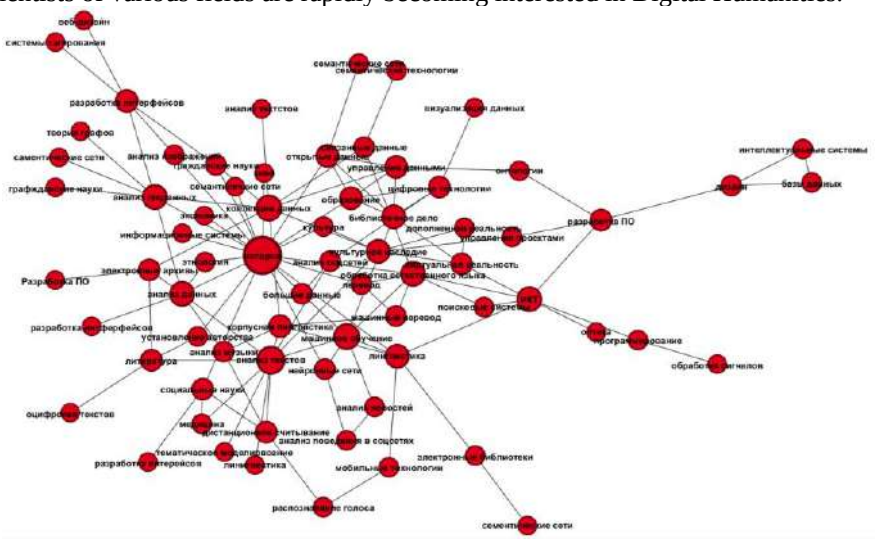

Fig. 4. Subareas graph

5 Subject Area Study Approach

The proposed approach has three main steps:

- Scientific materials collection.
- Keywords extraction from article abstracts.
- Keywords graph creation and analysis.

In Figure 5 the approach is described in detail.

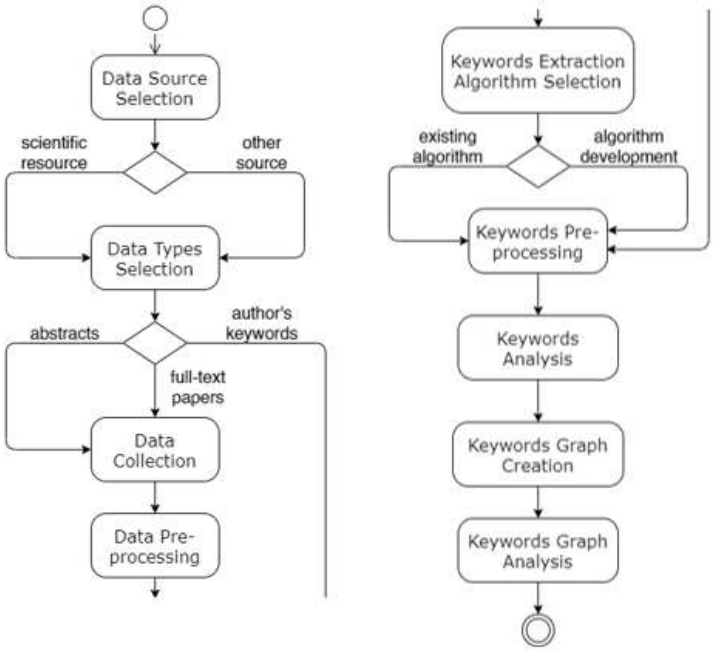

Fig. 5. Subject Area Study Approach

6 Conclusion and Future Work

In this paper, an approach to subject area analysis based on scholarly article abstracts keywords graph creation is proposed; its steps are described in detail for Digital Humanities area. Data was collected from Google Scholar, though additional research proved that the approach is applicable to other data sources and other subject areas as it was tested on arXiv.org data, and Elsevier Scopus and ScienceDirect data and applied to other subject areas, namely, Multimedia, Databases and Machine Learning.

Keywords extraction algorithm was described. Its accuracy is up to 77% which is quite a high result in terms of our study and conditions. Keywords graph analysis was represented by discovering subareas, graph communities, detecting most important ones and applying an idea of analyzing trends in subject area development.

Our future work will be focused on determining types of connections between keywords (nodes) as it widens the scope of research along with russification of the proposed keywords extraction algorithm. The latter seems to be more difficult task as there are not so many approaches to work with texts written in Russian. As we go forward, we plan to use more up-to-date natural language processing and machine learning methods in order to obtain higher accuracy of the proposed keywords extraction algorithm.

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On Resolving Conceptual Ambiguity in an English Terrorism E-news Corpus

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Abstract. Conceptual ambiguity in a restricted domain is a crucial, yet under-investigated issue in ontological analysis as it complicates the process of extracting relevant information from unstructured texts. This paper aims to reveal the sources of conceptual ambiguity in an English terrorism e-news corpus and explore ways to resolve it. In our study, empirical corpus-based methods are employed to determine sources of conceptual ambiguity in the corpus and suitable disambiguation methods. Our findings reveal four sources of conceptual ambiguity, namely, part-of-speech homography, lexical ambiguity, the plurality of conceptual meanings, and the extralinguistic context. We analyze three quantitative corpus-based methods applied to different types of conceptual ambiguity and outline the prospects of future research in this area.

Keywords: Ontological analysis, Conceptual annotation, Conceptual ambiguity, English e-news corpus, Terrorism.

1 Introduction

Research on ontological analysis is crucial for the development of natural language processing technologies witnessing now a trend towards semantization of textual metadata based on ontological analysis. Ontological analysis, which can be defined as the process of eliciting content knowledge of entities involved in a certain domain [5], essentially consists in, firstly, annotating lexical items in a text with ontology concept tags and, secondly, formalizing and interpreting the results of such annotation in accordance with a specific task. The first part of this process can be called (broadly) semantic annotation [6, 15], or, more precisely, concept labeling [14] or conceptual annotation, the term we use in this project to represent the notion of domain-oriented ontology-based semantic annotation.

Semantic annotation is a technique used to enrich content with various semantic information. Depending on the interpretation of this notion, it can be approached in three different ways: the first interpretation defines it as the process of assigning particular senses to polysemantic words usually based on a dictionary or an ontology [3]; according to the second interpretation, it means attributing certain universal semantic features to words based on a certain lexical classification [10]; in the third interpretation, it is viewed as mapping semantic relations between words in a text [9].

Conceptual annotation, in turn, can be viewed as a special case of semantic annotation based on ontology concepts and, perhaps, domain-oriented. Although similar to the first interpretation of semantic annotation in terms of mapping lexical items into an ontology, it is not entirely the same as its results are relevant in a specific domain; e.g., *people* in terrorism e-news regularly represent consequences of an attack (as they can be killed, injured, etc.), although this meaning is not inherent in the word.

Conceptual annotation can be done manually [6, 15], semi-automatically [13] or automatically [14]. Although manual conceptual annotation of text corpora ensures high-quality results if done properly, it requires considerable time and rigorous training of annotators to avoid inconsistencies, hence the need to facilitate rapid conceptual annotation by automating it to a certain extent. Insofar as processing of large corpora is concerned, semi-automatic annotation also has its limitations in terms of timing and training of annotators. Attempts at complete automation, in turn, cause various challenges, conceptual ambiguity in particular [14], even in a restricted domain [12].

We define **conceptual ambiguity** as a problem that emerges when a lexical item is assigned two or more (possibly, mutually exclusive) concept tags in the process of automatic conceptual annotation. Conceptual ambiguity seems relatively easy for an annotator to resolve; however, for a computer, it is irresoluble unless specific disambiguation instructions are given. To the best of our knowledge, little research has addressed this issue (see [14] where a machine learning algorithm was used to resolve conceptual ambiguity in web queries); nonetheless, the task of conceptual ambiguity resolution is close to Word Sense Disambiguation (WSD), which is "the ability to identify the meaning of words in context in a computational manner" [7], with allowance that, instead of the meaning of a word, the ontological concept is the subject of identification, which makes WSD methods, both knowledge-based and corpus-based, potentially applicable for conceptual ambiguity resolution as well. Other methods of corpus linguistics can also be applied for domain-oriented conceptual ambiguity resolution, namely the Edmundsonian methods for key word identification [4].

To this end, this paper addresses the problem of conceptual ambiguity in automatically tagged English terrorism e-news aiming to determine the sources of conceptual ambiguity in the corpus and explore corpus-based methods for disambiguation.

The rest of the paper is divided into three parts: Section 2 describes the resources used for ontological analysis, as well as the annotation scheme and procedure; in Section 3, the results of the experiment are presented and discussed; in Section 4, a conclusion is made and research prospects are outlined.

2 Resources & Experiment Procedure

2.1 Resources for ontological analysis

The experiment described in this article involved several resources:

– a language-independent domain ontology designed to process terrorism-related e-news in three languages: English, French, and Russian (see the development details in [11, 12]);

– an English lexicon linked to the ontology;
– a software prototype for conceptual annotation;
– a raw English terrorism e-news corpus (11,296 words).

Our domain ontology is represented in the MikroKosmos formalism, with its division of the reality into OBJECTS, EVENTS, and PROPERTIES (further divided into RELATIONS and ATTRIBUTES) [8], and contains 112 OBJECT and EVENT concepts and 27 PROPERTY concepts. Table 1 shows some of the top ontology concepts with their definitions. It should be noted that in order to ensure interoperability between the domain ontology and the MikroKosmos, concept labels are worded in English, though the content of a particular concept is determined by its definition, rather than by its label. For example, the scope of the concept WEAPON is not limited to weapons only as it can be seen from its definition 'weapons or weapon-like objects used to commit a terror attack, also functional weapon parts'. Thus, such lexical items as *nail bomb*, *explosive*, *truck*, *bullet*, etc. will all be mapped into WEAPON in the ontology.

Table 1. Some of the terrorism ontology concepts with definitions

Concept	Definition
AGENT	The perpetrator or organizer of an attack or an organization behind it.
WEAPON	Weapon or weapon-like objects used to commit terror attacks, also functional weapon parts.
TERROR ATTACK	An attack committed by a terrorist or a group of terrorists to intimidate population and achieve ideological or political goals.
LOCATION	The place where a terror attack was committed.

Although the ontology is multilingual and is linked to three lexicons, in this study, we apply it to the ontological analysis of an English corpus in search of language-specific indicators for conceptual ambiguity resolution. The English lexicon is composed of lexical items of up to 10 components; some of them are shown in Table 2.

Table 2. English lexical items mapped into ontology concepts

Concept	Lexical items
AGENT	accomplice of a suicide bomber, adversary, former soldier, infamous militant, jihadist gunman, knife-wielding man
WEAPON	armored car bomb, assault rifle, bomb-laden vehicle, combustible liquid, homemade mortar, incendiary mixture, lorry, vest
TERROR ATTACK	attempted hijacking, deadly shooting rampage, explosion, hostage taking, intimidation act, knife attack, mass shooting
LOCATION	downtown, fast food restaurant, Quetta hospital, railway station

The software prototype for conceptual annotation is based on lexical and ontological knowledge and designed to annotate texts with ontology concept tags. The raw English corpus was tagged automatically with this tool and post-edited manually to resolve conceptual ambiguity and obtain its "golden" version. The automatically tagged and "golden" corpora were then compared to reveal the sources of conceptual ambiguity.

2.2 Tagging schema and procedure

For feasibility, we selected 22 top ontology concepts and coded them under the tags: A = AGENT, BW = TIME, C = WEAPON, CR = CLAIM RESPONSIBILITY, D = DECLARE, DA = DIRECTION, E = OTHER TERRORIST ACTIVITIES, EW = CAUSE, HA = HAVE WEAPON, I = ASSUMPTION, K = ADVERSARY'S PLANS, L = LOCATION, M = SCALE OF ATTACK, N = NATION, OW = OTHER, P = CONSEQUENCES, RW = COUNTER-TERRORISM, S = SOURCE, T = TERROR ATTACK, UW = TERRORIST ORGANIZATION, X = GOAL OF ATTACK, Z = OBJECT OF ATTACK. We also used a number of tags for some lexical items irrelevant for the domain, at least in some contexts: different kinds of predicates (B, R, U), noun phrases (PO), adjectives, adverbs, names and abbreviations (O), numbers (Num), unknown items (UNK), and determiners (DEF). That was done to avoid linking a word to a concept in a non-terrorist context.

Normally, one lexical item should be assigned one tag at a time, with some notable exceptions that can be viewed as manifestations of conceptual syncretism. We define **conceptual syncretism** as a possibility for a lexical item to be mapped simultaneously into two or more concepts in the "golden" corpus. For example, in the sentence *At least 15 people were killed in an explosion that hit the rebel-held city of al-Bab in northern Syria*, tagging Syria with N and L is justified as it is both NATION and LOCATION, and both of the concepts are equally meaningful in the context[1]. The noun *suspect* is another good example of conceptual syncretism as it is tagged both A (AGENT) and I (ASSUMPTION), because a suspect, per definition, is a person suspected of a crime, i.e. a possible agent. However, if *suspect* is a verb, the tag A will be superfluous making this a case of part-of-speech homography (see Section 3.3 for details).

These examples show that conceptual syncretism is different from conceptual ambiguity in the fact that it does not need to be resolved; moreover, conceptually syncretic lexical items represent potential subconcepts or concepts modified by properties. For instance, in the above example, the combination L-N means that NATION can be linked to some other concept (TERROR ATTACK, which is clear from the context) by means of the relation LOCATION-OF. The combinations S-N (e.g., *Turkish media*) or Z-N (e.g., *Iranians*) mean that the SOURCE of the message or the OBJECT of the attack belong to certain nations/ethnic communities. The combination A-I, in turn, indicates that someone is assumed to be the AGENT, but it is not confirmed. Hence, ASSUMPTION can be viewed as an attribute able to modify other concepts.

However, only two concepts (N and I) are able to freely form tag combinations as manifestation of conceptual syncretism according to our current rules. Some other concepts form tag combinations with restrictions: e.g., RW can be a part of a tag combination unless its constituents are mutually exclusive (*RW-K, *RW-T), K can be paired with T (e.g., *to prepare an attack*) or OW (e.g., *to plan to recruit terrorists*), Z with L (e.g., *mosque*), UW with A (if a terrorist organization is not only mentioned in the text but also acts as the agent of a particular attack), etc.

[1] The order of tags is not meaningful and is only determined by algorithms of our annotation tool.

3 Results & Discussion

3.1 General corpus analysis results

The study found 193 unique tags in the automatically tagged corpus, 163 of them tag combinations (or multitags). After post-editing, 45 unique tags remained, 15 of them multitags that represent conceptual syncretism. Furthermore, we calculated relative frequencies of tag occurrences in both corpora and determined that the ratio of all (conceptual and non-conceptual) multitags to all tags in the automatically tagged corpus was 24 % and the ratio of conceptual multitags to all conceptual tags was 43 %, while in the "golden" corpus, the respective rates were significantly lower, 4 and 9 %.

Fig. 1 and 2 show the respective distributions of multitags in the automatically tagged corpus and its "golden" counterpart. Although some of the tags (e.g., L-N, P-RW, A-UW) appear in both figures, most of the tags in Fig. 1 require disambiguation. The data obtained suggest that conceptual ambiguity is rather frequent in the domain texts; moreover, it is diverse, and various methods might be needed to resolve it.

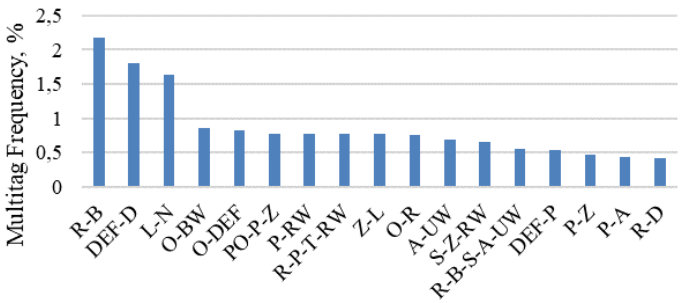

Fig. 1. Distribution of 17 most frequent multitags in the automatically tagged corpus; 100 % is the total number of tag occurrences in the corpus

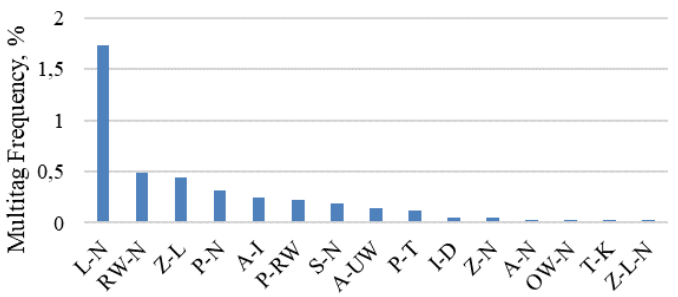

Fig. 2. Distribution of multitags in the "golden" corpus; 100 % is the total number of tag occurrences in the corpus

3.2 Sources of conceptual ambiguity

To identify the sources of conceptual ambiguity, we performed a comparative study of the automatically tagged corpus and the "golden" corpus. As a result, four types of conceptual ambiguity depending on the source have been revealed.

Part-of speech (POS) homography. This type of ambiguity arises when lexical items are identical at least in one form but they belong to different parts of speech. The examples are quite numerous in the English corpus among both domain-relevant and domain-irrelevant one-component lexical items: {act}$^{\sim T\sim R}$, which should be disambiguated as T (TERROR ATTACK) if *act* is a noun or as R if *act* is a non-conceptual verb; {bomb}$^{\sim T\sim C}$, which should be disambiguated as T (TERROR ATTACK) if *bomb* is a verb and as C (WEAPON) if *bomb* is a noun; {suspect}$^{\sim A\sim I}$, which should be left as is if *suspect* is a noun or disambiguated as I (ASSUMPTION) if *suspect* is a verb. Other examples are {is}$^{\sim R\sim B\sim S\sim A\sim UW}$, {may}$^{\sim BW\sim I}$, {sat}$^{\sim R\sim BW}$, {said}$^{\sim DEF\sim D}$, {report}$^{\sim S\sim D}$, {us}$^{\sim O\sim S\sim Z\sim L\sim RW\sim N}$. It should also be mentioned that lexical items in forms which do not coincide with each other (e.g., *has been reported*, *had bombed*, *suspected*) are ascribed a single tag due to the functionality of our annotation tool.

Lexical ambiguity. It is a possibility for a lexical item to have two or more interpretations in the context, which can be caused either by homonymy or by polysemy. For instance, the word *release* can have one of the two lexical meanings in the corpus: 'to make free' (about hostages or terrorists) or 'to make public' (about statements). Although choosing one meaning in the context is easy for annotators (cf. *Hostages were released* vs. *A statement was released*), it is not so for the annotation tool, hence the multitag RW-D (COUNTERTERRORISM / DECLARE). Some other examples are[2]:

be directed (DIRECTION OF ATTACK / OTHER TERRORIST ACTIVITIES)
1) 'to be aimed at an object' (about terror attacks)
2) 'to be guided by advice, helpful information' (about terrorists)

body (CONSEQUENCES / COUNTERTERRORISM)
1) 'a corpse'
2) 'a collective group'

station (LOCATION / SOURCE)
1) 'a bus or train station'
2) 'a radio or television channel'

underground cell (TERRORIST ORGANIZATION / COUNTERTERRORISM)
1) 'a small group acting as a unit within a larger terrorist organization'
2) 'a small room in prison located underground'

Khorasan (LOCATION / TERRORIST ORGANIZATION)
1) 'a region in the Middle East'
2) 'a branch of the Islamic State located in the Khorasan region'
3) 'an alleged group of senior al-Qaeda members operating in Syria'

[2] The definitions are taken from Dictionary.com and Wikipedia.org and adjusted to the terrorism domain if needed.

Plurality of conceptual meanings. It is manifested in one-to-many mappings between lexical items, which are identical in form and dictionary meaning, and ontology concepts, with only one of the latter relevant in a specific context. This can be illustrated by the word *police*: the word appears in three distinct types of sentences in the corpus:

1. **Police** (= COUNTERTERRORISM) apprehended the suspect.
2. The attacks targeted **police** (= OBJECT) and the military.
3. **Police** (= SOURCE): 5 dead, 8 wounded in airport shooting.

Thus, it is automatically annotated with a combination of tags S-Z-RW, only one of which should be preferred in each case — the decision that is quite easy for an annotator to make, but difficult for a computer. Ambiguities of this type are the most frequent in the corpus among both one- and multicomponent lexical items (see Table 3).

Table 3. Lexical items with plural conceptual meanings.

Lexical item/Tag	A	P	RW	S	T	Z
authorities			●	●		
detonated			●		●	
government forces		●	●			●
government official		●		●		●
fighter	●	●	●			
foreign tourist		●				●
killing		●	●		●	
military		●	●	●		●
soldier	●	●	●			●

Extralinguistic context. Ambiguities of this source are the hardest, is possible, to resolve even by an annotator. They arise from extralinguistic differences such as attitudes of different parties towards a certain issue. For example, the phrase *a Dogon group* can be tagged both A (AGENT) and RW (COUNTERTERRORISM) due to the fact that the Dogon militia is considered responsible for several attacks against the Peuhl community in Mali, which, in turn, is accused by Dogons of sympathizing with Islamist militants. In this perspective, Dogons' actions can be viewed as counterterrorism.

Each case of ambiguity induced by the extralinguistic context requires a thorough examination, after which only one point of view must be adopted, be it that of the global community or some other source. However, corpus data may not be enough to resolve this kind of ambiguity and commonsense knowledge should be employed in disambiguation. Considering the infrequency of this type of ambiguity in the corpus and the complexity of obtaining commonsense knowledge of this level, we currently find it extraneous to resolve ambiguity induced by the extralinguistic context.

It is important to mention that a multitag can emerge from several sources at the same time: e.g., the multitag for the word *accused* is R-P-A-I-D, wherein the plurality of conceptual meanings and POS homography are intertwined. If *accused* is a substantivized adjective, only the A-I tags are relevant; otherwise, if *accused* is

a verb, one of the R-P-I-D tags should be preferred. Cases of mixed-source conceptual ambiguity are not infrequent in the corpus, and they should be resolved progressively.

3.3 Disambiguation methods

In this section, we investigate three quantitative corpus-based methods for conceptual ambiguity resolution in the terrorism domain:

- a tag-ranking-based method;
- a co-occurrence-based method;
- a positional method.

Some other potentially useful methods are also paid attention to. In this paper, knowledge-based methods are not addressed as they require additional examination.

Tag-ranking-based method. This method is loosely based on the one described in [10], where it was proposed to renumber lexical meanings of certain lexemes based on corpus data as opposed to dictionaries and establish a hierarchy of meanings to resolve semantic ambiguity in the Russian National Corpus. In our turn, we propose to build tag rankings for frequent lexical items for which tag rankings can be calculated based on corpus data.

In our corpus, 10 lexical items meet the high frequency requirement: *army*, *children*, *civilians*, *control*, *incident*, *is*, *military*, *people*, *police*, and *security personnel*. For four of them, the data are not enough to build complete rankings, e.g., the word *military* which is automatically assigned tags P-S-Z-RW appears only with two tags in the "golden" corpus — RW and Z, which means that the military do not act as SOURCE in the test corpus and CONSEQUENCES related to them are not specified. Another example is the word *is* which is automatically tagged R-B-S-A-UW, but has either R or UW in the "golden" corpus, with R-tagged items accounting for 95 %. It clearly is a case of homography (*is* as a third-person present singular form of *to be* and *IS* as an acronym for *the Islamic State*) caused by our annotation tool not distinguishing between uppercase and lowercase letters. Even though the data are incomplete, given the high relative frequency of R-tagged items and a higher rate of other acronyms (*ISIS/ISIL*), we assume that referring to the Islamic State as *IS* is uncommon in our corpus, hence the multitag R-B-S-A-UW is unlikely to be disambiguated as S, A, or UW. Tag rankings for the other six items are: *army* — RW, S; *civilians* — P, PO; *control* — E, RW; *incident* — T, PO; *police* — S, RW, Z; *security personnel* — P, RW. While in some cases the predominance of a tag is clear (*incident* is TERROR ATTACK in 88 % cases, *civilians* represent CONSEQUENCES in 86 % cases), most of them are borderline.

Apparently, this method has noticeable drawbacks. Firstly, a considerable number of lexical items in the corpus are not frequent enough to build complete tag rankings for them. Secondly, frequencies of several tags assigned to one lexical item can be equal or close to equal, and thus none of them can be preferred over the other. Therefore, this method can be used either for a very limited number of lexical items, for which one of the tags clearly prevail (so that a "primary" tag can be identified), or in

combination with some other method. The reliability of the method, alone and in combination with other methods, is to be tested in further research.

Co-occurrence-based method. To test this method, we have built concordances for each tag in the "golden" corpus using freeware corpus analysis toolkit AntConc [1] and applied them to resolve conceptual ambiguity of the multitag S-Z-RW in the sentences:

1. **{Police}**$^{\sim S\sim Z\sim RW}$ {apprehended}$^{\sim P\sim RW}$ {the}$^{\sim UNK}$ {suspect}$^{\sim A\sim I}$.
2. {The}$^{\sim UNK}$ {attacks}$^{\sim T}$ {targeted}$^{\sim DA}$ **{police}**$^{\sim S\sim Z\sim RW}$ {and}$^{\sim O}$ {the}$^{\sim UNK}$ {military}$^{\sim P\sim S\sim Z\sim RW}$.
3. **{Police}**$^{\sim S\sim Z\sim RW}$: {5}$^{\sim Num}$ {dead}$^{\sim P}$, {8}$^{\sim Num}$ {wounded}$^{\sim P}$ {in}$^{\sim O}$ {airport shooting}$^{\sim T\sim L}$.

To resolve the S-Z-RW ambiguity in these three cases, we examined the narrow context: the right one in Cases 1 and 3 and the left one in Case 2. In Case 1, S-Z-RW is followed by P-RW (the double tag here is caused by conceptual syncretism, hence no disambiguation required). The concordance shows that P-RW can be preceded by A, L, DEF, I, RW, O, and P. Since no other tag of the listed is a part of S-Z-RW, it should be disambiguated as RW. In Case 2, S-Z-RW is preceded by DA; meanwhile, according to the concordance, DA is either preceded by Z or followed by it (with rare inclusions of UNK or DEF) in all cases, hence, here S-Z-RW should be disambiguated as Z. Finally, in Case 3, S-Z-RW is followed by Num and P. In the concordance, this sequence appears only once preceded by S, while it does not appear at all with the other two tags, which gives some indications, but cannot be completely relied on.

Although this method might not produce accurate results in all cases, we believe that tag co-occurrence can be used as one of the measures to calculate the probability of conceptual ambiguity resolution.

Positional method. This method is based on certain considerations from text stylistics and its idea is close to that of the classical location method for key word identification proposed by Edmundson [4]. News articles can be structured in various manners, but one of the most frequent and effective patterns is an inverted pyramid [2], where the information is presented in descending order, with the most important points written at the beginning of an article and the least important ones mentioned at the end. For this reason, we propose a hypothesis that sentences or entire sections of an article with an inverted pyramid structure that are closer to the top may have a higher rate of terrorism-related tags than distant ones. In this perspective, lexical items annotated with terrorism-related concept tags can be viewed as key words.

Following this assumption, we divided each of the articles in the "golden" corpus in two ways: 1) into sentences; 2) into five identifiable sections: Headline, Lead, Main Story, Background, and Reactions[3]; then, we formed testing positional subcorpora

[3] The headline and the main story which describes (shortly or in detail) a terror attack or some other terrorism-related event are mandatory for any news article, while three other sections are optional. The lead paragraph is placed right after the headline and used to summarize main ideas of an article. The background section gives additional information related to the

containing all 1st, 2nd, …, 19th sentences in Case 1 and all headlines, leads, etc. in Case 2 and calculated tag frequencies for each subcorpus.

The results for Case 1 are shown in Fig. 3. One can observe a decrease in concept tag relative frequency from 62 to 28 % in sentences 1–9, but then the curve rises again and remains at around 40 % with an upsurge to 47 % in sentence 18. The increase and the upsurge can be explained by two factors: firstly, the articles in question are of different length and from different sources, hence the discrepancies in structure; secondly, several articles contain information of other terror attacks at the end, which is related to, yet not crucial for the main story, hence the higher rate of concept tags. The results for Case 2 are similar (see Fig. 4), with a decrease from 62.3 % concept tags in Headlines to 40.2 % in Backgrounds.

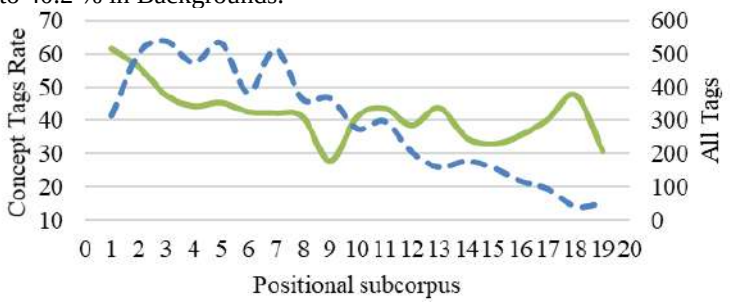

Fig. 3. Distribution of concept tags (green curve, left axis) depending on sentence position in an article (bottom axis) as compared to the number of all tags in the sentence subcorpus (dashed blue curve, right axis)

With that in mind, we can assume that the multitag PO-P-Z assigned to the word *people* may be disambiguated as PO if the sentence where it occurs is closer to the end of an article, e.g., *[There are] {**people**}$^{\sim PO}$ who have hatred for Islam and Islam is about peace* (Sentence 13 or Background). Meanwhile, if the sentence is closer to the beginning, the multitag can be disambiguated as either P or Z, as in *Car bomb kills 11 {**people**}$^{\sim P\sim Z}$ (?) in Mogadishu* (Sentence 1 or Headline). Neither P, nor Z can be preferred here so far due to the lack of specific positional data for these concepts, and some other methods should be used to disambiguate them.

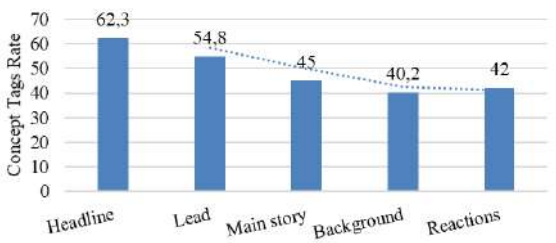

Fig. 4. Distribution of concept tags in sections of an article

attack or its perpetrator, such as the context of the attack or the terrorist's social background, while the reactions section provides various opinions regarding the attack.

It should be noted that the positional method based on sectional data has a serious drawback that makes it hard to apply in automatic ontological analysis: precisely, it might be difficult to divide the article into sections other than Headline, Lead, and Body (which comprises Main Story, Background, and Reactions) both automatically and manually, because they can be hard to distinguish; moreover, pieces of Background and Reactions can alternate throughout the article or be omitted altogether. On the contrary, sentence position data are easier to obtain and thus they seem to be of use as an auxiliary measure to resolve conceptual ambiguity.

Other methods. Methods that could potentially be used to resolve conceptual ambiguity are not limited to those already named; in particular, POS-homography-induced ambiguity can be resolved after disambiguation on the morphological level, and polysemy-induced ambiguity, after disambiguation on the lexical level. Indeed, if *act* is already determined to be a noun, it becomes clear that the right tag is T, not R; if *said* is determined to be a verb, rather than an adjective, the correct tag is D, not DEF. Furthermore, if we have already disambiguated the sense of the word *release* ('to make free' or 'to make public'), it is easy to decide whether it should be tagged P-RW or D. There is also a hypothesis to be checked that some concepts are more frequently represented in certain morphological forms (a so-called morpho-conceptual correlation), e.g., it seems logical enough that CONSEQUENCES are manifested rarely, if ever, in verbs in the future tenses. However, these methods should be further investigated.

4 Conclusion

We have presented the results of an experimental study of an English terrorism e-news corpus and have made an attempt to contribute into the field of domain-specific concept disambiguation. The study has shown that conceptual ambiguity must be treated as a serious enough problem of automatic ontological analysis due to its frequency and diversity both in the number of possible concept tag combinations and its sources. We have identified four sources of conceptual ambiguity that are present in the corpus to different extents; they are, namely, part-of-speech homography, lexical ambiguity, the plurality of conceptual meanings, and the extralinguistic context. We have also investigated three quantitative corpus data-based methods to resolve conceptual ambiguity and we find them rather promising, possibly when applied in combination to achieve a higher accuracy. Yet, these methods are to be further studied, tested, and evaluated on larger corpora and in other languages, as their accuracy (and even applicability) can be different for English, French, and Russian.

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E-Governance

On the Role of E-Technology Innovations in Agile and Interactive Policymaking

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Abstract. The main goal of the article is to present a theoretical analysis of the current state and prospects of the "digital government", to identify the most priority aspects of its interpretation in political theory. It is also important to outline the new opportunities that are provided by the e-technologies and new information potential for connecting citizens to the Internet and promoting actively both the principles of "digital democracy" and a new vision of the tasks of public policy. Particular attention is paid to the problem of implementation of e-technology innovations in the different levels of public policymaking. We demonstrate and problematize the role of four digital technologies in ensuring transactive institutional mechanisms in the policy process: block-chain technology, Issue-Based Information System, General Morphological Analysis, and Information System Integration. We regard these technologies and techniques as complementary ones.

Keywords: policymaking, digital government, e-technologies, information, design rationality, public policy, blockchain technology, political discourse, globalization, democratic governance.

1 Introduction

In modern scientific literature, the terms "digital management" and "digital government" refer to the use of information and communication technologies (ICT), in particular the Internet, to transform relations between government and society positively. At the state level, this implies the development and active implementation of standards for interaction between administrative services so that they can exchange data and integrate their actions while respecting the principle of confidentiality. Citizens of many states share the belief that digital governance can be used to increase overall confidence in public institutions in public policy and to create an atmosphere of goodwill, competence, honesty and predictability of government at the level of everyday political processes. At the same time, up to the present, specific features and difficulties of organizing the public management sector contribute to the emergence and implementation of poorly integrated and difficult to maintain applications. For example, individual administrative structures support various heterogeneous

applications for open databases to ensure transparency in public services, which leads to duplication of effort and waste of resources.

The costs associated with maintaining such poorly integrated systems may limit the use of resources attracted for future management projects and innovations. Meanwhile, the following fundamental question is still very urgent: how can information and digital technologies influence the management processes and transformation of leading political institutions? To answer this question, scientists often have to refute a very common point of view, according to which the new era in governance is nothing more than a continuation of the paradigm of "electronic government" and, therefore, it is simply a matter of pouring "old wine into new wine-bag". One of the goals of the article is to present a comprehensive analysis of two co-existing and mutually complementary managerial paradigms - the participation paradigm and the management paradigm. Besides, the article will develop general theoretical contours and parameters of a model aimed at explaining and predicting the most promising forms and methods of public administration at the federal, regional and municipal levels.

The immediate purpose of our review article is to explore core dilemmas which modern democratic governance have faced due to the inability to respond effectively to basic challenges of welfare state crisis from the 1980s onwards. The first failure was the inability of traditional governance machine to provide individualised public services of high quality in reasonable economic terms. Different policy innovation generalized under the doctrine of new public management was able to accomplish only an “icebreaker” role and trigger the service provision which could combine the strength of public-private-third sectors in partnership-like networks. Applications of e-technologies and programs in public sector service provision have concerned mainly responses to these challenges as well as the other complicated problems, especially in public policymaking

Secondly, the emergence of different type of organisations, in particular, the networks type structures between them causes huge questions of coordination because of extremely complex, uncertain and ambiguous institutional/organisational environments. The overall re-design of the public sector into nested hierarchies and networks type heterarchies as well as the high contingency of governments task environments should rely on the considerably higher capacity of information systems design and processing capacity.

Third, in this institutional context failed classical Eastonian policy input-output model of modern liberal democracies to ensure its legitimacy. This deficit of democracy was revealed in serious impasses in representation of public interests, in lack of accountability and the absence of enough legitimate policy outputs. The first response to this failure was the trend of depolitization of the policy process in which new public management and public choice theory played a central role. Thus a need to build up the policy process as highly open and interactive one presumes also the governing mechanisms in which policy and politics become intermingled. Hence, the policymakers faced with enormous complexity and volatility of policy process which traditionally has been built up as on the standardized elitist and formalized legislative procedures. In many countries, they refrained to meet this challenge and turned back

to the traditional style of governing which draws on the policy vs. politics dichotomy. However, at the same time, the innovative approaches of agile and iterative logic software development have become a benchmark experience for future innovations and should be used in the design in the policy process.

The latter trend indicates that the application of crucial innovations in e-technologies and instruments as an input of policy innovations would enable to respond to those challenges of democratic development in a longer perspective. Those innovations demonstrated in the current article are only selected examples. We intend to demonstrate first of all possibilities of joint innovations in two rather different sectors and to learn how such symbiosis would be developed in multiple other dimensions and in longer time perspective.

In the first chapter, we give an overview of recent developments in the research agenda on e-governance. The second chapter indicates the nature of shifts in interactive policymaking in the last decades. In the third to fifth chapters, we explore main responses to the need of interactive government and e-technologies and software development which have a great potential for the development of integrated responses to those challenges.

2 Theoretical Frameworks of Modern Scientific Debates

Over the past two decades, one can state with confidence a significant increase in the interest in the problems of digitalization and digital management. The attention of political scientists, sociologists, specialists in the field of strategic management, management theory, public policy, mass communications, etc. is concentrated on the current state, prospects and foundations of the “digital government”. To coordinate scientific and expert activities in this direction, joint international projects are being created. Combining examples and cases from administrative practices, they strive to cover all important aspects related to digitalization of management processes, first of all, to study strategies, principles and practices of digital management, the importance of the Internet for government and society, to achieve a deeper understanding of the concept and possibilities of “digital democracy” as well as problems associated with the translocation of public services on the Internet. For example, the Organization for Economic Co-operation and Development (OECD) is financing a special series - OECD digital government studies, dedicated to the introduction of digital technologies in public administration in various regions of the world [1, 2, 3, 4, 5]. In different countries of the world, many studies devoted to the above problems is constantly growing [see, for example, 6, 7, 8, 9, 10, 11]. The works of specialists in the field of mass media and political communications deal with the diverse problems associated with the analysis of the importance of digital and social marketing for management processes, the dynamics of emerging markets, forms and methods of social policy, in particular, how digital media and wireless communications, especially mobile phones and social networking platforms provide specific opportunities for transforming various sectors of public policy, economics and culture. One of the main research topics is the impact of social media

on consumer behaviour through the use of digital marketing methods [12, 13, 14, 15, 16, 17].

The fact that the study of the role of digital technologies in the structure of modern mass communications is not limited to purely pragmatic aspects is evidenced, for example, by Alberto Romele's recently published work Digital Hermeneutics: Philosophical Investigations in New Media and Technologies (2020). It undertakes an "ontological understanding" of digital technologies as "creative machines". In particular, Romele notes that today the boundaries between real and virtual, of course, are becoming more transparent. The human imagination has its analogue in the digital dynamics of articulation between databases and algorithms [18, cf.: 19].

Particular attention is paid to the implementation of digital governance principles in local government structures. For example, traditional urban planning has advanced significantly due to technological developments. New technological advances have created a new form of urban planning called e-planning, which combines the traditional elements of urban planning with information and communication technologies. However, as Carl Nunez Silva's Handbook of Research on E-Planning emphasizes, despite rapid progress in the professional world, the research on the use of ICT in urban planning remains extremely scarce and minimal [20]. This circumstance is also noted in a comprehensive study by David Holdstock on the problems of strategic planning in local government systems [21]. To compensate for this gap at the theoretical level, scientists, using the method of comparative analysis of specific situations in different countries and regions, set an important task to solve the problem of bridging the gaps between the federal, regional and municipal levels of government and to offer practical political solutions to promote municipal "e-governments" [22, 23,24].

As noted above, despite the high costs, many initiatives and projects in the field of "e-government" do not live up to expectations and systematically fail. This is because, although such projects were mainly focused on technical aspects, quality of service, usability and theoretical developments aimed at transforming management using ICTs, they had a limited impact on practice. Here are still gaps in the scientific literature related to the analysis of the failures of digitalization management projects, the lack of a deeper understanding of the reasons for the decline in citizens' trust in the government and scientifically developed hypotheses explaining how the state can solve this problem using digital technologies. A key study by the Organization for Economic Co-operation and Development (OECD) confirms that in industrialized countries, public confidence in governments has continued to decline over the past few decades [25]. Other studies show that a similar phenomenon can be observed in many other regions of the world, including the countries of the Middle East, North Africa, East Asia and Latin America. Although there is currently extensive literature on the analysis of declining confidence in governments in various regions of the world, several scholars insist on the need for further research to better understand this phenomenon [26, 27, 28, 29, 30]. Besides, there is no agreement on a common set of factors that contribute to lowering the trust and confidence of people in their governments.

For example, one of the factors that were identified as the reason is the decrease in the efficiency of their work. Another factor is growing inequality among the population [31].

Similar results are often found in studies on the effectiveness of new digital technologies and management. Although digital governance initiatives have long been implemented in most parts of the world and are already at a fairly "advanced stage", citizen confidence in governments remains a challenge. Moreover, several works cite numerous facts indicating that only a few of the implemented initiatives have achieved a real transformation of management (that is, fundamental changes in the way the government performs the basic functions in terms of achieving a marked increase in productivity and efficiency) [32, 33, 34, 35, 36, 37].

Studying the processes of the impact of digital technologies on power structures, some scientists emphasize that in the scientific literature there is no single definition of the term "power transformation" [38]. In many works, this term refers to increasing operational efficiency and changes in the process, structure, lines of power, focus, power, etc. [38, 39, 40, 41]. Some researchers consider the transformation of power to be the most important stage in the development of digital management [42]. M. Janssen and W. Shu define "transformational management" as "transparent, accountable, efficient and flexible" [43]. Transformation of management is often studied exclusively in terms of public services that stimulate confidence in the authorities and is much less focused on what role ICT plays in transformational processes.

3 The shift towards interactive policy process

In our recent article in Politex "Policy Analysis in uncertain and ambiguous context: agenda for methodological pluralism" [44] the main conclusion was: the focus of policymaking has shifted from the analytical design of policy content (policy program and deliberate intervention's plan) to the design and steering of policymaking arenas. This was a deeply practical shift at the end of the XX century. Theories of the policy process are generalisations of real practices of policymaking [45, 46, 47].

The science of policymaking largely refrained the presumption that policy is an enterprise of creating order, achieving intended aims and re-engineering the activity of social actors from the top and by elites assigned with powers. The latter could expect that they can engineer processes if they command substantial powers as sovereign holders of resources and means of compulsion. This remains today increasingly at the level of rhetoric, which would be convincing because of high capacity of mediatisation.

On the one hand, the policy becomes faced with high contingency because of increasing complexity and fostered tempo of changes. It becomes obvious that social substance and especially social transactions between individuals and between individual's networks and institutions have its own spontaneous (and largely unpredictable, also in sense of positive surprises) logic of unfolding. This awareness that maximum that we would hope to do is the adapt and harness changes means not

the diminishing of the capacity of social actors. Rather reverse, because of the successful solution of simple or brute social problems in advanced democracies policy become increasingly faced with wicked issues, which are not possible to define and solve because those are endless and eternal. We could at best to harness them, to trigger and nudge [49] actors. Foucault defined this level of policy development as the normalisation [48], i.e. as a state of affairs in a domain (let say traffic or community safety) which consist of huge number interdependent and intermingled issues and variables. For this reason, we cannot cause the expected change via direct interventions and to reshape the domain at our will, but only to give triggers to the largely spontaneous re-arrangements.

On the other hand, not only the complexity and globalization were the main reason for the emergence of wicked issues, but a changing role of individual actors in a democratic society. Basic technologies and motivational factors (vs hygiene factors) become to support individual-specific (instead of average mass) needs which presume constitutive forms of social relations, i.e. active citizenship and everyday involvement in determining policy inputs, as well as the responsive state. The very idea of constitutive institutions would date back to Vico and Hegel. The Marxian concept of capital was truly constitutive pattern of social relations. As an example would be the social constructivist conception of learning and pedagogy, in which Piaget, Vygodsky and Dewey played a central role in Europe and the US at the eve of XX century [50,51]. We cannot by-pass also the relational-constitutive concept of power. However, the Foucault conception of power relations [48] as the constitutive mechanism of transactions (visavis exchange) was even in the 1980s a shadow. Today the understanding of power as a productive constitutive mechanism (similarly to capital) becomes the presumption of new avenues of democratic governance.

Further, we would focus on three blocks or dimensions of innovation in the modern policy process where there is already provided certain digital solutions (digital info, methods, an analytical requirement to software and methods). Those solutions functionality could overlap and mutually complement specific hard- and software infrastructure.

4 Contingency governance as normality

In Mary Douglas classical group-grid theory the hierarchy, market (exchange) and community were presented as archetypical patterns of modern governance [52]. However, the fourth quadrant of cross-tabulation – the pattern of fatalism or social insulation - has remained largely unexplained. This was interpreted as the pattern in which individuals are atomized, surrounded by chaos, but governed by the intensive set of rules – like the prison, monastery or organisation in the crisis [52, 53]. However, the grid in post-modern society could be based also in norms, meanings or digital networks and through the constructivist prism, those are presented as continuously negotiated patterns. Digital infrastructure in this quadrant can diminish the weakness of asymmetrical relations (domination or negative-sum games) and increase their strength – providing scope for action that corresponds to the capacities

and incentives of an actor. I.e. digital technologies would enable the maximal "inclusion" of individual capacities and contribution of the networks, and hence, a new type of solidarity, which is based on sustainable long-term wins. Thus, in our time of digital technology, this pattern could be perceived as topological space which could be integrated through voluntary transactions between individuals as well as individuals and institutions. See upper left quadrant in figure 1. [Images from 51:96])

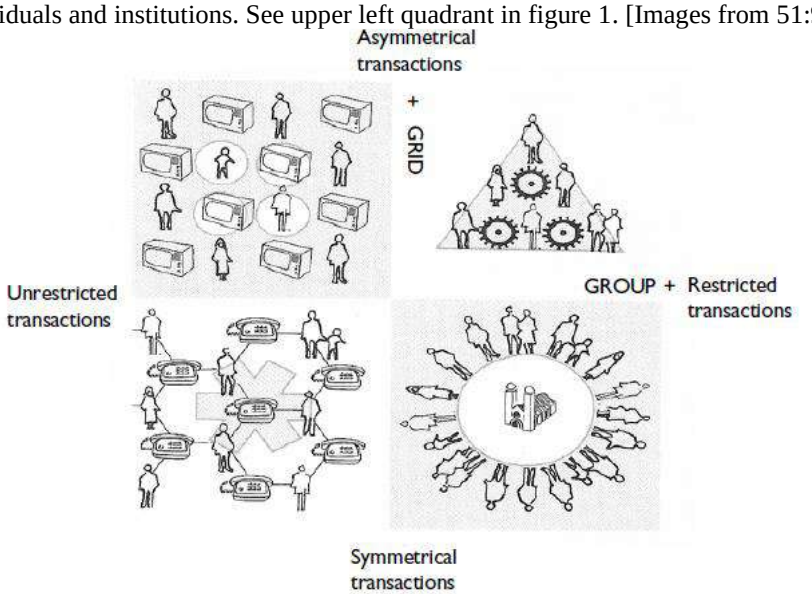

Fig. 1. Patters of transactions in different social space

This reminds our immediate past during CIOVID19, when we were "imprisoned" into our homes, but were able to be integrated into high-level communication via the internet and even carrying out regular lectures and seminars. Needless to say, I am signing my bills and documents at home to trigger numerous transactions, events, temporary action patterns with highly various partners. Topological space is organized differently but could be easily constructed by digital technologies. I.e. this is actually our social and political space in the XXI century. Government and governance are not exceptions.

To act, we should explore and organise this space differently. As Prigogine and Stengers demonstrated [54], this space should be conceived through the prism of contingency, not order. Order is emerging out of chaos as a largely self-organising process. So, we are living firstly in the context of market failures. New institutional economics teaches us how to achieve positive-sum transactions and how to institutionalise our transactions [55]. We cannon in this context to conceive and operate government as a completely organised hierarchy, but we should develop a vision on governance that considers government failure as normality and as criteria of normalisation (Foucault) [48]. Not only in the market but also the public sphere we should conceive contingency (uncertainty, ambiguity, volatility) not as a disaster but as an opportunity to constitute ourselves and our resources.

In XVI century Hobbes explored the government as sovereign force to pacify (even violently) or ramify chaos, to defend an individual's freedom or better to say – their lives. At the end of XX century, we had government and politics which were targeted to overcome the market and government failures. In the XXI century – we should become to master the contingency or failures' governance.

This means the emergence of the model of network-patterned social space or heterarchies. It is a highly contingent pattern, but at the same time, it enables a maximum of self-organisation and mobilisation of individuals to constitute via transactions their capacities. The organisational learning is such kind of transactive relational pattern, and we could live with contingency as soon as in all our transactions we are ready to learn. It's an opportunity of renewable resource generation, like weak ties or images (prestige); but these patterns highly probably fail. Digital technology enables us to build up this topological space, to predict and recognize those failures.

Governance in these conditions is steering via networks as heterarchies, i.e. metagovernance without direct domination. As Foucault says "the conduct of the conduct", or steering the big game which is assisted voluntarily by our small games in which we see our individual interests. Risks of failure increases, what is needed is a shadow of hierarchy (Scharpf) [56] as a warrant of possible dissolution in the context of failure. Network pattern has extreme complexity and unpredictability. The institutionalisation of networks presumes mechanism of negotiated rules (orders) and meanings or cognitive frames [57] In this context the focus of policymaking is not targeted so much on the development plan or program, although we as actors should have the action scenarios in any way; central focus of policymaking becomes the communication or dialogical construction of joint understanding through adequate communication. The communication is understood here not as an exchange of information but as the construction of joint meaning. Reflective communication could harness the extremely high-level conflicts and incompatibilities of people, who would not like to be any more the mass of similar pieces. This is also the new content of politics – to make those conflicts predictable.

Hence, the second role of governance (as meta-governor, as director of the big game) is to "switch on" networks and to switch back hierarchies (or strict disciplinary powers) in case of failure. The art of governance is the capacity of balancing between those ends. A completely new phenomenon like the COVID-19 pandemic and hybrid war presumes this capacity already. Northern Europe has managed to develop such capacity already.

Policymaking in this context is not the intervention (and politicians as creators) and even not as the solution of problems. This could be a case for simple issues. You cannot prevent or even reduce immigration by the high wall at state borders! At best you could start to know what is going on and what we should do at that moment collectively if we do not will to lose and crumble. I.e. the primary task of policymaker is the mediation of continuous dialogue between actors who should develop ad hoc responses. Policy actors could promote the unfolding the problem situation to identify and define interactively possibilities to adapt or to respond to the context or to trigger or harness of processes. This is summarised in Checkland's soft systems theory [58]

and Schön and Rein design rationality and learning in the policymaking [57]. Or, as Ch. Winship [59] said: „You don't' know where you are going, you might actually get there".

The case of digital innovation in managing this contingency. What would be the digital support for networks governance and metagovernance? Our first hypothesis is that blockchain technology would solve the same set of issues of transactions in networks as it is presumed by the new institutionalism and networks theories. Several important everyday transactions are ensured by this technology or its analogues (voting, ID certifying, real estate reliable databases, health services provision ect.) [60, 61]

This is the technology that makes possible individual's direct transactions with all constituencies of the network whereas metagovernor would be a guarantee that transactions are correct and safe; when at the same time autonomy and openness and impersonality (for others) of individual will be ensured. We expect also that based on this technology it's possible to reduce the miscommunication and legitimise the transaction context between constituents, and in case of increasing trust the transaction costs in networks could be lowered and reciprocity increased. Thus the application of this technology would support the long term rationality of calculations based on cooperative games and Pareto optimum without central intervention [62]. I.e. stable agreement or institutional patterns are not any more mediated, only warranted by the governor. Those aspects are summarized in table 1 below.

Table 1. BCT as enabling governance mechanism

Governing dimension	Tools	BCT opportunities
Access	Identify actors	Free access, only technical capacity needed
	Connect actors	Decentralized: dispersed nodes, but the central store of info
	Grant decision rights	Decision right embedded in the network, irreversible but openly revisable transactions Transparency for all
Control	Shared rules	Transactions transparent via central consensus ledger rules openly shared Smart contracts: algorithms of rules and penalties for transactions, automatic enforcement
	Collaboration/ competitors	Info encrypted: opportunity of decentralized transactions Transparency: through central ledger visible, restraints to opportunism
	Consensus vs. conflict	Irreversible: initial transaction fixed, all changes visible
Incentives	Motivate participation	Transparency and decentralisation motivate to participate
	Motivate specific actions	Smart contracts which are ensured by general rules and sanctions that are enforced automatically
	Facilitate innovative outputs	General rules as preconditions for trust promotes interest in interaction and cooperation

Source: adapted from [61]

The other hypothesis is that BCT would support the holographic principles of organizing. Holographic structuring is characteristic for open learning organisations and widely used currently in the policy analysis [63]. It is the other angle of the topologic or relational organisation of a networks' space. This conceptual issues would be subject to further discussion.

5 Agile and iterative policy design

Principles of the agile and iterative process come from the world of technology innovations, especially from software development. [64] In the policy sciences (as well as in art sciences) it is known as design rationality in handling wicked problems [57, 65] It means that the policy development is similar to software development or sculpture design: as the dialogue between the designer and its product or between provider and client in which the formation of product's format is simultaneously practical innovation and cognition of own needs and contextual possibilities. Already Rittel and Webber [66] pictured this as a solution of wicked problems. I.e. policy design is simultaneously multi-actor reflective communication, cognition and action-based innovation. This is a profoundly iterative process in all in all dimensions, levels and time points, and is a never-ending process (as complete mess). This pattern is demonstrated in a very simple form in figure 2. [60 pg.15] which is the result of the empirical study of car's door design. Usually, the policy dialogue is much complex and multidimensional - in one arena there could be dozens of "designers" and in one domain there could be a few arenas in different tiers of governance [67].

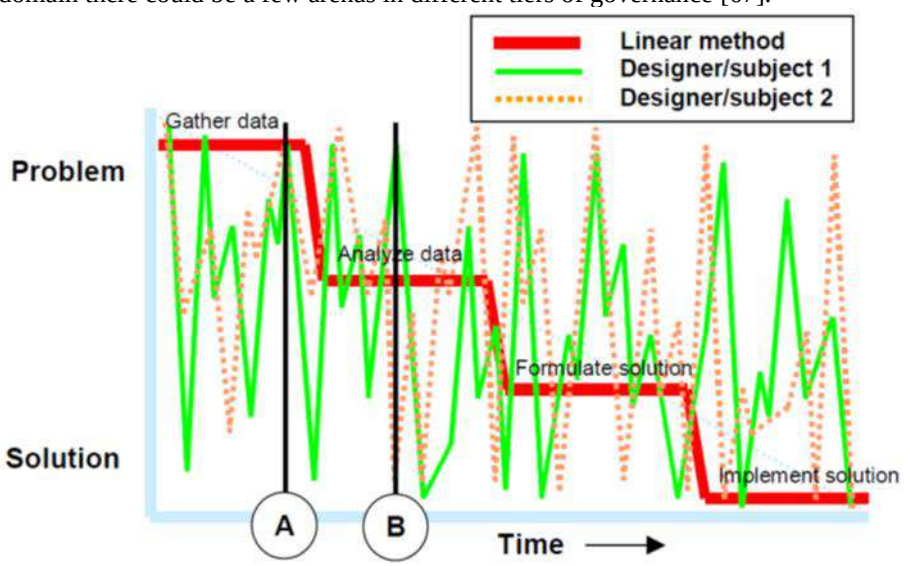

Fig. 2. The pattern of the iterative innovation process

Policy analysts have elaborated rather sophisticate conception of such critical or better to say unfolding and practice-based dialogue [68,69], which contains three stages: dialogue (learning of mutual listening or hearing others), debate (learning of argumentation) and negotiation (reaching ad hoc patterns of compatible interest). All those capacities of policymaking are practical. Policymaking becomes similar to the process where small kid, who cannot still speak, is learning via trials and errors to handle the e-tablet to listen video-clips. True, modern politicians are as a rule not yet so clever in a practical sense.

The theory of critical dialogue [see overview: 70] dates back to Dewey [50] and Mead/ Bulmer) symbolic interactionism, Gadamer's theory of fusion of horizon's, and on Bateson/ Goffman concept of cognitive frames, which was first formulated in the policy analysis by Schön, Rein [57] concept of action-framing. This understanding explores the policymaking process as practical communication of meanings between actors which command different "languages".

The case of digital innovation in policy design (1). Such a complicated process of critical dialogue is not possible to organise sustainably without sophisticated methods and software support. This method was developed by German engineer Horst Rittel [71] which later was adapted into digital format (64, 72). It is the Issue-Based Information System which principles have become a basis for different other development of digital support to social innovation [73]. We applied this method in the development of education steering network in Rapla county in Estonia in 2019-20 [74].

This is a sophisticated web-based instrument and method of steering of critical or reflective dialogue, which enable firstly, to develop the context of critical listening, secondly, to direct the argumentation towards well-structured logic of reasoning (argumentation culture and logic), and thirdly to save into collective memory and to reproduce in integrated form all the semiotic chain (Pierce) of debate. This enables to make the discourse into transactive and reflective: it enables us to observe yourself via the eyes of the audience and to observe one's actual performance in the context. This enables also mutually to learn and to discover new dimensions of actors as well as a context which initially was out of reach of all participants. Participants could figuratively to say "unpack" the initial problem situation into components which are unfolding and revealing, and enable to reach the points of compatibility or mutual fit[1]. This process and its outcomes Winship [59] compares with the puzzling game.

The case of digital innovation in policy design (2). The use of general morphological analysis method in the policy analysis and harnessing wicked problems in the context of high contingency. General Morphological Analysis [75] is the non-quantified problem structuring method (PSM) and an inference model which strives to represent the total problem space, and as many of the potential solution to the given problem as possible.

[1] About compatibility logic: If you can tell me why you say that plan A is great, and I understand your judgments, you have succeeded in objectifying your space of judgment to me. And although I might not share your judgment and might not be convinced, I understand you now. (Horst Rittel 1972)

A morphological field is constructed by setting the parameters against each other, in parallel columns, representing an n-dimensional configuration space. “Solution space” is synthesized by a process of internal cross-consistency assessment (CCA), and through pair-wise comparisons a cross-impact matrix forms. Such an inference model ensures that any parameter (or multiple parameters) can be selected as "input", and any others as "output". This is not a kind of causal matrix but a framework matrix to select and focus any pattern of variables. “With computer support, the field can be turned into a virtual laboratory with which one can designate initial conditions and examine alternative solutions, or conversely, designate alternative solutions to find the conditions that could generate such solutions.” [76 p. 6).

6 The institutionalisation of policy networks

How it’s possible to the institutionalisation of transactions in networks which are in the process of unfolding and constitution? Already Karl Weick spoke not about the organisation as a noun but about organizing as the verb. In institutional terms, this means a question: how to support mutual constitutive relations between citizens and institutions to ensure the positive-sum game of outputs. Here we should expect that Easton’s classical input-output model and of formal/ official representational politics would work only in a very general or symbolic terms [78].

Foucault’s biopolitics or policy which is targeted to the capacity-building of (productive) citizens should be supplemented with relational (and at least disciplinary) power (and policy) mechanisms. This mechanism must ensure continuous feedback mechanisms between citizens and institutions. Institutions should not only enforce policies but also should be able to trigger incentives of policy responsive behaviour of citizens (in environmental, health promotion, SME business, career development etc. policies). Foucault sees here the governmentality trend [48], i.e. institutionalisation of politics in everyday patterns of individual behaviour. Colin Hay [79] provides a new-institutional explanation to patterned contingency and demonstrates the new ontology of institutions. We demonstrated [44] that interactive policy process, which presumes merely citizens’ participation is not sufficient for the institutionalisation of network patterns under contingency. The policy should become transactive: input-output mechanisms should be continuous along all the policy cycle, from the stage of problem definition up to implementation and output evaluation. I.e. to ensure the quality of our social space we should be continuously involved into politics and policymaking, like already today in many countries in the health promotion, in transaction cost reduction, community safety development, and giving feedback as consumers of public goods in the framework of relational contracting etc.

The case of digital innovation. To ensure such continuous citizens – institutions transactions the - ISI - Information systems integration should be designed and build up [80]. Currently, ISI is already applied in some areas of public service, like health services. ISI could connect continuously all constituents of a network pattern and can integrate their hard and software developments and integrate a huge variety

of individual-level transactions [81]. In building up ISI one should give solutions to the following problems:

- To bound together with various autonomous organisation's inputs, outputs and throughputs and at the same time to retain their technical specific and autonomy;
- Technical solutions are needed to balance the networks units' autonomy needs, their heterogeneity and smooth distribution for end-users;
- To ensure direct communication (contacts) in the topological space to make transactions between them possible, but without their physical proximity and catch in a topographic space. This is a case for glocalisation of public services.
- To mobilise information and resource input from individual users (i.e. taxes) but also to combine different capacities of units to solve ad hoc individual (patient, student, family, consumer group etc.) issues, especially in a crisis.
- To make contacts with citizens available in case of crisis and to certify every transaction (paying taxes, receiving service).
- Technical solutions are capable to ensure a full picture of a domain from the access point of the individual user. This is a step towards holographic principles of organizing.

7 In conclusion

Three main challenges have been analysed in our article. Firstly, it is a need for governing in a highly uncertain institutional and social environment. Secondly, a need to develop agile and interactive policy style to harness wicked policy problems. Thirdly, to develop reliable modes of institutionalisation of governing networks. In our analysis, we tried to find out what innovations in the IT sector would support responses to those specific challenges and how these IT and software solutions would meet concrete innovations in the public policy. We revealed extensive affinities of IT solutions and needs of public policy innovations identified in the article. We focused on the one hand on two ongoing innovations streams in IT development: opportunities provided by Block-chain technology and Information System Integrations which contain huge possibilities to contribute to the "flattening" the topological space of governance and providing a technological framework for social as well as institution-building transactions to make them increasingly constitutive. On the other hand, we identified and analysed opportunities provided by two software solutions - Issue-Based Information System and General Morphological Analysis – which are already largely applied can contribute to the process of policy design. We consider those cases as an intermingling of IT solutions and governance needs at the level of institutional and policy design. However, opportunities for their application in governance innovation practices are still waiting for further studies

In the article, we proceeded from the premise that a "transcendental" growth of information and communication technologies (ICT) around has triggered a fundamentally new stage in the restructuring of governing mechanisms and processes aimed at a radical replacement of traditional ways of governing with a new *modus operandi* both at the level of intellectual potential and in the field of purely technical

means. With the penetration of the Internet into all spheres of public life, the need for digitalization and electronic control is constantly growing. New technologies offer the possibility of significant changes in the provision of public services as part of public administration. In order to ensure that all the advantages of digitalization are revealed is the combination of strategic initiatives with the ability to provide results that indicate the effectiveness of the governance. The sustainable nature of this process will largely depend on the coherence of political incentives and initiatives across the entire spectrum of public policy and administration. We tried also to explore which new opportunities are provided by the "digital government" for connecting citizens to the Internet and to modernize the sphere of public services?

However even more important issue is the active promotion of the principles of "digital democracy" and a new vision of the tasks of public policy. This implies a need for theoretical solution to the following fundamental problem: how the processes of digitalization and digital governance ensure the effectiveness of representative democracies in terms of new opportunities of the central government policymaking and citizen participation in decision-making at all tiers of governance.

Discourses on post-democracy [82] and anti-politics and de-politicisation of governance [78] on the one hand, and between the right wing conservatism versus liberalism, on the other hand, have indicated obviously the failure of classical Eastonian policy input-output model in modern liberal democracies to ensure its legitimacy. Recent COVID crisis in Europe indicated that government has either extremely limited capacity to govern in the context of high fragmentation of social space when everyday institutional patterns are broken down. This is because enhancing the sphere of collective choice and self-organized actions supported by different means of e-transactions in networks weakly fits with the official layer of modern representative democracy. It means that governance institutions should enhance the dispersion of power centres and draw on relational-constitutive power mechanisms in which network organisations and transactions prevail. As we demonstrated governance may extensively rely on different innovation in digital technology and software development.

Our main message was that today the *relativist* liberal democracy, as well as conservative rigidity, are both highly normative and highly politicised responses to rather untraditional and messy societal problems to be solved in order to retain already achieved quality of life across different borders. We expect that at the moments of high uncertainty and unpredictability those normative lighthouses could direct us to endless and incompatible rhetoric [79]. Instead, we expect that in such a context, the most reliable way is to draw on *critical pragmatist angle*, which could integrate different research and innovation strategies in different domains of activities, first of all in promoting jointly agile and interactive policymaking in different institutional-cultural contexts [44].

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Digital Transformation of Government Communications in Russia: from 2011 to 2020

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Abstract. The paper presents the results of two studies conducted with an interval of 9 years, which allow us to identify trends of government communications in digital public sphere of Russia. The authors draw conclusions about the active, but generally ineffective development of such communications that do not allow citizens to actively participate in political decision-making.

Keywords: political communications, public communications, digital public sphere, e-participation, social media, Russia.

1 Introduction

Last few decades, the concept of "public sphere" has become so widely and frequently used that there are few intellectuals who did not know who is Jürgen Habermas and how his works are related to this concept. However, starting from the period of active development of social media, the subject of intense theoretical debate and numerous empirical studies is the emergence and existence of the digital public sphere as the online equivalent of the traditional, seemingly imperfect, "old" public sphere. The advent of the digital public sphere has attracted a lot of attention in recent years because it has been conceptualized as an addition or even replacement of a previously existing, "classical", "old" concept of the public sphere as an essential element of modern democracy [1]. The digital public sphere is mainly defined as the sphere of online communication, participation in which is openly and freely available to everyone who is interested in discussing issues of common interest. The contemporary studies show that a distinctive feature of the digital public sphere is the visibility of the discussion or the results of the joint work of all actors in the network and that at least sometimes they affect the decision-making by other people. Among these studies are the ones presented in this paper.

In 2011, we carried out a structural analysis of public communications of the authorities in the Web 2.0 space at the federal and regional levels of government as part of a grant project of the Faculty of Applied Communications of St. Petersburg State University [2].

In January 2020, we conducted a second study, which allowed us to identify trends in the development of government communications in the digital public sphere

of Russia. The 2020 study can be called a trend study, since it was carried out on the same sample and relied on the same methodology that was used in 2011, with some adjustments. To compile a sample of the study, a list of servers of state authorities was used, available on the Official Russia website at www.gov.ru.

The main research questions were resolved during the study:

1. Can we see the growth of channels, tools and services used by public authorities to communicate with the citizens?

2. Do social media really open up wide opportunities for communication between public authorities and the audience, or is this just a political myth?

3. Do the authorities have an adequate and effective set of means of participation and cooperation with citizens for making democratic decisions?

Below we will try to answer these questions.

2 Research methodology

First of all, it is necessary to pay attention to the fact that representatives of all theories note the extreme importance of political communication in public administration. It should also be noted that the goal of political communication in public administration is not just the manipulation of the audience, but the achievement of agreement between the citizens and the government.

The study of government communications was developed by us within the framework of the post-classical paradigm, according to which modern communication technologies are not just a way of adapting to the external environment and the interaction of social actors with the external environment. It is, first of all, a way of constructing a social environment, forming public opinion on a variety of scales and the transformation of public capital into "informational" capital in the terminology of Castells [3-5]. The foundations of the Castells' concept are close to the ideas of Arendt [6] (the basis of society is the open public space) and Luhmann (society is generated by communication) [7]. Habermas's works on public sphere are also of great importance for our study [8-9].

It should be noted that the term "government communications" seems to us broader than "communications of public authorities". This is due to the fact that in the latter case, only public authorities designated as such in the constitution act as communicative actors who create, direct, and receive messages. Due to the nature of government actors whose functioning is connected with the implementation of state power, the communications they carry out are a priori political and public. The subject of government communications is information relations regarding the exercise of state power. At the same time, messages have the necessary attributes of public communication. They affect the needs / interests / values of citizens and have a public status. Accordingly, when in the future we will use the term "government communications", we will imply their political nature and public status. As a method of the study we used the network approach. Using network analysis accompanied by other methods such as case study, descriptive statistics, etc.

To search for knowledge about the really existing types of the studied phenomenon, typological and structural analysis was used. Methods of collecting and analyzing empirical data:

1. The formalized method is content analysis. It is carried out separately for each site and account in social media. It includes analysis of the total number of messages, the frequency of publications, general topics of messages, the use of special means of expression (links, photos, videos).

2. An unformalized method, which consists in adapting the content of a document to a research task based on an intuitive understanding, generalization of the content, and the rationale for the conclusions made.

3. Statistical methods.

The advantages of the selected methods are profitability, efficiency and versatility of the study. So the unformalized method is based on the understanding, comprehension and interpretation of the content of documents in accordance with the purpose of the study. A formalized analysis (content analysis) is designed to extract information from large arrays of documentary sources inaccessible to intuitive analysis.

Next, we will present in retrospect, first, the results of the analysis of Russian government digital communications in 2011, and then move on to the results of the 2020 study. In this text, the analysis is limited to government communications at the federal level.

3 Research results

3.1 Study 2011

An empirical study was conducted from September 1 to November 1, 2011. We analyzed the official websites of authorities, as well as blogs, microblogging (Twitter), social networks, video hosting (Youtube). First of all, we revealed that in 2011 all official bodies had the official website. We analyzed 62 sites of all branches of the federal government: legislative, judicial, and executive (52 of 78 sites) using the basic array method. Only 7 federal authorities had official blogs. 6 authorities did not have official blogs, however there were personal blogs, blogs of the public persons, or simply officials of the department. As for microblogging, it turned out that they were much more popular than regular blogs: 15 ministries had official Twitter accounts.

12 official YouTube channels were identified during a 2011 study. Social networks were not as popular as expected. The most popular was the social network Vkontakte, on which 17 official pages and two personal pages were registered. The local authorities had 12 pages on Facebook in 2011.

In general, the analysis showed that Twitter is the most convenient communication tool for the authorities on the Internet. VKontakte was a popular network. Although it is difficult to talk about any mass activity of federal government bodies on the Internet, because, as it turned out, only a little more than 10% of government departments at the federal level went beyond the boundaries of their own site (see Fig. 1)

Thus, the use of Web 2.0 technologies in public communications of the federal authorities of the Russian Federation in 2011 could not be considered effective.

The wide interactive possibilities of social media, which imply the priority of bilateral and multilateral communication, were generally unclaimed.

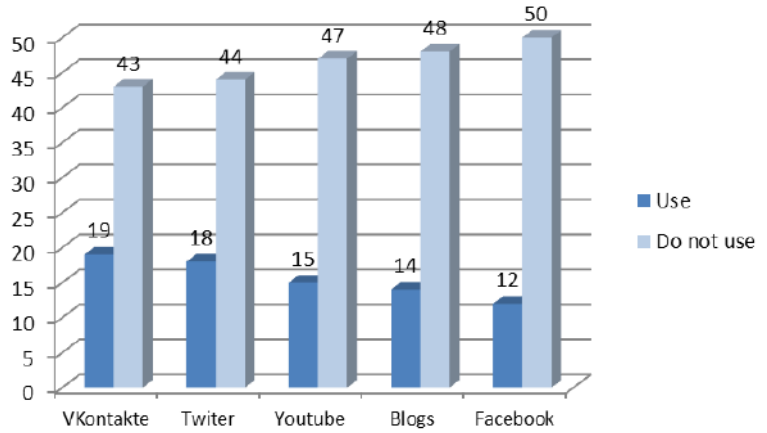

Fig. 1. The use of Web 2.0 tools in the activities of public authorities at the federal level in 2011

3.2 Study 2020

In 2020, a continuous sample was used, according to which digital public communications of all 83 federal government bodies of the Russian Federation were analyzed in accordance with the data of the Official Russia.

The study was conducted from 10.11.2019 till 01.15.2020. It should be noted that it was completed on the day when the government resigned. For convenience, the study is divided into two rounds. The first round is the analysis of websites; the second one is the analysis of social media. The main goal of the study is to compile a rating of authorities in the context of e-participation.

Tasks of the study:

1. determine the basic state of electronic means of participation provided by government websites by complete analysis of the websites, tools, services and content they provide;

2. identify the most effective social media used by federal authorities for communication between government and society;

3. assess the scale and degree of effectiveness of the use of e-communication by federal authorities for making democratically sound and technically rational decisions in the interests of all citizens on the one hand, and creating the image of a modern and effective government on the other hand.

A desk-top study was conducted — an inventory of available means of participation and cooperation on official websites and accounts of federal authorities.

Websites Analysis. Obviously, by the beginning of the 2020s, almost all sites at the federal level are regularly filled up, updated, have all the necessary sections and, accordingly, there is no need to evaluate their information and interactive components. Moreover, there is no point in evaluating the design of the site, its usability and search new optimization.

Therefore, for the analysis of sites, it was decided to apply almost the same list of criteria that was used in our other studies [10-11] related to the measurement of electronic participation opportunities provided by government websites (see Table 1). This list of criteria correlates with the methodology for evaluating e-participation, which is used by the United Nations [12-14].

In the case of the presence of investigated component, a rating "1" was set; in the case of absence - "0". Then the average value was calculated for each criterion for each authority. The results are presented in Figure 2.

Table 1. List of criteria for evaluating sites in the context of electronic participation

№	Criteria
1	Availability of a website e-Participation activities (calendar of public debate)
2	Reports on work results
3	Feedback (opportunity to write a message)
4	Multilingualism
5	Integration / presence in social media
6	Electronic consultations (opportunity to ask a question)
7	Electronic voting or referendum technologies
8	Use of mobile technologies

Figure 2 clearly demonstrates that by the beginning of 2020, almost all federal bodies of the Russian Federation provide feedback opportunities (97.3%), faithfully reports on their work (79.7%) and have accounts on social networks (77%).

However, only 9.6% of websites provide opportunities for e-consultations, a little more offer to vote on the website (20.5%). And, which is very strange in 2020, almost 77% of websites do not indicate the presence of mobile versions and there are no links to any other mobile applications.

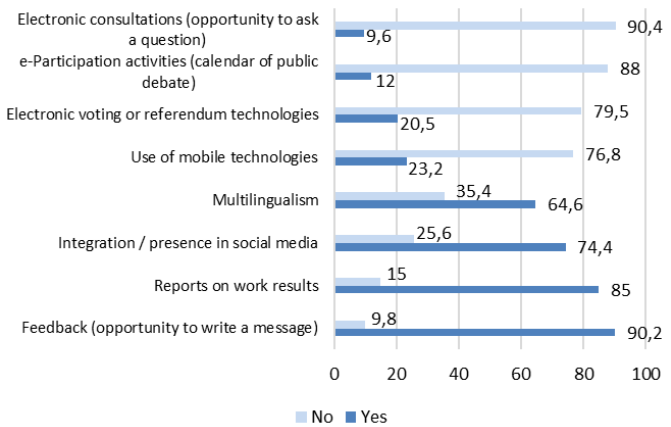

Fig. 2. The results of the federal authorities' websites analysis in the context of e-participation

In general, the conclusions regarding the provision of e-participation opportunities on the websites of federal authorities turned out to be disappointing. Most sites are only at the first (information) stage of e-participation (but perform it good). Some websites allow to organize and to hold consultations, but most of the government is still far up to the stage of decision-making.

Analysis of communications of federal authorities in social media. For analysis, we used those accounts, the link to which is posted on official websites, as well as on the portal of the Government of the Russian Federation.

It turned out that the federal authorities are very differently integrated into social media: some of them do not have accounts there at all, some are registered on the same social network, and some try to register on almost all popular networks at once. By the beginning of 2020, Facebook (65.8%) was the most popular social network among the federal government bodies of the Russian Federation. 59.7% used Twitter. Moreover, the government bodies represented on VKontakte (47.5%), Youtube (45.1%) and Instagram (40.2%) (see Fig. 3).

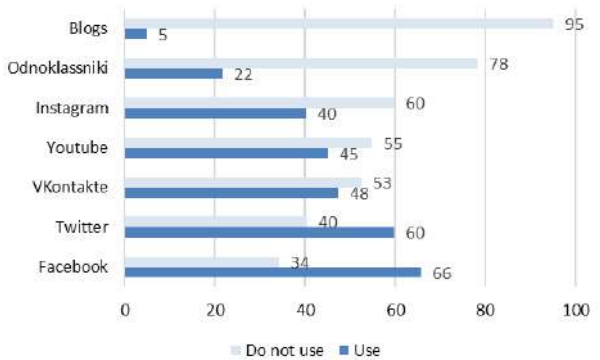

Fig. 3. The number of accounts of federal authorities in popular social media (in percent)

In terms of the number of subscribers to government bodies accounts, Twitter leads with more than 5 million users. The number of Vkontakte subscribers is approaching 3 million. Odmoklassniki with their 18 accounts are ahead of Facebook with 54 accounts in terms of the number of users. About 0.5 million users are subscribed to the channels of government authorities on Youtube (Fig. 4).

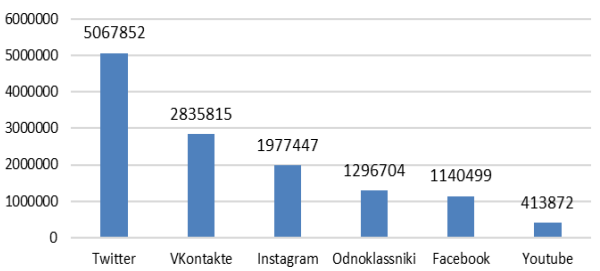

Fig. 4. The number of subscribers in social media

If we turn to a study conducted in 2011 (see Fig. 5), we can conclude that by 2020, the popularity of text blogs has faded. However, in 2011 it was not large: only 7 authorities had official text blogs, 6 ones had personal blogs of top officials, and one government body had an unofficial blog, that totally accounted for 22.6% of the analyzed authorities.

Figure 5 shows that the popularity of social networks is undoubtedly noticeable. Facebook demonstrates the greatest growth. The most popular social network in 2011 (Vkontakte) significantly lost to Facebook. The number of accounts on Youtube and Twitter almost doubled. Accounts on Instagram and Odnoklassniki were not analyzed in 2011.

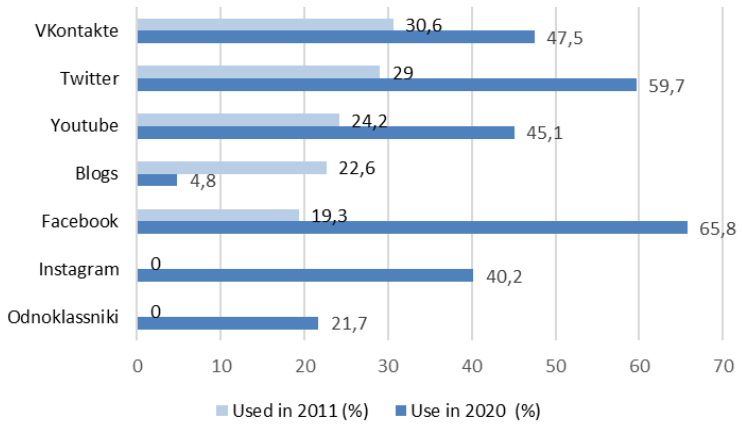

Fig. 5. Russian authorities in social media in 2011 and in 2020

In a detailed way, we have analyzed and identified some trends and tendencies in the activity of federal authorities on Instagram, since Instagram is now becoming increasingly popular among a wide audience and opinion leaders.

We found Instagram accounts with 33 federal authorities (40.2%) (Fig. 6). The total number of subscribers at the time of the study was 1977447 people (Fig. 7.)

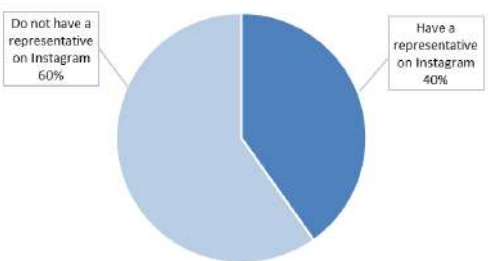

Fig. 6. Representation of federal authorities on Instagram

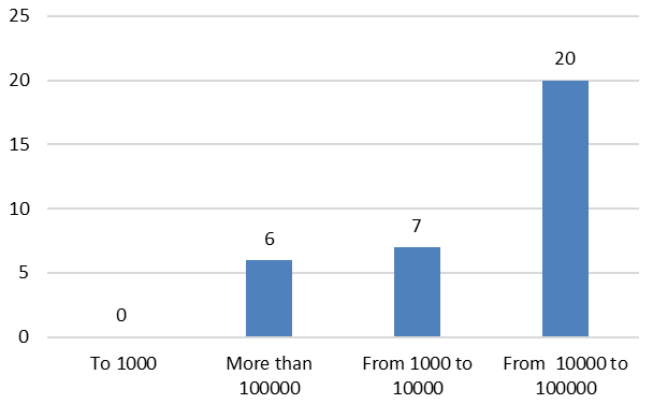

Fig. 7. Distribution of the number of subscribers on Instagram

It can be stated that the absolute majority of accounts of federal authorities on Instagram have an only information function. Among the topics discussed, all accounts unanimously lead news content, and almost all accounts contain congratulations on holidays. Some departments dilute their content with reference material for citizens, contests, etc. In two accounts of departments there is even a humorous content.

In almost all representative offices, there is a very low activity. Even in accounts with more than 20 thousand subscribers, the number of likes and comments is disproportionately small. In almost all departments, there is no official representative who could communicate with users in the comments and respond online to questions arising on topics.

The most active are the State Duma, the Federal Agency for Youth Affairs, the Ministry of Internal Affairs, and the Ministry of Defense. The most active account by a wide margin must be recognized as the profile of Dmitry Medvedev, chairman (at the moment, former) of the Government of the Russian Federation. At the time of the study he had more than 2.6 million subscribers and 581 posts.

Among the least active body are the Accounts Chamber, the Federal Agency for State Property Administration, the Ministry of Science and Higher Education, and the Federal Service for Alcohol Market Regulation. The account with the lowest activity indicator was recognized as the profile of Valentina Matvienko as the head of the Council of Federation (higher chamber of Russian parliament) with 13 publications and the last update a year ago.

Based on the analysis, we built a ranking of information activity on Instagram and an index of involvement of federal authorities.

The following formula was used to calculate the information activity index:

$$\text{Information activity index} = \text{number of posts} / \text{number of subscribers} \quad (1)$$

To compile the ranking, the indicators were ranked in descending order.

Engagement rate is the level of audience engagement in the activity of an account (an indicator of user interaction with published content).

To provide engagement formula, we used the program Xprofile. Engagement formula (a week metrics) is following:

$$ER = (likes + comments) / followers * 100\% \quad (2)$$

In our activity ranking (if we divide the number of posts by the number of subscribers), the leader was the Federal Agency for the Commonwealth of Independent States, as well as the Central Election Commission. The last three places are occupied by the State Duma, the President of the Russian Federation and the Ministry of Culture. Accounts of D. Medvedev and V. Matvienko were not included in the ranking, because only the accounts of departments were analyzed.

But the activity ranking does not coincide with the engagement index, which shows how many people interact with publications (like or comment). Only one agency, Federal Agency for State Property Management, provides the content that is interesting to the user, that is, subscribers really react to it. Four more departments can be considered more or less active on Instagram. They have average indicators for the audience engagement index. These are the Federal Biomedical Agency, the Federal Customs Service, the Federal Service for Supervision of Natural Resources and the Ministry of Defense. The vast majority of accounts do not fall into any standards on the level of involvement.

It should be noted that the engagement index was calculated from indicators for the week and was fully relevant only on January 13, 2020. That is, in different weeks, different agencies are leaders or outsiders. But, nevertheless, our experience in conducting such studies shows that, on average, this index reflects the trends correctly.

Thus, at this stage, keeping Instagram accounts by federal authorities is rather attributive and image-based instrument than a valid communicative tool. All imagine flats are more like abbreviated press centers. Due to the low activity of the audience, most departments cannot effectively use all the tools of this social network in order to spread their influence on the audience. The lack of feedback from departments in the comments also greatly inhibits this process. Therefore, at the moment, it cannot be said that Instagram is an effective platform for communication between federal authorities and the public. Unfortunately, the similar conclusion can be made virtually with respect to all the analyzed social media.

So, it cannot be denied that over ten years, Russian ministries and departments have gradually improved the content of their Internet websites. The number of pages in different social networks was increased significantly. However, these changes are more visible than substantial. With an abundance of websites and social media accounts, only a few of them contribute to improving the image of the government or its bodies. The presence of a website or an account on a social network in the government does not mean that it effectively uses these public communication tools.

4 Conclusions

In conclusion, we note that the digital public sphere of modern Russia is undergoing changes, which Habermas largely foresaw. The Internet is actively developing in all

areas of life; “ordinary citizens efficiently and creatively interact with each other online“ [15]. Like most researchers, we cannot but agree with the thesis that modern Internet technologies have fundamentally transformed and changed communications in all areas.

Nevertheless, the impact of the Internet on government communications in Russia today can be called insignificant, and the wide interactive possibilities of social media, which suggest the priority of bilateral and multilateral communication, remain generally unclaimed.

Unlike Western European and American practice, in which blogs and social networks are most often a full-fledged platform for communication between public persons and citizens, in Russia, social media in the political sphere serve primarily as a modern and technological analogue of a message board used for information or propaganda. Most of both politicians and officials are trying to apply new technologies to implement outdated communication models. They are not yet ready for dialogue and open two-way communication with users, or simply not interested in them. This situation can apparently be explained both by national managerial traditions and by the features of the political system that has developed in Russia today.

The comparative results of two studies presented in this paper demonstrate that the main achievement of the Russian “digital democracy” was only improved access to information. The government supports e-information rather than e-consultation and, moreover, not joint decision making, as is assumed in the concept of e-participation. Government authorities prefer to inform about the decisions made, rather than consult with citizens before the making decisions. Unfortunately, we have not yet been able to detect the tangible impact of existing digital communication platforms, forums that provoke online discussions, on decision-making by “institutional policy” [16] and find evidence of an increase in e-participation today compared with a ten-year-old situation. This is consistent with the observation by a number of scholars that government actors tend to use online campaigns for information and education purposes, while civil society actors usually conduct campaigns in an attempt to influence current political debate or political decisions, mobilizing for certain actions and increasing social pressure [17].

The answer to the research question (whether the Russian authorities have a sufficient and effective means of participation and cooperation with citizens for making democratically sound decisions) is negative. Despite the growth of the online channels, tools and services, they are inefficiently used by public authorities to communicate with the citizens.

And yet, despite the ambiguity of the digital public sphere of Russia, there are communication platforms in the Russian segment of the Internet that, at least from time to time, influence other discussion platforms and contribute to finding collective solutions. However, this conclusion needs further substantiation and identification of the conditions under which such digital public communications can develop.

Of course, it is necessary to continue research in this direction. The research methodology, of course, needs to be improved. In such a dynamic environment as the Internet, many indicators quickly become obsolete, but new ones appear.

We need projects focused on the study of factors contributing to communication, and, in general, the effective functioning of the system of e-interaction between government bodies, business and citizens in digital environment. Moreover, an important component of this issue is not only theoretical study, but also the implementation of applied research using social science methods and tools of modern Internet research. It seems that the studies described above allow us to identify problems and areas for further work by communication specialists in government.

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Cities in the New Media Reality: Between Freedom of Creativity and Digital Control

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Abstract. In this article the authors consider the contradictory effects of the digitalization process of urban media environment and implementing a wide range of «smart city» technologies, namely: the rapid increase in the speed and quality of communications, on the one hand, and the possibility of establishing total digital control over all transactions and movements carried out by urban dwellers, on the other hand. Thus, the new media environment and the service infrastructure of the city form a significant potential for improving the quality of life, but at the same time significantly reduce the scope of personal freedom and the possibility of creative development.

This dilemma is revealed by the authors using an example of Singapore - one of the leaders in modern digital technological development. Another case considered by the authors in the article concerns the comparison of the specifics of urban digitalization policy models on the example of Moscow and St. Petersburg. The authors analyze them in the context of the new social, economic and political risks posed by the COVID 19 pandemic.

The general conclusion is the need to ensure an institutional environment that reflects the new conditions of technological development and is based both on the principle of self-restriction of the technology introduction into a person's personal space and on a new «digital» ethics.

Keywords: New Media, Digitalization, Communication Channels, Serendipity, Transaction Costs, Network Structures, Quality of Life, Creative Spaces.

1 Introduction

The 20th century entered the world history not only as the era of bloody wars, great discoveries and the end of global ideologies, but also as the century of ultrafast urbanization: «in the 20th century, cities flourished, despite the persistent efforts of people to destroy them with the help of bombing from the air and constant growth of suburbs» [1, p.13].

The statistics on urban population growth are probably comparable only with the growth in the amount of information consumed and analyzed during the scientific and technological revolution of the second half of the 20th and beginning of the 21st centuries. If in the 1900s. the urban population of the planet was no more than 200 mil-

lion people, by the end of the 1990s it exceeded 3.5 billion people, and by 2050 at the current dynamics of resettlement (daily up to 200 thousand people), it will reach 70% of the total number [2]. By the end of the 21st century, the urban population of the Earth is predicted to grow up to 8 billion people, with a total population of 10 billion, which will radically change not only the structure of the population, but also its designed landscape.

Such a rapid growth of the urban population is explained not so much by the desire for a higher income (which remains an illusion for many immigrants), but rather by an increase in the chances of education, career growth and an increase in social status.

Moreover, the quality of life is determined in the context of the Fourth Industrial Revolution, first of all, by the degree of involvement in global digital flows, the ability to select and apply relevant knowledge. In this regard, the potential of urban communication infrastructure is crucial.

Despite the ubiquity of digital technologies that makes digital communication available in hard-to-reach corners of the planet, cities remain key communication hubs of the global media network: «The city is a powerful communication technology that provides real-time communication between different individuals and groups, as well as the rapid dissemination of new ideas and practices. Even in the age of instant digital communication, cities still provide constant contact with the strange, with the unfamiliar, with the unknown» [3, p. 236].

Hence the main goal of the article is to analyze the advantages and risks of digitalization and the development of a new media environment in relation to the formation of new forms and methods of urban policy. The context of the global pandemic, which has significantly influenced both the dynamics of digitalization and the tightening of the citizens' behavior control procedures, makes this issue particularly relevant.

The new network media environment called Geomedia, which is defined by S. McQuire as the process of convergence and ubiquitous distribution of digital devices and platforms, the use in everyday life of the location data of services based on geolocation and also the increasing penetration into ordinary life of distributed feedback in real time, is turning into a powerful force that shapes the contours of public space, and they are beginning to play an extremely important role in the politics of modern public space [6, p.35].

As the space of cities is becoming more and more saturated with mass media, the old ways of forming territorial boundaries, which previously determined the geometry and rhythm of everyday life, are undergoing serious revision. The function of urban public space as a locus for the implementation of certain practice of social interaction and communication is largely reconfigured under the influence of a new logic, opening new possibilities for recording, archiving, analyzing and extracting various streams of information [6, p.36].

2 Theoretical Frameworks

One of the most important functions of cities is to multiply diversity, a bizarre combination of different cultures, behavioral styles, social and professional groups, etc. like

in a kaleidoscope. This function of a modern city contains an exceptional creative potential. Cities are not only centers of science and education in the organizational and institutional sense, but also a space, where the creative potential of a person can be developed unhindered and receive support. To analyze the effectiveness of the creative potential realization, the authors propose to use the concept of «serendipity», which today is not so common in scientific works.

In the context of our theme «serendipity» is understood as the possibility of randomness, uncertainty range of the interactions, the clash of various factors, formed the urban environment, since it is a city providing the infrastructure to enable development of intuition.

It is to this dimension of the study of this phenomenon the famous sociologist R. Merton devoted one of his latest works, emphasizing the influence of serendipity on creative, innovative activity, the possibility of scientific discoveries, which is extremely important for the development of the modern urban environment. Merton wrote of «serendipity pattern» as a way of coming to unexpected scientific discoveries [4].

This approach is close to the synergistic concept of social development, which describes the processes of new forms of social order emergence from chaotic, random interactions and mutual influence of various actors. Hence, another important theoretical concept is the concept of «bifurcation», defined in synergetics as the behavior of complex systems in a nonequilibrium state when the system makes a transition from one dynamic mode to another [5].

In the new conditions of an extremely complex, turbulent media environment, the question arises of the information relevance, its truth or false. The thesis is quite provocative, but true as social networks (in particular, Facebook) has managed to change the answer to the question: «What do I need to know?» «You need to know what your friends and friends of friends already know, but you still haven't» [3, p. 241].

Social media turned out to be an effective tool for both grouping and their subsequent autonomization, deliberate or accidental separation of them from the other social world. In this sense, the phrase of the American journalist and media space researcher Paul Carr, who suddenly realized that he's «existing in a little twitter bubble filled with people close in racial, political, linguistic and social senses» is indicative [3, p. 241].

It is chance meetings that make city livable, stimulating creativity and ultimately safe. Areas with small neighborhoods where pedestrians are easy to move around combine residential, commercial and recreational functions, with vital energy that can be found neither in typical, purely residential areas, nor in central neighborhoods that become unpeopled in the evenings when offices are closed. The source of this energy is in chance meetings between people using the area for various purposes [3, p. 246].

Open source urbanism is characterized by more horizontal, multiple, and sensitive feedback between urban dwellers and the city. However, Sassen warns that the smart city concept may turn into a technocratic fantasy of a totally controlled space [6, p. 20].

As a result, a new disciplining reality arises, very similar to the state of society that Gilles Deleuze defined as a «control society», in which the old pro-governmental

strategies of segregation and physical isolation, typically occurring in Foucault's disciplinary regimes, are replaced by the ubiquitous digital modulation [7].

Scott McQuire very accurately noticed the ambivalence of a digital society and a digital city, in which the tension between the potential for new forms of citizen engagement and self-organization and the tendency towards marginalization inherent in similar projects under the influence of new forms of technocratic control, which they themselves often produce, is becoming ever stronger [6, p. 20].

3 Between Freedom of Creativity and Digital Control: Case of Singapore

The dilemma of weakening of personal freedom and increasing of digital control is clearly shown through the example of Singapore - one of the leaders in modern digital technological development. As Professor John Curtis Perry accurately described, «Singapore is a controversial subject, described as "The Big Apple of Asia," or "Disneyland with Capital Punishment." On the one hand, there are those who admire its efficient government and material accomplishments; on the other hand, there are those who deplore its antipathy to freedom of expression. We can all ask how much an authoritarian government stifles the creativity necessary to nourishing a productive society» [8].

Singapore presents a special set of regime political and administrative characteristics. Firstly, the city-state, which gained independence in 1965, has developed over the years within the framework of the de facto one-party (the People's Action Party has been in power since 1959) and the authoritarian political system as a whole, and accordingly, has not experienced the consequences of a competitive political struggle. Secondly, political ideologies in the country have been clearly secondary (in contrast, for example, with China), and politics as a whole has had rather a technocratic content. Therefore, the stability of the course and the management team in Singapore has always been very high, with an extremely low level of corruption (4th place in the world according to 2019) [9]. This, in turn, has ensured the effective phased implementation of the «intellectual territory» project, called Smart Nation.

The goal of implementing Singapore's Smart Nation concept is to make Singapore «an outstanding city in the world … for people to live, work, and play in, where the human spirit flourishes» [10]. The program is aimed at improving the quality of public services, strengthening communication with citizens and introducing innovations in the private sector. According to Singapore laws, the use of data collected by Smart Nation does not require the consent of citizens or the permission of the court. This approach seems undemocratic. Moreover, it violates the rights of citizens. In addition, with a possible cyberattack, the security of a huge amount of private data may be at risk. In general, many aspects of life in Singapore, including public transportation and housing, are controlled by state-owned companies. While the population of Singapore is more than 5 million people, approximately 80% of citizens live in government apartments. And, despite the fact of Singapore being recognised as a democratic state, democracy here has national specific features: the country, as mentioned earlier, is de

facto led by one party; voter's identity card should be indicated on the ballot papers; and the right to freedom of speech and expression guaranteed to Singapore citizens by the Constitution is violated by total censorship.

Thus, the civil society and government feedback system in Singapore has a number of features related primarily to the centralization of the political decision-making process and the relatively weak participation of civil society institutions in it. According to the Press freedom index 2019, Singapore took the 151st place, which is significantly lower than many post-Soviet states, including Russia [11].

The total digital control over all transactions and movements carried out by the townspeople has allowed Singapore to create a stable basis for high-quality technological development and innovation.

4 Digital Transformation in the Structure of Communicative City Management: Comparative Analysis of Moscow and St. Petersburg

The new global challenge of the COVID19 pandemic, which at the beginning of 2020 covered the most technologically advanced countries in Europe, North America and Southeast Asia, repeatedly updated the problem of determining the content and main directions of digital technologies development. Moreover, the range of problems associated with digitalization is very wide: from ensuring public safety and controlling the spread of the disease to developing effective forms of distance learning. All these problems are related to the issues of digital control and restriction of citizens' freedoms, which requires a deep ethical-philosophical, legal and political analysis. Today, the whole range of pandemic consequences is difficult to objectively assess, however, it is important to note the importance of choosing the digital development strategies of individual territories, which laid the foundation for the rapid development of digital technologies in a crisis situation caused by the pandemic. From this perspective we will briefly compare two Russian cases: Moscow and St. Petersburg.

Moscow and St. Petersburg have formed the basis for knowledge-based urban development management as part of a global trend and a federal strategy for improving public administration.

The construction of the information and communication system for managing the metropolis in Moscow went through several successive phases. They can be provisionally structured as follows:

Phase 1. 2000-2011. The development of urban infrastructure and electronic society technology within the framework of the state target program «Electronic Moscow».

Phase 2. 2012-2017. Informatization and centralization of electronic public services, carried out in the framework of the Information City program adopted in 2012.

Phase 3. 2018 - present. Development and implementation of a full «smart city» concept [12].

The success of Moscow in the process of a «smart city» organization is ensured by several factors. Firstly, it is a broad administrative and resource support of the city authorities. Secondly, the emphasis on advanced research and world best practices in

the field of smart cities designing, as well as drawing the attention of representatives of market leaders, scientific and expert organizations. Thirdly, the dominance of the information and communication technology industry in the structure of the city's economy. By 2017 industry enterprises registered in Moscow produced more than 70 percent of the total industry in Russia. Fourth, the availability of a sufficient number of highly qualified world-class labor resources in the city [13].

In St. Petersburg, the implementation of the urban development concept on the principles of multidimensional knowledge was sequentially behind federal programs without accelerated development and significant regional features. The phases of building an information and communication management system can be structured as follows:

Phase 1. 2002-2015. Development of urban infrastructure and e-government technology.

Phase 2, 2015-2017. Open government technology development.

Phase 3. 2018 - present. Development and launch of the «smart city» concept.

Although the current phase allows us to evaluate only the experience of conceptualization and partial implementation, the existing approach to implementing the strategy in St. Petersburg differs significantly from the Moscow one primarily by institutionalizing this process as part of a consortium with ITMO University, which is responsible for determining development priorities and the implementation format of the «smart city» concept.

Firstly, the main emphasis is on the management architecture (basic principles: a comfortable environment for citizens, coordination of management, development of urban infrastructure, process monitoring, joint design of the environment, human capital), and not on the target qualities of controlled environments and the level of innovative development. While for Moscow, priorities were chosen: improving the living environment of citizens, citizen participation in management, the use of machine intelligence, a barrier-free environment, the involvement of science and business, digital document management, the use of end-to-end technologies, import substitution, and environmental protection). It should also be noted that the conducted sociological studies recorded a common perception of the «smart city» concept among public servants and urban dwellers in St. Petersburg, who expect from the implementation of this concept to improve the quality of urban governance and, as a result, the quality of citizen's life.

Secondly, the claimed method for assessing the strategy goals achievement includes only 5 separate indicators for St. Petersburg, compared with 2 complex indexes based on dozens of indicators for Moscow.

Thirdly, despite the declared principles of co-management, the current implementation of smart St. Petersburg strategy follows the principles of project development based on internal expert selection, which leaves a limited range of opportunities for implementing an open innovation model that has already proved its competitiveness in terms of solving the problems of breakthrough city development as part of a collaborative strategy and global competition. At the same time, the data of expert surveys record the high role of risks related to both information security (hacking elec-

tronic networks, cyber terrorism) and the inflexibility of authorities in relation to expanding forms of citizens and businesses participation.

To determine the degree of the smart city technology development in Moscow and St. Petersburg in a comparative perspective, we used the typology proposed by Bill Hutchinson, executive director of the EY smart cities development center, in which he conditionally identifies three stages of the development: smart city 1.0; «Smart city 2.0»; «Smart city 3.0». The key difference is based on the degree of coordination and «convergence» of the overall strategy for the «smart city» concept implementing, as well as the degree of balance of the technological and socio-humanitarian components: «Smart City 1.0» is similar to those old systems for business and government, some elements of which were automated without general strategy. «Smart City 2.0.» carries out basic «strategic consolidation». «Smart City 3.0» conducts a comprehensive «strategic consolidation», and basic intellectual technologies are integrated into its infrastructure [14].

Assessing the current stage of the «smart city» technology implementation in Moscow and St. Petersburg through the prism of this approach, taking into account the above technological, managerial and institutional features, we conclude that Moscow has already reached the «Smart City 2.0» phase and is preparing to the transition to the «Smart City 3.0» phase, while St. Petersburg is only completing the transition from the first to the second phase of the smart city technology development.

5 Conclusion

In the Fourth Industrial revolution innovation development process in general has become much more unpredictable and less controllable by both the business and the state. A particular relevance in this regard belongs to the problem of finding ethical and moral foundations for further technological development, as well as the danger of establishing total control over a person and, as a result, erosion of the democratic foundations of modern society and urban governance, in particular. There is a devaluation of the value foundations of politics and governance, in which new technocratism, selfish rationalism and utilitarianism become the dominant principles. Multiplied by the effects of modern information and communication technologies, they lead to the spread of the so-called «Post-truth politics», blurring the line between truth and fiction.

The development of the «smart city» digital technologies leads to dual effects. Firstly, this is a significant multiplication of communicative interactions, which allows «everyone to communicate with everyone», which makes it possible to obtain information almost instantly, send back a reaction to it, correct and express one's own position [15]. Such an opportunity certainly makes the feedback system of the conditional subject and the control object the most effective in a network environment.

But on the other hand, attention should be paid to the designers of these technologies and their direct owners (global IT corporations) who become owners of a huge amount of data (visual, interpersonal contacts, personal «tracks» in the Internet, social networks, etc.), the use of which practically is not subject to any kind of public scruti-

ny. Thus, we are speaking of the possibility of total targeting, that is, conscious control and behavior direction (economic, political, social) of a huge number of these technology users.

It is not a coincidence that many experts note a significant transformation of culture, which «is becoming a means of obtaining data (intimate coordinates) that are used to compose portraits of consumers, send targeted messages and direct communication in the right direction» [6, p.40-41].

Therefore, it is necessary to ensure an institutional environment adequate to the new conditions of technological development, based on the new «digital» ethics and the self-restriction principle of technologies introduction into a personal space.

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Urban Transportation Challenges: Social Issues and Digital Data Analysis

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Abstract. The goal of this study is to determine the contemporary problem areas of urban traffic management policy in Russia. This study applies web content analysis of search engine-generated images to explore visual narratives, social and political categories of urban traffic. It also makes use of cosmogram perspective (external depictions of urban traffic composition with connections traced between its elements). The analysis showed that urban traffic categories constitute public concern and contentious frames. It indicates Russian public opinion anxiety of specific traffic challenges that are usually out of the government and city management agenda. This study also discusses some prospects for urban governance and urban transportation assessment supported by digital analysis technologies.

Keywords: Urban transportation, Road traffic, Urban governance, Social issues, Traffic congestion, Road Rage, Digital data analysis, Visual sociology.

1 Introduction

Urban transportation combines multiple relationships and a wide range of policies: environmental, technology and innovations, public health and safety, quality of life and social security, mobility of human resources, finance and economy. The growing importance of urban transportation not only contributes to urban development, but also creates new issues for urban policy and communication between city government, stakeholders and public interest groups. At the same time, even challenges [1] that urban transportation presents to urban planning and risk management are largely out of the focus of contemporary urban research because of strict boundaries between jurisdictions and responsibilities of institutional and management structures. Thus, transport-specific problems are found outside the boundaries of the typical management model that evolved in developing countries at the national and urban levels where cities have experienced an explosive growth of motorization combined with uneven development of the corresponding services and infrastructure.

With such imbalance, the new global management standards of urban governance evaluation, which are often based on indicator design and data analysis, have little potential in relation to complex, multilevel and varied all-nation or city-specific challenges to urban transportation development.

Not infrequently, side effects of transport reforms give rise to contentious public demands or protest movements, as post-Soviet Russia has been showing from time to time [2, 3].

Urban management agenda rarely includes non-political and non-social issues. Even anticipatory management agenda and smart city strategies are not free from aberrations of the new digital urban ontology that generates objects without tracing the processes of their origin.

2 Background Review

Contemporary studies of the urban transportation problems described above relate to the lager areas of public policy, which, however, are mostly plagued by economic and operational inefficiency of transport models, infrastructure, etc. This is most relevant to congestion studies, since transportation and mobility are important not only for global urban research [4, 5], but also for sustainable development championed by the smart city strategy [6, 7]. Social issues related to traffic congestions are driven by road rage violence [8], stress and psychological problems [9], as well as by new opportunities offered by the paradigm of traffic digitalization and the necessity to manage free parking space. Longer commute of city residents generates new services that bring economic and social capital, but the downside is the loss of air quality and high carbon dioxide levels, which point towards an imbalance in urban development. Imposing tolls and environmental regulations for balancing traffic risks and compensating the costs of infrastructure maintenance could inspire political contention. The anti-mainland cross-border driving movement in Hong Kong, the protest campaign in Johannesburg after the launch of the "e-toll" system for drivers, and the yellow vests protests in France have shown that the government is trapped by management problems.

The rising transportation-based business models ("on-demand" employment for taxi or last mile deliver services) open the door for debates on uberisation of labor in the modern city [10]. Recent studies in urban geography and anthropology highlight how the popularization of new vehicles in cities affects public life [11], safety, and city environment in general [12, 13].

As preparations for the launching of autonomous urban transport show, technologies not only raise the issue of public morality on the new technology-governed roads [14], but do so in very specific ways because public perceptions differ across the world, as shown by the experiment on modeling of road accidents in the MIT Media Lab: Moral Machine [15].

The situation in Russia is different. In some respects, a number of traffic problems in Russia are similar to developed and newly industrialized countries like China, India, etc. [16, 17]. The post-Soviet transformations related to the change of political regime have contributed to complexity of regional and urban spaces, which creates both limitations and opportunities for local management. Due to lack of citizens' support, administrative regulatory measures and law could be undermined with [18], the high-tech strategies produce managerial aberrations, impose barriers for management

and facilitate public contentions. Even with digital solutions, urban management remains short-sighted, as it uses digital technologies for innumerable data collection and standardization, implementation of performance indicators, dashboards, and further steps to create its own digital twin [19, 20]. The limited effects of digitalization are also linked to complexity and interconnectedness of processes and chains in urban life, where it is difficult to outline the specific areas of regulation.

The urban traffic space also becomes a field for ethnic, legal and economic conflicts, due to shadow and informal economy, legal bias, rampant drivers' behavior, and the overlapping of public, political and private spheres in a hybrid political regime that often depends on patrimonial relations. This means that solving the traffic problem requires more attention and deeper understanding of indirect effects and relationships which, however, are often neglected. Accordingly, mismanaged issues are ready to be pushed into the area of public initiatives and often politicized discontent.

Contemporary Russia provides interesting examples of the politicization of road traffic issues at different levels. One example is the recent attempts of an anti-governmental leader to manage digital claimant initiatives by the creation of the on demand crowd service "RosYama," designed as a platform for complaints about the necessity of road repairs. The goal was to give city inhabitants an instrument for control of urban infrastructure and management [21]. Another case is the creation of "StopXam," a vigilante movement which showed the social polarization of pedestrian-driver relations [22]. When Platon, the new system of vehicle tolls, was imposed, truck drivers launched Anti-Platon, a cross-regional protest campaign that highlighted socio-economic challenges to Russian government [23].

The hybrid nature of current urban traffic problems in Russia is not limited to the certain functional characteristics of urban transport. It requires understanding the broader context of urban and national life, which creates challenges for scholars and management strategists.

On the other hand, this field of research requires not only an interdisciplinary approach and a special research agenda, but also specific methods of data analysis. One example of such analysis paradigm is attribute analysis of geo-tagged images of cities used to characterize the identity of urban spaces [24].

Another line of research develops the conceptual city perception of Kevin Lynch [25] and employs it for advanced analysis of the visual data from commercial services (e.g., Google Street View), photo-sharing websites (e.g., Flickr) or crowd-sourced images to assess such qualities of urban spaces as transport accessibility, safety, preservation of natural environment, etc. [26].

3 Data and Method

The purpose of this article is to determine the problem area of traffic management policy in Russia using digital analysis of visual data. In contrast to urban studies, where the analysis is based on perception of objects and their configurations, our

interest relates to broader understanding of road traffic, including the sources of possible social antagonisms.

In respect to this question we implemented the research perspective formulated by the anthropologist John Tresch, who called it the cosmogram concept. Cosmograms are "external depictions of the elements," between which connections are traced. These elements and their combinations encompass world we live in, no matter what the nature of each element is (whether it is material or ideal) [27]. Another methodology for cosmographical analysis of the social realm is ANT (actor-network theory). It enables the analysis of far-reaching and persistent chains of elements that frame urban transportation as spatial co-relation of events, routine processes, frames of communication and human actions.

Our research on urban traffic governance recognizes that traffic and its elements are the matters of public concern and seeks the means to describe them and identify them as parts of social agenda or political contention.

For such purposes, semantic analysis was applied for web content to create visual narratives and distinguish social and political categories of urban traffic. The visual sociology perspective provides public concerns related to, frames, and perceptions of the key elements of traffic ontology: transportation, drivers, vehicles, traffic issues, etc. Following this principle, we attributed traffic-related objects and human actors to social and political agenda.

The usual challenge of this research optics is linked to sampling and limits of data validity. Our innovative research design makes use of the visual narrative principle where the researcher has to follow visual artefacts in the space of public knowledge. Internet was considered such space, which provides complex interrelated reality, arranged by recent events that attracted public attention, social agenda, and algorithms of search engines.

This paper uses a new source of data, the most popular search engines in Russia (yandex.ru and google.com), to analyze visual representation of the following traffic categories: vehicles, traffic, road users, traffic issues (four key words for web search query for each category). For each category, the sample size was limited to 500 images per one search engine with default browser settings. The defined samples have two time frames: 2014 and 2020. Images from the samples with a particular focus on the road traffic attributes were manually coded one or more times. Images without evident visual attributes were not coded.

4 Results

Table 1 contains data only on selected (24 of 46) attributes that are mentioned further in the text. For this reason, some categories and data with less importance were excluded from the table. Generally, it shows general public awareness and concern of urban traffic in Russia in relation to the following traffic attributes in 2014: government regulation, traffic incident, drivers' gender, drunk drivers, traffic congestion and road rage.

In-depth study has shown that attributes of traffic categories mainly follow social frames of personal risks perception and mobility limitations (car accident, bodily injury, traffic congestion, road rage, privileges of public servants, crime and security experience, driving while intoxicating, environment and weather conditions, car expenditures, engine emissions, bumpy roads). They also provide evidence of social stratification (public transport, shared taxi and cargo vehicles, motorcycles and bicycles, presence of women and children, social inequality) and conflicts (road rage, protest actions), as well as political relations (government regulations, traffic privileges of high-rank officials, protest actions).

The connection between road traffic and government regulation practices is relatively evident in this time period: the images show a large quality of regulation markers (high proportion of images with restrictive traffic signs, traffic control procedures, vehicle impoundment, etc.). There are also references to protest actions and conflicts with state officials, mostly because of traffic privileges for cars of public servants with emergency flashlights.

We defined tree major issue-related attributes of road traffic for year 2014: traffic congestion, road accidents, and road rage (drivers' aggression). First, traffic congestion had high-value connections not only with incidents where cargo vehicles or public transport were involved, but also with the impact of nature (encounters with wild animals, bad weather conditions, natural disasters), construction works that had relation to urban development and the work of the city utility services. Second, road accidents were connected with public transport and cargo vehicles, but also with minibuses (marshrutkas), motorbikes, and cycles. Road accidents also define social and gender inequality. Third, road rage had direct reference to contentious politics. As previously mentioned, they are related to protest actions, government regulations, social inequality, and traffic priorities granted to public servants.

Despite the unifying drive of government regulations and public contention towards them, the cosmogram of Russian road traffic in 2014 could be displayed as a hybrid association of elements with high perceived risks and uncertainty for the drivers and the public in general. These risks were attributed to different types of drivers and vehicles. For example, the analyzed images of marshrutkas, old Soviet- or Russian-manufactured cars typically showed ethnic attribution (labor migrants from Caucasus and Central Asia countries). On the other hand, the analyzed data gave us another interesting evidence on public function of vehicles as markers of social status and power mediators (expensive car = road rage = traffic privilege). For this reason, car expenditures and vehicle types are important factors of drivers' stratification on the road.

A comparison with this year's data shows that public perception of traffic objects and their relations has significantly changed. Most notably, public attention to road situation in general and, in particular, to traffic congestion has increased. This focus on traffic situations and their participants confirms the inefficiency of current regulations or even a crisis in transport planning in many Russian cities, as it shows that traffic congestion is one of the key challenges for road traffic in Russian cities. In this respect, we can define the relationship between bad situation on the road and car accidents, as well as with the problem of driver fatigue. An evaluation of changes in the general data dynamic will show the developments of Russian cultural, social and political perception and interpretation of road traffic.

First, to a large extent, a number of groups were legitimized as road users and traffic participants: motorcyclists, women, and the elderly people. In the public perception, they no longer appear as traffic problems or carry exclusive blame for accidents where they participate.

On the other hand, cyclists are sometimes still assessed as undesirable (problematic) road users, and ethnicity still often as a basis for negative perception (more often in relation to taxi drivers, rather than drivers of marshrutkas).

Second, there is a general decrease in public perception of road traffic as a dangerous activity that carries a threat to its participants, which is well demonstrated by a decrease in attention to such elements as car accidents and road injuries, speed measuring cameras, road rage, and drink- or drug-influenced drivers. The decline in attention to speed cameras is most notable, since their use has traditionally been associated with the need for drivers to have proof of their innocence in a traffic incident before the traffic police.

At the same time, road traffic continues to focus on the problem of road safety for children. At the level of public practices this is associated, for example, with the mass use of stickers proclaiming that there is a "Baby on board." This warning sign has become legitimized among drivers.

Third, the issue of road traffic has largely lost the political context that was previously associated with the issue of road privileges (emergency flashlights) for civil servants, perceived as result of bribes, and gave rise to various protest actions.

At the same time, our data shows notable decrease in public attention towards poor road quality and road construction works, which could be defined as a positive effect of mass urban reconstruction and transport policy in Russian regions.

The growing importance of cargo-carrying processes should be noted separately. Together with other trends, it indicates, in general, a more rational perception of transport and road traffic. In terms of popular traffic culture it may indicate a transition from the paradigm of romantic vehicle ownership to a model of practical vehicle use. The focus on expensive cars (11.6% in 2020) is more of a marketing nature than a social one, given the reduction in social inequality.

Notably, the car remains the tool of personal self-representation and identity, including the political aspect of historical memory, which is recorded in relation to the theme of remembering the Great Patriotic War (1941-1945), promulgated by media campaigns and the popular practice of placing celebration posters as symbols of honor. This visual attribute (≤1% in 2020) was not detected in 2014.

Finally, we can note that the perception of road traffic in Russia largely corresponds to the trends witnessed in developed countries: there is more demand for automotive innovations (car-sharing, electric vehicles, etc.), opportunities for people with disabilities, and environment-friendly traffic.

One other issue, which links developments in Russia to the situation in developed countries, is rather a problem than a benefit: there is increased use of mobile devices by road users, which causes public concerns about safety (using a phone while driving).

Table 1. Selected visible attributes of Russian road traffic: comparison of key traffic categories

Name of the attribute	Vehicles		Road traffic		Road users		Traffic issues		Ratio for all categories	
	2014	2020	2014	2020	2014	2020	2014	2020	2014	2020
Transport regulation, traffic police actions	6.2	2.1	25.1	24.6	38.0	10.4	29.4	31.1	27.2	16.2
Traffic congestion	3.3	5.0	9.2	38.5	0.2	0.0	0.6	20.0	2.6	14.6
Cargo-carrying	30.3	21.1	3.6	0.4	1.5	22.0	8.3	5.4	9.1	12.9
Public transport	21.3	25.9	10.4	2.5	2.1	5.0	6.6	1.6	8.5	10.8
Children	0.0	0.6	11.9	15.7	4.7	9.8	1.7	7.1	4.4	6.9
Traffic incident	1.1	1.2	4.3	3.8	11.2	16.8	9.0	3.6	7.4	5.1
Dashboard camera and traffic surveillance	0.6	0.2	0.6	1.3	2.2	2.1	8.0	7.0	3.3	2.7
Traffic injuries	0.0	0.1	0.0	0.2	4.2	5.1	3.7	2.2	2.5	1.6
Minibus (marshrutka)	2.1	1.9	0.8	0.3	1.5	1.9	2.1	1.2	1.6	1.4
Taxi	1.3	0.5	0.6	0.0	1.1	5.3	0.5	0.9	0.8	1.4
Cycles	2.0	0.8	1.9	0.7	0.3	1.6	0.9	2.1	1.1	1.3
Gender	0.1	0.1	0.2	0.1	4.6	2.1	4.6	3.0	2.9	1.3
Mobile device	0.0	0.2	0.0	0.0	0.5	1.9	0.2	1.0	0.2	0.7
Social inequality	0.0	0.0	0.0	0.2	1.5	0.4	1.8	2.0	1.0	0.7
Motorcycle	1.4	0.6	2.3	0.7	0.7	0.2	2.3	0.8	1.6	0.6
Road rage	0.0	0.0	0.1	0.2	2.5	3.1	0.2	0.0	0.9	0.6
Bumpy road	0.4	0.0	4.7	1.6	0.2	0.0	0.2	0.4	1.1	0.4
Drink- or drug-influenced driver	0.1	0.0	0.1	0.0	7.6	1.8	0.5	0.3	2.7	0.4
State officials' priority	0.5	0.2	0.4	0.5	0.3	0.2	1.5	0.7	0.7	0.4
Protest action	0.0	0.0	0.7	0.2	0.1	0.2	2.6	1.0	0.9	0.4
Elderly people	0.0	0.0	0.1	0.0	1.9	1.0	0.3	0.6	0.7	0.4
Driver fatigue	0.0	0.0	0.0	0.1	0.5	1.6	0.0	0.0	0.2	0.3
Ethnicity	0.0	0.0	0.0	0.1	0.4	1.0	0.2	0.0	0.2	0.2
Crime and security	0.3	0.0	3.9	0.0	1.8	0.0	0.6	0.0	1.6	0.0

Notes: Data are given in percentage terms. Zeroes show that some attributes are irrelevant for specific traffic categories or years.
Sample size: 30000 images. The total number of coded traffic attributes: 15874.

5 Discussion

The research method used for this study is not free from limitations. The main issue is related to data collection, as search engine algorithms are often opaque and require precisely formulated search queries. Moreover, data selection is dependent on news-makers, social agenda, web-optimization of information sources, and web-marketing. On the other hand, public consciousness is also influenced by regular use of multisided communication and the Internet, so it experiences a similar influence of various agendas and media. A solution to this limitation is the use of different data sources depending on specific research task.For further research based on web-sourced images, we intend to include more image attributes and make use of computational analysis. This research method has been tested in recent studies of objects and their compo-

sitions with traced connections, which used visual data analysis for “scenes understanding” [28].

Respectively, key elements of further research plans include: introducing efficient and reliable methods of analysis; a focus on perception as indicator of social transformation in the human-centered perspective; a focus on system cognition that makes it possible to verify attributes of images with software algorithms or manual coding; and development of spatial (country, region, city, place) and issue-specified (description, keywords and tags) data analysis.

As for the technical aspect, our plan includes overcoming the limitation of sample size while preserving the sufficient level of accuracy and quality of image recognition. This technological development will facilitate deeper categorization of the visual content while defining lager number of attributes, powering up algorithm-driven cognitive network analysis.

The analysis of digital data on social issues has some implications for urban management that are related to new opportunities of digital instruments for data mining in general. In addition, it is extremely important to avoid reduction of complexity of urban processes and relations among road traffic elements, in particular to standardized metrics and dashboards that can seem a convenient measuring tool for the purposes of urban management and planning. This is a part of the general challenge of the managerial paradigm of new digital ontology of space, which the researchers of modern management technologies are focused on and often criticize [29].

At the same time, the development of this research area allows not only to assess the dynamics of problem perception in time and place, but also to identify new relevant points of focus of public attention and predict the future agenda (as new elements of cosmogram in the area under research). That point is demonstrated by the data from 2020, where we see the emergence of new elements: car-sharing, attention to people with disabilities, personal electric transport. From this point of view, even in the machine learning model of urban assessment such methodology and framework of analysis allows to understand reality instead of reducing it, because this approach includes post-analysis of the samples, where images are compared and new categories of perception are defined. This technique is important for education and development of the automatic recognition software.

In this logic, regular revision of machine learning algorithms supports and contributes to the development of decision-making processes for regional management in countries with significant territorial differentiation by levels of socio-economic development and socio-cultural dominants in problem agendas.

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Political Communication of Youth in the Internet Space: Effects on Influence on Political Consciousness and Behavior

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Abstract. The main research issue of the report is to assess the nature, direction and intensity of the influence of network political Internet communication and the priority receipt of political information from online sources on the system of ideological values of youth and the characteristics of their political behavior. The report analyzes the data of two mass youth surveys conducted by the authors in 2018 and 2019. The sample size in both studies was 1,000 respondents; quota sample with control of parameters of gender, age, education, region, type of settlement; the method of collecting information was personal standardized interview. Additionally, the research deals with the features of political communication of youth in the Internet. The research was financially supported by the grant of the Russian Foundation for Basic Research No. 18-011-01184 “The Potential of Youth Political Leadership in the Course of Political Socialization and Circulation of the Elites in the Russian Regions in the 2010s (on the example of South-West Siberia and the North-West of the Russian Federation)”, 2018-2020. work was conducted with support of RFBR grant №16-36-60035 “The research of social efficiency of e-participation portals in Russia”.

Keywords: Online Political Communication, Features of political discourse in online communities, Russian youth, Political behavior of youth online and offline, The ideological values of youth

1 Introduction

The thesis about the influence of mass media on the political behavior of citizens since the 1950s is obvious and not in need of confirmation [18; 16]. However, there are issues to clarify in connection with the emergence of new communication channels and a change in the audience of various media both online and offline, as well as political socialization of new generations. Which channels of receiving political information for youth are currently in the highest priority? Which of them have lost their significance? Is there a link between the priority media and mass communication, and specific forms of political behavior? What channels of political information

should political consultants and political technologists pay special attention to in order to try, more or less effectively, to correct the political activity of youth?

The base of the empirical component of the research is a solid and fundamental theoretical platform related to determining the role and place of the youth part of society in the social and political process.Thus, the studies analyzing the political culture of young people [1; 8; 34]; problems of state regulation of youth politics [10; 35]; existence and orientation of social ties among young people [14; 29]; interaction of different youth cultures and subcultures [22]; youth electoral intents [20]; features of its political behavior [31]; youth leadership [3; 13; 27] as well as the latest works on the features of political mobilization through the Internet [19; 26; 32; 30] allow to conclude on the effectiveness of using the proposed tools with the construction of appropriate conjugation tables for conclusions on the peculiarities of assessing the future of young people. Especially since these conclusions, in our opinion, are possible to extrapolate to Russia as a whole, as the study took place in different both in urban and rural areas of the Russian Federation.

The change and formation of the most diverse forms of political behavior and political activity of citizens due to the constant development of the institution of the state as such, and, ultimately, the constant formation of subjectivity and independence of society; more rationalization of the political process and the growing importance of legitimizing the political system through political participation are points to remember. The traditional forms of political behavior include electoral activity; participation in political campaigns; conventional interaction with state authorities and local self-government; various political organizations, and personal contacts with various actors; participation in legal actions, etc. Herein, the traditional set of various forms of political behavior closely relates to the sociocultural context and characteristics of the political regime in a particular society, a specific space and time.

The transition from traditional forms of activity to new forms of "direct" participation [7], related, among other things, to self-identification and political consciousness must be considered exactly in this context. This determines the choice of representatives of young people playing a significant role in changing socio-political processes, both as a subject and as an object of management as the object of research.

From a practical point of view, the study of sustainability, as well as the dynamics of the models of political behavior of Russian youth, including the Internet space, should provide additional opportunities for more efficient prediction of the degree of political activity and analysis of the laws of political behavior of youth.

The theory of political activity (political communication is undoubtedly a part of such activity) of citizens belongs to the category of traditional issues in the social sciences all over the world.

2 Literature review

Political scientists, political psychologists, and political sociologists last few decades have actively studied the characteristics of political behavior, fixing the diversity of forms of political actions, their intensity and frequency.

Among the latest research on the topic: the coverage of global leadership in a communication context [21; 24]; a fundamental comparison of models of youth political leadership emerging in various types of societies [1; 6; 17]; and states with different political regimes [12], as well as in the face of serious world crises, one of which is happening right before our eyes [11; 23]. Also there is a discussion around the need to modify typologies of political behavior in the context of the new reality of online communication and the intensification of political processes [9; 5; 13; 15]; the growth of society's demand for effective management system with considering the specifics of subjects and management objects [33], and power institutions on political innovation.

Scientists discuss an objective request to study motivation of youth to participate in public and political projects in leadership positions, as well as the principles of organizing work within youth movements and organizations [3; 28]. The issue of cooptation technologies for youth from among civil activists and people with high rates of political participation remains relevant [2; 4].

Summarizing a brief review of research on the topic, the youth consciousness, in the framework of manifesting its political behavior in various forms, is quite structured and classified. This allows to proceed to the empirical part of the study, relying on a combination of systems and integrated approaches, hence realizing the main objective of the study, consisting not only in clarifying the questions of the beginning of the article, but in classifying the main mechanisms of youth political communication. Such a classification can be used in both academic and practical activities, adjusting accordingly regional and federal youth policy.

At the same time, in order to obtain the clearest picture of the importance of Internet sources for the formation of political behavior of young people, first, we will focus on information about the nature of the use of the Internet. Materials of the research project "Prospects of educational model of free arts and sciences in the light of economic and sociocultural trends of the XXI century in the Russian context" (2018, All-Russian study of youth, sample size of 1530 students of all stages of education; Research carried out by scientists of SPbSU, project manager D. I. Raskin) give detailed information about the nature of behavior of student youth of Russia in the Internet space.

The priority in using the Internet by students is finding information and communicating online. Daily 93% of students use Internet resources to find information, read news, 3.2% do it 4-5 days a week. Communication in social networks takes place daily in 88.6%, 4-5 days a week - in 4.6% of students. The messengers daily use 79.9% of students, 4-5 days a week - 5.5%. Noteworthy is the search for information from young people directly using electronic versions of books and articles not connected. Daily 42.7% of students access Internet resources for reading books, 25.4% do so every 4-5 days a week, 14.3% - 2-3 days a week. Every day 40.6% of students use Internet resources to watch films, 17.6% - 4-5 days a week, 15.9% - 2-3 days a week.

Students deliberately walk away from answering a question about attitudes to Internet games. About 46% avoided the answer, saying that they could not assess the periodicity of their own game online; just under 5% simply refused to answer this

question. About 26% said they do no more than once a month and only about 13% admitted playing Internet games daily or 4-5 days a week. We have no reason to believe that for employed, self-employed or unemployed youth, the time resource coincides with the indicators of student youth in terms of reading books (it is slightly lower) and playing online (students tend to consider this time to be discrediting them). In any case, online communication for all groups of young people is extremely significant and takes a significant resource of time.

3 Research design

The report analyzes the data of two mass youth surveys conducted by the authors in 2018 and 2019. The sample size in both studies was 1,000 respondents; quota sample with control of parameters of gender, age, education, region, type of settlement; the method of collecting information was personal standardized interview. Moreover, the features of political communication of youth in the Internet were analyzed. The studies were conducted and the report was prepared as part of the implementation of the RFBR grant, predicted the potential of youth political leadership (on the example of South-West Siberia and the North-West of the Russian Federation in 2018–2020).

A study of young people in four Russian regions (Altay Territory, Leningrad and Novosibirsk Regions, St. Petersburg) in 2018 and 2019 showed that only 2.3% of residents between the ages of 14 and 30 do not use any sources to obtain political information. Almost 98% receive this information. In many cases, it is not a question of purposeful search for political news, as the information policy of the media online and offline, interpersonal communication turn a person sometimes simply into a recipient of the information stream.

4 Findings

As part of the data analysis, the variables related to the main types of information sources involved by youth, the degree of interest in these sources, the experience of conventional and non-conventional policies, as well as the index of youth political activity were the subjects of analysis. Together with the simple distribution and construction of contingency tables, we use elements of factor analysis and analysis of standardized residues, which, in our opinion, together allow to draw quite reasonable and valid conclusions.

As the table. 1 data show, the leaders in bringing political information to young people are information Internet resources, news feeds, videos, etc. and social networks and instant messengers. At the same time, more than half of young people (51%) use all forms of online sources to receive political news, 19.3% use only Internet information resources, news feeds, videos, etc., 17.4% use only social networks and instant messengers; 12.3% of youth do not use these resources at all.

Table 1. Sources of political information for Russian youth (%) of Internet usage by respondents, %

Types of sources	2018	2019
Social networks, instant messengers	68,3	70,7
Internet inform. resources, news feeds, videos, etc.	70,3	65,9
Friends, acquaintances	41,4	45,2
Central television	42,0	39,6
Relatives	27,0	33,6
Regional / local television	17,2	17,0
Radio	10,6	12,5
Scientific literature	8,4	7,4
Regional and local newspapers	4,9	6,7
Central newspapers	4,4	4,5
Party literature, campaign materials	3,1	2,7
Other	1,6	1,6

Compared to the results of 2018, the distribution data for 2019 show that such sources of information as social networks and instant messengers (growth by 2.4%), physical environment (friends and acquaintances (+ 3.8%), and also relatives (+6.6)), radio (+ 1.9%), traditional print media (regional and local newspapers (+ 1.8%), as well as the central press (+ 0.1%) have increased; and vice versa, young people began to use such sources as information Internet resources (drop by 4.4%), television (central (–2.4%) and local (–0.2%), scientific literature (–1.0%) as well as party published I and propaganda materials (-0.4%) less.

The gender factor does not affect the priority of sources of political information; some differences in other socio-demographic characteristics are recorded. Young people from 18 to 21 with incomplete higher education, 1st – 3rd year university students, and residents of megacities are inclined to use all the options for obtaining political information online more than others obtain. The youngest people from 14 to 17, school students, people with incomplete secondary and primary vocational education prefer to use for these purposes only social networks and instant messengers. People officially employed from 26 to 30 largely focus only on Internet resources, news feeds, videos, etc. Young people from 26 to 30 with secondary vocational education, working informally, with a monthly income for each family member up to 10,000 rubles, residents of the countryside show a great tendency not to use online resources to get political information at all.

The status self-esteem of people with various types of obtaining political information online is quite interesting. Respondents who consider themselves to the upper layer prefer to obtain it only in networks and instant messengers; those of an intermediate layer tend not to use online resources for this purpose at all; people referring themselves to the layer between the middle and lower, use all types of online sources to receive political news.

Young people using all forms of online sources for receiving political news tend to rate their interest in political events in the world as quite high, and in political events

Russia as very high. Citizens under 30, using only social networks and instant messengers to receive political news, tend to rate their interest in world events and political processes in their country as quite low. Fundamental differences in the level of interest in political events in their region and place of their residence, depending on the priority method of obtaining information, have not been identified. In all cases, people who are not interested in politics are not inclined to use any channels for obtaining information on this subject from the online space.

The thesis of the "party of television" and "party of the Internet" is fully justified in relation to youth. Those who do not use online resources to obtain political information at all tend to watch federal television channels (53.6% of the group; the statistically significant standardized balance is +2.0) or listen to the radio (16.8% of the group; the statistically significant standardized balance is +2.2).

Young people who use all forms of online political information sources are more inclined than other groups to read non-fiction (12.8% of the group; the statistically significant standardized balance is +3.4) and communicate on political topics with friends and acquaintances (52% of the group; the statistically significant standardized balance is +3.7) on these topics. This group is more skeptical about the prospects for changing the quality of life (21.3% of the group; the statistically significant standardized balance is +2.1).

Table 2. Grouped sources of political information (2018 data, factor analysis results)

Variables	Component		
Party literature, campaign materials	1	2	3
Regional and local newspapers	0,672		
Central newspapers	0,670	0,325	
Scientific Literature	0,664		
Central Television	0,504		0,345
Regional / local television		0,751	
Radio		0,665	
Inform. Int. Resour., New tapes, videos, etc.		0,445	
Friends, acquaintances		–0,373	0,355
Relatives			0,773
Social networks, instant messengers			0,700
			0,509

The explanatory ability of the calculated model of factor analysis of sources for political information for young people with a high level of political activity is 70.71%. Because of factor analysis, including all the sources of information on politics used by young people (Table 2), three factors were formed.

Factor 1 "Printed Products" combined party literature, campaign materials, regional and local newspapers, central newspapers, non-fiction.

Factor 2 "Traditional channels of television and radio information" has recorded the delimitation of traditional non-print media and Internet information resources.

Factor 3 “Online Personal Communication Circle” has included communication in social networks of not only friends and acquaintances, but also relatives. Although the analysis showed that this youth group with high rates of involvement in political activity uses all sources of political information, the traditional media and communication with relatives have the greatest impact. The political mobilization of young people is easier under the influence of network communication with friends and political advertising materials than under the influence of scientific analytical materials printed in the traditional way or obtained from virtual space.

Contrary to popular beliefs in social circles, social networks, instant messengers, and Internet channels in general have less mobilization ability to form a stable model of active political behavior. They work well to mobilize young people for one-time “high-profile” actions, but in the end, they are inferior to more traditional sources of information.

The analysis of the level of youth’s interest in world and Russian political events, depending on the preference of various types of online sources is also of considerable interest.

Table 3. The level of youth interest in world political events of users of various types of online sources (2018, % by column)

Degree of interest	Doesn’t use resources online for political information at all	Uses only Internet sites to receive political news	Uses only social networks and instant messengers to receive political news	Uses all forms of online sources to receive political news	Total
Very interested	11,2	15,8	7,4 –2,2	15,1	13,4
I’m rather interested in	21,6 -3,5	41,3	38,6	48,7 +2,3	42,2
Rather, not interested	24,8	27,0	35,2 +1,8	26,5	27,9
Not interested at all	27,2 +5,1	11,7	14,8	6,8 -3,2	11,6
Difficult to answer	15,2 +5,3	4,1	4,0	2,9 –2,0	4,8
Total	100,0	100,0	100,0	100,0	100,0

From the presented data (Tables 3 and 4) it can be seen that in the question of correlation of the level of youth interest in political events in the world and in Russia, and the types of various online sources, the following results can be recorded. There is a direct connection between the manifested sufficient interest in world events and the substantial interest in Russian events, and the declaration of the use of all forms of online sources to receive political news (the statistically significant standardized balances are +2.3 and +1.9, respectively), as well as a manifestation of weak interest in

policy and use only social networks and instant messengers (the statistically significant standardized balances are +1.8 and +3.1, respectively).
A high correlation between ignoring world political events and the declaration of non-use of online resources for obtaining political information (the statistically significant standardized balances are +5.1 and +6.1, respectively), and the presence of negative feedback in intuitive cases is self-evident. Finally, data on the political practices of youth with various priority sources for obtaining political information online is of particular interest.

Table 4. The level of youth interest in Russian political events of users of various types of online sources (2018, % by column)

Degree of interest	Doesn't use resources online for political information at all	Uses only Internet sites to receive political news	Uses only social networks and instant messengers to receive political news	Uses all forms of online sources to receive political news	Total
Very interested	12,8 -2,3	24,0	17,0 -1,6	26,7 +1,9	22,8
I'm rather interested in	40,8	48,0	45,5	51,3	48,3
Rather, not interested	16,0	19,4	27,3 +3,1	13,9 -2,0	17,6
Not interested at all	23,2 +6,1	7,1	7,4	4,6 -2,6	7,9
Difficult to answer	7,2 +2,3	1,5	2,8	3,5	3,5
Total	100,0	100,0	100,0	100,0	100,0

We see that the level of political involvement of Russian citizens under 30 who receive political information online is higher than those who do not use virtual space for these purposes (Table 5). The only exception is participation in the elections. Over the past 2-3 years, 35.9% of all youth voted in the elections, including 44% who do not use the Internet as a source of political information, as well as 36% of young people who use all the information capabilities of the online space.

Because of the grouping of the data of the 2019 study (Table 6), four youth groups were identified that differ in the degree of potential and actual political activity. Potential political activity is absent in 14.7% of young people, low – in 44.5%, medium – in 29%, high – in 11.8%. Realized political activity is absent in 34.6% of youth, low – in 55.5%, medium – in 7.8%, high – in 2.1%. Thus, there is a high indicator of the unrealized political activity of young people, as well as a low indicator of the number of those who are actively involved in the political life of our state (the political activity of only one in ten can be estimated as medium or high).

Table 5. Political practices of youth with various priority sources for obtaining political information online (2018, % of the group, the second digit in the cell is the value of a statistically significant standardized balance) various types of online sources (2018, % by column)

The experience of political actions in the last 2-3 years	Doesn't use online resources at all	Uses only Internet sites	Uses only social networks and instant messengers	Uses all forms of online sources	Total Sample
Participated in the elections	44,0	36,2	29,5	36,0	35,9
Appealed to government bodies	16,0	21,9	15,3	22,2	20,2
Discussed politics on social networks, reposted political information	6,4 –2,6	13,8	6,8 –3,0	21,7 +3,4	15,7
Participated in strikes, rallies, demonstrations	7,2	8,7	3,4 –2,6	12,2 +2,1	9,4
Participated in the work of public organizations	4,8	4,1 –2,0	6,3	11,4 +2,5	8,3
Appealed to public organizations	7,2	5,6	4,0 –1,6	8,7	7,1
Participated in the work of political parties	3,2	2,0 –1,7	0,0 –2,9	7,5 +3,1	4,6
Participated in unauthorized protests	2,4	3,1	2,3	6,2 +1,9	4,4
Materially supported politicians, their projects	0,0	1,5	0,6	2,9 +1,7	1,9

Table 6. Potential and real political activity of Russian youth (2019, %, vertical)

Number of forms of political behavior	Potential political activity	Real political activity	Level of political activity	Potential political activity	Real political activity
0	14,7	34,6	none	14,7	34,6
1	22,5	35,5	low	44,5	55,5
2	22,0	20,0			
3	18,0	5,4	average	29,0	7,8
4	11,0	2,4			
5	5,1	1,5	high	11,8	2,1
6	3,5	0,3			
7	1,4	0,1			
8	0,8	0,2			
9	1,0	0,0			
Total	100,0	100,0	Total	100,0	100,0

Table 7. Joint occurrence of youth participation in various types of political activity in the last 2-3 years (2019, statistically significant standardized residuals)

Political activities	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Appealed to government bodies	+6,1	+2,4	+2,8	+4,3	+2,7			
Appealed to public organizations		+2,6	+1,6	+4,9	+8,6		+4,9	
Participated in authorized strikes, rallies, demonstrations				+6,0	+4,3	+8,1	+5,8	+3,9
Participated in the elections				+3,2	+2,1			
Participated in the work of political parties					+6,1	+2,8	+4,1	
Participated in the work of public organizations							+3,7	+2,2
Participated in unauthorized protests							+4,2	+2,2
Materially supported politicians, their projects								+1,7

Legend of Tables 7: (1) Addressed public organizations; (2) Participated in authorized strikes, rallies, demonstrations; (3) Participated in elections; (4) Participated in the work of political parties; (5) Participated in public organizations; (6) Participated in unauthorized protests; (7) Material support for politicians, their projects; (8) Discussed politics on social networks, reposted political information.

The Table. 7 presents statistically significant standardized residuals that fix the presence of stable indicators of the joint occurrence of various forms of political behavior. Usually, voters, as well as young people applying to government bodies, usually participate in unauthorized protests, financially help politicians and support their projects, discuss political events on social networks and repost political information not quite systematically, but rather spontaneously and situationally. Practicing the same way in public organizations has the only difference: they tend to financially support the projects of politicians and respond to various fundraising campaigns. For youth representatives participating in the elections, participation in authorized strikes, rallies and demonstrations is situational. A similar situational behavior is characteristic of youth representatives working in public organizations regarding participation in unauthorized protests, and for workers in political parties - regarding political activity on social networks. Absence of negative relationship between the forms of political behavior is important to note.

We see that the level of real political activity of gender groups in the youth environment is not different. At the same time, among young people who do not take part in political life, as expected, people under 18 with primary and incomplete secondary education, school and college students (technical schools, colleges) predominate (statistically significant standardized balances are + 5.2, +5.7, +4.9, +1.8, respectively); among people with low political activity – young people 26 to 30, as well as university students (the statistically significant standardized balances are +1.7, +1.7, respectively), with average political activity – higher education holders, officially employed (working with registration under the contract and entering data into the workbook), as

well as owners of monthly incomes up to 10,000 rubles per family member, subjectively referring to the intermediate between the middle and lower social stratum or directly to the lower layer (the statistically significant standardized balance are +2.7 , +2.2, + 2.1, +1.9, +1.8, +1.9).

The special socio-demographic profile of young people with a high degree of political activity is poorly visible, but among them there is a higher proportion of officially employed young people; in addition, young people from the Novosibirsk region are more involved in politics among the surveyed regions (senior balances are +2.9, +2.1, respectively). It is important that, contrary to popular beliefs, there were no significant differences in the political activity of young people living in different types of settlements, with the only exception: in small cities, young people are slightly more inclined to show a low level of involvement in political life (the statistically significant standardized balance is +1.6).

5 Conclusions

The data presented in the article, in our opinion, correspond to an understanding of the close interconnection of forms of political participation, sources and degree of interest in political information and political behavior as a condition for a significant impact of participation on real political processes of such an important social group of any society as youth. There are undoubted different points of view on the degree of significance of this social group for people who directly make decisions at a particular moment in the development of society, and, moreover, in the face of heterogeneous social and political conditions in such a complex country as the Russian Federation, it is quite problematic to extrapolate the data to the entire public space of our country. Nevertheless, we argue that the conclusions presented below are not only a case for describing the situation in four specific regions, but can be used and involved in making decisions on adjusting youth policy nationwide.

In the course of the research, we present the following conclusions: (1) The most popular sources of political information for young people are Internet information resources, news feeds, social networks and instant messengers; (2) There is a tendency to increase the popularity of information sources such as social networks and instant messengers, the physical environment (friends and acquaintances, as well as relatives), radio and traditional print media; (3) Gender does not affect the priority of sources of political information. More than others tend to use almost all options for obtaining political information online young people between the ages of 18 and 21 with unfinished higher education, students of 1-3 courses of universities, residents of megacities. Only social networks and messengers prefer to use the youngest people between the ages of 14 and 17, school pupils, people with incomplete secondary and primary vocational education. They focus only on information Internet resources, news feeds, videos, etc., to a greater extent, people between the ages of 26 and 30 who are officially employed; (4) Respondents who consider themselves to the upper social layer prefer to receive political information only in networks and instant messengers. Those who relate themselves as an intermediate layer between the upper

and middle layers tend not to use online resources for this purpose at all; and those referring to the layer between the middle and lower use all types of online sources to receive political news; (5) The thesis of the "TV party" and "Internet party" in relation to youth is relevant. Those who do not use online resources to obtain political information at all tend to watch federal television channels or listen to the radio; (6) The political mobilization of youth occurs under the influence of network communication with friends and advertising political materials easier than under the influence of scientific analytical materials presented in a traditional way or obtained from virtual space; (7) The political mobilization of young people is under influence by online communication with friends and promotional political materials more than by scientific analytical materials presented in the traditional way or obtained from virtual space; (8) At the same time, contrary to popular beliefs in scientific and journalistic circles, social networks, instant messengers, and Internet channels in general have less mobilization ability to form a stable model of active political behavior. They work well to mobilize young people for one-time "high-profile" actions, but in the end, they are inferior to more traditional sources of information; (9) There is a direct connection between the manifested sufficient interest to world events and the substantial interest to Russian events and the declaration of the use of all forms of online sources to receive political news, as well as the manifestation of a weak interest in politics and the use of only social networks and instant messengers. High correlation between ignoring world political events and a declaration of non-use of online resources for obtaining political information, and the presence of negative feedback in intuitive cases are self-evident; (10) The level of political involvement of Russian citizens under 30 who obtain political information online is higher than those who do not use virtual space for this purpose. The only exception is participation in the elections; (11) We identified four groups of youth that differ in the degree of potential and actual political activity, from the absence to the highest degree; (12) The presence of stable indicators of the joint occurrence of various forms of political behavior. Usually, voters, as well as young people applying to government bodies, participate in unauthorized protests, financially help politicians and support their projects, discuss political events on social networks and repost political information not quite systematically, but rather spontaneous and situational. Those who turn to social organizations behave almost the same way, the only difference is their financial support the projects of politicians and response to various types of fundraising campaigns. For youth representatives participating in the elections, participation in authorized strikes, rallies and demonstrations is situational. A similar situational behavior is characteristic for youth representatives working in public organizations regarding participation in unauthorized protests, and for workers in political parties regarding political activity on social networks; (13) The level of real political activity of gender groups in the youth environment does not differ. Among young people who do not take part in political life, as one would expect, people under 18 with primary and incomplete secondary education, school and college students (technical schools, schools) predominate. Among people with low political activity – young people from 26 to 30, as well as university students; with average political activity – holders of higher education, officially employed (officially working with registration), as well as owners of monthly incomes of up to 10,000

rubles per family member, subjectively referring themselves to the intermediate between the middle and lower social strata or directly to the lower layer; (14) The special socio-demographic profile of youth with a high degree of political activity is poorly visible, but among them, there is a higher proportion of officially employed young people; in addition, young people from the Novosibirsk region among the surveyed regions are more involved in politics. It is important that, contrary to popular beliefs, there were no significant differences in the political activity of youth living in different types of settlements, with the only exception: in small cities, youth are slightly more inclined to demonstrate a low level of involvement in political life.

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The Development of Russian Youth Digital Citizenship: How to Analyze and Tackle the Internet Communication Risks

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Abstract. The paper is focused on the communication safety of children and young people in the social media space as a condition of Youth digital citizenship development. The authors presents the results of an intellectual search for the analysis of the most common risks of Internet communication faced by Russian children, or teachers and counselors working with children. The research design includes discourse-analysis of the social media posts reflecting the most relevant Internet risks, automated social media analysis with the special tool – software for new media monitoring (IQBuzz) and eye-tracking for destructive online content neurovisual reaction measuring (kind of neurovisual modeling of the Internet-content perception). The article covers the algorithm of tackling the Internet risks: 1) defining of the Internet risks markers; 2) identifying of the Internet risks triggers; 3) developing of recommendations for teachers and counselors to minimize Internet risks for children and young people. The prospect of the research could be the social graph analysis oriented to the identification of the destructive online group connections' density, destructive opinion leaders' techniques and features of the asocial users" activities. The final product is the measures to maximize the opportunities that open up in the digital environment for Youth: social project activities, civic activism, and digital democracy.

Keywords: First Keyword, Digital Citizenship, Youth, Teenagers, Social Media, Social Media Monitoring, Internet Communication Risks, Digital Markers of Internet Risks, Internet Risks Triggers, Neurovisual Techniques to Counter Destructive Network Communities.

1 Introduction

Russia, like most countries with national Internet audiences exceeding two thirds of the total population, links further social, economic and political development with digitalization. The country has grown a new generation of "digital citizens" who have reached adulthood, the socialization of which was carried out including through Internet communication. At the same time, Internet risks faced by Russian children, adolescents and youth are a significant obstacle to the development of a culture of digital

citizenship. In Russia, there is still no educational program aimed at creating a culture of "digital citizenship", approved at the state level.

According to the founder of the concept of digital citizenship, K. Mossberger, this definition is understood as the ability of individuals to participate in society, to fulfill their civic responsibilities in the course of network communication [8]. In the framework of the concept of digital citizenship, a number of authors focused on methodological issues of preparing and adapting citizens to life in a digital environment. For example, M. Ribble defines digital citizenship as the norm for appropriate, responsible behavior regarding the use of technology [10]. He offers an authoring methodology for teaching digital citizenship in order to help students become productive and responsible users of digital technologies. In turn, L. Jones and C. Mitchell emphasize educational technologies for achieving the quality state of digital citizenship of youth [3]. K. Mattson focuses on the beneficial aspects of digital youth citizenship programs [6]. Researchers such as W. Bennett, C Wells and A. Rank explore the possibilities of civic education in online and offline environments [1]. D. Ohler proposes to redefine the roles of citizens in the modern globally connected infosphere and proposes the adoption of a comprehensive “roadmap” for moving towards citizenship in the 21st century based on demanded digital competencies [9].

The problem of Internet communication risks impact on the children and young people socialization begins to draw the researcher’s attention. It should be recognized that foreign researchers slightly earlier than in Russia began to study it. The impact of online risks on children, protection from them and prevention is considered by John Brown [3] The research of European scientists in the field of Internet safety of young media users within the framework of the pan-European project "EU Kids Online" and the national project "British Children on the Internet" (UK Children Go Online) under Professor S. Livingstone [5]. For example, the study found that users with higher levels of digital competence face more online risks than their less convergent peers Studies of cyberbullying by R.M. Kowalski [4] are quite influential, which provide a methodology for measuring this Internet risk and measures to prevent it. Important for this work are T. Milosevic 's research [7] on studying the actions of social networks, including Facebook, Twitter, Snapchat and Instagram, to overcome the problem of cyber intimidation by young users. Pamela Whitby 's work [11] informs parents what their child will face online. This practical guide shows that children can be protected from the dangers of the Internet, from the risks of chat and games with family rules.

2 Research methodology

The methodology of social-media flows analysis presenting digital markers of Internet risks data for schoolchildren involved implementation of the following research procedures algorithm:

1. Justification of groups’ selection in social media as objects of qualitative analysis of message content. The logic of the applied target selection is in the formation of a selective set of online communities containing dialogues of participants about Internet risks. Research cases were made by such risky situations as cyberbullying, school

shooting, and suicide pushing. For each of these risk types, 20 online communities have been selected, and 1800 documents have been analyzed. The result of understanding the content perception of relevant social-media groups was a dictionary of digital markers - requests for automated accumulation of relevant information flows.

2. Discourse analysis of unloaded social-media messages of the primary amount, used to refine search queries and compile final dictionaries of search queries. To identify the "purity" (relevance) of messages accumulated in the preliminary array, a systematic sample was used (step - 10), a total of 1500 messages were analyzed (500 in each of the three arrays).

3. Automated upload of Internet content using created marker dictionaries and online service for monitoring social media IQBuzz, a total of 953,000 messages have been uploaded (together for all types of streams about Internet risks), depth of accumulation 2016 - 2018.

4. Quantitative and qualitative analysis of downloaded Internet content was carried out using automatically generated statistical reports on technological, content and dynamic characteristics of information flows. The interpretation was performed according to the criteria specified by the program:

- Weight of information flows;
- Dynamics of information flows;
- Tag clouds - semantic core of information flows;
- Publication activity and user audience of opinion leaders;
- Distribution of information streams by gender and age of the user audience.

3 Research results

Cyberbullying/Harassment on the Internet. Cyberbullying is understood by the authors as a systematic and targeted negative online impact on the social and media user for the purpose of causing psychological trauma and/or introducing depression.

Markers - the basis for selecting accounts as units of analysis for the research case "cyberbullying":

- a small number of friends on social media;
- discriminatory Internet content on friends pages;
- the prevalence of negative comments on the posted information;
- when discussing events/actions - transition to personality assessment;
- labelling and the use of insults;
- personality depreciation/reduction to any disadvantage.

In the course of information flows unloading implementation where digital markers of cyberbullying were reflected, the following search queries were used: (sample of the digital markers, translated to the English): "bulling&in&school", “cyberbulling”, "victim&bulling", "harm&in&school" “teacher& bulling”, "Internet&bulling"[1].

[1] Original markers in Russian: "буллинг&в&школе", "школьная&травля" "школьный&буллинг", “кибербуллинг”, "жертва&буллинга", “жертва&буллинг "унижение&в&школе" "коллективная&травля" учитель& буллинг”, “учитель&травля”, "групповая&травля" "интернет&травля" "оскорбления*{1}школ%", "оскорбле-

Total number of social-media documents accumulated according to these digital markers - 280,000, source of unloading - blogochosting "Vkontakte," depth of unloading - period from 1.01.2017 to 10 October 2018.

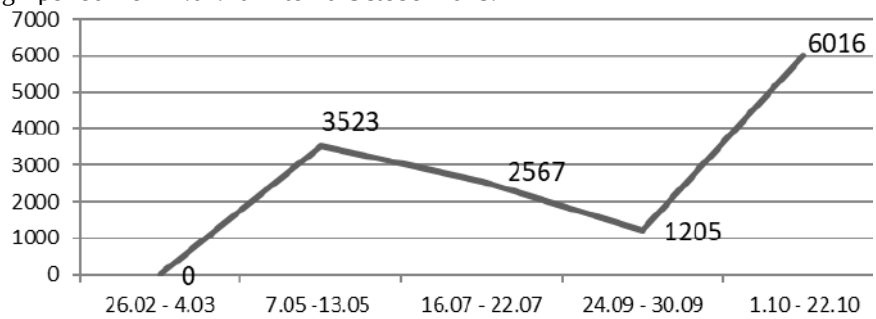

Fig. 1. Dynamics of information flows on cyberbullying in social media in the period from 26 Febr. 2018 to 22 Oct. 2018

The dynamic characteristics of the resulting arrays of relevant documents are shown in Figure 1. According to these data, a remarkable intensification of the analyzed flow occurred at the end of February - the beginning of March 2018, and the maximum extremum is at the end of September 2018. These peaks have substantial intersections with offline events concerning cyberbullying. At the beginning of this spring there was an active discussion in traditional and new media of the intensive growth of network groups with a destructive focus: pushing to harm health and life, immoral and criminal social actions. It was during this period that the number of reports attempting to make sense of the factors, causes, triggers of cyberbullying, and ways to prevent and counter this type of Internet risk increased dramatically. At the end of September 2018, the surge in reports of cyberbullying could be explained by the indirect impact of the Kerch tragedy, which significantly affected social media content, including information flows about cyberbullying.

The gender ratio of the identified authors of the uploaded social and media documents indicates the de facto parity representation of masculine and famine groups among the user audience of the cyberbullying streams (see Figure 2).

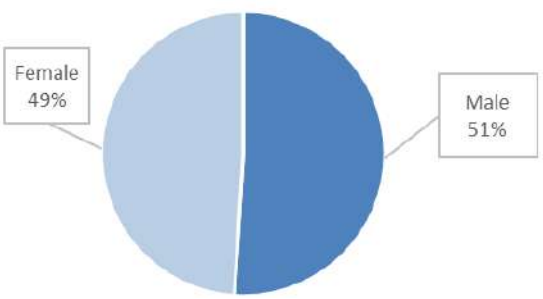

Fig. 2. Gender distribution of cyberbullying reports authors

ния*{1}одноклассн%", (травля|травить)&-(соба%|хим%|орган%), "дразнят&в&школе", "обзывают &в&школе"[In Rus.].

This shows the de facto equal chances of young people and girls, men and women becoming victims of cyberbullying or meeting the problem indirectly through family members. The age ratio of documents authors, which reflect the problems of cyberbullying, generally repeats the contours of the most active audience of social media: users between the ages of 26 and 35 most actively publish documents on cyberbullying, also rather widely represented in this audience people aged 36-45 years (see Figure 3). These two age groups obviously represent a commonality of parents concerned about the risks of cyberbullying to which their children are exposed. A rather small proportion of users aged 15 and under in the analyzed audience can be explained by the fact that registration of accounts in social media is possible only from the age of 14. Young people as young as 16- 25 are also quite heavily represented in the structure of the user audience of streams about cyberbullying, which indicates harassment in the network as a problem typical for both teenagers and youth age group.

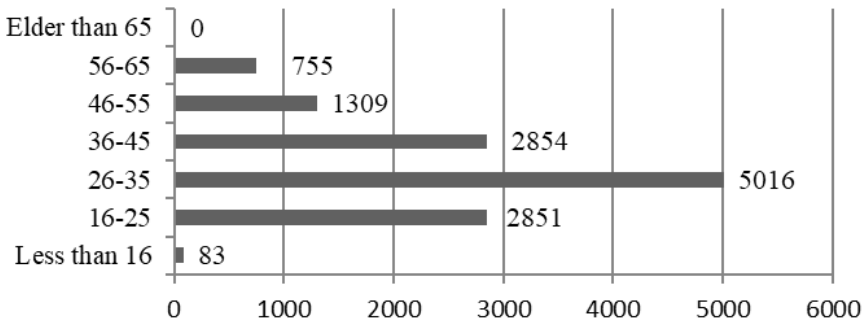

Fig. 3. Age characteristics of the stream audience about cyberbullying, in absolute value

On the one hand, the digital environment becomes a space of harassment, moral damage and mental damage, while the social and media space provides opportunities to express the reaction of victims of cyberbullying, as well as to find like-minded and sympathizers.

There is a complex correlation between the emergence of depression in adolescents and young people, threatening suicide attempts and involvement in communication through social media. This connection is expressed in the fact that depressive states did not end in suicidal actions most often in those members of the younger generation who had the opportunity to be constantly online, and, on the contrary, removal from communication in the network as a whole more often caused installation for suicide [1], [2], [9].

Pushing for suicidal behavior.

Pushing for suicidal behavior in a network environment as a research case was interpreted as a targeted psychological influence on the user in order to form a behavioral setting on committing suicide.

Markers - the basis for selecting accounts as units of analysis for the research case "pushing for suicidal behavior":

- intense and prolonged harassment/exclusion of the account author;

- involvement of the account author in online communities presenting suicide as a form of game/quest;

- involvement of the account author in online communities presenting suicide as freedom/adulthood/choice;

- posting suicidal content on the account.

The unloading of the social and media stream presenting the digital markers of suicidal behavior was carried out using the following search queries: (sample of the digital markers, translated to the English: «Death| (Siniy Kit)| #makesuicide | @kill yourself || funeral| | {heaven & hell &inferno}2.

By means of the listed digital markers 102 802 messages of their blog hosting site VKontakte from March 1, 2016 till November 1, 2018 were accumulated.

The tags were divided into several semantic groups. The first group includes words such as "Post," Original, "Text." It is the most numerically represented group of tags, indicating the perception of suicide reports as unique documents popular in the environment of social media posts and meaning "Farewell Post" (suicide note) and "The Original Way to Leave Life." The second group of tags contains the words: "New," Life, "Live," Want, "Good," House. " This pool of word usage is semantically close to such logic: "Suicide is the beginning of a new, good life, it will give a new, good house." The third group is tags that combine words that indicate a clear order of action (instruction group): "Place," Need, "Make." Thus, the whole sequence of tags fits into the scheme: "The original way to leave life, which will provide a new, good life and find a new and good house."

Analysis of the names of influential blogs and online groups reflecting conversations about suicide shows that the most numerically voluminous audience has a block of priest Vladislav providing spiritual assistance in difficult life situations. The remaining groups have from hundred to four hundred among their user audience. Group names are entirely based on the names of their creators and do not carry a serious semantic load. These groups are not so-called "death groups" that stimulate and encourage adolescents to commit suicide. Real "death groups" - closed communities, accounting and unloading of messages of which online service for monitoring social media does not carry out.

The socio-demographic analysis of the suicide reports authors indicates the prevalence of girls among them, users aged 15-17 and most often residents of large cities.

The dynamics of the social and media flow about suicide, presented in Figure 4, shows that this flow is unstable, has many peaks of different intensity and falls to virtually zero. Most of the relevant messages are recorded in the blogochosting "VKontakte." The peak in March 2016 is due to a case that took control of the Civic Commission on Human Rights: "On March 23, 2016, the Civil Commission on Hu-

[2] «Смерть| (синий кит)| #уходиизмира | самоубийство| (покидая мир)| death | смерть| выход| #откобэйниться| выпилиться| умереть| сдохнуть| @килл | 200| двухсотка| @килла| #kill | похороны| отпевать| отпевка| самоубийства| покинуть| прыжок| @лобби| (улететь в лобби) | отчакрыжиться| Подохнуть| {рай & ад, 3}| #чистилище| прощание | @пз (предсмертная записка) |Ня пока (ня.пока либо #няпока); Самовыпил (самовыпилиться); f57; вскрыться #депра #жизнелюб #суи #су #СУ #с/у #сушник #фен» [In Rus.].

man Rights was approached by Andrei Vershinov from the city of Arzamas, who reported that on March 10, 2016 his aunt Elena Vershinova (both names changed) committed suicide allegedly after having taken an antidepressant on the appointment of a psychiatrist" (http://www.cchr.ru/news/464.htm). Although the woman was not in suicidal groups, a surge in social media activity triggered this due to the active circulation of reports of this suicide online.

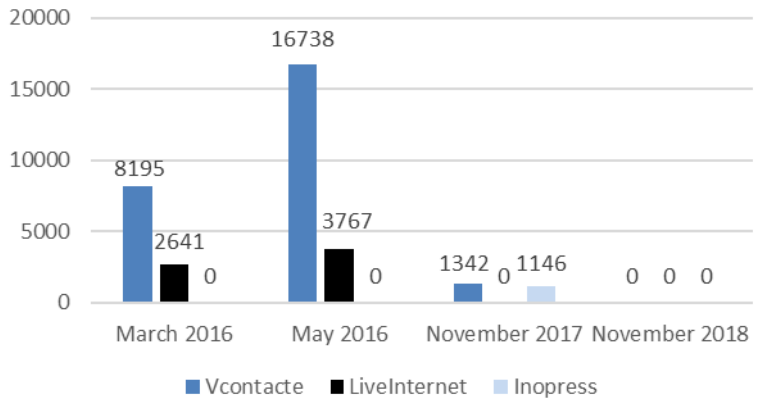

Fig. 4. Dynamics of social and media reports of suicides between March 2016 and November 2018, in thousands

Taking into consideration the fact that messages from closed "death groups" were not included in the unloading, and the statistics presented in figure 6 (measured in thousands of documents) reflect only an open online discourse about suicide, it is obvious that there is a very wide interest in the topic of stimulating suicidal behavior in social media.

Distribution of online content of extremist and terrorist content, involvement in extremist, terrorist activities (school shooting)

This type of Internet risk is interpreted by the team of authors from the point of view of mobilizing users through online propaganda of radical, extremist attitudes: readiness to participate in actions of civil disobedience, terrorist actions. An integral part of the risk type is school shooting, which can be reduced to motivation in the network space for the organization of terrorist acts in educational institutions. School shooting served as a specific case for exploring the process of distributing online content of extremist and terrorist content.

Markers - the basis for selecting accounts as units of analysis for the research case "school shooting."

- posting content on their accounts that discriminates against people/ groups/nations based on their ethnicity and religion;
- subscriptions to online communities that distribute extremist content;
- intensive support of this content through "likes," exchanges, retweets, etc.;
- consciousness of "besieged in the fortress";
- transfer of one person qualities to a group/people/nation;

- having friends who share extremist, nationalist views;
- the instructive nature of the content in the adolescent 's account;
- use of symbols in the account aimed at escalating history;
- development of symbols and application of protest metaphors.

Accumulation of socio-media flow reflecting school shooting markers was performed using the following digital markers:

Filter 1 (columbine) (Vladislav & Roslyakov) & (true & crime & community) (natural & selection) (natural & selection).

Filter 2 "blow up the school" "blew up the school" "blow up the school with everyone inside" "want to kill my classmates" "make something like columbine" "repeat columbine" "repeat columbine in my school" "make them columbine" "finish my classmates" "eric harris" "eric haris" "erik harris" "Eric harris and dylan klebold" "harris and klebold" "harris klebold" ""eric harris cool" "eric harris did well" "school-shooting in Kerch] columbine & shooters".

With the help of the listed digital markers, 570,000 messages were unloaded in the Russian-language and English-language segments of social media: "Facebook," Vkontakte, "YouTube," Odnoklassniki, "Twitter," Instagram "for the period from January 8, 2018 to October 22, 2018.

Figure 5 shows a surge in the intensity of flows about school shooting in social media in connection with the tragic accident in Kerch in September 2018. An alarming signal is the fact that the main contexts analysis of this stream messages indicates attempts to glorify the teenager who carried out this terrorist act and romanticize his motives.

Gender analysis of the audience of the studied stream showed that the involvement in the information flows of "Colombian communities" is more inherent to the male audience than to the female audience - respectively 64% and 36% - see Figure 6.

The dominance of the maskulin gender group among the authors of reports of school shooting shows that, compared to girls, young man are more predisposed to carry out the devotions under consideration, and are more ready to respond to calls for asocial actions, which is due to the specific psycho-emotional and socio-psychological development of this part of adolescents and young people.

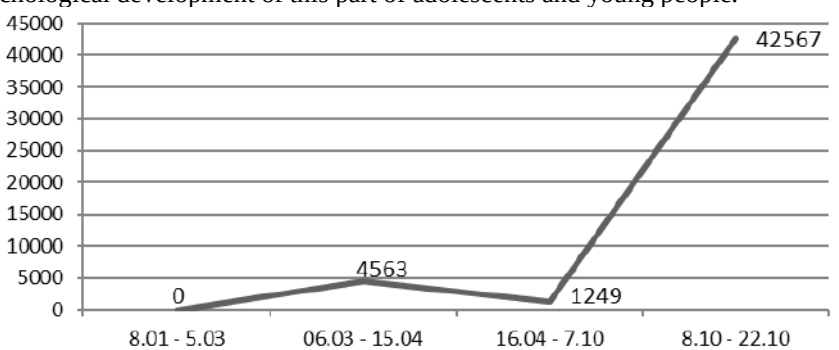

Fig. 5. Dynamics of social and media flow reflecting digital traces of school shooting between January 2018 and October 2018 in blogochosts "Facebook," Vkontakte, "YouTube, " Odnoklassniki, "Twitter," Instagram"

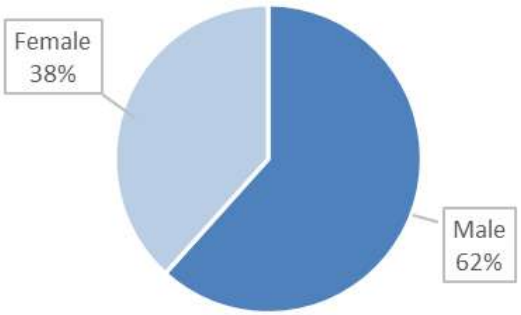

Fig. 6. Gender ratio of audience streams on school shooting

According to the data of Figure 7, most interested in the subject of school shooting, are representatives of the younger generation and number more than 8 thousand authors under 35 years of age. It should be noted that the number of authors under the age of 25 is only half of the number of speakers (about 4,000 authors). The number of youngest authors under the age of 16 is only 451. In general, this corresponds to the portrait of the most active user of social media, as well as the age characteristics of parents of those teenagers who are in the most sensational for perception of ideas of school shooting.

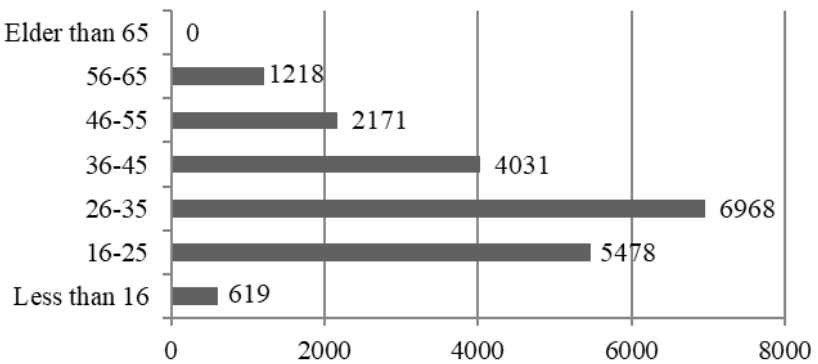

Fig. 7. Age ratio of school shooting reporting authors

Analyzing the publication activity of the most influential network groups associated with school shooting, note that the largest user audience has a community "Natural selection," it features 20,027 participants. It is a group that designs and distributes ideas of necessity of natural selection, rejection of values of humanity and mercy, realization of the principle "Survives the strongest."

"The World of Maniacs and Serial Killers" group generally semantically and discursively repeats the contours of ideas circulated in the "Natural selection" community, spreading the values of mass murder in order to uphold their principles and achieve their goals.

Participants of this network group deny, subvert the importance of morals and morality in human society. This group has a very wide audience (281,718). In another rather representative online community - "World of Crimes" - there is a discussion of various ways of killing people, options for committing crimes. Despite the absence of explicit calls for school shooting or other crimes in this group, the very fact of active communication on these topics can serve as a trigger for the formation of the user 's position on the organization of socially dangerous actions.

Analysis of the tag cloud typical for the school shooting flow revealed several semantic word usage groups associated with a particular discussion context. The first group of words: "crimea 'college' place |" indicates the intense circulation in social media of reports about the Kerchen episode of school shooting, which literally blew up the network environment in late September - early October 2018. The second group of tags: "murder 'life' child |" concerns an indication of the social essence of school shooting. And the third group of the most common in the analyzed stream of word usage: "weapons 'explosion' murder |" concerns the technological aspect of the organization of school shooting.

4 Conclusions

The semantics of flows about cyberbullying indicate that teenagers with specific appearance or special behavior are the main target of online harassment. Different, specificity serves as a basic reason for cyberbullying. In this regard, only helping a teenager to adopt himself and his characteristics, to master communication competences, can be a central measure to prevent and overcome the negative consequences of cyberbullying.

The semantic core of the stream, which reflects the push towards suicidal behavior, allows to identify the main techniques applied by the leaders of this stream - depreciation of human life, gamification in the process of formation of suicidal attitudes of the user audience and romanticization of suicides. Countering the involvement of adolescents in suicide networks should include legal measures, as well as mandatory and regular psychological support for adolescents whose behavior demonstrates markers of participation in suicidal online communities.

Linguistic analysis of reports belonging to the flow of school shooting reveals two main ways to mobilize extremist and terrorist attitudes of teenagers by network leaders: emotional rationalization of mass killings, involving primacy of motives of power, administration of educational institution, classmates, as well as glorification of terrorists; rational reasoning, applying the ideas of the concept of natural selection and denying the importance of morality and morality to society.

Significant measures to prevent the involvement of adolescents in online school shooting communities are their belief in the need to have an opinion, to critically sense, to reflex from various sides the information coming from the network; discuss what consciousness manipulation technologies are used in online groups mobilizing extremism and terrorism, and the benefits that network leaders derive from their criminal activity.

It is obvious that in conditions of internment-risks it becomes extremely important to manage effectively strategies of child behavior by teachers, parents and other participants of educational environment, to build in children resistance to emerging internment threats.

Countering the communication of schoolchildren to destructive network communities can be organized in the following areas:

1) demonstration of doubt of such sources of information and malice of their leaders;

2) proof of inaccuracy, damage, nullity of the destructive information itself;

3) switching the attention of the Internet audience to other information of constructive content.

The criteria for selecting the relevant content may be its entertainment (what can shift attention), logic (what meets common sense) and normative acceptability (what meets the rules of the reference group). Opposition to such content should consist in encouraging alternative creative actions through the formation and awakening of positive meanings, the popularization of acceptable standards of behavior and role models.

The effectiveness of countering destructive network communities in all three areas mentioned above can be facilitated by neuro-visual techniques such as the use of well-known warning symbols, the management of discourse by changing attention concentrator objects, the targeted use of verbal and graphic metaphors. Thus, our eye tracking studies with the help of eye trackers show that additional mobilization in the perception of graphic images can be provided by the use of familiar symbol-warnings. The appearance of a red line on the computer screen for 7-10 seconds in combination with the inscription of the type "Beyond the line it is impossible!" significantly reduced the time of respondents to consider high-risk zones and increased the time of view stay in safe zones. For example, when looking at a person on a computer screen standing on the edge of a cliff, on the ledge of a high-rise building, on a rock, the time of sight in places of possible fall after the demonstration of a red line inadvertently decreased on average more than twice (567 respondents participated in experiments). At the same time, the time of sight in safe places of such images increased more than one and a half times.

With the help of the eye tracker, we have also found multiple manifestations of changing the nature of information perception by changing attention concentrator objects. Such a change is easily ensured by increasing the font of one of the verbal fragments of the visual stimulus, its color, highlighting, features of the design, as well as by purposeful introduction of such elements. Similarly, they act on the perception of the proposed content of metaphor drawings (for example, all known "emoji," recognizable images of fairy characters, etc.).

The authors of the article have compiled a list of recommendations for prevention and counteraction of risks considered in the article for teachers, counselors, specialists in the field of educational work.

Recommendations for preventing and combating cyberbullying:

- presence of teachers, counselors, experts in the field of education in global network;

- monitoring of the teenager accounts and the immediate environment;
- formation of the acceptance and identity culture among children;
- "social producing" and navigation of students and pupils in search of friendly online communities.

Recommendations for preventing and combating suicidal behavior in the Internet environment:

- direct and immediate designation of teachers and counselors presence at Internet space;
- operational appeal to management of an electronic resource;
- operational appeal to law enforcement agencies;
- creation of group for friends, relatives, the immediate environment support/notification about this risk;
- professional psychological maintenance;
- changing activity (after overcoming crisis) on game types of activity (sport, tourism, quests).

Recommendations on preventing and combating the dissemination of extremist, terrorist content and involvement in extremist, terrorist activities (school shooting) on the Internet:

- an appeal to the necessity of having the personal opinion;
- stimulation of critical thinking development;
- offering alternatives and switching attention to socially useful activity;
- help in reflection of terrorist and extremist content;
- discussion of consciousness manipulation technologies;
- development of the students communication culture on the Internet in school, installation on immediate informing adults on any threats or alarms connected with Internet communication.

Thus, the formation and development of a culture of digital citizenship in Russia is possible due to the interaction of civil and government structures aimed at creating conditions to minimize the negative effects of Internet communications and maximize the opportunities that open up in the digital environment: social project activities, civic activism, and digital democracy.

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Internet Psychology

Do I Need IT? Russian Pensioners' Engagement with Information and Communication Technologies

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Abstract. Digitalization of industry and everyday life leads to the need for wider adoption of information and communication technology (ICT) skills. Although today's education does focus on IT competences, they were largely inaccessible for the people who are now nearing the retirement age or older. Correspondingly, only about 1/3 of people from this demographic group report the mastery of even basic IT skills, which suggests that the notorious age-related digital gap still persists. Meanwhile, competence in IT is required for both more successful and flexible employment (which is particularly important in the light of the pension reform ongoing in Russia) and for continuous usage of computerized cognitive training (CCT) programs. In our paper we study IT competences in pensioners and people approaching the retirement age and report the results of two surveys that we ran with a total of 295 elder participants. Our results suggest that in the socially active group of seniors the reported computer usage is comparable with more traditional household and dacha-related activities. In the general population, however, people aged 50 and over show relatively little interest towards improvement of their IT skills. We outline some measures for greater engagement of pensioners with ICT, which can ultimately contribute to long-term improvement of their cognitive functions and preventing age-related dementia.

Keywords: Human Resources, Social-Economic Status, Cognitive Status.

1 Introduction

The gap between different generations' knowledge and skills remains significant even as the world is supposedly becoming "flat". With age, it becomes more challenging for people to accept novel things, to remain flexible, to reject methods and techniques that used to be effective in the past. Meanwhile, the number of retired people in Russia is increasing: prior to the pension reform in 2019, the average growth was 1% per year and the total number was approaching 50 million people. Correspondingly, the studies of employment and work activities in elder people are gaining extra momentum in advanced countries, as life expectancy and the share of seniors in the population are increasing in all of them.

Information and Communication Technologies (ICT) are widely recognized as effective means for supporting physical well-being in elder people, but the cognitive aspect should not be underestimated also. Some researchers see ICT as the instrument for broadening the horizons, acquiring new skills and seeking new interests [1, 2]. The others emphasize the need in overcoming technical difficulties and accessibility of various forms of network interaction (e.g. e-communication for medicine, education, etc.) [3, 4]. There is actually ongoing discussion whether the impact of ICT on elder people's health is ultimately positive, as the negative effects include for instance increased stress [5-6].

In any case, the ubiquitous development of ICT led to the diffusion of the related IT competences, in both work activities and at home. But age is generally negatively correlated with ICT competence level, although the latter is also affected by the culture, education, IT infrastructure, economic environment, and other factors. Greater adaptation of elder people to the new technologies would let them maintain their work abilities (which are increasingly vital in the light of the pension reform in Russia) and improve the general quality of life. Moreover, computerized training can help in saving cognitive functions and preventing age-related dementia: numerous data related to the cognitive training of information selection speed, various components of attention, memory, and their comprehensive enhancement programs suggest not only short-terms effects of training, but also long-term improvements. The latter are accompanied by the structural and functional changes in the cortex and hippocampus, as well as changes in the activity of the mediator systems of the brain, which leads to adjustments not only in the cognitive, but also in the emotional state [7-9]. The leading role of behavioral and social factors is highlighted by the findings about positive effect of cognitive training combined with aerobic training of physical activity [10]. The protective effect of such training is also supported by the data of genetic, bio-chemical and Magnetic Resonance Imaging analyses.

Still, despite the noted positive effect of the computerized cognitive training (CCT), only 10-12% of elder people are prone to systematically exercising its program [11, 12]. It seems that the situation could be improved by changing the social norms of prestigious behavior and development of web resources dedicated to cognitive stimulation, customized for effectiveness for personal features of users of different ages. So, our article is dedicated to the study of IT competences in pensioners and people approaching the retirement age, with respect to the barriers for wider ICT usage. This involves the following contributions (the sample in our studies were the elder people residing in the Siberian Federal district, mostly in the city of Novosibirsk):

- assessment of elder people's adoption and interest towards IT-related skills and activities;
- identification of elder people's habits in personal usage of IT;
- identification of the relation between the level of IT competences adoption and career history for pensioners and those who approach the retirement age;
- testing the hypothesis that self-satisfaction with IT skills is high in elder people.

The rest of the paper is organized as follows. In Section 2 we overview existing research works related to IT competences in general and how the elder people use or can better use them for their benefit. In Section 3, we describe the methodology of two surveys that we ran with a total of 295 Russian people of pre-retirement and retirement age, while in Section 4 we present the surveys' results. In the Conclusions we summarize our findings and make proposals for the further work aimed on wider engagement of elder people with today's ubiquitous ICT.

2 Related Work

2.1 IT Competences in Digital Economy

Our literature review of related works suggests high interests of researchers towards the influence of digitalization on work career, employment and population's health. Joseph Quinn and his co-authors notice that the current demographic and economic changes have significantly increased risks of the future pensioners that causes workers in the USA to remain professionally employed until later age than before [13]. Berkelaar & Buzzanell have introduced the generalizing concept of *digital career capital*, which is implicitly monitored by employers and becomes progressively more important in human capital in general [14]. About a decade ago yet another related term was introduced (see e.g. in [15]): *digital competence*, which represents more broad conception of knowledge and work skills. In its elementary level, modern workers must be able to use computers, mobile devices, work with software and apps in their professional domain, and use the Internet.

Approaching from the other side, Frey & Osborne considered how workplaces are subject to computerization and forecasted its forthcoming impact on the labor market in the USA [16]. Particularly they focused on the analysis of risk for the number of jobs and the relation between probability of a job computerization, the wages, and the education level. OECD's publication "Skills for a Digital World" (2016) considers the close interconnectedness of the processes in the digital economy, including in the aspects of skills, training and labor. It was also repeatedly noted that the digital environment and workplaces, which are not bound to a particular time and space, require new competences and qualifications.

At the same time, the digital environment becomes integral part of the developing health care and social security. Thus, IT needs to be mastered by broad strata of future workers of different professions, not just the ones related to the actual ICT domain. According to the well-established approach by Jens Rasmussen (1983), the human performance models can be divided into *Skills*, *Rules* and *Knowledge*, depending on if routine or novel tasks are performed by workers [17]. The *knowledge* model is recognized the most demanded in the context of the digitalization of economy and the communications. Let us illustrate some professions in Russia that imply different levels of mastery of ICT and the corresponding different performance models (Table 1).

Table 1. Examples of professions with different manifestation of IT competences (in the Russian labor market)

N	IT competence level	Examples of professions	Performance models
1	Medium or high ICT mastery	Accountant, engineer, scientist, programmer, system administrator, financial analyst, broker	Knowledge
2	Some elements of ICT mastery	Operator, seller, teacher, educator, consultant	Rules
3	Does not imply mastery of ICT	Handyman, loader, driver	Skills

2.2 ICT and the Elder People

The analysis of the age structure of ICT professionals in Russia in 2018 suggested that among the high qualification specialists 7.0% were older than 50, and 0.8% were aged 60-72. In the medium qualification level a) technicians: 11.8% were older than 50, and 1.6% were aged 60-72, b) electronics specialists: 30.2% older than 50, and 6.9% aged 60-72. Of the qualified ICT "blue collars", 29.0% were older than 50, while 6.1% were aged 60-72 [18].

In today's environment, mostly high level of IT competences is required to implement the *Knowledge* performance model. This situation started in 2000s, while previously the set of competences for the *Knowledge* model was different, and the model itself was not in such high demand. Accordingly, people of pre-retirement and retirement age who are still employed have difficulties in responding to the labor market requirements and update their competences. The results of a study of Russian researchers aged 50-70 by G.L. Volkova suggest that in this demographics the most popular form of advanced trainings is specialty courses, while the second most popular form is computer courses. For the researchers aged 30-49, computer courses were already in the third place, while for the ones younger than 29 they were the least popular form [19]. Thus the demand for updating computer skills and IT competences in general is the highest in the people of pre-retirement and retirement age.

In 2018, researchers from the Institute for Statistical Studies and Economics of Knowledge of the HSE conducted a study of households with regard to the Internet skills [20]. In it, they introduced an integrated indicator of various actions on the network, which included:

1. Being a part of social networks
2. Sending/receiving emails
3. Phone and video chats online
4. Searching for information about goods and services
5. Uploading personal files to websites, social networks, cloud storages for public access
6. Searching for information related to health or medical care services
7. Performing financial transactions
8. Buying/selling goods and services on the Internet

9. Downloading software
10. Online learning

With respect to the performed actions, four levels of Internet skills were identified: basic (1-2 actions), intermediate (3-4 actions), high (5-6 actions) and advanced (7-10 actions). According to the survey (2018), 33% of the participants had basic level, while 32% had intermediate level. The results that were obtained for the people of pre-retirement age are presented in Fig. 1. For male participants the share was notably higher, while with age it decreased, and on overall less than 36% possessed at least basic skills among the pensioners.

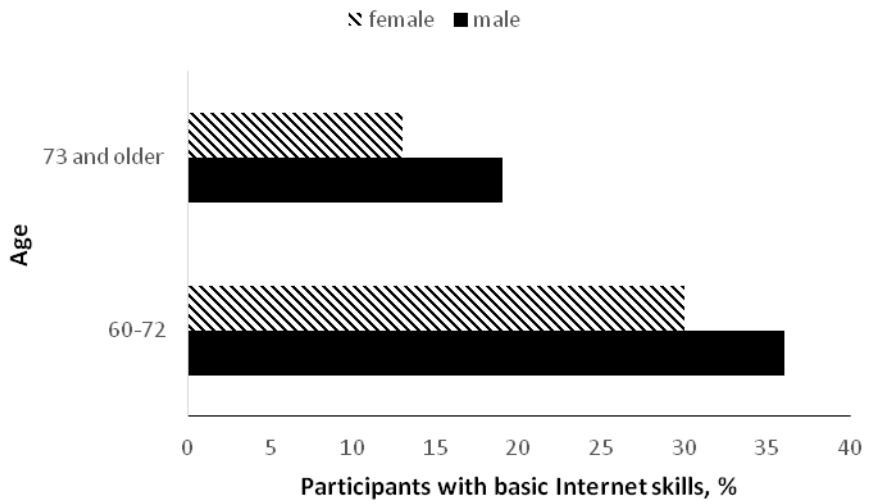

Fig. 1. Share of the elderly survey participants with basic internet skills (Russia, 2018) [2]

The results of a somehow similar survey of pensioners in the USA suggest that the age-related *digital gap* that persisted already a decade ago (see e.g. in [21]), still endures. The level of ICT mastery was found to be affected by the levels of education, income, and the social-economic status [22]. Meanwhile, ICT for the elder people potentially imply the following benefits:

- Instrument for obtaining knowledge and learning new skills, which contribute to better cognitive status and the quality of life,
- The means for barrier-free communication, both social and with various organizations;
- The mechanism for maintaining and improving health status.

2.3 Effect of Cognitive Training Programs in the Elderly

Organizational difficulties and the increasing expenses associated with population ageing in developed countries support the relevance of preventing age-related devel-

opment of cognitive dysfunctions [23, 24]. The use of internet technologies is learning for children and young adults is a given and is beyond doubt, although some problems related to computer addiction and the changes in the structure of thinking, especially speech functions and social communication, are noted [25]. The effectiveness of cognitive training for the elder people is still being discussed, particularly in the aspect of transmission of the results to succeeding in everyday activities [26, 27]. Still, the positive effect of the training for mental health and functional status of the brain has been proven in both psychometric and neurophysiological research works (e.g. [27, 28]).

ICT skills in elder age are prerequisite for using the computerized training of attention and memory, which is lately extensively used for activating cognitive reserves of the brain in the context of atrophy of neurons that grows with aging and the resulting violation of the brain's functional systems [8, 23, 30-32]. For that end, both dedicated software and various types of computer games are employed. The systematic training allows to improve the speed of motor reaction and visual discrimination, the functions of working memory and attention, as well as to increase the efficiency of more complex planning and strategic thinking operations [33-35]. Several hours of the training have been found to improve the above indicators and even intelligence in general. Neurophysiological research has shown the compensatory development of structures and functions of different areas of the frontal cortex as a result of working memory training [36]. It is noted that already 10-hours computerized training in thinking flexibility for the people aged over 65 caused improvement in solving various cognitive tasks, including ones that were not presented in the training, as well as prevented the decrease in the quality of life 5 years later [37]. Still, better results are noted from longer training [38, 39], for which both the trainee's mastery of IT skills and interest towards the training and the software's usability are essential.

However, despite the many psychometric and neurophysiologic proofs of the cognitive training's utility for recovering speed characteristics of mind and memory in the older age, this technology so far does not see ubiquitous usage, due to several psychological and organizational factors. For instance, we previously found in our survey of elder women attending computer courses in People's Faculty of Novosibirsk State Technical University (NSTU) that the priority of cognitive activity was low in the motivational inductors profile [11]. Only 20% of the elderly students took part in the cognitive training program that we implemented in the dedicated online software, and only 8% of the pensioners completed 20 sessions or more. Insufficiently vigorous usage of the proposed online technology can be associated with age-related weakening of the activity initiation functions due to age-related changes in brain structures, especially the prefrontal areas of the cortex [12, 23, 40, 41], as well as with low levels of IT skills that we also discovered in the survey with that group of older students.

So, a large body of inter-disciplinary research supports the increasing importance of IT competences in shaping the digital career capital, in the usage of digital environment, preservation of mental health and functional ability of the brain, which is particularly important for elder people. However, our overview of the related data for Russia suggests that people in pre-retirement and retirement age do not possess suffi-

cient knowledge and skills in IT. To analyze the degree of IT adoption for this demographic group in the non-capital city of Novosibirsk, we ran two survey studies, which we describe in the subsequent Section of our paper.

3 The Surveys Methodology

First of all, there is currently a certain controversy regarding retirement and pre-retirement age in Russia. The pension reform has started in 2019 and is expected to be implemented until 2028, gradually increasing the default retirement age as shown in Table 2. The concept of pre-retirement age was officially introduced in the Federal Law 350-FZ "On amendments to certain legislative acts of the Russian Federation related to the appointment and payment of pensions" in 2018. Particularly, the citizens who have reached the pre-retirement age are subject to certain tax exemptions and social security measures. The planned dynamics of the pre-retirement age that follows the changes in the retirement age in the period of the pension reform is also presented in Table 2.

Table 2. The dynamics of retirement and pre-retirement age in Russia in the period of the pension reform (2019-2028)

	Period									
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Retirement age:										
females	56	57	58	59	60	60	60	60	60	60
males	61	62	63	64	65	65	65	65	65	65
Pre-retirement age:										
females	51	52	53	54	55	55	55	55	55	55
males	56	57	58	59	60	60	60	60	60	60

In our surveys, we considered the participants who have reached the age of 55 to be of retirement age, while the ones who have reached 50 to be of pre-retirement age. The main method used in our work was a questionnaire, distributed personally or over Internet.

In the first survey, we studied activities in pensioners who were students of the People's Faculty of NSTU (which is also called "the third age college") in 2018-2019. The total number of the students taking part in the survey was 203 (184 females, 19 males), and their age ranged from 55 to 78 years (mean = 66, SD = 5.1).

Our second survey studied IT skills and interest towards them in elder people and was mostly distributed over the Internet in 2015-2019. The total number of respondents was 92, all of them aged over 50 and residing in the Siberian Federal District of Russian Federation. The self-reported age distribution of the participants is presented in Table 4.

4 Results

4.1 Survey 1: The Pensioners' Activities

Of the participants that reported the demographics, 66% had higher education, 2% had incomplete higher education, 5% had full secondary education and 27% had secondary special education. Most of them had or used to have occupation as administrative workers (32 people), engineers (27), economists and accountants (21), medical workers (14), teachers (12). The rest 97 participants have self-specified various other professions.

Only 60 subjects turned in the fully completed questionnaires, with their self-reported activities estimated on a scale from 1 (lowest degree) to 5 (highest degree). The resulting data are presented in Table 3.

Table 3. Results of the survey of the pensioners' activities

Activities	Mean	SD	Median	Min	Max
Cooking	3.64	1.09	4.00	0.00	5.00
Home plants	3.47	1.32	4.00	0.00	5.00
Walking	3.13	0.79	3.00	2.00	5.00
Gardening around the house	2.72	1.43	3.00	0.00	5.00
Sea holidays	2.72	1.15	3.00	0.00	5.00
Picnic	2.07	0.90	2.00	0.00	4.00
Camping trips	1.52	0.77	1.00	0.00	4.00
Fishing	1.38	0.85	1.00	0.00	4.00
At the dacha:					
Growing plants	3.76	1.43	4.00	0.00	5.00
Gardening	3.75	1.35	4.00	0.00	5.00
Recreation	3.02	1.35	3.00	0.00	5.00
Struggle for the harvest	2.95	1.38	3.00	0.00	5.00
Cognitive activities:					
Reading	3.78	1.08	4.00	0.00	5.00
Watching TV	3.62	1.04	4.00	0.00	5.00
Using computer	3.60	1.03	4.00	1.00	5.00
Singing / drawing	3.28	1.29	3.50	1.00	5.00
Going to theater	3.25	1.00	3.00	0.00	5.00
Physical activities:					
Physical exercises	3.55	1.05	4.00	1.00	5.00
Dancing	2.51	1.28	2.00	0.00	5.00
Going to sauna	2.38	1.29	2.00	0.00	5.00
Game sports	1.53	0.93	1.00	0.00	4.00

Presumably, high popularity of cooking and summer cottage (dacha) facilities and the low ratings for fishing are due to the dominance of women in the sample and indicate the preservation of stereotypical female roles among pensioners. Elsewhere, we can note the overall balanced distribution in activities, which include work both at home and at dacha, cognitive and physical activities.

The comparable ratings of reading, TV and computers suggest that most of the pensioners had actually mastered the IT and use the resources of the Internet. Correspondingly, CCT to support the cognitive functions and prevent age-related dementia should be available for elder demographics. On the other hand, the sample in the People's Faculty is not representative of the whole population, since only socially active pensioners seeking new information and new forms of communications enroll there. The share of such active group in the whole population of female pensioners in Russia can be estimated as 13-30% [20].

4.2 Survey 2: The Pensioners' IT Skills

The age distribution of the 92 participants who took part in the survey is presented in Table 4. As for the education, in the group of pre-retirement age responders 19.7% graduated in a major related to ICT (economic cybernetics, mathematics and informatics, applied mathematics, computer operator, etc.). In the elder age group, this share is lower (see in Table 5), since at the time of their study computer skills were not so widely demanded and were not taught in the education system. Moreover, those who had IT-related major did not always work in this field. On the other hand, since at a certain moment the demand for ICT specialists significantly exceeded supply, some respondents worked in this field despite having no formal specialized education.

Table 4. The responders' age groups and specialized education

Age	Number of responders	Share of the responders who graduated in an ICT-related major, %
50-60	61	19.67
60-70	24	8.33
70+	7	0.00

Table 5. The responders' distribution per the professions and the education majors

Profession type	Number of responders	Share of the responders who graduated in an ICT-related major, %
Medium or high ICT mastery	9	77.78
Some elements of ICT mastery	11	100.00

Of the 12 responders aged 50-60 who had ICT-related education, only 11 worked in the related field, while 4 responders who did not have the education, did have ICT-related jobs in their career history. Of the responders aged 60-70, only 1 of the 2 who graduated in ICT-related major had a corresponding job, while 4 responders reported having worked in IT industry despite having no related education. In the age group over 70, only 1 responder had a short experience of working as computer operator (inputting data on received goods into information system), even though he did not have a related education. The data presented in the above tables suggest that nowadays the economy mostly demands highly educated employees who have medium or high mastery of IT competences. The development of ICT leads to decreased oppor-

tunities for non-specialists to get an IT-related job. This situation is notably different from the period of 1980-2000 when due to the shortage of specialists the barriers for employment in IT industry were rather low. It was then when some of the today's pensioners managed to obtain ICT-related work experience and the corresponding competences.

Further, we surveyed all the participants on the personal use of ICT – the resulting data is presented in Table 6 (multiple options could be selected). The list of ICT uses was composed according to [20]. The most popular uses that we found were: engaging in social networks, searching for information, watching videos and reading news, articles and books.

Table 6. The responders' personal use of ICT

ICT uses	The number of positive responses
Engaging in social networks	79
Searching for information	79
Watching videos	74
Reading news, articles and books	72
Uploading personal files	68
Listening to the music	62
Buying / selling	54
Sending / receiving e-mails	47
Performing financial transactions	38
Downloading software	24
Distant learning	17

Interestingly, the responders' satisfaction with their IT competence level was rather high, particularly in the 50-60 age group. The responders aged over 60 reported that they see little need in acquiring an IT competence.

5 Discussion

The results of our study of ICT effect in the work history correspond to the research of the age structure in Russian IT specialists in [18] and confirm the shortage of the industry-related professional skills in Russian elder people found in [19]. The discovered personal uses of ICT (Table 6) are in line with the international trends found in elder people, who have also moved from mostly reading e-mails and information search [42] to communicating via messengers and social networks. In this, our results is more consistent with [43] who found that the people over 80 are mostly interested in online messaging and obtaining new information, and also that the ICT usage had relation with psychological well-being of the oldest-old participants.

The related research works studying the Russian pensioners are not entirely consistent, which may be explained with varying samples. For instance, for the sample of 50 elder people in [44] they found that the most popular ICT uses were e-government services, information search and online communication.

In the study of 68 people in [45] they found that the communication and reading news items were the most prominent. All in all, it seems that somehow different concepts are used to describe more or less the same activities. Probably greater sample sizes and consideration of the factors such as national culture, age, gender, education level, family status, etc. would be needed to achieve better consistency.

All in all, our research suggests that ICT usage for personal purposes by elder people may allow developing their social relationships, decrease the perceived isolation, provide mental stimulation beneficial for their overall health, broaden the worldview, improve the set of skills and knowledge, and share the experience. As for the generalizability of our study, we need to note that we only covered the subjects aged over 50 residing in the Siberian Federal district of Russia, who were mostly female (82.7%) and had higher education (62.4%). This demographic is generally renowned for their high level of mental and physical activity, the desire to obtain better competences, as well as the balance between the household and outdoors tasks. Although they do not show much use of online technologies, they are self-satisfied with it.

6 Conclusions

The global extension of IT usage, both in industrial context and at home, and the need to maintain physical and psychological health of the ageing population call for wide adoption of IT competences. However, their mastery in Russian citizens of pre-retirement and retirement age remains moderate: only 36% of males and 30% of females in this demographic group possess at least basic IT skills. At the same time, learning IT skills nowadays remains one of the most popular forms of training and continuing education.

However, training in IT implies that elder people need to engage in relatively atypical activities, and the previously formed social-cultural behavior stereotypes act as barriers for that. This in particular limits their abilities in changing career tracks and choosing new professions (Table 1), which is essential in the light of the ongoing pension reform in Russia. At the same time our survey of the people aged over 50 in the Siberian Federal District suggested low relation between the formal education in IT and choosing career in this industry.

Arguably even more severe effect of elder people's low engagement with ICT is neglect of computerized cognitive training, which proved to be effective in maintaining mental health and preventing age-related dementia, as well as for improving functions of attention, memory and flexibility of thinking [46]. Unfortunately, even such socially active group of elderly as the students of People's Faculty who self-reported recurrent usage of computers comparable with the traditional household activities (Table 3) showed little interest in continuous CCT.

Overall, our results suggest that the age-related IT gap first noted some decades ago still persists and that motivation in elder people remains the key barrier for overcoming it (cf. [21]). To make broad strata of the elderly population engage with ICT and CCT, more usable websites targeting this particular user group need to be devel-

oped, taking into account the age-related differences in perception and memorizing information, as well as individual variability in the dynamics of these processes.

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Metacognitive Strategy of Students with Problematic Internet Use

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Abstract. The paper presents the results of a study of metacognitive strategies in students. The study found that students with normative internet behavior, with problematic internet use, and students with symptoms of Internet addiction are characterized by different level of such metacognitive strategies as Introspection, Quasi-reflection, Formulation of questions, Role-playing games. The conscious formulation of questions for filling the gaps in knowledge is typical for students with normative internet usage; Introspection, Quasi-reflection, Role-playing games - for respondents with problematic Internet use. It was revealed by factor analysis that non-constructive metacognitive strategies implying creating imaginary communication situations, focusing on one's own thoughts, fantasies, and problematic experiences are part of a unified symptom complex with symptoms of Internet addiction. The results can be applied in cognitive-behavioral therapy for problematic Internet use by developing constructive metacognitive strategies in students.

Keywords: problematic internet use, internet addiction, metacognitive strategy, metacognitive regulation, university student.

1 Introduction

University students can be perceived as a group of the most active Internet users nowadays. According to a number of surveys, the majority of students almost constantly use various types of mobile devices and gadgets for different types of online activities, such as search, communication, educational and creative activities, gaming etc. In this respect, the importance of study of the psychological consequences of students ' involvement in virtual interaction is increasing. One of these consequences is defined as a problematic Internet use – excessive non-functional involvement into the Internet communication, which implies long-term and systematic uncontrolled using of the Internet. Problematic Internet use is defined as a factor of risk of the Internet addiction. A significant number of studies of a problematic Internet use are currently being

implemented. However, the issue of its psychological mechanisms remains open. One of the promising area in solving this problem is the study of the characteristics of metacognitive regulation of behavior of Internet users ' as prerequisites for its problematic use. Particular relevance in this respect acquires the identification of metacognitive and reflexive strategies that mediate the normative or problematic character of Internet communication among the university students.

2 The Main Features of Problematic Internet Use of Students

The Internet usage is defined as an integral part of the daily life of the university students. Modern Russian students are, indeed, the first representatives of the "digital generation", which since childhood are being strongly interacting with cyberspace. They use different practices of an internet-communication; implement different types of activity in the virtual space [29]. According to the data of D. V. Rudenkina and A. I. Rudenkina [25], 97% of Russian young people consider themselves active Internet users and actually can't imagine their life without it. They spend a significant amount of time on social networks, at scientific and educational resources, gaming sites. The Internet becomes a kind of living space for university students, where communication, cognition, entertainment and recreation are realized [10, 38]. Thus, most young people use smartphones and other gadgets all the time to get the access to the Internet. They are inclined to problematic Internet use without specific purposes, which is related to a decrease or loss of control over interaction in the network, willingness to be online constantly, deterioration of emotional well-being when it is impossible to get the access in to the Internet, expressed by preference for virtual communication [8, 21, 31, 32, 33]. As it was demonstrated in the survey of Varlamova S. N. et al [30] problematic Internet usage or a moderate tendency to Internet addiction, is common to 95% of young people in the world's metropolises. Problematic Internet usage often replaces or deforms various types of student activity. The negative consequences of problematic Internet usage by youth could be communicational difficulties, weakening of social ties and frustration, escapism, formation of emotional Internet addiction, acts of aggression and autoaggression in situations of limited access to the network, reduced academic performance and deterioration of quality of life, the risk of various forms of deviant behavior (gaming addiction, cyberbullying, cyber vandalism, etc.) [2,3,24,34,36]. A number of studies have identified psychological preconditions for problematic Internet usage among students, which include communication problems, a tendency to fantasize, focus on their inner world, a low level of reflection, conceptualization of their own cognitive and emotional processes, difficulties in decisions making, difficulties in semantic regulation of life activity, etc. [5,6,11,17,19,26]. Therefore, it is essential to review predictors of problematic Internet use.

3 Metacognitions and Their Role in Problematic Internet Use

Metacognitions constitute the ability to carry out "thinking over thinking", namely, reflection and self-regulation of cognition. Metacognitive processes serve as an integral regulator of activity, responsible for evaluating, interpreting, and controlling

cognitive activity, and also involve in regulating emotions and cope behavior [12, 13, 14, 18]. Thus, metacognitions can be both constructive and non-constructive. Disruption of metacognitive regulation can be observed in neurotic disorders, adaptation disorders, addictive behavior, etc. [7, 16].

The role of metacognitive processes in the building of problematic Internet use is not properly studied, though, there are specific studies of diverse aspects of this problem. Thus, the thesis of Leili Mosalanejad and Mohammed Amin Ghobadifar shows that negative metacognitive beliefs diminish emotional self-regulation, so serve as preconditions for over involvement in Internet communication [23]. M. Spada et al [27], who showed that metacognitive abilities act as mediators between emotional regulation and behavior, obtained similar results; metacognitions influence the manifestations of negative emotions, which, in turn, act as preconditions for problematic Internet use. Metacognitive beliefs about anxiety, the impossibility of control and danger, the necessity to control your thoughts, cognitive confidence and cognitive identity reinforce the tendency to problematic Internet usage. Conversely, developed emotional regulation decrease the propensity to problematic Internet usage. There valuable results were obtained in the study of Dorit Alt, Meyran Boniel-Nissim, which demonstrate that problematic Internet usage is connected with a formal and superficial approach to adolescents learning, as well as with the fear of missing opportunities or benefits (FoMO "fear of missing out") [1]. It was revealed by D. P. Tkachenko that the tendency to control of anxiety in situations of self-presentation is typical for people who tend to escape from loneliness and social problems in virtual reality [28]. In fact, there are no studies devoted to interconnection between metacognitive strategies and problematic Internet use among students, which explains the relevance of this work.

4 Research Questions

In accordance with the results of a theoretical analysis of the problem of the correlation between metacognitions and the problem of the Internet usage for students, we posed the following research questions (RQ):

RQ 1: Is there any difference between the metacognitive strategies among students with normative, problematic Internet use and students with signs of Internet addiction?

RQ 2: What is the correlation between metacognitive strategies and problematic Internet use of students?

RQ 3: What are the main factors of metacognitive regulation of students' behavior on the Internet?

5 Methods

5.1 Participants

The participants were 111 students (28 males, 83 females, M= 22,6 SD=3,84) from full-time and extra-mural courses in social sciences and the humanities at various institutions of higher education in Saint Petersburg, Russia.

The choice of humanitarian students was a result of a desire to partially eliminate the influence of a subjects chosen educational field (precise sciences, natural sciences and technology). The sample group showed a numerical preponderance of young women, which according to the data of the Federal State Statistical Service is roughly in accordance with the gender distribution in the general overall body of students studying social sciences and the humanities [37]. Based on the Chen Internet Addiction Scale (CIAS) and according to the report by Malygin et al. the cutoff point at a score of 65 to determine Internet addiction via CIAS gave a good performance in respect of reliability and validity [22]. Following Malygin et al., we adopted this cut-off value to classify normal internet use (n= 31, range = 27–42), problematic internet use (n=59, range=43–64) and internet addiction (n= 21, overall level of IA >65).

5.2 Measures

Problematic Internet use. The adolescents completed a CIAS – the self-rating questionnaire comprising 26 items, with a four-point Likert's scale ranging from 1 (Does not match my experience at all) to 4 (Definitely matches my experience). The questionnaire was specially developed for assessing internet addiction [9]. The scale (IA) is made up of five subscales: 1) compulsive use (5 items); 2) withdrawal symptoms (5 items); 3) tolerance (4 items); 4) interpersonal and health-related problems (7 items); 5) time management problems (5 items) and two integral indicators: 6) key symptoms of IA (IA-Sym = (Com+Wit+Tol)); 7) negative effects of Internet use (IA-Rp = (In+Tm)). The CIAS was adapted for use in Russia by V.L. Malygin et al. [22]. According to their report, the cutoff point at a score of 65 was used to define IA; ranges of 27–42 and 43–64 respectively were classified as normal internet use and problematic internet use (PIU). Cronbach's alpha fell in the range of 0.757 the scale of compulsive use to 0.9 on the scale of time management problems. IA test/re-test correlation on all subscales showed a good performance on reliability (a Pearson's correlation coefficient not less than 0.7–0.75).

Differential Test of Reflexivity [20]. The questionnaire consists of 30 statements grouped in 3 theoretically based scales:

1. Introspection (e.g. "Often I am completely focused on my condition"):
2. Systemic reflection (e.g. "I usually think about the reasons for what is happening to me"):
3. Quasi-reflection (e.g. "I can dream and forget about everything").

Respondents rated the statements on a four-point Likert's scale ranging from 1 (Does not match my experience at all) to 4 (Definitely matches my experience). The internal consistency of the questionnaire scales has values between Cronbach's alpha=0.79 to 0.83.

The Scale of Self-assessment of Metacognitive Behavior by D. LaCosta [14]. This technique was developed in 1998 and is a short questionnaire, fairly easy to use and interpret. Respondents are required to assess the following metacognitive strategies as: 1) Strategic planning (planning, monitoring and evaluation of activities); 2) Formulation of questions (conscious formulation of questions addressed to gaps in a particular field of knowledge); 3) Conscious decision-making (predicting the effect and consequences of each choice); 4) Differentiated assessment (reflective assessment of one's own actions according to various criteria); 5) Comprehension of achievements (correlation of subjectively assessed achievements with objective feedback); 6) Overcoming subjective limitations (awareness of the possibilities of solving complex problems and persistent conscious search for solutions); 7) Paraphrasing and summarizing the information received (rethinking of incoming ideas); 8) Designation of cognitive behavior (definition of the used cognitive strategies and their significance for solving the problem); 9) Definition of terminology (wording of precise definitions of initially vague, ambiguous, or poorly understood terms); 10) Role-playing games (playing the position of a communication partner, a mental dialogue with him); 11)Keeping diaries (writing down your own thoughts); 12) Modeling (building mental representations of experience). Respondents rated the statements on a five-point Likert's scale ranging from 1 (very rarely) to 5 (very often). The summarizing scale of the questionnaire "Overall level of metacognitive behavior", Cronbach's alpha: 0.743.

5.3 Data Analysis

The chi-square test was used for determining whether level of PIU were independent of student's gender. We conduct the ANOVA to examine the metacognitive strategies in different groups of independent variables (normal/ problematic internet use/internet addiction). The samples were homoscedastic (Levene's test, $p>0.05$). The Scheffe test to correct alpha for to account for multiple comparisons and Spearman's correlation coefficient to examine the associations between CIAS and metacognitive behavior. To determine the dimensions of the factor model metacognitive regulation of internet behavior, the factor analysis (principal component method) with varimax rotation computed. A test of using factor analysis was carried out based on the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's teste of sphericity. Statistical significance was set at a level of $p < 0.05$. The Statistica 10.0 software package was used for analyses in this study.

6 Results

In the first stage of the study, we specify that the indicator of PIU does not depend on the sex of students ($\chi 2$ (2) =0.93, p=0.62). In the next stage, a comparative study of metacognitive strategies in groups with different CIAS score (normal internet use/problematic internet use/internet addiction) was conducted.

Table 1 (Means and SD of reflexivity parameters) contains significant distinction in the forms of reflexivity of the survey participants. The indicator of systemic reflection, associated with the ability to look at yourself from the outside, declines depend-

ing on the build-up in signs of Internet addiction, however these differences are presented only at the level of the trend.

There were found quite significant differences in introspection indicators (F=8. 31, p <0.00), the state, related to concentration on one's own state and experiences, the Sheffe post-hoc test are significant at p < 0.05. In addition, quasi-reflection, related to separation from the relevant situation (F=9.13, p<0.00), the Sheffe post-hoc test are significant at p < 0.01. These forms of reflection are often related to such negative effects as maladaptive styles of coping, pessimism, neuroticism, low success in solving problems and lack of social support [19]. The severity of these metacognitive strategies increases depending on the strengthening of signs of Internet addiction.

Table 1. Means and SD of reflexivity parameters
(Note: significant differences are highlighted)

Variables	Normal Internet Use		Problematic Internet Use		Internet Addiction	
	M	SD	M	SD	M	SD
Systemic reflection	40.61	4.23	40.24	5.00	39.24	5.64
Introspection	20.81	6.45	23.88	5.14	27.38	6.21
Quasi-reflection	22.97	5.87	26.20	4.61	29.00	5.17

Table 2 (Means and SD of parameters metacognitive behavior) contains significant differences in the parameters of metacognitive students behavior.

Table 2. Means and SD of parameters metacognitive behavior
(Note: significant differences are highlighted)

Variables	Normal Internet Use		Problematic Internet Use		Internet Addiction	
	M	SD	M	SD	M	SD
Strategic planning	3.68	1.17	3.29	1.18	3.10	1.37
Formulation of questions	3.84	1.04	3.62	1.02	3.25	1.03
Conscious decision-making	3.77	0.99	3.64	1.01	3.81	0.98
Differentiated assessment	4.13	0.88	3.97	0.96	3.62	0.97
Comprehension of achievements	3.48	0.96	3.47	0.95	3.67	1.02
Overcoming subjective limitations	4.03	0.84	3.75	0.98	3.90	1.04
Designation of cognitive behavior	3.71	0.90	3.29	0.93	3.38	1.20
Definition of terminology	3.32	1.28	3.32	1.11	3.24	1.18
Role-playing games	2.77	1.23	3.37	1.29	3.52	1.33
Keeping diaries	2.10	1.51	2.03	1.33	2.43	1.60
Modeling	3.48	1.03	3.32	1.15	3.57	1.12
Overall level of metacognitive behavior	42.29	7.15	40.81	6.67	41.86	7.36

It was revealed that significant differences in such parameter as "formulation of questions" (conscious formulation of questions, addressed to gaps in a particular area of knowledge) (F=3.49, p <0.03) are most vividly observed in students with normal

Internet use. The "role games" parameter, which means playing the position of the communication partner and mental dialogue with him, is more typical for respondents with signs of Internet addiction ($F=2.89$, $p<0.05$). In both cases, the Scheffe test are significant at $p<0.05$. The rest differences are presented at the trend level, while the severity of some metacognitive strategies decreases depending on the increasing the level of the independent variable, while others decrease.

In order to identify metacognitive strategies, associated with raising or lowering of total CIAS score, a correlation analysis was conducted, the results of it are presented in table 3. It is revealed that such forms of unproductive reflection as introspection and quasi-reflection are positively correlated with all parameters of problematic Internet use, as well as with total CIAS score.

Table 3. Correlation coefficients between indicators of PIU and reflexivity parameters (Note: highlighted coefficients are significant at *p< 0,01; **p<0.001)

Variables	Intro-spection	Quasi-reflection	Differenti-ated as-sessment	Role-playing games
Compulsive use	0.38**	0.32**	-0.17	0.18
Withdrawal symptoms	0.33**	0.34**	-0.18	0.13
Tolerance	0.43**	0.31*	-0.10	0.14
Interpersonal and health-related problems	0.34**	0.30*	-0.17	0.22*
Time management problems	0.26*	0.34**	-0.25*	0.19*
Key symptoms of IA	0.43**	0.38**	-0.18	0.17
Negative effects of Internet use	0.34**	0.35**	-0.23*	0.23*
Total CIAS score	0.42**	0.39**	-0.22*	0.21*

Table 4. Factor loading and factor structure of metacognitive regulation of Problematic Internet Use

Variables	Factor1	Factor2	Factor3
Differentiated assessment	0.78	0.06	0.28
Overcoming subjective limitations	0.77	-0.18	0.05
Comprehension of achievements	0.71	0.17	-0.05
Designation of cognitive behavior	0.60	-0.12	0.19
Conscious decision-making	0.56	0.33	0.15
Introspection	0.01	0.80	-0.02
Quasi-reflection	0.08	0.78	-0.06
Total CIAS score	-0.15	0.69	-0.12
Role-playing games	0.10	0.57	0.31
Keeping diaries	-0.07	0.12	0.65
Formulation of questions	0.42	-0.03	0.68
Strategic planning	0.14	-0.13	0.75
Expl.Var	2.62	2.28	1.70
Prp.Totl	0.22	0.19	0.14

Also metacognitive «role-playing games» strategy positively interconnected with an interpersonal and health-related problems (r=0,22, p=0,05), time management problems (r= 0,19, p=0,05), negative effects of internet use (r=0,23, p=0,05), total CIAS score (r=0,21, p=0,05).

To identify the structure of metacognitive regulation of Problematic Internet Use, the factor analysis (principal component method) with varimax rotation and factor scores coefficients was computed. The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) = 0.714; in Bartlett's test of sphericity $\chi 2$ = 324.97, df =66, α=0.000. Three factors were extracted with an eigenvalue greater than one. The variables with the factorial loading are shown in Table 4.

The third factor (with 14% variance) combines metacognitive parameters of behavior, related to strategic planning of activity: keeping diaries (0,65), formulation of questions (0.68), strategic planning (0,75). Table 5 (Intercorrelations among factor of metacognitive regulation of Problematic Internet Use) shows the results of intercorrelations between factors of metacognitive regulation of problematic Internet use.

Table 5. Intercorrelations among factor of metacognitive regulation of Problematic Internet Use (Note: **p<0.001)

Factors	F1	F2	F3
Factor 1 «Monitoring and evaluation»	1.00	-0.43	-0.70**
Factor 2 «Parameters of metacognitive behavior reinforcing symptoms of Internet addiction	-0.43	1.00	-0.26
Factor 3 «Strategic planning»	-0.70**	-0.26	1.00

As shown in Table 5, factor structure included one independent and two consistent factors. The independent factor covers parameters of metacognitive behavior, which are positively related to a total CIAS score. Interrelated factors reflect the predominance of metacognitive strategies, aimed either at monitoring and evaluating performance or at strategic planning.

7 Discussion

7.1 Findings

The obtained empirical data showed that students with normative Internet behavior, with problematic Internet use, and signs of Internet addiction are characterized by different level of expression of such metacognitive strategies as Introspection, Quasi-reflection, and Formulation of questions, Role-playing games. While, the conscious formulation of questions for filling the gaps in knowledge is typical for students with normative usage of the Internet. Role-playing games - tendency to replay mentally a dialogue with the opponent, unproductive reflection - Introspection, manifested in focusing on their own internal problems and states, Quasi-reflection – escaping into a fantasy, is more common for students with problematic Internet use and Internet ad-

diction, while these strategies are most evident for Internet addicts. The leading role of these metacognitive strategies in the problematic Internet use is confirmed by the results of correlation analysis. Thus, tendency to Introspection and Quasi-reflection assumes high severity of all signs of the Internet addiction.

Frequent usage of Role-playing games is connected with the existence of problems in the field of time planning, health, inner world of the individual relative to the Internet addiction. The ability to formulate questions consciously, in contrast, reduces the negative effects, associated with the Internet usage, and, first of all, problems with time management. It was revealed by factor analysis that non-constructive metacognitive strategies implying creating imaginary communication situations, focusing on one's own thoughts, fantasies, and problematic experiences are part of a unified symptom complex with signs of Internet addiction. Constructive strategies that involve metacognitive regulation of all main components of activity planning, monitoring and evaluation, are not predictors of a problematic Internet use. The results of our study are consistent with the data obtained in a number of studies. In particular, Marcantonio M. Spada [27] and others found out that negative metacognitive convictions are connected with negative emotional experiences and can cause PIU, since interaction on the Internet can serve kind of tool for improving the state, reducing metacognitive discomfort. Fatemeh Bidi et al [4] found that metacognition plays a significant role in shaping of coping strategies and largely determines mental health. Non-constructive metacognitions lead to non-adaptive coping strategies, including the problematic use of the Internet. In a survey of L. Mosalanejad and M. A. Ghobadifar [23], it was shown that metacognitive persuasions, acting as factors of increasing anxiety, are more common for students with PIU. This allows us to make a conclusion that metacognitions can act like preconditions for problematic use of the Internet among University students.

7.2 Study limitation and directions of future research

The limitations of this study are, first of all, that the results were obtained on a sample of students in the Humanities, a significant part of which are girls. Despite the fact that we found no differences in metacognitive strategies and problematic Internet use depending on gender, in the future it is advisable to expand the sample of the study, to balance it by gender and educational orientation. The establishing of correlations between metacognitive strategies and PIU with emotional and cognitive characteristics also acts as prospects for further researches, which will allow more detailed explore the role of metacognitions in PIU and Internet addiction of students.

8 Conclusion

This survey revealed metacognitive strategies that strengthen and weaken problematic Internet use by students. Metacognitions aimed at one's own inner world and imagination -introspection, quasi-reflection, mental playback of dialogues with a partner, strengthen PIU and act as preconditions for Internet addiction. Metacognitions that regulate cognitive activity and involve planning, monitoring, and activity evaluating, weaken the PIU. The achieved results reveal the possibilities of metacognitive therapy

in correcting Internet-dependent behavior, and allow determining directions of psychological prevention of PIU among students through the development of constructive metacognitive strategies.

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Flow Experience Related Perspectives of Digital Persuasion

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Abstract. Characteristics of digital influence as a result of the use of specially organized computer programs and online facilities are discussed. Since the results of this influence may be regarded as an endeavor to provoke a sort of a digital persuasion, the analysis turns to the patterns of captology (CAPTology means an acronym: Computers As Persuasive Technologies) introduced by B.J. Fogg. Obvious psychological mediators are proposed, including overt ones (aka attractors), and latent ones (aka latent mediators). The selected patterns give rise to attempts aimed at reinterpretation of empirical studies performed by the authors during the last two decades. Thorough motivational research aimed at investigation of psychological impacts through overt and latent mediation has been done within communities of online video gamers and hackers who appeared to participate in the studies during the specified period. Through reinterpretation, both attractors and latent mediators have been presented as motivational patterns for the research participants to go on with the selected activities, i.e. gaming or hacking. Attractors are shown to be interactive motivation, while a latent mediator has been shown to be flow experience. While attractors and mediators can be possibly presented as being the opposites, they have been shown to impact the study participants uniformly.

Keywords: persuasion, captology, flow experience, attractors, latent mediator

1 Introduction

Psychology of persuasion is a growing field of studies [1]. Persuasion may be verbal and visual, overt and latent, direct and mediated by signs and/or instruments for distant communication. Patterns of mediation are of primary interest since the modern world – the world of the wide web – is overwhelmed with mediation facilities. The most important are online media and computer network facilities based on digital transactions. To be successful in changing people's attitudes or behaviors the software programs need to be interactive. Needless to say, interactions form a milestone in the use of digital technologies. Human beings may be unaware of any persuasive, deceptive, coercive or cheating features inherent of visiting various web-sites or the use of numerous computers and gadgets such as smartphones, i-pads, readers or smart

watches [2–4], as well as designing software pieces such as e-agents and playing an online or mobile game [5; 6].

The persuasive role of extensively used software has been emphasized by B.J. Fogg who first coined the term "CAPTology" from an acronym: Computers As Persuasive Technologies and then in 2003 published a book "Using Computers to Change What We Think and Do" [7]. This concept has got diverse marks: both positive [8] as well as critical – the latter mainly because of being eclectic and rather far from the rules and habits, acknowledged by generations of scholars, of introducing new terminology [9]. At any case, the captology related ideas and the practice are worthy to discuss and to learn more about their usefulness.

Digital technologies are persuasive, since they promote changes in human behavior and/or attitudes in numerous ways, taken as (1) tools, (2) medium or (3) social actors: see more on this 'functional triad' at B.J. Fogg [7]. Fogg analyzes various changes and describes persuasion as a change in people's attitudes and behaviors: namely, a change realized without application of rude methods such as for example deception or coercion. It is important to note that such a change is due to human-computer interactions, not due to computer-mediated communication. Also, following Fogg's captology, genuinely persuasive intents are endogenously built-in, i.e. they are not exogenous. That means, persuasion needs to be planned: any side effects, even serious ones, are believed to be outside the captology field. Successful persuasion and corresponding changes in attitudes and/or behavior might differ. Even minor changes, facilitated by processes of human-computer interaction, show a way for more or less dramatic changes of behavior or attitudes.

B.J.Fogg suggested a term "Captology" and offered a new way of using modern technologies for improving users' lives almost 20 years now. By offering a specialized interaction or content users could change their habits, learn new skills and improve their lives significantly. Following Fogg's idea, persuasive intents are endogenously built-in, i.e. they are not exogenous. That means, persuasion needs to be planned: any side effects, even serious ones, are believed to be outside the captology field. Since that time, a lot of work has been done in terms of offering users specialized/personalized content, whicht could impact their life. But the intent behind this personalization process was driven mostly by advertising efforts.

2 Captology and social media

Even though not planned or predicted by B.J.Fogg, some of the mechanisms of captology were quickly developed and used widely by advertisers. These days users of search engines are getting information and ads based on their previous searches, recent websites used, information from their social networks profiles, keywords from their recent phone calls. Social media users are dealing with armies of paid bloggers and users, promoting this or that product or lifestyle and present themselves as ordinary peer users. Such an attack on users was not planned by researchers, but was used and abused by businesses and search engines creators and made its impact on overall perception of online interaction, especially in information search/exchange.

After noticing such tactics, even not very advanced users take precautions when doing their research online (use anonymizers when browsing, mistype certain words

in their own posts in order to hide them, turn off their phones while having serious conversations, create closed social network groups and seriously check social profile of any newcomers). Thus, even when there is no real captology process in work, some of its side effects are already quite widespread. The era of invisible and gentle persuasion became dead even before it started its' life.

Following Fogg's idea, persuasion may happen not only in form of convincing users, but also by training the habits a person acquires by using digital technologies daily. While some processes referring to captology are already working, their efficiency or usefulness are partly in question. Some of the examples could lie in the field of gadgets use: new phones, smart-watches, as well as the ways of using them have been pretty well and quite fast accepted and learned by public. Other examples lie in the field of using the new technology of smartphone applications, or social networks.

Talking about the ways people communicate nowadays and use social media/networks, it is important to step back and look through the changes new technology brought to us during the past years. New-born email communication was becoming widespread in 1990-ies: snail-mail communication has lost its popularity by that time: communication through an exchange of thoroughly written and thought-through letters was slowly fading. An opportunity to write an email and send it quickly to any part of the world brought written communication skills back. Meanwhile, an imitation bias has been introduced: the more an interaction pattern would be able to reproduce face-to-face interaction features, the better it would be [10]. Thus, parallel to technical advances in communication mediums, the users kept reducing their habits of writing down their thoughts and expressing their feelings in writing. Thus, the pendulum swung back: modern technologies offer better and faster, compared to an exchange of written messages, ways of communication, namely, sending/receiving audio-messages, videos, or photos. So sound chats and photos, mediating the exchange of expressions and impressions, took the place of textual communication [11]. As Snapchat and Instagram are replacing social communication platforms, the amount of thorough verbal descriptions appears to be radically reducing, being replaced by images, selfies, and videos.

The opposite mechanism of a "negative" captology process is represented by a so-called "Facebook depression". While researchers are still arguing whether Facebook tends to make users depressed, many of them complain that processes of constantly browsing highly positive posts from online friends and endless vacation pictures makes some of them feel bad [12].

Another change worth mentioning is presented by a new communication etiquette: if 20 years ago people used phone communication without any planning, just politely asking respondents if they have time to talk, nowadays users have to plan any way of face-to-face communication, which demands both sides to be present in the conversation, be it a simple phone call or video-conference. It doesn't sound appropriate for modern teenagers (and sometimes adults) to "just call". Sh. Turkle discusses the new etiquette of teenagers: their main way of communication is texting and it is considered impolite to knock at the door; to ask a person to come out you need to text first, even if you are just 15 feet away [13]. At the same time, asynchronous communication became very widespread - it is ok to start communication with a stranger, using various types of messengers or even texting.

Research of teens' communication culture shows that visual – photo – component is taking over the verbal communication. Such effects lead to increased depression rates. It is well known how important is appearance in adolescence; the increased use of selfies often facilitates critical thoughts and concern referring to their face and/or shape. At the same time, video communication is becoming acceptable by families as a way of communication between family members who have to live and work in remote areas [14].

3 The search of mediators for persuasion

Persuasion operates through psychological mechanisms – cognitive, motivational, affective, attitudinal, subliminal, etc. Impacts may possibly take the form of new mental links and particularly of psychological transformations which are important in modifying the operation of psychological mechanisms which mediate goal setting, decision making, assessment and acquisition of stereotypes, re-patterning of knowledge structures, etc. Persuasive digital technologies impact and transform mental processing: psychologists are aware that any digital element such as a computer "serves as a new tool for mental activity and thereby transforms thought" [15; p. 379]. Transformation means that new psychological plans and strategies, and/or goal setting and decision making procedures, as well as updated learning and working skills, etc. emerge, and possibly substitute mental mechanisms which were formed earlier, since the latter ones often turn out to be less effective than the new transformations, or newly-transformed ones.

Digital persuasion is a sort of an "overt" – that means, easily observed and anticipated level of behavioral/attitudinal changes [7]. There are many reasons to differentiate additionally latent behavioral/attitudinal changes – these are often fundamental in their impact and may result in both immediate and postponed outcomes. Latent changes may refer to subsequent forms of behavior, not to the actual ones. Also, from an acting human being's and/or observer's perspectives, changes may be productive or counter-productive dependent on assessments of outcomes; these assessments may often be alternative. Though the changes may be minor ones, the result in restructuring (transformation) of mental content may be serious enough [15]. A good example of a major transformation was described by Sh. Turkle [13] in her very first book on psychology of handling digital technologies in early youth: upon having contacts with computers, younger children come to a conclusion that these are "sort of alive" (i.e., intermediate between "alive" and "non-alive"), and this idea has not been registered earlier in Piaget's [16] studies of children's concepts.

Thus, computer-mediated persuasion is dependent on certain mediators whose function is to give rise to various changes of behavior and/or attitudes. When the changes are the ones that have been overtly anticipated – the case, which is thoroughly investigated in the Fogg's book [7] – the mediators of this type might be called *attractors*. The mediators which stimulate postponed forms of behavior we will call *latent mediators*; it is reasonable to differentiate them from *overt mediators*, or attractors, leading to anticipated forms of behavior/attitudes change. Both types of mediators may be selective in the effects they cause. Indeed, while although practically all the digital technologies are persuasive, the impacts are often selective.

Selective persuasiveness gives a cue that some fundamental psychological mechanisms cause and give rise to possible latent behavioral/attitudinal changes. Another important point is that it may happen that an important attractor which results in overt behavioral/attitudinal changes, is not the exclusive mediator: other mediator(s) may cause latent changes which are to take place in the future. Mediators leading to latent changes may be latent indeed, i.e. cannot be easily traced through possible behavioral/attitudinal changes.

To analyze in more details processes of overt persuasion causing various selective changes in behavior and/or attitudes, as well as inherent latent mediators, we reinterpret in this paper the previously published empirical studies. These studies refer to motivations of the members of new communities which came into being with the advance of the digital communities such as communities of computer hackers and online gamers. In these studies different types of motivation are presented as a psychological mechanism playing the role of a persuasive mediator.

4 Digital interaction as an attractor

As it was mentioned above, several online studies of hackers' behavior have been done in early 2000s. At first, it was supposed that cognitive motivation – the one the hackers themselves always name as an explanation of their activity – is not the sole motivator. Based on the results of the content-analysis study of 279 self-presentations posted by hackers at the web-site www.kuro5hin.org in 2000, it was supposed that interactive motivation is no less important for hackers than curiosity – a personality trait which definitely refers to cognitive, or informative motivation [17]. Indeed, 59 % of postings contained some (often weak) form of a sender's willingness to start interaction. Social forms of motivation were less impressively stated by hackers, compared to the cognitive motivation, but the analysis showed that social motivation was an important *attractor* for the hackers [17].

This finding was important for the study in which examples of both cognitive and social forms of motivation were formulated and presented to hackers. Indeed, the results of the factorial study show that the supposed social motivation is connected to the cognitive motivation [20].

4.1 Cognitive and social types of hackers' motivations

In the empirical research of hackers' motivation the methodology based on the semantic differential technique [21] was used. The main purpose of the study was to reveal the hackers' verbal replies concerning their motivations, based on evidences expressed by a large sample of hackers. Thus, it was intended to put specially organized questions to a large sample of self-selected hackers.

The underlying idea was to identify the most meaningful categories, constituting the "semantic space" of personal constructs which people use to categorize any input information. The technique goes back to Osgood's et al. [21] method of semantic differential and to Kelly's personal constructs theory [22]. The resulting *multiple identification technique* has been worked out. It was used previously, for example,

in the study of university students' motivations [23] and in mass political psychology studies [24].

The multiple identification technique allows the scholars to identify the semantic space of participants' motivations, based on their matching of possible motivations to possible actions. During the research procedure the participants have to estimate the probability that a certain motivation could really motivate a certain hackers' action. These estimations give a chance to uncover the actual categories through which a person or a group perceives and evaluates incoming information units; also, to find out which categories are the basic ones, the most important and fundamental for a person or a group, including a large group. The methodology was adapted to the hackers' audience: specific types of actions and motivations were selected.

The study [20] was done online: self-selected participants (N = 338) were recruited from visitors of specialized web sources, popular among hackers. Subjects filled out a web questionnaire, representing a matrix (37 motivations x 17 actions). Participants had to estimate the probability that a particular motivation could really motivate a particular action.

Factor analysis (Varimax rotation) was used: six significant factors, explaining 15.4, 14.4, 13.4, 12.1, 10.5, and 8.8% of dispersion were described. The factors were called: "Need in Recognition – Interaction Avoidance"; "Active Aggression – Passive Instructions Following"; "Typical Hackers' Motivation"; "Self-Realization through Cognition"; "Publicity Actions"; "Peer Recognition – Acceptance in Society". The factor structure shows that the social and the cognitive components of hackers' motivations are tied together in five out of the six factors. Thus, the members of the communities of hackers can be characterized as being both cognitively and socially motivated.

To sum up the results, one has to admit that contrary to popular beliefs but in good correspondence with the results of the content-analytic research, briefly discussed earlier in the paper, hackers did not appear to be complete outsiders and individualists. Instead, replying the questions put to them, they presented themselves as a tightly connected group with strong cognitive motivation and personally interested in peer recognition and other social types of orientation. Since web-sites and web-forums through which hackers mostly interact with peers have been organized as evident attractors for all those engaged in hacking, it is very likely that hackers were attracted both by being a member of community, and by hacking actions. Thus, the hackers' web-sites and web-forums are evident *attractors* – just like any other web-site and web-forum – since they aid interactions and "push" participants to accept peer recognition and social ties as actual motivators.

It is possible to state that interaction, as an anticipated behavioral/attitudinal change characterizing the members of hackers' communities, is at least partly induced by the very existence and popularity of specialized web-forums. This makes it evident that social interaction is one of attractors of hacking. Earlier in the paper it was hypothetically stated that attractors and latent mediators often act simultaneously and possibly independently, and unlike attractors, which are often easily enough recognizable, latent mediators can be most often identified through the use of special methodologies. The goal of our next research was to check this supposition. In doing this we restrict ourselves with motivations as mediators and attractors.

5 Flow experience as a latent mediator

Two types of motivation are often differentiated in psychology: extrinsic type depends on bonuses: money rewards, gifts, and positive feedback; intrinsic type depends on human beings' interests and challenges, when tasks and trials are taken for their own sake. Following Malone and Lepper's study [25], B.J. Fogg [7] distinguishes such intrinsic motivators as fantasy, curiosity, challenge, control, competition, cooperation, and recognition (the latter three refer to a social, or a group level), and makes successful attempts to work out real ways to use intrinsic motivators within persuasive digital technologies.

There are well-elaborated theories and models of intrinsic motivation; the most developed ones are the self-determination theory [26] and the flow theory [27]. Our research was based on the latter. Flow theory is being efficiently used in the area of human-computer interaction. In an analytical chapter it was shown [28] that the use of digital technologies represents a variety of areas to study flow experience. The major research areas are:

- Online marketing/shopping,
- E-learning/teaching,
- Cyber-recreation (often, online/computer/video gaming, including massively multiplayer online role-playing games (MMORPGs),
- Virtual interaction.
- Virtual psychological rehabilitation, such as immersive systems of virtual reality;
- Illicit penetrations into virtual environments and computer security regulations;
- Usability testing, measurement of web-site's attraction, friendliness, adaptation to target populations.

The theory originated by M.Csikszentmihalyi rests on an observation that people report the state of "flow" while doing diverse things like going into their favorite sports or hobbies, or just washing dishes and cleaning the floor. Flow is an experience of deep involvement into a certain activity (and these activities vary greatly), with the feeling of being competent: a new action freely follows the previous one, and there is no need to push oneself to do too boring or too difficult an activity. Usually, in flow nobody feels time passing by. A person experiences flow as "a unified flowing from one moment to the next, in which he is in control of his actions, and in which there is a little distinction between self and environment, between stimulus and response, between past, present, and future" [27, p. 36].

The main antecedent of flow is precise matching of someone's skills (i.e., competence) and task challenges. Flow is placed at the cutting edge of person's skills, and it is a moving target. Increased skills lead to an increase of challenges, if the precise matching has to be saved, and the choice of greater challenges demands an update of skills. With high level of confidence we can state that feedback, interactivity and the match between one's skills and current challenges are the main characteristics of flow as seen from a human-computer interaction perspective [28]. Nowadays, various models of group flow: leadership, or team flow experience are being investigated and introduced [30; 31]; when meaning is created "with and through" group's optimal

experience, engagement is born, «highly sought after by companies because it correlates strongly with high performance. Engagement is what emerges when we are achieving something that exceeds our individual nature…» [30, p. 2].

Since flow is known [28] to be experienced while playing computer games, communicating via instant messaging or chats, web related learning or shopping, and other behaviors related to the use of digital technologies, we **suppose** that flow may turn to be a *latent mediator* responsible for causing latent behavior changes. This hypothesis is being investigated in the current paper by readdressing to the multicultural [31] empirical data collected during the last twenty years.

5.1 Flow experience in hacking: a latent mediator

In the online study of flow motivation in the hackers' communities [18] the participants (N = 457) reported they experienced flow, and thus flow motivation was a latent flow 'crisis' (i.e., no flow), followed again by periods of flow renovation: flow was experienced by the least and the most competent hackers, while moderately competent participants more often than others had reported of 'crisis' periods.

The flow crises were shown to be caused by participants' inability to match step-by-step their updated skills with correspondingly updated challenges. These mismatches lead to a popular and socially accepted escape from the hackers' community through a 'cognitive rise' (an update of competence not followed by an update of task challenges). The flow motivation then changes into cognitive motivation, which is also an intrinsic type of motivation; such type of behavior seems to be a well-known mechanism of escape from hackers' community. This escape method can be easily traced in real biographic stories of hackers who changed their fate to become, for example, experts in computer security.

It was also found [18] that hackers developed two main mechanisms of task choice and goal setting in hacking. Highly experienced participants chose interesting tasks, even if these projects were too complicated. Moderately experienced participants mostly chose tasks, which they felt they were able to complete easily enough, thus saving flow experience. Such a goal-setting process, which leads a person to experience flow all the time, appears to be a rather rare motivational mechanism: most often participants reported they were unable to keep matching their skills (competencies) and challenges, and thus lost the flow experience, only to experience it at a later stage of their task choice processes.

In the reported study [18], it was shown that flow motivation is a *latent mediator*, indeed – hackers make special efforts in task choice and in goal setting to keep experiencing flow. This mediator parallels the previously shown attractor, i.e. interactive motivation. Thus, the hypothesis we put forward earlier in the paper – namely, that attractors and latent mediators may motivate human behavior in parallel – is correct. To check it within another sample, this time consisting of videogamers as specific digital technologies users, we discuss briefly and reinterpret the study, published in [19].

5.2 Playing online games: interaction as an attractor, flow as a latent mediator

This research was carried out within a community of online gamers. It seems to be evident that interaction should be named a strong attractor for the community of multi-user online players.

Online games are a class of group role-play games with rich interaction facilities. These games supposedly contain special sources of attraction, otherwise people would never play them. As an overt attractor we can assume ability to gain achievements, common to a great many of games [32]. Additionally, we may assume the existence of other attractors as well, such as game content, rich communication facilities, invitations to unite in teams and pursue teamwork strategies.

Results of the online study (N = 347) showed that the following factor structure characterized motivations of online players: Flow, Achievement, Interaction, Cognition, Activity/Passivity and Thoughtfulness/Spontaneity [19]. Flow appeared to be the strongest factor, while Achievement and Interaction followed it. In several follow-up interviews, participants (variously competent online gamers) always mentioned such advantages of playing online games as rich interactions and easiness of achievements; some interviewees mentioned also rich cognitive facilities. Neither of respondents mentioned flow experience – this factor, the most heavily loaded one, had to be made evident using special psychological methodology. No wonder that it is never discovered in studies of online gamers, held by observers/participant observers and interviewers. It is worth mentioning that flow motivation has been discovered among the strongest factors within diverse communities of online gamers – namely, gamers speaking Chinese, English, French and Russian [19; 31; 33].

It is important that in the community of online gamers we have found the same attractor (namely, interactive motivation) and the same latent mediator (namely, flow motivation), as in the previously discussed community, that of hackers. This makes us believe that a parallel work of several attractors and (possibly, several as well) latent mediators is a common thing, a usual practice. In our research, it should be mentioned, the attractors and latent mediators were unidirectionally oriented, i.e. both sorts of mediators pursued participants (hackers and online gamers) to go on with the behaviour they had chosen for themselves. Particularly, the *attractor(s)* overtly motivated hackers/gamers to continue the chosen behavior, while the latent mediator was motivating hackers and online gamers in a *latent* manner.

To follow up the study with new samples of the Web users which were almost unavailable at the period when the main part of empirical studies have been performed, we may suppose that quite promising samples of research participants would be all those who play the so-called serious games. Nowadays researchers deservedly give worthy attention to all those who participate in serious games [34]. One more promising area of research in the field of captology would be the attempt to discover hypothetical psychological mechanisms behind social networking – the activity which is highly fascinating to multitudes of the net users [35]. These two areas of studies may be considered as rather attractive regarding the follow-up work in the field.

6 Conclusion

Persuasion, as it is usually described, seems to represent an overt type of impact through the digital facilities. It was supposed that there are various levels of behaviors and attitudes change, not all of them referring to computer-mediated persuasions. It was hypothesized that one is able to empirically investigate highly diverse mediators, including those which parallel persuasions. A certain type of such mediators was called latent mediators, responsible for non-immediate behavior changes. These types of mediators possibly lead to psychological transformations.

After having reinterpreted the results of online studies within the communities of hackers and online gamers, the suppositions have been confirmed: overt attractors (i.e., interactive motivation), as well as a latent mediator (i.e., flow motivation) have been found and described. Both the attractors and mediators seem to motivate participants of our research series uniformly. It can be hypothesized, however, that various attractors and latent mediators motivate research participants differently, possibly in the opposite manner. This is an interesting situation of mediators in conflict, a perspective for future empirical research. According to the authors' experience, serious games and social networking can be considered as highly attractive activities to follow up the study in captology aimed to search specific latent motivators and attractors.

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The Relationship of Media Multitasking to Adolescents' Productivity and Executive Functions

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Abstract. This exploratory research addresses the phenomenon of media multitasking being widely spread among children and adolescents in the context of digital socialization. The switch between different digital environments requires attention with regard to studying the relation of a media multitasking strategy to cognitive strategies and productiveness of activity. To research this problem a quasi-experimental study, including digital tasks of various types on a computer and smartphone, the dots task for executive functions and a socio-psychological questionnaire, was conducted with adolescents aged 15-17 (N=33). The results show that media multitasking is not related to user activity level and time required to fulfill the quasi-experimental tasks. The positive correlations of media multitasking with productive fulfillment of the quasi-experimental tasks, including the productivity of determined actions, and negative correlations with executive function were also found. The data partially correspond with previous studies but appear to be rather contradictory and should be further explored.

Keywords: Media multitasking, Multitasking, Cognitive function, Adolescents, Executive function

Introduction

Modern children are developing in new conditions mediated by adopting digital technologies into everyday life which cannot but have transforming influence on different cultural practices. Thus, data on population studies indicate that user activity of coming generation is growing significantly which altogether changes their lifestyle [31, 32, 33]. The digital world's specific characteristics that allow to simultaneously perform different activities with electronic devices, or integrate media and common sources of information, or combine offline and online activities stimulate a wider promotion of such strategy as media multitasking. Even ten-year-old intergenerational studies show [5] that children and adolescents actively adopt media multitasking and easily incorporate it into their lives. For example, while doing their homework, at the same time adolescents listen to music and message on social media networks. At the same time older generation frequently see simultaneous performance of several tasks as an unnecessary problem and try to avoid doing like that [16]. It is also shown that a more advanced user activity is related to media multitasking.

Thus, while studying, pupils and students use at least two or more media flows within 7.5 - 10.45 hours [27]. In 2014 Korean scientists discovered that 90% of university students work in a multitasking mode [8]. The students' answers show that during classes 69% of students text on messengers, 28% use Facebook and check their email, and 21% do something not related to their studies on their computers.

Let us briefly discuss what phenomenon media multitasking is and some of its research directions. People have started to regularly use the term media multitasking since 1990s; information technology began to actively enter people's daily lives then. Recent studies identify the phenomenon of media multitasking from the three perspectives: 1) as the simultaneous use of several media technology tools; 2) as the combination of using media and traditional sources of information; 3) as the combination of using offline and virtual activities [2, 4, 6, 7, 8, 11, 28, 29]. In other words, different variations of the term media multitasking can be explained by combining sources of information environment that are used by a person. In accordance with the Milgram and Kishino's continuum, information environment can be completely virtual, or mixed, or real [19].

One of the significant research areas in this field is to study the correlation of media multitasking with various cognitive processes in adolescents and youth: volume and shifting of attention, low stability and concentration of attention as well as cognitive control and executive functions [3, 4, 15, 20, 22, 23, 30, 33]. Many studies have shown a negative effect of media multitasking on cognitive processes, yet a number of papers have presented reverse conclusions. Heavier media multitasking has been associated with worse performance on fluid intelligence measures [20], on demanding working memory tasks [4, 11, 23], on task switching [23]. On the opposite, the study of American youth has shown media multitaskers are characterized by a developed ability to switch attention and cognitive control [1]. Other studies have demonstrated that respondents who media multitask have a broader scope of attention [4, 14]. One of the few studies of adolescents' executive functions and media multitasking showed an association between heavier media multitasking and better inhibitory control [2].

The methodology of media multitasking research has some weaknesses. Most studies in this area rely on self-assessment methods, for example Media Multitasking Index [20, 30]. Quasi-experimental and experimental schemes are rarely used in media multitasking research. Media multitasking studies are more often conducted on a youth or student sample, and data on children and adolescents are presented in few studies [2, 3, 24, 35].

Although increasing digitalization and rapid changes in everyday life are relevant issues, there is a lack of research in the area of media multitasking and principally studying this phenomenon among adolescents during their daily digital activity. Hence, the purpose of our study is to examine specific characteristics of cognitive functions in adolescents with different levels of media multitasking.

The hypotheses of the study are the following: H1) a preferred level of media multitasking is connected with user activity; H2) a preferred level of media multitasking is connected with productivity; H3) a preferred level of media multitasking is connected with the time needed to perform the tasks; H4) a preferred level of media multitasking is connected with executive functions.

1 Methods and Procedure

1.1 Methods

The following methods were used in the study: 1) socio-psychological questionnaire on sociodemographic characteristics, intensity and features of online user activity; 2) quasi-experimental scheme of multitasking mode when using a computer and smartphone; 3) the Hearts and Flowers dots task in the modification of T.A. Akhutina, A.A. Korneyev, A.N. Gusev [10]; 4) by using the Entsefalan 131-03 (21/26 channels) electroencephalograph-analyzer, recording cognitive evoked potentials following auditory stimulation.

In the context of our study, we operationalized the concept of media multitasking as shifting among different types of digital tasks or their parallel performing. Unlike other studies that often use self-assessment tools (Media Multitasking Index) [17, 23, 28], we also developed and used a quasi-experimental scheme to reproduce the conditions of everyday media multitasking. The scheme comprised a number of tasks reproducing typical students' activities. The tasks included: 1) searching online for the definition of an unknown word; 2) solving several arithmetic tasks and tasks on rearranging syllables in several words in Google forms; 3) reading an online text; 4) watching a short video; 5) answering the questions from 3 messages sent to the mobile phone during the experiment.

To study executive functions and cognitive control, the dots task was used. This task required to press the response button in reaction to the signal. This task was performed on a computer and included 3 blocks with gradual increasing of complexity: a block of 20 congruent trials (with all the responses on the same side to a dot (heart) appeared); a block of 20 incongruent trials (with all the responses on the opposite side opposite to a dot (flower) appeared; a mixed block of 20 trials combining both congruent and opposite probes. The main parameters were the quality of performance (number of correct answers) and average response time.

1.2. Sample

The study sample comprised 33 adolescents aged 14 to 17 (mean=15,9) - 28 girls and 5 boys.

1.3 Procedure

The study procedure consisted of recording evoked potentials, quasi-experiment, performing dots task, and filling out a questionnaire. During the quasi-experiment, the participants were sitting with their own smartphones at the interviewer's computers. The participants used their own smartphones, which could differ in some technical characteristics. The main requirements were: Internet access and the devices' habitualness. The participants received printed instruction with a tasks list and the following oral instructions from the interviewer: "Now you will have to complete several tasks.

They are written on this paper. Please, read and remember what you will have to do. You will not have the opportunity to look at it again. You should complete them as quickly as possible in any order". Then, the printed instruction was taken. Four windows were opened on the screen. Every 2 minutes the interviewer sent a message with the question. During the experiment, five different music segments were played in the background (croaking of frogs, drums, guitar, chorus from a children's song, the sound of the surf). After completing the tasks, the interviewer asked several questions about the meaning of the text, a few details about the video, music, and then, after filling out the questionnaire, the definition of the word searched on the Internet. The data were collected in 2019.

1.4 Data processing

The data were processed using IBM SPSS Statistics 14. The correlation analysis of data was performed using the nonparametric Spearman correlation coefficient.

2 Results

2.1 Level of media multitasking

Level of media multitasking was measured following the number of switches while performing the tasks in the quasi-experiment. The number of switches was determined as follows: it has been recorded how many times a respondent returned to a task after he/she at first started the task and without finishing it, switched to the other tasks, and then returned to the original one again. The sum of such additional returns to all the tasks has been estimated. The mean value of the number of switches is 4.5; minimum is 0 (N=3) and maximum is 12 (N=3).

2.2 Media multitasking, time and productivity

For evaluating the results of performing the quasi-experimental tasks, three indices were used: general productivity, productivity of determined actions and productivity of undetermined actions. Depending on the quality of performing a task and its content, different number of points (min=0, max=4) was given. Thus, memory, analysis and comprehension tasks had a higher score than arithmetic and anagram tasks. General productivity of performing the quasi-experiment comprised the sum of points for all the task. The productivity of determined actions was evaluated based on the tasks clearly defined by the instruction (solving arithmetic tasks and anagrams, searching online for information, reading a parable). The productivity of undetermined actions was evaluated based on the tasks not given in the instruction (recognizing background audio pieces sounded during the quasi-experiment, answering to the questions about small details in the watched video, reproducing the definition of the term found online).

The nonparametric Spearman correlation coefficient between involuntary and voluntary components appeared to be insignificant (r=0.228, p=0.2) which may indicate certain independence of these indices.

Based on the general productivity index, the respondents can be divided into three groups: the group with the high level of general productivity consisted of 7 persons; the group with the moderate level consisted of 18 persons; the group with the low level consisted of 8 persons (mean±SD=4.5±3.3 points). In accordance with the productivity of determined actions, the group with the high level consisted of 5 respondents, with the moderate level consisted of 22 respondents, with the low level consisted of 6 respondents (mean±SD=6.5±1.9 points). In accordance with the productivity of undetermined actions, the group with the high level consisted of 6 respondents, with the moderate level consisted of 22 respondents, with the low level consisted of 5 respondents (mean±SD=8±2.6 points).

The time needed to perform the experiment positively correlates to general productivity (r=0.425, p<0.014) and productivity of undetermined actions (r=0.537, p<0.001). The productivity of determined actions does not correlate to overall time needed to perform the experiment. The number of switches positively correlates to general productivity (r=0.491, p<0.01) and productivity of determined actions (r=0.516, p<0.01). The correlations of number of switches with productivity of undetermined actions and time needed to perform the quasi-experiment are not found.

2.3 Media multitasking and user activity

User activity was calculated as an average time for time online on weekdays and weekend. Average time for user activity was 5.43 hours (min=1 h, max=12, SD±3.18). Significant correlations of user activity level with number of switches, overall time needed to perform the quasi-experiment, indices of general productivity, productivity of determined and undetermined actions are not found.

2.4 Media multitasking and executive functions

Three respondents were not included into data processing because they had given no right answers while had been performing the dots task. Upon analyzing the results of the dots task, the following was obtained: the number of switches between the tasks during the quasi-experiment negatively correlates to the number of correct answers in the second incongruent series of the dots task (r=-0.378, p=0.039). The index of general productivity correlates with the index of average time needed to perform the first congruent series of the dots task (r=0.447, p=0.013) and number of correct answers in the second incongruent series of the dots task (r=0.388, p=0.034). The productivity of determined actions correlates with the index of average time needed to perform the first congruent series of the dots task (r=0.4, p=0.028).

2.5 Media multitasking and evoked potentials

Upon analyzing evoked potentials, the negative correlation of amplitude N2 with the number of switches between the tasks of the quasi-experiment ($r=-0.457$, $p<0.013$) was shown. Amplitude P2 also negatively correlates to the number of switches between the tasks of the quasi-experiment ($r=-0.414$, $p<0.026$).

3 Discussion and conclusion

In accordance with the accepted definition of media multitasking, we regarded the number of switches as its main index [25]. The majority of the adolescents who took part in this study (91%) more or less prefer the media multitasking strategy. Such data correlate with existing studies showing high level of media multitasking among adolescents and youth [8, 27]. All the respondents demonstrate advanced digital activity, given that, in this sample, the correlation with the level of media multitasking is not found. Yet, foreign studies show the positive correlation between the level of media multitasking and advanced user activity [12, 16, 18]. Hence, hypothesis 1 was not confirmed in our empirical data. The obtained results of absent correlation can be determined by the sample size and its homogeneity in relation to user activity.

For analyzing the task performance productivity, three indices were used - general, productivity of determined actions and productivity of undetermined actions. Such approach allowed analyzing the obtained data at the quality level. It was assumed that, as a complicated process, multitasking is related to both voluntary and involuntary cognitive functions. The study shows that productivity of determined actions and productivity of undetermined actions are not related, that is, they are independent indices. In addition, productivity of determined actions more correlates with general productivity. Rather high indices of general productivity and productivity of determined actions are typical for adolescents choosing a more media multitasking strategy. However, in regard to productivity of undetermined actions, such tendencies are not revealed. Thus, we can assume that modern adolescents actively engaged in mixed reality, switching between offline and online, and different digital environments deliberately use the multitasking strategy and to a certain extent achieve a better result. Hence, hypothesis 2 was confirmed. Yet, the obtained data do not correspond with a number of studies [9, 15] which requires further more extensive research.

Hypothesis 3 was not confirmed. The speed of task performance in the format of our quasi-experiment did not depend on an adopted behavior (single-tasking or multitasking) strategy in digital environment.

Upon studying executive functions by using the dots task, it was shown that choosing a more single-tasking strategy stipulating sequential and thorough performance of the tasks given in the instruction during the quasi-experiment is related to the higher indices of executive functions. For single-taskers, smaller number of occurring mistakes in the incongruent series of the dots task is common, that is, a delay of an unsuitable answer. It may indicate a lower level of impulsivity. Thus, hypothesis 4 was partially confirmed.

It also correlates with the data of some studies linking adolescents' media multitasking with a lack of cognitive control and higher level of impulsivity effecting executive functions [14, 17, 19].

The results of analyzing evoked potentials show that the greater the amplitudes of N2 and P2, the more single-tasking strategy to solve tasks is chosen by a respondent. According to the study data, the spike of N2 is related to correct stimulus recognition and working memory processing [4, 21]. The spike of P2 is responsible for analyzing received information and its initial processing, that is, single-taskers analyze information more in depth while solving tasks [26].

Thus, the obtained data of our exploratory research indicates an ambiguous and complicated correlation of media multitasking with different adolescents' cognitive processes and some indices of their activity such as user activity, productivity and time needed to perform tasks. On the one hand, adolescents choosing media multitasking as a strategy in digital environment appeared to be more productive, including in the context of random task performance, though not faster than less media multitaskers. On the other hand, greater impulsivity and lower indices of executive functions, working memory, information processing are typical for media multitaskers. Sample size and unbalance by gender should be specified as research limitations. The obtained results require further more in-depth research in this field. Today's adolescents are to some extent forced to act in media multitasking mode in the context of the lifestyle digitalization. In this situation, it is important to understand the limitations and opportunities that media multitasking strategies offer.

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Digital Experience and Cognitive Development in Primary School Students

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Abstract. In this study, authors examined a children experience of using digital devices and its relationships with children's cognitive development. Previous research has shown contradictory findings that reflected associations between children engagement with digital technology usage and cognitions. The study approved hypothesis about qualitative changes in children's digital experience after one year. In just one year the landscape of the known by children mobile apps has significantly transformed and expanded. Children continue to master their digital opportunities in the field of those mobile apps which are widely used by adults. The results of the study show there is a qualitative leap in the digital experience of children who hold down in their minds not only the apps that they usually use but also apps related to them. However, adults tend to associate the digital experience with negative consequences. The findings of this study have shown positive connections between the digital experience, cognitive development and learning outcomes of children. It could be supposed that cognitive development is accompanied by enrichment of the digital experience which is its integral part in modern conditions of children's mental development.

Keywords: Primary School Age, Digital Technology Usage, Apps, Digital Experience, Children, Cognition, Memory, Attention

1 Introduction

Modern children develop and live in technology-saturated environment [6; 7; 10; 22; 27; 41]. Most of them begin to use digital devices earlier than learn to speak. Some of them have had their own digital devices before they started going to school. These children don't know the world without Internet-based technology and perceive physical and a virtual reality inseparably [12; 34]. Evidently, they get into the swing of solving their tasks and satisfying their needs with mobile apps. In the light of L.S. Vygotsky's sociocultural theory of children development [48] digital devices have become one of the most influenced cultural tools affected developing child's cognitions.

Moreover, modern children interact constantly with both human and nonhuman mediators in their perception and communication with the rapidly changing world [24]. The fundamental changes of sociocultural landscape of Childhood lead to different ways of cognitive and social development of modern children, compared with their predecessors' development. Such a situation has become one of the most discussing issues in modern psychological literature over the last decades. Researchers indicated that mental transformations in children development express themselves through decreasing number of children with average intellect and growing polarization of developmental levels in children [17; 40]. Psychologists tend to warn of decrease of cognitive activity, declining of mnemonic and attention skills, and impaired imagination [5; 9; 17; 40; 45]. However not the all researchers have agreed with such a negative impact of digital technology on children development. Those who investigated an association between digital technology use (DTU) and cognitive development of children reported rather contradictory results. It was indicated by a number of studies that there was positive impact of computer games on visual spatial and spatial reasoning skills, perceptual motor skills, creativity, and reaction time [18; 23; 26; 28; 30; 46; 51]. By contrast other studies didn't reveal any connections between DTU and children's cognition [20; 33; 38], or showed negative effects of DTU manifested in a decrease in verbal memory performance and increased inattention [19], decreased academic achievement [3; 13; 25]. Thus it is needed to continue investigations for examining connections between DTU and cognitive skills of children. Moreover, the most of studies in this area were conducted with samples from adolescence to older. There is not clear picture of relationships between DTU and children cognitive development in primary school age. So this paper raised next research questions:

- What changes have been occurring in children's digital experience during the primary school age?
- What connections might be found between DTU and children's cognitive development in primary school age?
- How does digital experience mediate academic outcomes of children?

Therefore, the main objective of this study was to examine relationships between children digital experience, their academic outcomes and cognition. Another aim of the study was to evaluate change in children' digital experience under natural conditions of their development over one year. We tested the hypothesis that digital experience of children connected to their academic outcomes and level of cognitive skills' development. We also hypothesized that there could be qualitative changes in children's digital experience after one year.

2 Digital Technologies and Cognition

The modern world has been taking on much more digital-based features that remade the usual ways of thinking and problem-solving [16]. So mobile devices can help an individual to add technical tools to the act of thinking at any moment when, for example, he or she needs to gain relevant information, evaluate a product or calculate the necessary expenses.

Augmented human cognition not only adds efficiency to an individual's life, but it might alter the cognitive process itself. It is clear that widespread use of calculators has dramatically reduced basic arithmetic fluency [29], digital address book function on smartphones facilitated to displace part of human memory to digital space [4], and so on. Nowadays people don't need to keep in mind the content of necessary information for decision making they rather need to know where they can find that information. It turns smartphones into sources of transactive memory or an external memory store [44]. D. Dennett has called an inclusion of external tools in internal cognitive processes as situated cognition [14]. The extended mind is another definition of cognitions when they are acting with help of the environmental tools [8].

Despite of all the benefits of digital devices' usage, fears about transformation of mental processes by digital technologies were occurred in press and scientific literature more and more often [2; 5; 9; 15; 17; 40; 45]. These anxieties have been spurred by digital divide between generations. Adults have never been lived as children in a technologically complicated environment and do not know precisely what upbringing practices might be useful for digital natives [35]. Nonetheless, Henry H. Wilmer, Lauren E. Sherman and Jason M. Chein have shown in their review of studies exploring the connection between mobile technology habits and cognitive functioning that smartphone usage and attention have rather negative relationships. They also have found some evidence that mobile devices habits might have negative impact on mnemonic functioning [49]. At the same time, most of research was based on self-report questionnaires that rather estimated DTU habits than breadth and content of digital experience. Another issue is related to what cognitive functions are more suitable for changing social conditions and might provide a more successful adaptation to a complex environment of modern life.

3 Method

3.1 Participants and procedures

The study involves 235 children aged between 9 and 10 (110 girls (46,8%), mean age 9,53 SD=0,51). All of the children were within the range of normal without any disabilities or developmental delays. There were 110 3rd graders (45,6% girls) and 125 4th graders (48,00% girls) of one of Saint-Petersburg schools (Russia). The study was a part of the large-scale monitoring of mental and social development of school students so parents gave permission to participate their children earlier. Notwithstanding information about this study was presented to parents on parent-teacher meetings. Parents were informed about goals and objectives of the study, and stages of their children's participation in the study. The study was conducted in school during children-psychologist meetings. Each child was examined individually, apart from others in a school psychologist's office. Additionally, 11 teachers were asked to assess children's engagement with DTU. Teachers filled Evaluation of the child's engagement with DTU for each child in their classes separately.

The monitoring is carried out annually, and the digital experience measurement included in the monitoring second year. In this regard we conducted data screening

to identify children that had 2 year of measures for digital experience. There were 62 3rd graders (41,94% girls) and 93 4th graders (54,84% girls) who had both Icon Recognition test scores and teachers' evaluation of engagement with DTU from the 2018 year's study [35].

3.2 Measures

3.2.1. Digital Experience

In this study we used three types of a source of information to measure digital experience. It couldn't possible to use self-report questionnaires because children don't have enough abilities to estimate the amount of time which they have spent using mobile devices. In regard to this matter, the Icon Recognition Test was used with children for direct estimation of their digital experience and recognition of different types of mobile apps. At the same time, we used an indirect assessment of digital experience by means of teachers' evaluations of child engagement with DTU and peers' evaluation of the child digital experience through digital sociometry.

Icon Recognition Test (IRT). This test was used to estimate an experience of children with mobile devices [35]. The IRT contains 25 app's icons and 25 foil pictures without any verbal captions under pictures. Three types of apps were used including standard icons for calling, texting, shooting and keeping photos, social media apps, and games apps. The children were asked to choose those pictures that they could earlier see on screens of any devices. We instructed them not to guess but check only those pictures in which they are sure. An amount of icons selected minus an amount of foils selected was calculated as the total scores. The test had a high internal reliability (Cronbach's Alpha (standardized) α=0.77, split half r=0.81).

Digital Sociometry. Sociometry is well known as a qualitative technique created by J.L. Moreno to measure degree of relatedness among people. Sociometry is based on choices that people make in interpersonal relationships. The choices are made on the basis of some criterion. We used the criteria which was adopted for the aims of the study. Children were asked to choose up to five classmates whom they would contact if they need to learn something about mobile phones. Additionally, children had to choose up to five classmates whom they would not contact in such a situation. Digital sociometric status (DSS) was calculated by subtracting negative nominations from positive choices referred to the total amount of pupils in the class. DSS was identifying as peer acceptance and rejection in relation to the child's digital experience.

Teacher's evaluation of the child's engagement with DTU Scale. A ten-pointed Likert scale (1-almost not interested in DTU; 10- excessive interested in DTU) was used to evaluate children's engagement with DTU by teachers (TE).

3.2.2. Cognitions

We examined different cognitive skills including memory skills, attention, and thinking abilities (generalization, causal inference, comprehension). All the techniques used were selected according to their capacity to predict successful learning outcomes and the children age.

Memory tests. We used two memory test developed by L. M. Shipitsyna [37]. These tests based on the ten words technique which was proposed by A.R. Luria. Children were provided with two sets of ten objects to measure visual and auditory working memory. The first set contained 10 pictures of objects (cat, umbrella, bag, chair, clock, pyramid, fish, butterfly, bucket, hedgehog). Children were asked to remember what was painted on the pictures and to write it after the presentation. The visual memory scores were calculated as the sum of the correctly reproduced words. The second set included ten words (mountain, star, window, bun, handle, soap, spring, glasses, book, squirrel). The words were spoken to the children and, after that, the examiner asked them to write down the remembered words. The auditory memory scores were calculated in the same way as the sum of the correctly reproduced words.

"The Fourth Superfluous" Test. The test includes five sets of words [37]. There were four words in each set (like, a sparrow, a tit, a dove, and a bee). Three of them could be combined into one group whereas the fourth word didn't belong to this group. Children were asked to find the fourth superfluous word and to name the group formed by the remaining words. This test was used to measure generalization strategies and ability to highlight the essential features of objects. The overall score was calculated as a sum of the correct choices.

Picture Arrangement Test "Sequential Pictures". The test contains three series of comic-strip pictures presented in a mixed-up order [37]. The task of examinee is to arrange them in the right sequence to tell a story that makes sense. The first set of pictures has four sketches ("a key"), the second one has five sketches ("a swimmer"), the last set of pictures has six sketches ("dodgers"). The test was used to assess a child ability to understand social situations and to generate appropriate inferences about causal relations of events. The causal inference scores were calculated as a sum of correct arrangements of pictures.

"Absurdities in the Picture" Test. The "Absurdities in the Picture" test contains the picture where animals are located in the ridiculous situations (for example, a cat in a nest, a goose on a chain in a dog-house, etc.) [31]. Children were asked to find everything that seems to them strange and wrong. After that the examiner asked them to explain what is wrong and how should it actually be. The task time was limited to three minutes. The test was used to evaluate the child's elementary representations of the surrounding world, his or her comprehension of logical connections that exist between particular objects of the world (animals, their way of life, and nature at whole). The overall scores were calculated as a number of inconsistencies found, corrected for ability to explain the absurdities of situation.

The Piéron-Rusen test. The Piéron-Rusen test is a well-known technique used in Russia over a long period of time [39]. This test had been developed by H. Piéron as a modification of Bourdon test and, after that, the test has undergone a significant modification implemented by Russian psychologist E.I. Rusen in the third decade of the twentieth century. The test contains a sequence of geometrical figures (triangles, circles, rhombs, squares). There are 10 rows of 10 geometric shapes. Children were instructed to fill different figures by different symbols. Squares should be marked by plus, triangles should be marked by dashes, rhombs by points. Circles should remain unmarked. Children had 60 second to complete the test. The test is intended to meas-

ure a sustained attention's level. Three indicators of sustained attention were measured including number of correctly filled figures (correctness index), number of mistakes, and the level of sustained attention.

3.2.3. Learning outcomes

In this study we used last quarter grades (QG) in core subjects (Language, Math, Reading) and reading skills development test by L. A. Yasyukova [50]. The Yasyukova test is considered a measure of a level of reading skills as a part of universal learning actions. The test contains excerpt from a fairy tale where words are omitted in sentences. The task of examinees is to fill missing words fitted the meaning of the sentence. The task time is limited to seven minutes. The overall score was calculated as a sum of correctly filled words according to the test keys.

3.3 Data Analysis

In this study descriptive and comparative analysis to evaluate gender and grade level differences were conducted. Gender, grade level, and digital experience were determined as independent variables. We split up the sample into three groups according to the parameters of digital experience (low, middle, and high level) using cut-off values ($\overline{x} \pm \frac{1}{2}s$). We used analysis of variance and Pearson chi-square criteria for comparative analysis, the related samples were compared by the Sign test procedure to identify qualitative changes in children digital experience after one year. The next step was performed by analyzing a correlational structure of all the study variables. All analyses were calculated in Statistica v. 6.1 (StatSoft Inc.).

4 Results

The results of recognition of mobile apps icons according gender and grades of education are shown in Table 1. The Table 1 also contains results of comparison of icons' recognition for paired longitudinal samples by the Sign test procedure. For two inferential samples, a qualitative leap in digital experience was found. Children recognize mobile apps significantly better after one year. The enhancements were revealed among the recognition of icons of social media apps, Google apps, and standard smartphone features. At that, these enhancements less concerned with the recognition of game apps. There were no significant differences in recognition of the most mobile games' icons (Masha and The Bear, Fiksiki, Tree cats, LEGO, Monster Trucks racing game, Toy Pop Cubes). We also didn't find significant correlation between IRT scores 2018 and 2019 years ($r=0,03$; $p>0,05$). However, significant correlation between TE scores 2018 and 2019 years was revealed ($r=0,70$; $p<0,01$). It was assumed that gender and grade of education might moderate digital experience. The results have shown that there are not so many differences between 3rd and 4th graders.

3rd graders significantly better recognized mobile apps associated with games (Tree cats – $\chi^2=4,60$, $p<0,05$; Fiksiki – $\chi^2=5,03$, $p<0.05$). At the same time, 4th graders significantly better recognized Skype icon ($\chi^2=4,37$, $p<0,05$). Similarly, too few differ-

ences were found when girls and boys were compared in their recognition of mobile apps' icons. Girls significantly better identified Google Photos app's icon (χ^2=5,68, p<0,05) and Dr. Panda School app's icon (χ^2=6,65, p<0,01). On the contrary, boys were better in recognition of such mobile games apps' icons as LEGO (χ^2=11,00, p<0,01) and Minion Rush (χ^2=4,08, p<0,05).

Table 1. Icon Recognition Test: Mobile apps and results for the most identified icon (Note: *p<0.05; **p<0.01)

Mobile application	Percent identified					
	Longitudinal samples (n=155)		Total sample of 2019 year (n=235)			
			Gender		Grade	
	2018	2019	boys	girls	3rd	4th
YouTube	90,21*	96,30*	95,58	94,23	94,12	95,65
Vkontakte	81,96**	94,07**	95,58	94,23	94,12	95,65
Phone	81,44**	97,04**	94,69	97,12	97,06	94,78
Google Maps	80,41**	96,30**	94,69	95,19	94,12	95,65
Photo Camera	79,38**	88,15**	85,84	91,34	87,25	89,57
Gallery Android	77,32*	84,44*	85,84	85,58	89,22	82,61
Instagram	74,74**	93,33**	92,92	94,23	94,12	93,04
Fiksiki	73,20	70,32	69,03	71,16	77,45*	63,48*
Masha and The Bear	70,10	71,61	69,91	78,85	78,43	70,43
Google Play Music	67,01**	88,39**	92,92	85,58	92,16	86,96
Weather	63,92**	86,67**	89,38	88,46	86,27	91,30
Tree cats	62,89	64,94	58,41	68,27	70,59*	56,52*
Mult (Russian cartoon app)	62,89**	79,26**	76,11	84,62	84,31	76,52
LEGO® NINJAGO	62,37	63,70	76,99**	55,77**	68,63	65,22
Facebook	60,82**	94,04**	93,81	94,23	93,14	94,78
Minion Rush	55,15**	83,70**	85,84*	75,00*	76,47	84,35
Skype	49,48**	74,81**	76,99	75,00	69,61*	81,74*
Google Photos	46,91**	89,63**	84,07*	94,23*	86,27	91,30
Google-Play-Movies	39,18**	84,44**	87,61	81,73	88,24	81,74
Twitter	39,18**	77,78**	76,99	81,73	75,49	82,61
Monster Trucks racing game	31,96	46,67	47,79	54,81	56,86	46,09
Google drive	24,74**	80,74**	83,18	81,73	83,33	81,74
Toy Pop Cubes	19,59	25,93	32,74	31,73	31,37	33,04
Dr. Panda School	17,53**	32,59**	29,20**	46,15**	36,27	38,26
Gdz (made homework)	12,89**	28,15**	35,40	36,54	34,31	37,39

Analysis of variance revealed significant contributions of gender and grade in IRT scores, DSS and evaluation of children's engagement with DTU by teachers (see Fig. 1). Each factor affects the digital experience's parameters separately. So all the parameters of digital experience were higher in 4th graders (F=10,34; p<0,0001). However, we found a more contradictory effect of gender on parameters of digital experience (F=6,30; p<0,0001). Girls were evaluated significantly less engaged with DTU than boys by teachers, but girls had higher IRT scores than boys. At the same time, girls and boys had the similar scores in DSS.

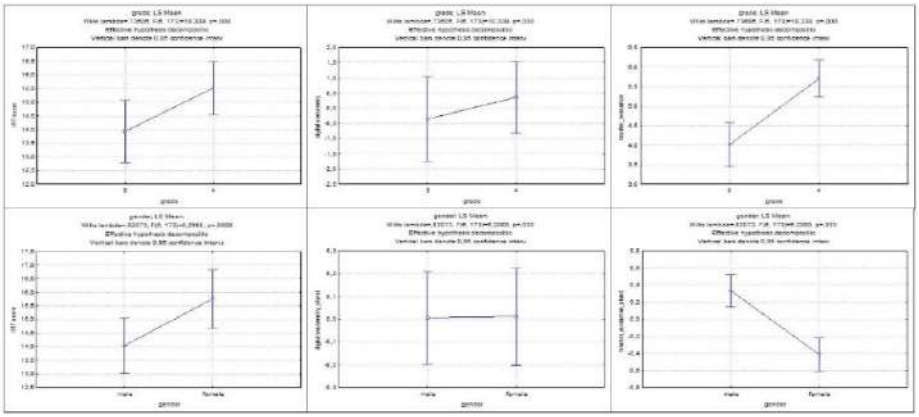

Fig. 1. Effects of gender and grade on estimation of digital experience

We also revealed significant contributions of digital experience parameters in cognition variables (see Fig.2). Children with higher IRT scores had more developed visual memory (F=2,85; p<0,05), sustained attention (F=4,42; p<0,05). They more easily disclosed causal relationships between events (F=4,04; p<0,05). Interestingly, the memory development of children who had middle DSS was higher than the rest.

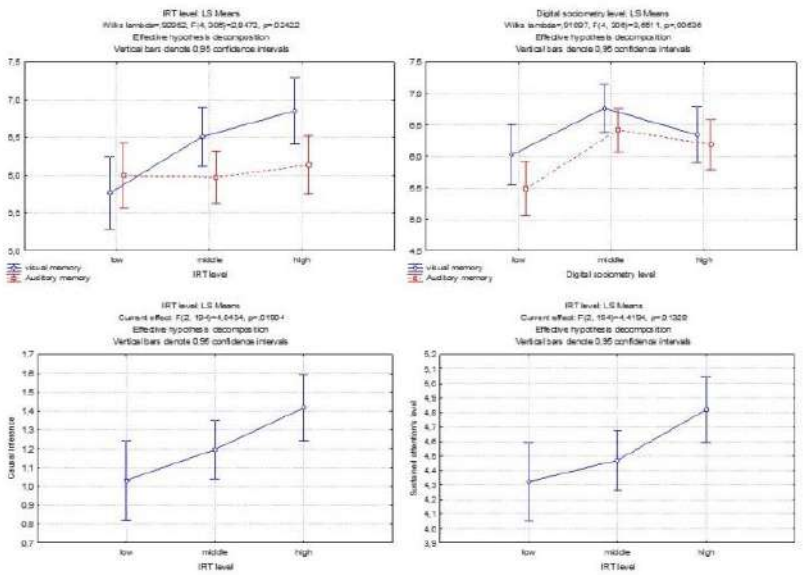

Fig. 2. Effects of digital experience on cognition

There were obtained significant correlations between IRT scores and cognition variables (see Table 2). The children who had higher visual memory skills (r=0,23, p<0,01) and higher ability to understand social situations and to draw deductive rea-

soning inferences (r=0,20, p<0,01) recognized mobile apps icons better. It is important to note that DSS and teachers' evaluations of children engagement with DTU didn't have any connection to cognition variables.

Table 2. Means, Standard Deviation, Correlation coefficients between IRT scores, DSS, teacher's evaluation of children's engagement in DTU and cognition's variables
(Note: *p<0.05; **p<0.01)

Variables	1	2	3	4	5	6	7	8	9
1. Visual memory	-								
2. Auditory memory	0,29**	-							
3. Generalization	-0,01	0,01	-						
4. Causal inference	0,27*	0,16*	0,08	-					
5. Comprehension	0,16*	0,13	0,10	0,16*	-				
6. Sustained attention	0,17*	0,25**	0,09	0,10	0,16*	-			
7. DSS	0,07	0,14	0,06	0,06	0,12	0,03	-		-
8. TE	0,10	0,02	-0,01	0,05	-0,04	0,01	0,14	-	
9. IRT score	0,23**	0,13	0,08	0,20**	0,07	0,08	0,16*	-0,02	-
Mean	6,59	5,97	3,67	1,21	5,18	1,51	-0,05	5,11	14,99
Standard deviation	1,72	1,45	0,92	0,73	1,57	1,01	6,11	2,61	5,10

The results revealed disturbingly low correlation between IRT scores and teacher's evaluation of children's engagement with DTU. But there was connection between IRT scores and DSS. The children who recognized mobile apps icons better were rated higher in DSS by other children (r=0,16, p<0,05).

Finally, we conducted analysis of variance and correlation analysis to find associations between digital experience parameters and children's learning outcomes. There wasn't significant contribution of IRT scores in average quarter grades of children (F=1,70, p>0,05). However, DSS and TE significantly contributed to average quarter grades and these contributions were opposite (See Fig.3). When children need to get advice about digital technology they seem to prefer peers who had higher learning outcomes (F=29,13, p<0,0001). When teachers evaluated children's engagement with DTU they tend to rate higher those students who had lower learning outcomes (F=4,20, p<0,05).

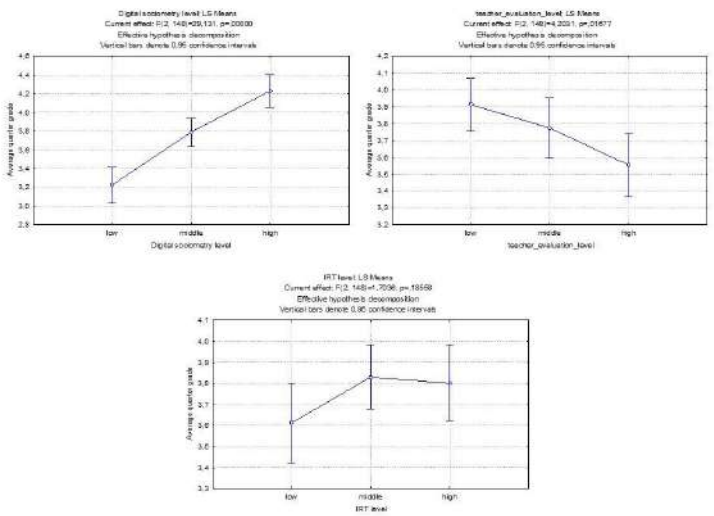

Fig. 3. Effects of digital experience on learning outcomes

Analysis of correlational matrix revealed strong associations between IRT scores; DSS and learning outcomes (see Table 3). The children who recognized mobile apps icons better had higher learning outcomes and were rated higher in their DSS.

Table 3. Means, Standard Deviation, Correlation coefficients between IRT scores, DSS, teachers' evaluations of engagement with DTU, and learning outcomes (Note: *p<0.05; **p<0.01)

Variables	1	2	3	4	5	6	7
1. IRT score	-		-				
2. DSS	0,16*	-					
3. TE	-0,02	0.14	-				
4. Reading skills	0.18*	0.41**	-0.06	-			
5. QG Language	0.19**	0.43**	-0.03	0.52**	-		
6. QG Math	0.28**	0.48**	0.02	0.56**	0.76**	-	
7. QG Reading	0.22**	0.44**	-0.08	0.62**	0.64**	0.64**	-
8. Average QG	0.26**	0.51**	-0.09	0.64**	0.90**	0.90**	0.86**
Mean	14,99	-0,05	5,11	5.41	3.49	3.68	4.22
Standard deviation	5,10	6,11	2,61	2.50	0.79	0.80	0.78

It is important to note that teachers' evaluation of children's engagement in DTU didn't have any significant correlation with children's learning outcomes.

5 Discussion

The findings of this study help to disclose some aspects of digital experience and its connections to cognitive development and learning outcomes in primary school children. The study approved hypothesis about qualitative changes in children's digital

experience after one year. In just one year the landscape of the known by children mobile apps has significantly transformed and expanded. In children's minds, mobile games give way to apps whose main functions are connected to different forms of communication and media consumption. Many children have begun to own smartphones in primary school age that let them discover digital worlds more extensively and intensively. Higher DSS of 4th graders might indicate also an intensification of communication on the topic of digital technology, as children get older. Children continue to master their digital opportunities in the field of those mobile apps which are widely used by adults. The results of the study show there is a qualitative leap in the digital experience of children who hold down in their minds not only the apps that they usually use but also apps related to them (for example, Google products apps like Google Drive). Such uneven, abrupt development of children's digital experience is confirmed by the absence of significant correlation between two points of IRT scores dimension with a gap of one year. In primary school age, none has the internal advantages of developing the digital experience even if he or she had more knowledge about mobile devices just a year before. However, adults tend to associate the digital experience with negative consequences. Their estimates do not fundamentally change throughout one year despite the qualitative transformation of the children's digital experience. Teachers attribute higher engagement with DTU to lagging students, although this connection is not evident. Importantly, there were gender differences in estimation of children's engagement with DTU caused by vulnerability of such estimates to social bias and gender stereotypes. So quality of estimation of children's digital experience by adults might be equivocal that has already been doubted in previous studies [32; 35; 36; 47].

The findings of this study have shown positive connections between the digital experience and cognitive development. We revealed connection between IRT scores and visual memory skills, sustained attention, causal inference and learning outcomes of children that approved the first hypothesis. The connections between executive functions, learning outcomes, and the digital experience raise a set of psychological questions for further research as they do not correspond with some previous studies [3; 13; 19; 25; 49] but approve others [1; 11; 21; 42; 43]. It is important to study the formation of the children's digital experience in its inseparable connection with the child mental development. G.U. Soldatova and A.E. Vishneva suggest that there may be found a golden mean for a time of Internet usage by children that could provide better support to their cognitive development [42]. The results of this study might not be approval for causal relationships between the digital experience and cognitions. We only can say that cognitive development is accompanied by enrichment of the digital experience which is its integral part in modern conditions of children's mental development.

6 Conclusion

Despite of increasing expansion of digital technologies to daily children lives there are still many open issues related to children interaction with digital devices.

In this study we revealed breadth and content of children digital experience and its associations with cognitive development and learning outcomes. We found that enrichment of digital experience is embedded in children's cognitive development since it is a part of perception, exploration, and reflection of the surrounding world. Gaining knowledge about the digital world doesn't contradict but rather supports cognitive development of children. The findings of this study may serve as a framework for the development of supporting psychological programs used in processes of digitalization and personalization of elementary education. We also suppose that this study would contribute to the development of methodological discussion dedicated to questioning how to measure the experience of children with digital devices.

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Content Analysis as a Method of Researching Spatial and Social Presence

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Abstract. This paper is the continuation of previous research presented the forms which spatial, social and personal presence (self-presence) can take. Experiencing the presence phenomenon in virtual reality is accompanied by various contradictions and temporary distortions of the natural worldview. Earlier, phenomenological description of presence based on interviews with the participants of the test was obtained. This paper offers a quantitative content analysis of those same interviews. The categories of social virtual presence and absence have been introduced, as well as social presence and absence as relatively independent categories. Social virtual presence implies the feeling of somebody being next to you in virtual reality, while social virtual absence is when a person is under the impression that there is nobody there, even if there are indications of another person's presence. This paper will treat social presence as the feeling of another person's presence nearby, which also involves having a notion of the person's exact location. Social absence will be understood as the feeling of nobody being around. When in virtual reality, a person can simultaneously experience different combinations of these states and spatial presence, by which this paper implies the feeling of physically being in a virtual environment.

Keywords: Virtual Reality, Phenomenon of Presence, Spatial Presence, Social Presence, Content analysis

1 Introduction

The distinctive feature of a person's interaction with virtual reality is the fact that a person's perception of his or her location and the location of other people may change. A person's presence in the physical world is more or less devoid of contradictions; i.e. being in a space, a person has the idea of who is nearby, what he or she can touch and where he or she can move using certain means. Distortion of these perceptions is usually connected with an altered state of consciousness. Virtual reality presents bigger and smaller opportunities at the same time. A person can be underwater while standing on an underwater cliff, but cannot touch the objects located there. One should understand that, in a sense, a collision or even an injury resulting from it also relates to the opportunities that are present in the physical world and not present in the virtual one. When in virtual reality, people decide for themselves where they are, why they can do things they could not do in the physical world and cannot do things that

they could do in the physical world. They may conclude that none of this is real and, as a result, not experience the phenomenon of presence. They may assess the environment they are in as partially real, accepting its natural opportunities as certain rules of the game, may ignore their inability to perform certain operations, and, finally, may perceive the circumstances as if they can do all the things they are able to do in the physical world. All this relates to the variations in presence phenomenon experiences.

According to [3], when in virtual reality, a person cannot fully tune out the physical world because his or her body is in it. Experiencing the presence phenomenon in virtual reality is a kind of a personal choice, at times conscious, at times not [23].

Previous papers discussed these effects in detail through the example of participants' responses in a structured interview. The method of phenomenological analysis was used, which made it possible to demonstrate manifestations of spatial, social and personal presence (Self-presence) as the versatility of contradictive notions, impossible in the real world but possible in virtual reality.

The approach underlying the series of the conducted studies, described both in the previous papers and in this one, is connected with the description of the presence phenomenon experience manifestations. This approach includes the study of individual cases, the experience of presence by each particular person. Such an approach allows us to highlight the options of a person's interaction with the surrounding space and with other people, included in the virtual reality and/or present in the same physical room. Based on the elicited options of interaction, one can further determine both the state of a specific virtual reality environment user and the developed environment itself. In the latter case, the responses of the whole group should be evaluated collectively.

The goal of this paper is the description of manifestations of different types of presence in virtual reality participants, based on content analysis of their responses to the questions of a structured interview.

The question is raised regarding the applicability of the content analysis method for processing the participants' responses during a structured interview. Will content analysis of the responses allow us to detect spatial and social presence as separate types and describe their interaction with each other?

Further, the effects emerging in virtual reality are discussed, when a person includes or excludes the notion of other people in the same virtual environment that he or she is in, who did or did not have the opportunity to manifest themselves in this virtual environment. Manifestations of spatial presence are described quite simply: as a situation when a person perceives himself or herself as being in the virtual environment. Phenomena connected with the perception of other people are more complex in their description. For example, we should separate the situation in which other people are perceived as being in the same virtual environment and the situation in which a person perceives the presence of other people in the same physical space while interacting with a virtual environment. One can define the situation in which a person perceives another person as a participant of the same virtual environment as a social virtual presence. Equally important is social virtual absence, which is not simply a situation when a person does not perceive other people in the same virtual environment, but rather a situation when a person ignores the participation of other people

in the virtual environment. The perception of other people as being in the same physical room with the person participating in a virtual environment can be defined as social presence.

This paper puts forward a hypothesis that the use of content analysis will make it possible to elicit the descriptions of such phenomena as spatial presence, social virtual presence, social virtual absence, social presence and social absence as separate recognizable categories and to demonstrate their interaction with each other.

It is of importance that, for this paper, of interest are the individual cases, certain manifestations of the presence phenomenon experience. The responses presented here do not cover all the possible options of experiencing the presence phenomenon and do not profess to give exhaustive description.

2 Modern approaches towards studying presence

For the sake of this paper, of the most interest are the papers devoted to experiencing spatial presence and its connection to the plausibility of the events taking place, as well as to experiencing social presence.

Let us recall the types of presence discussed in the paper [12]:

- spatial presence, recognized as presence in a certain space; in earlier papers, for example, in [14] it is referred to as environmental presence;
- social presence, recognized as joint presence in a certain space, as well as the sense of other people's presence nearby;
- self-presence, probably, corresponds with the notion of personal presence from earlier papers, [10], [14], [11]. Self-presence is a type of presence occurring when a person perceives the body, emotions and/or identity of a technological version of themselves as their own.

Further, this paper will use these particular types of presence.

Some authors offer their own terms, in some respect close to the types of presence. The paper [12] provides a discussion about perceptual and social real ism, which are crucial aspects of presence. Perceptual realism occurs when an environment supports actions in it, when the environment's response is perceived as plausible and adequate. Social realism refers to a more general notion: when an event, taking place in an environment, is plausible, when it can happen in the real world. A virtual environment may have high perceptual and low social realism. It can also be the other way around.

The paper [22] offers the notions of social presence and co-presence, which imply the ability of being somewhere together, perceiving other people and being perceived by them, interacting with other people. The issue is raised regarding realism and authenticity – a crucial issue in terms of this paper's discussion. Authenticity does not necessarily mean realism.

Similar ideas are expressed by M. Slater, when he talks about place illusion and plausibility [13]. As it has been mentioned before [4], according to [25], there are three main approaches to the research of presence: a mediated-objective school of thought approach, mediated-subjective school of thought approach and inner presence school of thought approach.

The first two approaches describe presence as an essential element in mediated experience. The third approach describes presence as a phenomenon that does not require median systems (VR technologies etc.).

The schools of mediated presence define presence as a perceptual illusion of non-mediation. [25] criticizes this approach, whilst stating that mediated presence schools of thought provide valid definitions for a number of notions, such as immersion and involvement. According to [25], the mediated presence approach does not provide answers to the grand questions: why do we feel presence and what is its role? Similar questions are broached by S. Triberti and G. Riva, the inner presence school of thought exponents, in their paper [26]. They also discuss the schools of mediated presence, which, according to them, do not provide answers for the questions regarding the evolutionary reason for presence phenomenon emergence, regarding its causes and its function.

Exponents of the third approach define the presence phenomenon in their papers as a conscious feeling of being in the outer world, as a phenomenon controlling the differentiation between the inner and the outer [17], [28], [21], [18], [20], [27], [19], [29], [26]. They suggest viewing presence as presence in any environment, not necessarily created with VR technology. They regard presence as the central component of conscious mental life [29]. According to these researchers [26], the feeling of presence allows continuous adaptation of one's activities in an external environment. This approach relates to the notions of intentions and actions: the more intentions the environment enables to be fulfilled, turned into actions, the stronger is the feeling of presence is.

There are other papers as well, examining presence through a broader lens, not only as presence in virtual reality. For example, [15], suggest that presence is linked with successful execution of one's intentions, with a person perceiving himself or herself as a successful author of his or her own actions. In [8] presence is defined as a personal state occurring both in real and in virtual environments, while mediation is regarded as not only a means of creating virtual reality, but any situation in general, in which actions are executed indirectly. For this reason, presence is addressed through the example of driving a car, in order to demonstrate the flexibility of this approach.

An important aspect connected with the presence phenomenon is covered in the paper [16], namely, the issue of interconnection between presence and a person's perception of his or her own movements in a virtual environment. Unlike the researchers from the school of inner presence, who suggest that a virtual environment creates unlimited opportunities, the paper [16] specifies that virtual environments are limited in comparison with the real world; in particular, movements are highly encumbered. [16] links presence and illusory own movement in a virtual environment. Experimental materials demonstrate the connection of presence with a person's perception of his or her movements in a virtual environment.

The phenomenon of presence, independent of which school's definition a researcher utilizes, is a subjective experience which involves a person interacting, in one way or another, with the surrounding reality (for the representatives of the mediated presence school of thought this would be virtual reality).

Of interest for this paper are papers by Slater devoted to transitions from the state of presence in virtual reality to presence in the real world. The paper [24] describes a new measure for presence in immersive virtual environments (Ves), based on the number of transitions from virtual reality to the real world, which are reported by the participant while his or her interaction with virtual reality. According to [23], presence may be looked at as a selection mechanism that organizes the stream of sensory data into an environmental gestalt or perceptual hypothesis regarding the current environment. The environment hypothesis is continually reverified or else a break in presence occurs.

For the purposes of measuring presence, quantitative methods are mostly used, for instance, those described in the paper [6].

The paper [5] provides a description of qualitative methods, including that of content analysis. Paper [9] uses content analysis to look for topics connected with experiencing spatial and social presence.

Paper [7] describes the results of a qualitative content analysis of immersive virtual environments (IVEs). It discusses experience acquired by a person in virtual reality, which is significantly structured by agency, when virtual reality experience causes self-directed affect, thus somewhat unintentionally engaging a player's body as a feedback site.

3 Methodology

3.1 Participants

Eighteen people were chosen for the study of the connection between presence and intellectual task accomplishment and exhibited experiencing presence in the course of the study [1].

A more in-depth description of them can be found in [2] and [4].

The experimental group included:

- 11 people (4 males and 7 females) in the experimental group, solving the task in virtual reality.
- 7 people (1 male and 6 females) in the control group, solving the task on a computer screen.

The majority of the selected participants have manifested themselves as being able to experience the presence phenomenon [2] and [4].

3.2 Study protocol: virtual environment, equipment, procedure

As was already mentioned in [2] and [4], a popular 'Grand Theft Auto: San-Andreas' game was chosen, which features both a sufficiently rich game world and the opportunity to fly a helicopter with a reasonably realistic 'behavior'.

The image was broadcasted onto Emagin Visor Z800 head-mounted display.

The participants were offered a flight over a virtual city, forest or lake, in slightly overcast weather conditions, at time scale of 1 hour = 1 minute, starting at noon and ending at 10 pm (so that the duration of stay in VR would not exceed 10

minutes). A ThrustMaster Top Gun Fox 2 Pro USB joystick was used as the controller.

For the participants to feel included into the environment they were given an opportunity to act in first-person mode, i.e. during the flight, participants did not see the helicopter or the character, as if they were 'flying over the city themselves'.

For the purposes of providing the naturalness of control, many excessive control functions were blocked (exiting the helicopter, shooting etc.), with the exception of the relatively obvious ones: joystick tilts, controlling forward – backward moves and left – right moves, and the ascending button, which, when pressed, enables you to gain altitude and when released – to go down.

The participants were also able to move through the fog and clouds, which helped intensify the sensation of movement through the environment [2] and [4]. Emagin Visor Z800 does not provide full isolation, so the overhead lights in the physical room where the test took place were turned off to minimize the number of distracting visual stimuli.

Special conditions were also created, in which the effect of these factors was intensified, and the conditions in which the effect of these factors was mitigated (except the realism, which remained at the same level throughout the entire test: the level provided by the 'Grand Theft Auto: San-Andreas' game).

The participants were offered two episodes, with a small break in between. In one of the episodes, they were piloting the helicopter themselves, and in the other episode, the operator piloted the helicopter. The choice of delivery order was random.

In addition, some of the participants (randomly chosen) had the opportunity to give commands to the operator during the passive episode. In the active episode, some of the participants were intentionally exposed to difficulties with joystick control: its response level to tilts dropped, which led to delayed reaction of the system to the participant's actions.

These episodes will be further referred to as:

- 'fully functional activity' (an active episode with controlling the flight without additionally introduced obstructions),
- 'activity with reduced sensitivity' (an active episode, where flight control was hampered by reduced sensitivity of the joystick),
- 'flight with oral control' (a passive episode, where a participant could give commands to the operator regarding the direction of flight for the helicopter; if a participant did not give commands, the helicopter remained at one spot) and
- 'flight without control' (a fully-passive episode, where the operator made his own decisions in directing the virtual flight).

Participants were given a task to fly around the city following the special marker rings that were located in the sky; however, if they got off track and lost the rings or flew in the other direction, this was not considered a failure. The main goal was the flight itself and observation of the views [2] and [4].

3.3 Interview: questions and discussion

When both episodes were completed, the participants were interviewed and asked questions relating to their impressions, their expectations and fears connected with the virtual environment.

In general, the interview is divided into several main blocks. The first block is conditionally labelled as environmental or spatial and includes questions connected with expectations regarding the environment (for instance, whether the participant had expected the opportunity to touch virtual objects or the possibility of these objects touching him or her). The first block also includes questions connected with the participant's notion of his or her own location: in the virtual environment, in the physical room where he or she really is, or, possibly, both at the same time.

The second block, conditionally labelled as social, refers to other people or a person in the same room. Depending on the possibilities of the environment, this block may include only questions of whether the participant had remembered about the location of other people in the room, or it may also feature questions about the notion of other people in the virtual reality.

As part of this research, the participants were asked about their perception of their own location: whether they were in the air, in the helicopter, in the real room (where the test took place), or simultaneously in the room and in the helicopter. In their opinion, who controlled the helicopter (in cases where the helicopter was controlled by the operator): the operator, a character from the environment, or did the helicopter act on its own? In what way was the operator controlling the helicopter perceived: as an environment character; as a person from another (real) world, controlling the helicopter from there; as an instrument; or did the participant not think about it? Where, in participants' opinion, was the experimenter (or the experimenter together with the operator) in case of the independent flight? Nearby in the helicopter? Nearby in the real room? Did the participant think of them at all? Were they nonexistent at all to him or her? The questions were asked in no particular form, in the course of conversations with participants, with reference to the events occurring while interacting with the virtual environment.

The participants' responses have been subjected to phenomenological analysis the results of which are described in [2] and [4], as well as to content analysis, the outcomes of which are given below.

3.4 Content analysis

Quantitative content analysis of the participants' responses to the structured interview has been performed. Content analysis was performed by a group of experts including a specialist in the field of method conformance inspection, with vast experience in analyzing texts, and a specialist in the field of computer psychology.

The procedure of the analysis involved several stages.

The first stage involved experts determining which elements can be ascribed to the topic of spatial and social presence. The decision was based on the context that had been created by the participant's preceding words or questions from the experimenter

in the course of the interview. At this stage, experts defined the categories within which word count was to be carried out:

- Spatial presence, which covered all the responses where participants directly confirmed their feeling of being in the virtual environment, and responses in which they reported their location being in the sky, in the helicopter, their expectations when touching virtual objects etc. – Social virtual presence, which included all the references to other actors of the virtual environment, regardless of whether the participant associated them with real people or not.
- Social virtual absence, which included all the cases when the participant directly denied the presence of other people in the virtual environment, even though he or she had interacted with them. For instance, the participant claimed giving voice commands directly to the helicopter, not to the operator, or asking questions, but claimed he or she had been doing that into the void.
- Social presence, including all the cases when the participant noted the presence of other people nearby in the real world ('You were here, in the room'.).
- Social absence, when the participant forgot about other people present nearby in the room (maybe, for a while).

The difference between social virtual absence and social absence is that in the case of social virtual absence other people influenced the events in the virtual environment (in our test, the operator was piloting the helicopter and obeyed commands), but the participant 'forgot' about their participation; while in the case of social absence, the participant simply 'forgot' that other people were in the same room with him or her.

The third stage involved counting the observation units included in a certain category. A word from the fragment of a response, dealing with the chosen topic, was considered a unit of measure; whether the word is a noun, an adjective, a verb, a particle, a conjunction or a preposition was of no significance.

For instance, in the following dialogue, the 'spatial presence' category featured seven words (the experimenter's questions in this case are not considered an element of the text, although they may provide context): *Did you have any expectations of the environment? Headwinds, branches grazing?*. – 'With the branches – yes'. – *Like what?* – 'That they will lash, or there will be a sound'.

Some words fell into several categories at the same time; for instance, the information about the experimenter seen with peripheral vision belonged simultaneously to the negative statements of spatial presence, being a part of the real world, and to social presence, because the participant admitted the presence of another person near. A number of controversial cases, when it was impossible to determine, for example, whether these words really describe spatial presence or are a description of the virtual environment as a picture, were not included into any category.

The responses of one of the female participants were excluded from the content analysis because they were recorded as a summary, not a verbatim transcript.

During the fourth stage, for the purposes of evaluating spatial presence, the coefficient of imbalance was calculated, where all the statements confirming the presence hypothesis were considered positive, and all the statements relating to the feeling of being in the real world (from direct claims to references of circumstances,

such as a knock on the door or catching a glimpse of the screen or even the experimenter with peripheral vision) were considered negative.

In order to assess social virtual presence, social virtual absence, social presence and social absence, the specific weight was calculated.

The fifth stage was the interpretation of the results and it is described in the following section.

4 Results and discussion

Results of content analysis can be observed in Table 1. As previously noted, the coefficient of imbalance was calculated for spatial presence, defining the representation of statements in the text relating to this type of presence. Positive meanings correspond with those self-reports in which the participants mainly claimed having experienced spatial presence. Negative meanings correspond with self-reports in which the participants mostly claimed not having experienced spatial presence, either by stating it directly or by describing impressions from the real world. It should be noted that social virtual presence and the state which we will refer to as 'social virtual absence', in the same way as social presence and social absence, are not directly opposed to each other. For this reason, specific weight is calculated separately for each of them. It is assumed that, to ignore another person's presence nearby, efforts are required, probably, non-conscious ones, that is why absence should be considered a special state, not just a negation of presence.

As this paper focuses on individual cases, neither the coefficient of imbalance, nor the specific weight of certain categories was calculated for the group – only for each participant separately. However, in other studies, when evaluating the intensity of the feeling of presence (be it spatial or social presence) caused by the environment, the calculation of these coefficients for the group as a whole may be carried out.

The numeration of participants in Table 1 corresponds with the numeration used in previous research [2] and [4].

The participants' responses differed in the total number of words. Some responded briefly, others gave detailed answers. Table 1 shows that both the coefficient of imbalance ratios, calculated for the spatial presence category, and the specific weight ratios, connected with the sphere of social presence, are relatively low. This can be explained by the fact that participants not only answered the questions regarding their presence experience given by the experimenter, but also expressed their impressions, associations, gave examples from personal experience, not connected directly with the events happening during the experiment.

Before analyzing the acquired ratios, mean values should be calculated, as well as the relative range of variability, see Table 2. Before the calculation, the ratios of those participants, whose coefficient of imbalance, calculated for spatial presence, turned out to be below zero, were excluded from the selection, because negative ratios indicate the prevalence of responses stating the fact that they had not experienced spatial presence.

Table 1. Content analysis results

#	Total number of words uttered during the interview	Coefficient of imbalance, c	Specific weight, K			
		Spatial presence	Social virtual		Social	
			Presence	Absence	Presence	Absence
1	1213	0.241	0.070	0.012	0.013	0.007
2	428	-0.112	0	0	0.033	0.026
3	794	0.135	0	0	0.106	0.016
4	389	0.115	0.044	0.039	0.062	0.018
5	970	0.073	0.026	0.005	0.019	0.004
6	498	0.454	0	0.026	0.032	0.038
7	519	0.430	0	0.104	0.037	0.008
8	351	0.033	0.020	0	0.011	0
9	534	-0.202	0	0	0.099	0
10	177	0.021	0	0.073	0.040	0
11	144	0.090	0.014	0	0.042	0.160
12	658	-0.041	0.076	0	0.102	0
13	–	–	–	–	–	–
14	114	0.087	0	0.088	0.018	0
15	770	-0.085	0.003	0.031	0.009	0.004
16	655	0.280	0	0	0.108	0.070
17	418	0.013	0.017	0	0	0.012
18	565	0.108	0.156	0.014	0.062	0.021

Table 2. Statistical processing of the content analysis results

Statistical ratios	Coefficient of imbalance, c	Specific weight, K			
	Spatial presence	Social virtual		Social	
		Presence	Absence	Presence	Absence
Average	0.160	0.027	0.028	0.042	0.027
Max	0.454	0.156	0.104	0.108	0.16
Min	0.013	0	0	0	0
Max-min	0.441	0.156	0.104	0.108	0.16
Relative range of variability, %	36.3	17.1	26.7	39.2	17.0

A low level of the relative range of variability of the measured parameters indicates sufficient conformance of the sample group selection with all the parameters: the coefficient of imbalance, calculated for the spatial presence, and the specific weight for the social virtual presence, social virtual absence, social presence and social absence.

Of principal interest during the analysis of the results are, obviously, the participants with the maximum level of spatial presence. There were two such participants: participant 6 (female), with c = 0.45, and participant 7 (female), with c = 0.43, fol-

lowed by participant 1 (female), with $c = 0.24$ and participant 16 (female), with $c = 0.28$. All the four participants demonstrated the coefficient of imbalance above average.

Some participants show negative values for the coefficient of imbalance calculated for spatial presence. This is participant 2 (male), with $c = -0.11$, participant 9 (female), with $c = -0.20$, participant 12 (male), with $c = -0.04$, and participant 15 (female), with $c = -0.09$. This means that denial of spatial presence prevailed in their responses over the statements indicating them having experienced spatial presence.

Participant 1 (female) demonstrated the specific weight for social virtual presence $K_{\text{social virtual presence}} = 0.07$, which is significantly higher than the average in the group. The specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0.012$, which is below average. This shows that participant 1, mostly perceiving herself as present in the virtual environment, included other people into the virtual environment as well and did not forget about their influence on the virtual environment events. The specific weight of social presence was $K_{\text{social presence}} = 0.013$. This is significantly lower than the average in the group. The specific weight of social absence was $K_{\text{social absence}} = 0.007$, which is significantly lower than the average. This means that in the participant's responses the presence or absence of other people nearby did not take a lot of place.

Participant 6 (female) demonstrated the specific weight of social virtual presence $K_{\text{social virtual presence}} = 0$, which is significantly lower than the average. Her specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0.026$, which is proximal to the average. This means that participant 6, perceiving herself as significantly present in the virtual environment, did not include other people into this virtual environment, but did not ignore their influence on the events either. The specific weight of social presence was $K_{\text{social presence}} = 0.032$, which is below average in the group. The specific weight of social absence was $K_{\text{social absence}} = 0.038$, which is above average in the group. This means that participant 6 forgot about the fact that other people were near her in the physical room.

Participant 7 (female) demonstrated the specific weight of social virtual presence $K_{\text{social virtual presence}} = 0$, which is significantly below average. The specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0.104$, which is significantly higher than the average and is the top value in the group. This shows that participant 7, while perceiving herself as present in the virtual environment, did not include other people into this environment and ignored their influence on the events in this environment. The papers [2] and [4] demonstrate that the participant thought that she was giving commands directly to the helicopter. This case is one of the examples of contradictory experiences when interacting with virtual reality. The specific weight of social presence was $K_{\text{social presence}} = 0.037$, which is slightly lower than the average in the group. The specific weight of social absence was $K_{\text{social absence}} = 0.008$, which is significantly below average in the group. This shows that participant 7 noted the presence of other people in the same room but did not pay much attention to them.

Participant 16 (female) demonstrated the specific weight of social virtual presence $K_{\text{social virtual presence}} = 0$, which is significantly lower than the average. The specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0$, which is signif-

icantly below average. This shows that participant 16, while perceiving herself as present in the virtual environment, did not include other people into this environment, and did not ignore their influence on the events of the environment either. The specific weight of social presence was $K_{\text{social presence}} = 0.108$, which is significantly higher than the average and is the top value in the group. The specific weight of social absence was $K_{\text{social absence}} = 0.07$, which is significantly higher than the average in the group. This shows that, while perceiving herself as present in the virtual environment, she did not include other people into this environment, feeling their presence nearby at one moment and forgetting about them the next moment. This result is an example of contradictory experiences when interacting with virtual reality.

Participant 18 (female) demonstrated the top value of the specific weight of social virtual presence in the group. Her values of spatial presence are below average, with $c = 0.108$. Her specific weight of social presence was also above average, with $K_{\text{social presence}} = 0.62$. This means that, despite the fact that participant 18 perceived herself as not strongly present in the virtual environment, she simultaneously included other people into the virtual environment and remembered about their presence in the same physical room. This is another example of contradictory experiences when interacting with virtual reality.

Further, we are going to examine the correspondence between the negative values of the coefficient of imbalance, calculated for spatial presence, and the types of social presence. Participants 2, 9, 12 and 15 gave responses indicating the fact that they had perceived themselves as present in the real, physical room more than in virtual reality.

Participant 2 (male), with $c = -0.11$, demonstrated the specific weight of social virtual presence, $K_{\text{social virtual presence}} = 0$, which is significantly below average in the group, and the specific weight of social virtual absence $K_{\text{social virtual absence}} = 0$, which is significantly lower than the average. This means that participant 2 did not perceive himself as present in the virtual environment, did not include other people into it, but did not ignore their influence on the events of the virtual environment. The specific weight of social presence was $K_{\text{social presence}} = 0.033$, which is below average. The specific weight of social absence was $K_{\text{social absence}} = 0.026$, which is proximal to the average in the group. Thus, despite the fact that participant 2 did not perceive himself as present in virtual reality, he was inclined to ignore the presence of other people nearby.

When analyzing the responses of participant 9 (female), a contradiction arises between the results of the phenomenological analysis and the content analysis. She, see [2] and [4], gave responses regarding spatial presence, from which it was clear that she perceived herself at times in the virtual world and at times in the real world; however, the results of the content analysis indicated the negative values of the coefficient of imbalance, $c = -0.202$. The specific weight of social virtual presence was $K_{\text{social virtual presence}} = 0$, which is significantly lower than the average in the group, and the specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0$, which is significantly lower than the average. This means that participant 9 did not include other people into the environment either and ignored their influence on the events of the environment. Her specific weight of social presence was $K_{\text{social presence}} = 0.099$, which is significantly higher than the average in the group. The specific weight of social absence

was $K_{\text{social absence}} = 0$, which is significantly lower than the average. Thus, participant 9 did not forget about the presence of other people near her.

Participant 12 (male), $c = -0.041$, demonstrated the specific weight of social virtual presence, $K_{\text{social virtual presence}} = 0.076$, which is significantly higher than the average in the group. The specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0$, significantly lower than the average in the group. This means that participant 12, although mostly perceiving himself as present in the physical room, not in virtual reality, included other people into the virtual environment and did not ignore their influence on the events of the virtual environment. The specific weight of social presence was $K_{\text{social presence}} = 0.102$, which is significantly higher than the average in the group. The specific weight of social absence was $K_{\text{social absence}} = 0$, which is significantly lower than the average. Thus, participant 12 did not forget about the presence of other people near him.

Participant 15 (female), $c = -0.085$, demonstrated the specific weight of social virtual presence, $K_{\text{social virtual presence}} = 0.003$, which is significantly lower than the average in the group. The specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0.031$, which is above average in the group. Thus, we can assume that, although participant 15 did not perceive herself as present in the virtual environment and did not include other people into it, she mostly ignored the influence of other people on the events of the virtual environment.

It should be mentioned that participant 11 (female) demonstrated the highest specific weight of social absence in the group, although her other indicators do not stand out. We can assume that the fact of forgetting about other people itself is not necessarily connected with intense spatial presence.

It should be noted that by no means all the participants" responses can be regarded as striking examples of the presence phenomenon experience. This is because not all the participants of the experiment had intense or contradictory experiences.

Another outcome of this paper is the division into social virtual and social presence. Social presence is a phenomenon that does not require immersion into virtual reality; it occurs when a person feels there is somebody else near. Social presence is a crucial phenomenon that, essentially, allows communication between people. It does not always correspond with reality. A person may be involved in his or her work, may even be in virtual reality, feeling somebody nearby, while the other person has already left the room. Experts testing computer games in virtual reality demonstrate how often the feeling of another person's presence nearby fails them, when they are about to point out an important element of virtual reality, but the colleague, who had been present at the beginning of their work, has already left.

There is one more crucial aspect of social presence, understood here as the feeling experienced by a VR user of another person's presence in the same real-life room as he or she is. It lies in the fact that experiencing social presence indicates at the same time a low level of spatial presence experience. This is due to the fact that another person is, undoubtedly, a part of a physical world, and realizing his or her presence nearby 'yanks' the person out of the virtual environment. However, this connection is indirect, which is indicated by the results of the previous papers [2] and [4]

and is supported by the results of content analysis (participant 3 shows high level of spatial presence and big specific weight for social presence).

Social virtual presence, as the name suggests, occurs only in virtual reality. As shown by these and further experiments, to experience social virtual presence it is not necessary for a real or virtual partner to be present in virtual reality. The paper [3] shows the way a participant imagined the presence of another person in virtual reality.

No less remarkable is the distinction of social virtual absence and social absence as independent terms. Our previous paper [2] and [4] has already discussed 'social absence', but this term included both social virtual and social absence. However, it is crucial to separate them. Social absence can be described as a feeling of nobody being around. It can be explained as 'a person not noticing anyone around them'. As can be seen from the example of participant 11 (and everyday life experience indicates the same), social absence is not necessarily connected with high spatial presence. Perhaps, it can be caused by intense involvement. Social virtual absence is a feeling when a person denies the presence of the other person with whom he or she is interacting, as demonstrated in [2] and [4].

5 Conclusion

The method of content analysis applied to analyzing the responses of the participants in the structured interview has shown interesting results, supporting and extending the outcomes of the phenomenological analysis. It is important to realize that not all people who have experienced interaction with virtual reality will necessarily report experiencing the presence phenomenon. This explains the fact that not all the participants provided results with high coefficients of the types of presence in question. It should be noted, that content analysis provides results not only in the form of acquired coefficients. In the process of distinguishing categories, one can elicit crucial notions, uncovering the details of experiencing the presence phenomenon. In this case, the notions of social virtual presence, social presence and social absence have been identified as separate, stand-alone experiences.

The specific feature of this paper is the fact that another person (the operator), physically present in the same room as the participant and not visually presented in the virtual environment, influenced the events of the environment by controlling the virtual helicopter in one of the two episodes. In a number of cases, participants interacted with him, giving him oral commands; in other cases, they were deprived of the possibility to give commands. Social virtual absence can be applied to this research: it is the denial of the fact that the helicopter was controlled by the operator, not a mechanism or a program. In other environments, it can manifest itself in other ways or not manifest itself at all.

This paper uses content analysis individually, because the experiences of each separate participant are under the magnifying glass. As can be seen from previous papers and from the content analysis results, each person reacts differently to the same environment: what may disturb and distract one person, may have no influence on another person's experiences.

However, changes in the environment and in the interaction scenario may alter the experiences, increasing the probability of experiencing certain types of presence. In order to understand the extent to which changes in the environment and in the interaction scenario differ, content analysis has been applied to the responses of the whole group.

Based on the defined categories, one can see manifestations of both contradictory experiences, such as in participants 7, 16 and 18, when a person's notion of his or her location contradicts his or her notion of the location of other people, and non-contradictory experiences, as in the other described examples.

Content analysis has shown that a person can perceive himself or herself as present in the virtual environment and, while interacting with other people who influence the virtual reality but are not presented there as an avatar, ignore this influence and his or her own interactive actions. While perceiving himself or herself in the virtual environment, he or she can at the same time understand that there are other people nearby, in the same physical room. A person can simultaneously include other people into the virtual environment and remember about their presence nearby, in the physical space.

In the course of content analysis, such phenomena have been detected as experiencing spatial presence, social virtual presence, social virtual absence, social presence and social absence; interaction between them has been demonstrated, which proves the hypothesis put forward in the introduction.

Obviously, applying content analysis to the responses of a structured interview devoted to virtual reality experiences has its limitations and issues that need to be addressed. First, the question arises of what should be regarded as one message subject to analysis. In this case, the summation of all the responses of a participant in the course of the interview was chosen as one message. That is why presence values calculated in the course of the content analysis turned out to be quite low. Another important issue is the absence of clear criteria for high and low values. In this paper, the results of each participant were compared to the average value. Apart from that, in those cases when participants noted perceiving themselves in the virtual environment and in the room where the experiment took place, the results of the content analysis could indicate the fact the a participant had not experienced spatial presence.

This paper does not discuss the influence of the program providing the virtual scene, the VR devices, and the scenario of possible events and individual features of the participants on experiencing the presence phenomenon, because the focus is on the method that allows detection of ways in which a person can interact with space and perceive other people. One cannot suppose that users of other virtual environments will necessarily experience the same effects as described in this paper. However, one can be sure that this method makes it possible to detect manifestations of the effects connected with spatial interactions and perception of other people. Naturally, when evaluating the developed environment by means of content analysis, be it educational, academic or entertaining virtual reality, requirements are raised for the selection of a participants sampling group, for its representativeness and compliance with the environment's target audience.

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Psychological Determinants of Cyber-aggression in Institutionalized Adolescents

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Abstract. The article presents the results of a study aimed at the analysis of psychological determinants of cyber-aggression in institutionalized adolescents, in comparison with peers who live in parental families. Data collection was carried out with Cyber-Aggression Typology Questionnaire, Strengths and Difficulties Questionnaire, Buss-Perry Hostility Inventory, Questionnaire for assessment of the adolescents' experience of online communication. The study involved 248 adolescents aged 13-16 years, 32.6 % institutionalized adolescents from orphanages. The results suggest that the institutionalized adolescents more distinctly tend to cyber-aggression, which is more closely correlated with problem behavior, in comparison with their peers. At the same time, cyber-aggression of girls-orphans is hardly determined by emotional and behavior problems, while institutionalized boys' cyber-aggression could be a manifestation of hyperactivity.

Keywords: institutionalized adolescents, orphanages, cyber-aggression, predictors of cyber-aggression, problem behavior, aggression.

1 Introduction

Despite the efforts for the family placement of children living without parental care, nowadays more than 70000 children and adolescents live in orphanages in Russia (according to Ministry of labour and social protection of the Russian Federation for 2019). Psychological studies of the development of institutionalized adolescents who deprived of parental care indicate the hardships in their socialization, as well as various difficulties of adaptation to independent life at post- institutionalized stage. Orphaned adolescents often have poor experience and deficient communication skills. The Internet provides great opportunities for communication, socialization in different groups, expansion of social experience, so it could be an important resource for developing of orphans' social skills [6; 26]. Today institutionalized adolescents usually have daily access to the Internet and actively use the opportunities of the Internet, mainly for leisure and communication [1]. However, there are no studies aimed at analyzing the quality of orphans' online communication, despite of the fact that or-

phans' psychological traits could contribute to decrease the benefits of using the Internet and increase its negative effects [19]. According to recent research, one of the main online risks for Russian adolescents is online aggression [36]. Adolescents often become victims of cyber-aggression as well as they actively use aggressive communication in the Internet themselves. Therefore, our study examines the spread of cyber-aggression in online communication of institutionalized adolescents and its psychological causes, in comparison with adolescents from parental families.

2 Psychological determinants of cyber-aggression in adolescents

2.1 Cyber-aggression as a form of online behavior in adolescence

Cyber-aggression is the deliberate harm to other Internet users to assert one's own personal significance [15, 39]. Cyber-aggression differs from "face-to-face" aggression significantly, On the one hand, this difference is determined by the peculiarities of the Internet space. Cyber-aggression can be initiated by aggressor from anywhere and at any time [25]. A wide audience witnesses cyber-aggression, and the actions of the cyber-aggressor can be supported by the activity of other users voluntarily or unwittingly [23]. On the other hand, there are several psychological peculiarities of online communication such as the anonymity and distorted feedback, which contribute to decreasing self-censorship and to increasing the number of aggressive actions as well as underestimating the harm for a victim [5; 28; 37]. Moreover, cyber-aggression is less visible for parents and teachers, and adolescents feel freer to demonstrate aggressive actions in the Internet [16, 36].

Cyber-aggression manifests in various forms of online behavior such as sending humiliating messages, public insults, spreading rumors, damaging personal photos, etc. [10]. These actions could be aimed at causing victim to have negative emotions (proactive cyber-aggression) or at responding to victim's provocative behavior (reactive cyber-aggression) [11]. According to K. Runions [31], it is possible to describe cyber-aggression of adolescents by clarifying their motivational goals (appetitive or aversive cyber-aggression) and abilities to behavioral self-control (impulsive or controlled cyber-aggression). This model suggests four forms of cyber-aggression in adolescence: rage (impulsive-aversive form of cyber aggression), revenge (controlled-aversive form of cyber aggression), rest (impulsive-appetitive form of cyber-aggression) and waiting for a reward (controlled-appetitive form of cyber-aggression) [30]. Impulsive forms of cyber-aggression probably decrease with adolescents' growing up, while controlled forms of cyber-aggression persist and obtain defensive functions [36].

Special attention should be paid to the psychological prerequisites of cyber-aggression in adolescence. Empirical studies suggest that cyber-aggression is associated with high rate of aggression "face-to-face" [28], as well as low level of empathy [7], emotional intelligence [42], self-control [38] and moral awareness [8].

Adolescents who demonstrate cyber-aggression often tend to deviant behavior and other behavioral problems [9] as well as Internet addiction [42].

The number of cyber-aggressive actions increases with emotional stress [41]. In addition, the psychological background of cyber-aggression differs for boys and girls, while the number of cyber-aggressive actions is about the same level [33; 40; 42]. Every form of cyber-aggression is probably determined by specific psychological factors [30] but empirical data are too generalized, therefore the psychological prerequisites of different forms of adolescent cyber-aggression are not still identified.

2.2 Psychological characteristics and online behavior of institutionalized adolescents

Today, there are no psychological studies of the cyber-aggression of institutionalized adolescents. At the same time, there are enough information about those psychological characteristics of orphans, which are usually considered as psychological prerequisites for cyber-aggression. This information suggests that the determinants of orphaned adolescents' cyber-aggression probably differ from their peers.

Thus, researchers identify a special type of personality of institutionalized adolescents. These adolescents demonstrate poor development of self-control, predominance of reactive behavior, orientation to external control, tendency to overly emotional response, resentment [29]. They differ from their peers by a high level of aggression [27] as well as tendencies to anger [4] and depression [24]. At the same time, their emotional intelligence and self-control are often poorer in comparison with adolescents from parental families [34]. The prevalence of behavioral and emotional problems among institutionalized adolescents exceeds the problem level among their peers by 2-5 times. The similar data are obtained by surveys of adolescents-orphans in India [20], Egypt [13], Turkey [35], Pakistan [2].

Russian researchers note that online communication is one of the main forms of institutionalized adolescents' online activity [1], although their needs for online communication are lower than among their peers, probably because their social circles are more narrow, and most of their friends are available "face-to-face" [21]. Orphaned adolescents are at risk of problematic Internet use, since the Internet often becomes a source of compensation for the orphans' specific needs such as emotional discharge, self-affirmation, formation of attachments, etc. [12]. However, they usually do not have sufficient communication skills and choose non-constructive ways of communication associated with manipulation and pressure, which often appear in the aggressive actions [3]. Thus, we can assume that these psychological characteristics of institutionalized adolescents contribute to developing cyber-aggression in online communication, but this hypothesis requires empirical testing.

3 The present study

This study was aimed at analyzing the psychological determinants of cyber-aggression of institutionalized adolescents, in comparison with peers who live in pa-

rental families. The first hypothesis posited the prevalence of cyber-aggression in orphaned adolescents. We hypothesized that adolescents-orphans more often show aggression in online communication as well as become victims of cyber-aggression. According to the second hypothesis, the severity of appetitive and aversive cyber-aggression in orphans persists throughout adolescence, while in their peers it decreases as they become older. Finally, we predicted that cyber-aggression of institutionalized adolescents is stronger determined by emotional and behavioral problems than of their peers.

3.1 Participants and procedures

248 adolescents aged 13-16 participated in the study (M=14.56; SD=0.79, 51.2 % female), among them 81 institutionalized adolescents-orphans *IA* (M=14.24; SD=0.61, 43.2 % female) and 167 adolescents who live in parental families *FA* (M=14.79; SD=0.72, 54.5 % female). Institutionalized adolescents lived in orphanages and studied at ordinary schools. The study was realized in St.-Petersburg and Leningrad region in 2019. Participants took part in the study voluntarily, everyone had informed consents of parent (for adolescents from parental families) or director of the orphanage (for institutionalized adolescents). The survey took them about 40 minutes.

3.2 Measures

3.2.1. Cyber-Aggression Typology Questionnaire

Cyber-Aggression Typology Questionnaire was developed by K. Runions et al. for assessment of the tendency to cyber-aggression and its leading motives [30]. The questionnaire takes into account two dimensions of cyber-aggression (aversive/appetitive and controlled/impulsive) and provides to assess different motives of cyber-aggression such as impulsive-appetitive, impulsive-aversive, controlled-appetitive and controlled-aversive cyber-aggression as well as the general tendency to cyber-aggression. The authors' version of the questionnaire includes 29 items which requires the assessment with 5-point Likert scale (from 1 – "almost never" to 5 – "constantly"). For current study, this questionnaire was translated into Russian and its structure was verified by exploratory factor analysis. Factor analysis did not confirm the four-component structure of the questionnaire for our sample. Attempts to allocate four factors produced unsatisfactory resulting factor loads ($\geq$0.27 for first and second factors but $\leq$0.06 for third and fourth factors). Finally, two factors were identified. These factors combined 20 items of the questionnaire (see Table 1).

Thus, for our sample, only one dimension of cyber-aggression was relevant, which allowed distinguishing its appetitive and aversive forms. These factors were used as the scales of the questionnaire for current study: the scale of appetitive cyber-aggression (min=10, max=50; Cronbach alpha 0.95; d=0.12, p>0.20) and the scale of aversive cyber-aggression (min=10, max=50; Cronbach alpha 0.94; d=0.13, p>0.20).

3.2.2. Strengths and Difficulties Questionnaire

Strengths and Difficulties Questionnaire is aimed at assessment of problem behavior in children and adolescents [17]. This questionnaire was adapted and validated for Russian sample [18]. It includes 25 items evaluated with 3-point scale (from 0 – "not

about me@ to 2 – "exactly about me"). The items are equally distributed to five scales: "Emotional symptoms", "Behavior problems", "Hyperactivity / inattention", "Problems at communication with peers" and "Prosocial behavior" (min=0, max=10). The total indicator of problem behavior is calculated by summarizing of "Emotional symptoms", "Behavior problems", "Hyperactivity / inattention", "Problems at communication with peers" (min=0, max=40). For current study, we used a version for adolescents' self-assessment. This questionnaire is widely used in different countries and it shows its relevance to survey problem behavior of institutionalized adolescents who could have hardships with behavioral self-assessment [20; 13].

Table 1. Factor loading and factor structure of Cyber-Aggression Typology Questionnaire (Note: F1 – appetitive cyber-aggression, F2 – aversive cyber-aggression)

Items	F1	F2
If I get teased or threatened, I get angry easily and strike back online right away	0.36	**0.70**
If someone makes fun of me on the internet, I get frustrated and respond angrily online right away	0.36	**0.71**
I overreact before I have a chance to think about the consequences when someone says something mean online	0.25	**0.81**
If someone says something online to hurt me, I post something back right away to get back at them	0.26	**0.78**
If somebody criticizes me online or in a text, I often react aggressively without thinking of the consequences	0.40	**0.75**
I hastily respond to something written online and regret it later	0.33	**0.75**
I respond very quickly to a message or post that is disrespectful to me	0.36	**0.65**
I get back at people who make fun of me on the internet because their posts hurt more the more I think about them	0.25	**0.75**
I like using my ICT device(s) to plan my revenge when I feel angry at someone	0.44	**0.63**
If I need to get revenge on someone, I would rather strike back using my ICT device(s) where I can plan out how to do it	0.48	**0.66**
Sometimes I'll team up with my friends to bring someone down online	**0.76**	0.38
Sometimes I can be mean to people online to get what I want	**0.82**	0.36
When I don't like a person, I use the internet to make them feel like they do not belong in my group	**0.64**	0.53
I pretend to be someone else online to ruin somebody else's friendships	**0.69**	0.51
I have at times used the internet to make someone look like bad	**0.79**	0.33
I get carried away having fun online and others think I'm being a cyberbully or a troll	**0.77**	0.41
I make fun of people I don't know on the internet without thinking about whether they will see it or not	**0.72**	0.42
If I'm having fun and joking online, I don't care if someone's feelings get hurt	**0.80**	0.17
I repeatedly annoy people online because I think it's funny	**0.68**	0.45
Joking online is so much fun that I don't worry about whether someone might be bothered by what I say	**0.76**	0.29
Explored variance	6.87	6.78
Unique Variance Accounted for by Factors	0.34	0.34

3.2.3. Buss-Perry Hostility Inventory

Buss-Perry Hostility Inventory (adopted by S. N. Enikolopov and N. P. Tsibulsky [14]) allows evaluating three components of aggression: instrumental (physical aggression), affective (anger) and cognitive (hostility). This questionnaire contains 24 items assessed with 5-point Likert scale. In general, the questionnaire can be scored from 24 to 120 points, including 9-45 points for "physical aggression", 7-35 points for "anger" and 8-40 points for "hostility". This questionnaire is relevant to vulnerable groups of adolescents, including adolescents-orphans.

3.2.4. Questionnaire for assessment of the adolescents' involvement in online communication

Questionnaire for assessment of the adolescents' involvement in online communication was developed for current study. It includes 4 questions: 1) How many hours a day are you online? ("less than one hour"; "1-3 hours"; "4-8 hours"; "8 hours or more"); 2) How many hours do you spend for online communication in social networks, chats, forums? ("less than one hour"; "1-3 hours"; "4-8 hours"; "8 hours or more"); 3) How often do you demonstrate aggression in online communication? ("never"; "rarely"; "sometimes"; "often"; "constantly"); 4) How often do you receive aggression from other Internet users? ("never"; "rarely"; "sometimes"; "often"; "constantly").

3.3 Data Analysis

Data analysis included comparison of the IA and FA samples by Fisher's test ϕ^* and Student's test, t (with a preliminary estimate of the distribution by the Kolmogorov-Smirnov criterion, d), as well as correlation analysis (Spearman's correlation coefficient, r_s) and multiple regression analysis to assess the impact of psychological factors to cyber-aggression in institutionalized and non-institutionalized adolescence. These calculations were computed by IBM SPSS Statistics.

4 Results

The results show that institutionalized adolescents, according to their own assessment, spend about the same amount of time on the Internet as their peers who live in parental families (see Table 2). At the same time, girls in both groups use the Internet for communication significantly more often than boys. Institutionalized girls choose the answer "1-3 hours" twice often in comparison with boys (55.6 % and 26.7 % in the samples of girls and boys, $\phi^*=4{,}13$, $p<0.01$), while boys prefer the point "less than 1 hour" (19.4% and 48.9% correspondingly, $\phi^*=4{,}47$, $p<0.05$), a similar situation is observed among adolescents from parental families.

The self-assessments of cyber-aggression experience in institutionalized adolescents and their peers have no significant difference. Adolescents of both groups declare that they do not usually become the victims of cyber-aggression as well as cyber-aggressors (see Table 3).

However, the Cyber-Aggression Typology Questionnaire revealed that rates of appetitive and aversive cyber-aggression in adolescents-orphans surpass the similar

indicators in their peers significantly (t=2.59, p<0.01and t=3.02, p<0.01correspondently). Institutionalized adolescents were characterized by higher rates of problem behavior (t=4.23, p<0.001) and aggression (t=3.19, p<0.01) with lower rates of prosocial behavior (t=3.14, p<0.01).

Table 2. Online daily time (%)

Sample	<1 hour	1-3 hrs	4-8 hrs	>8 hrs
How many hours a day are you online?				
IA	17.3	55.6	23.5	3.6
FA	17.4	48.5	26.3	7.8
How many hours do you spend for online communication?				
IA	35.8	39.5	22.2	2.5
FA	41.3	42.5	13.2	3.0

Table 3. Experience of cyber-aggression (%)

Sample	Never	Seldom	Sometimes	Often	Constantly
How often do you demonstrate aggression in online communication?					
IA	30.8	49.4	12.5	7.3	-
FA	31.1	52.7	14.3	1.9	-
How often do you receive aggression from other Internet users?					
IA	27.2	50.6	17.3	3.7	1.2
FA	29.3	49.2	19.1	1.2	1.2

Moreover, there are multiple positive correlations between indicators of cyber-aggression, problem behavior and aggression in the sample of adolescents-orphans, while in the sample of their peers similar correlations are absent (see Table 4).

Table 4. Means, SD and correlations of cyber-aggression, aggression and problem behavior for the samples of institutionalized adolescents and their peers (Note: * – p<0.05)

Indicators	M	SD	2	3	4	5
Institutionalized adolescents						
1. Aversive cyber-aggression	30.83	6.89	0.66*	0.08	0.35*	0.39*
2. Appetitive cyber-aggression	35.63	7.19	1.00	-0.30*	0.37*	0.32*
3. Prosocial behavior	6.85	2.11		1.00	-0.18	0.06
4. Problem behavior (total)	17.17	5.35			1.00	0.42*
5. Aggression (total)	63.93	11.24				1.00
Adolescents from parental families						
1. Aversive cyber-aggression	26.21	9.74	0.86*	0.07	-0.07	0.14
2. Appetitive cyber-aggression	30.73	12.32	1.00	0.08	-0.11	0.10
3. Prosocial behavior	7.83	1.73		1.00	-0.30*	0.04
4. Problem behavior (total)	13.22	5.59			1.00	0.07
5. Aggression (total)	60.45	9.89				1.00

Pairwise comparison of the samples of institutionalized girls and boys proved that the rate of aversive cyber-aggression is similar, while the rate of appetitive cyber-aggression is significantly higher in boys-orphans (t=3.31, p<0.01). In addition, there were positive correlations between indicators of aversive and appetitive aggression

in the sample of girls-orphans, while in the sample of orphaned boys these indicators are related to appetitive cyber-aggression only (see Table 5). We did not find significant differences between rates of cyber-aggression, problem behavior and aggression in the samples of boys and girls who live in parental families. The structure of correlations in these samples did not differ. However, in contrast to the samples of institutionalized adolescents, there were negative correlations between cyber-aggression rates (both forms) and age ($0.35 \leq rs \leq 0.47$) for boys and girls living in parental families. For the samples of institutionalized boys and girls, similar relationships were not found.

Table 5. Means, SD and correlations of cyber-aggression, aggression and problem behavior for the samples of institutionalized girls and boys. Note: * – $p<0.05$

Indicators	M	SD	2	3	4	5
Institutionalized girls						
1. Aversive cyber-aggression	30.60	63.83	0.32*	0.16	0.45*	0.47*
2. Appetitive cyber-aggression	32.67	7.08	1.00	-0.20	0.37*	0.32*
3. Prosocial behavior	8.00	1.68		1.00	-0.23	-0.13
4. Problem behavior (total)	17.72	7.04			1.00	0.33*
5. Aggression (total)	63.14	9.88				1.00
Institutionalized boys						
1. Aversive cyber-aggression	31.97	6.90	0.87*	0.13	0.22	0.27
2. Appetitive cyber-aggression	37.17	6.23	1.00	-0.44*	0.58*	0.52*
3. Prosocial behavior	6.17	2.07		1.00	-0.04	0.17
4. Problem behavior (total)	16.83	4.14			1.00	0.60*
5. Aggression (total)	64.45	10.43				1.00

According to regression analysis, emotional problems were identified as a predictor of aversive cyber-aggression for girls-orphans ($R2=0.85$, Adjusted $R2=0.69$, $F(9.8)=5.19$, $p<0.02$). The problems in communication with peers, behavior problems and aggression explained over 50% of variance in their appetitive cyber-aggression ($R2=0.51$, Adjusted $R2=0.29$, $F(9.20)=2,29$, $p<0.05$). In the case of institutionalized boys, hyperactivity was defined as a predictor of aversive cyber-aggression ($R2=0.45$, Adjusted $R2=0.29$, $F(9.20)=2.26$, $p<0.05$), and behavior problems predicted appetitive cyber-aggression ($R2=0.29$, Adjusted $R2=0.18$, $F(9.61)=2.76$, $p<0.01$). Similar regression model for appetitive cyber-aggression was obtained in a sample of boys from parental families ($R2=0.16$, Adjusted $R2=0.04$, $F(9.45)=0.96$, $p<0.14$), but the significance of this model was very low (see Table 6). Regression models for cyber-aggression in other samples were insignificant. Thus, cyber-aggression of institutionalized adolescents is more closely related to problem behavior than in adolescents from parental families. This tendency is particularly evident in the sample of the girls-orphans.

Table 6. Summary of multiple regression analysis for predicting cyber-aggression.

	Variable	B	SE B	β	Sig.(p)
	Aversive cyber-aggression				
IA (girls):	Emotional problems	3.27	1.11	2.95	0.02
IA (boys):	Hyperactivity	2.54	1.34	1.89	0.05
	Appetitive cyber-aggression				
IA (girls):	Behavior problems	6.98	3.04	2.29	0.03
	Problems in communication	6.91	3.09	2.24	0.03
	Aggression (total)	6,98	3.00	2.32	0.02
IA (boys):	Problems in communication	1.24	0.79	1.58	0.05
FA (boys):	Problems in communication	4.37	2.01	2.17	0.03

5 Discussion

The results of our research demonstrate the relevance of studying the features of online communication and, particularly, cyber-aggression of institutionalized adolescents. According to orphaned adolescents' self-assessments, their time for the Internet is similar to the adolescents from parental families (at least within one region). Moreover, adolescents-orphans are just as interested in online communication as their peers, and this fact does not fully correspond to the previous information [21]. Meanwhile girls-orphans are more focused on online communication (in comparison with boys), and this trend is typical for adolescence [32]. Institutionalized adolescents and adolescents from parental families evaluate their experience of online aggression as quite rare (both as an aggressor and a victim), however adolescents-orphans manifest appetitive and aversive cyber-aggression more frequently. We suggest that the similarity of self-assessing the cyber-aggression experience of institutionalized adolescents and their peers (taking into account predominance of cyber-aggression among them) means underestimate of cyber-aggression, its impact on other people and the consequences for interaction with them. Probably orphans tend to consider cyber-aggression as normative behavior on the Internet more than their peers. Therefore, the first hypothesis of our investigation was partially confirmed: institutionalized adolescents are more likely to show aggression in online communication. However, we cannot conclude anything unequivocally about the prevalence of their experience of victimization in online communication, since their assessments do not seem to be fully adequate to the real situation. This issue needs to be clarified in further research. At the same time, the prevalence of cyber-aggression in online behavior of institutionalized adolescents highlights the importance of studying its psychological determinants in this subgroup of adolescents.

The study also confirmed the hypothesis about persisting the severity of appetitive and aversive cyber-aggression in orphans throughout adolescence as well as declining cyber-aggression in their peers by growing up. According to results of correlation analysis, for adolescents from parental families maximal rate of cyber-aggression are observed in younger adolescence. This is largely consistent with the results of other studies, which suggests that mainly protective cyber-aggression persists as adoles-

cents grow up, while other forms of cyber-aggression lose their relevance [36]. The decrease of cyber-aggression could be the result of a general tendency to reduce aggression from younger to older adolescence [22]. Thus, the absence of similar correlations could prove much closer relationship between cyber-aggression and problem behavior in adolescent-orphans, which was found in our study.

According to the third hypothesis of our study, we found a higher rate of emotional and behavioral problems in institutionalized adolescent (in comparison with peers), as it had been shown by other researchers previously [2; 13; 20; 35]. The results of our study suggest that the most significant determining factor for the appetitive cyber-aggression of institutionalized adolescents (both boys and girls) is problems in communication with peers. Taking into account a similar regression model in the sample of boys from parental families, this relation could demonstrate a general direction of communicative development in adolescence. In addition, behavioral problems and aggression were identified as predictors of appetitive cyber-aggression in a sample of girls-orphans. This fact allows us to assume that the appetitive cyber-aggression in girls-orphans is a much more serious problem, in comparison with boys. Institutionalized girls are less likely to demonstrate cyber-aggression than boys are, so the high-tailed aggression in online communication of girls-orphans probably reveals various emotional and behavioral problems. Aversive cyber-aggression of girls-orphan is also determined by emotional problems, while in boys it is caused primarily by hyperactivity, which indicates low self-control. In general, cyber-aggression of girls-orphans is significantly more loaded with emotional and behavioral problems.

6 Conclusion

Nowadays, institutionalized adolescents use the Internet widely, but information about their online behavior is fragmentary. In the current study, we examined such form of online behavior of adolescents-orphans as cyber-aggression, as well as its psychological determinants. The results showed that the determinants of cyber-aggression in adolescence are different for institutionalized adolescents and adolescents from parental families. Psychological determinants of cyber-aggression in adolescence are emotional and behavioral problems (especially for girls) as well as insufficient self-control skills (primarily for boys).

The findings of our study could serve as a frame for developing the effective programs aimed at psychological and pedagogical support of cyber-socialization of institutionalized adolescents. We also expect that this study will be developed in a more detailed investigations which will be targeted to online behavior of institutionalized adolescents. In addition, it will be appropriate for future research to move from studying the cyber-behavior of adolescents by self-assessment questionnaires to survey of their actual Internet activity.

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University Teachers' Verbal and Nonverbal Behavior as a Factor of Students' Evaluating Online-lectures

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Abstract. The significance of psychological investigations of e-learning corresponds with intensive development of online education. The article presents the results of the study, which was aimed at analyzing the features of the university teachers' verbal and nonverbal behavior as a factor of students' evaluating the effectiveness of online-lectures. Students (n=453) watched videos of 30 online lectures (10-12 minutes, 50% female lecturers) and evaluated their content (parameters "Quality of content", "Usefulness for future professional activities") and emotional impression. The verbal and nonverbal behavior of lecturers was described by two experts with such parameters as "Kinetics", "Paralinguistic", "Interaction with students" and "Lecture content". The results of cluster analysis reveal three behavior models of online-lecturers: "open communicative position with spontaneous verbal behavior", "open communicative position with drafted verbal behavior" and "closed communicative position with drafted verbal behavior". Multivariate analysis identified the models of verbal and nonverbal behavior of male and female lecturers, which determine the highest evaluation of lectures: open communicative position with drafted verbal behavior for female lecturers and closed communication position with spontaneous verbal behavior for male lecturers.

Keywords: online-lecture, university teacher, verbal behavior, nonverbal behavior, students, students' subjective evaluation of lecture effectiveness.

Introduction

Nowadays, there is a rapid growth of distance learning technologies in education, including the spread of online-lectures. These technologies are expanding the pool of potential students [25], providing educational opportunities for employed students as well as for students with health problems, members of racial and ethnic minorities [16]. Thus, online technologies make educational services more accessible. At the same time, online learning places high demands on students' academic motivation and self-regulation [9, 18]. Therefore, the problem of its effectiveness in general and the

effectiveness of online lectures in particular is related to the students' interest in learning, readiness for autonomous working with educational materials and using them to complete various educational tasks. Psychological factors of students' interest and motivation in offline learning are studied fairly completely to date. Psychological studies of offline learning show that developing and improving of students' interest in offline learning is largely determined by verbal and non-verbal behavior of the teacher, which manifests his personal and professional traits [3, 13]. Effective and ineffective models of the teacher's offline behavior are described in previous studies. However, "teacher-student" interaction in online learning differs appreciably [44], therefore it is not possible to transfer this information directly. Currently, the patterns of effective and ineffective models of the teacher's online behavior have not been sufficiently studied [7]. This study analyzes the features of verbal and non-verbal behavior of an online-lecturer, which contribute to improving the effectiveness of online-lecture (by students' evaluating).

1 Verbal and nonverbal behavior of online-lecturer

1.1 Online-lecture as a form of "teacher-student" interaction

An online-lecture is a form of transmission of educational material using the Internet. Experts identify three forms of online-lectures: public media-lecture (monologue of the lecturer to the real learners in a classroom, which is filmed and posted on the Internet); lecture-visualization with audio (a lecturer comments some slides or clips, but there are no his/her image in the video); media-lecture without audience (lecturer gives information in the studio without learners) [46]. This classification is based on two parameters: the availability/absence of a teachers' image and real learners in a video. Each of these parameters could influence the students' perception of educational information.

The availability of a teacher's image in a video was evaluated negatively in the ear-ly stages of online technologies, since it was assumed that it added excess information to educational materials and provided an excessive cognitive load on students [14]. However, the recent studies have shown that the students usually prefer video-lectures, which include the images of the teachers. Moreover, the students are more involved in this type of online-lecture. The availability of the teacher's image in the video contributes to the perception of various social signals, which contribute to improving the outcomes of learning [12, 36]. Experiments show that students spend no more than 25 % of the time to perceiving of the teacher, and it does not disrupt the assimilation of knowledge and does not increase the time to process the information [19]. Students are more engaged in the content of video-lecture if the teacher's image is available [26]. The quality of assimilation of the information improves if online-lecturer is personalized [33]. In addition, the availability of a teacher's image assures students that they are able to complete the educational tasks, which are shown in the video [29]. However, the effectiveness of the video with a teacher's image varies depending on the type of knowledge: this image could contribute to the assimilation of declarative knowledge, but interfere with the development of procedural skills [28].

In general, research data mainly support the theory of social presence [43] as a more relevant framework for studying online communication “teacher-student”. This theory argues that social signals from the teacher (eye contact, facial expressions, gestures, etc.) contribute to better understanding of the information by the students [48, 49].

The problem of the audience's presence in the video-lecture remains debatable. Some researchers believe that the availability of the real learners in the video is more preferable, since it contribute to developing an emotional background of “teacher-students” communication, which catalyzes the transfer of the teacher’s personal experience [30]. And, the lecturer’s behavior highlights his/her personal and professional individuality if the learners are available, because it is the most common context of “teacher-students” interaction [24]. “Student-student” interaction also is a significant part of online learning [42]. Thus, the students’ demand for presence some learners on the video could be quite strong. At the same time, the availability of some learners in the video could promote the reduction of the students’ subjective contact with the teacher and the decrease the degree of their involvement in the online-lecture.

1.2 Examination of verbal and nonverbal behavior of the online-lecturers

Currently, the online-lecturers’ behavior and its impact on the effectiveness of online learning are not enough detailed in empirical studies, despite the fact that other aspects of online communication (for example, social networks or on dating sites) are described more completely. The main research focus is on verbal and nonverbal means for expressing the social presence of the teacher, which is crucial for attracting online students [4, 39]. The most important predictors of social presence in a virtual classroom are social cues, and teachers should provide them for their online students [38, 45]. The researchers emphasize that, a presence does not emerge automatically in the Internet environment, but it needs intentional development [34]. In this regard, the issue of the ways to establishing and maintaining a presence of the teacher is relevant for online education [35]. Another issue concerns the teacher’s means of encouraging social presence of students, as it is considered an important factor in the development of interest in learning and its effectiveness [47]. The online-lecturer has the greatest impact on maintaining the presence, as carried a dominant communicative load [21].

Several verbal and nonverbal aspects of the teacher’s online-behavior is proved as the factors, which contribute to enhancing social presence and thus to improving the effectiveness of online learning. Some experts describe elements of nonverbal behavior that affect the effectiveness of online-lectures: relevant use of paralinguistic means (pauses, timbre, rapidity of speech, expressiveness, etc.) [11]; bodily signals supporting a sense of presence [8]; teacher’s immediacy as a complex behavioral model [6]; kinetic aspects of communication (gestures, facial expressions, pantomime) [17]. Other researchers describe the features of the online-lecturer's verbal behavior: the special introductory messages to manage students’ impressions [40]; the peculiar techniques for constructing and maintaining the expert status [20]; the methods for personification of the lecture communications, including the use of personal pronouns *Me* and *We* [37]. Special attention is paid to the presentation of educational information in a video lecture, which is implemented by use of verbal techniques too [42]. The content of the online-lecture should be as informative as possible, but clear

and structured, in order to avoid excessive cognitive load [32]. The importance of text structuring also reveals in other genres of online communication [15].

In general, studies of online-lecturer's verbal and nonverbal communication show its relevance for the social presence, and, consequently, for the effectiveness of online-lecture, but the complete models of the effective verbal and nonverbal behavior of online-lecturer have not yet been described.

We should note that the gender specificity of verbal and nonverbal behavior is found out in terms of offline communication [5, 27, 31], in particular gender specificity of the teachers' behavior [1]. Moreover, students could interpret the same behavior of male and female teachers differently [10, 22]. But, we have not found information about gender characteristics of verbal and nonverbal behavior of the online-teachers.

Thus, we can assume the proven contribution of the teacher's verbal and nonverbal behavior to the effectiveness of online-lecture. But, many issues of the effectiveness of the online-lecturer's verbal and non-verbal behavior remain unclear. It determines the importance of studying the relationship between the verbal and nonverbal behavior of an online-lecturer and its relation to students' evaluating of a lecture.

2 The present study

This study was aimed at analyzing the features of the teacher's verbal and nonverbal behavior as a factor of students' evaluating the effectiveness of online-lecture. Firstly, we hypothesize that it is possible to identify generalized models of verbal and nonverbal behavior of teachers, which are connected with high students' evaluates of online-lecture. Secondly, we predicted the difference between the models of verbal and nonverbal behavior of male and female online-lecturers that allow students to rate an online-lecture highly.

2.1 Participants and procedures

483 participants took part in the study, among them 30 teachers (aged 27-77, M=43.17; SD=11.56, 50 % female, teaching experience 12.13±8.52 years) and 453 students of pedagogical faculties (aged 18-24, M=19.10; SD=1.27, 79.6 % female). For the study, a video recording of 30 lectures was made in the format of a media-lecture without audience (video characteristics: 25 frames/sec, 1920x1080; 117 kilobits/sec, 48000 kHz, stereo). All lectures were presented as part of the Educational psychology course. The teachers chose the topics for their lectures on their own. To unify the shooting conditions, we asked teachers not to use multimedia presentations during the lecture, but if necessary, teachers could use the whiteboard. Each lecture lasted 10-12 minutes. According to the research protocol, students who participate in the study watched an online-lecture by an unknown teacher, and then evaluated it using the questionnaire. We invited 15-18 students to watch every online-lecture. The students and the teachers took part in the study was voluntary; each participant was informed about the research program and signed an informed consent.

2.2 Measures

2.2.1. Analysis of the lecturer's verbal and nonverbal behavior

Two independent experts carried out the analysis of the lecturer's verbal and nonverbal behavior using the scheme, which is presented at Table 1. In accordance with the literature review, we identified kinetic (location in the frame, gestures, poses, eye contact; facial expressions) and paralinguistic (intonation) parameters of nonverbal behavior, as well as content (structuring and drafting the lecture) and interactive (method of self-presentation, speech tempo, involvement of the audience in communication) parameters of verbal behavior. Developing the analysis scheme, we took into account the opportunity to objective evaluation of these parameters. The experts had detailed descriptions of the parameters. We used the schemes for analysis of verbal and nonverbal behavior in "face-to-face" communication [20, 23, 38] to make the descriptions of verbal and nonverbal parameters of online-lecturers' behavior. Afterward, the experts' rates were averaged.

Table 1. The scheme for analysis of lecturers' verbal and nonverbal behavior

Parameters	Indicators	Measures
	Nonverbal behavior	
Kinetics	Location in the frame: sitting; standing; moving	Dichotomous score (1–sign is present, 0–absent)
	Gestures: illustrators; adapters; concern about appearance	Absolute units
	Posture: open posture – closed posture; facing the audience –removed	% of total time
	Eye contact with the camera	% of total time
	Facial expressions: goodwill – neutrality	Smiles, absolute units
Paralinguistic	Intonation accents	Absolute units
	Verbal behavior	
Interaction with students	Tempo of speech	Words, absolute units per minute
	Self-presentation: name; position/status	Dichotomous score
	Involving students in communication: addressing the audience; jokes; using pronoun *I* and *We*)	Absolute units
Lecture content	Structuring: verbalizing the lecture purpose and plan; summing up the lecture	Dichotomous score
	Drafting: reading pre-prepared text; availability of text support (paper or gadget); links to authorities	Dichotomous score

2.2.2. Evaluating the effectiveness of online-lectures by students

To evaluate the effectiveness of the online-lecture, students were offered four 7-point scales. Two of these scales dealt with the content aspect of the lecture ("Quality of content", "Usefulness for future professional activities") and other ones concerned its emotional impression ("Interest", "Readiness to watch such lectures on their own"). Students' scores for each lecture were averaged.

2.3 Data Analysis

We used averaging the experts' descriptions of lecturers' verbal and nonverbal behavior as well as the students' evaluations of the content and emotional impression of online-lectures. Cluster analysis (Ward's method, option "by columns") was carried out for a comprehensive description of models of online-lecturers' verbal and nonverbal behavior. Criteria analysis (Mann-Whitney U-test, Fisher φ*-test) was applied to compare groups of teachers with different models of verbal and nonverbal behavior. The distribution of student lecture scores calculated using the Kolmogorov-Smirnov criterion d, which allowed us to use ANOVA-analysis F ($0.11 \leq d \leq 0.12$, $p > 0.20$) for their analysis. These statistical procedures were implemented by IBM SPSS Statistics.

3 Results

At the first stage of the study, we analyzed the features of verbal and nonverbal behavior of teachers (see Table 2). The comparison analysis revealed that the male and female behavior significantly differed in the parameters "availability of a text support", "using the pronoun We", "smile", which were higher in women as well as in the parameter "giving a lecture standing/moving", which was higher in men. The next stage was aimed to identify the most distinctive features of lecturers' verbal and nonverbal behavior by cluster analysis. Since our data had been presented by different types of scales, we converted numerical and percentage scales to rank scales by quartile selection. Clustering allowed us to distinguish two groups of lecturers, which differed in nonverbal behavior (L=6.2), and two groups – in verbal behavior (L=5.4). Pairwise comparison showed the parameters of verbal and nonverbal behavior with the greatest distinguishing power: "smiles", "open posture", "jokes" and "availability of text support" (see Table 3).

According to these results, we identified two types of lecturers' nonverbal behavior: open communication (group 1, n=20) and closed communication (group 2, n=10). In turn, the following types of verbal behavior were described: drafted verbal behavior (group 1, n=18) and spontaneous verbal behavior (group 1, n=12). Eventually, we obtained three models of lecturers' behavior: 1) the lecturers with open communicative position and spontaneous verbal behavior (M_1, n=12); 2) the lecturers with open communicative position and drafted verbal behavior (M_2, n=8); 3) the lecturers with closed communicative position and drafted verbal behavior (M_3, n=10). We did not find any lecturers with closed communicative position and spontaneous verbal behavior among the participants of our study.

Table 2. Verbal and nonverbal behavior of online-lecturers

Parameters	Total	Male	Female	U / φ*
Nonverbal behavior				
Sitting	63.3%	60.0%	66.7%	-
Standing or moving	36.7%	66.7%	26.7%	φ*=2.26, p<0.05
Gestures-illustrators	64.11	64.87	63.41	-
Gestures-adapters	24.57	39.27	9.87	-
Gestures of concern about appearance	2.12	1.26	2.93	-
Open posture	78.2%	72.7%	82.9%	-
Posture, facing the audience	97.3%	97.3%	97.4%	-
Smiles	8.97	6.80	11.13	U=64.50, p<0.05
Intonation accents	125.73	114.06	137.40	-
Eye contact with the camera	52.0%	45.3%	58.4%	-
Verbal behavior				
Speech tempo	108.35	109.32	107.37	-
Introducing himself/herself	40.0%	46.7%	33.3%	-
Presenting his/her position/status	43.3%	53.3%	33.3%	-
Links to authorities	76.7%	73.3%	80.0%	-
Addressing the audience	1.87	1.00	2.33	-
Verbalizing the lecture purpose and plan	100%	100%	100%	-
Summing up the lecture	76.7%	73.3%	80.0%	-
Jokes	0.70	0.80	0.60	-
Using the pronoun *I*	6.30	7.67	4.93	-
Using the pronoun *We*	8.67	5.66	12.07	U=69.00, p<0.05
Reading pre-prepared text	13.3%	6.7%	20.0%	-
Availability of text support	63.3%	40.0%	86.7%	φ*=2.81, p<0.01

Table 3. Comparison of lecturers' groups identified by cluster analysis

Parameters	Group 1	Group 2	U / φ*
Smiles (nonverbal behavior)	1.58	0.51	U=66,00 p<0.05
Open posture (nonverbal behavior)	89.4%	65.7%	U=68,00 p<0.05
Availability of text support (verbal behavior)	100%	8,3%	ϕ*=2.23, p<0.05
Jokes (verbal behavior)	0,30	1,10	U=66.5, p<0.05

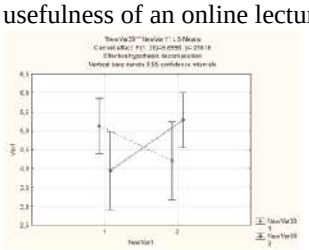
At the third stage of analysis, we compared the students' evaluations of the content and the emotional impression of the lectures in line to the lecturers' behavior models. The ANOVA analysis did not obtain significant difference; although there was

a trend to decreasing evaluations of lectures in the cases of lecturers' closed communicative position and drafted verbal behavior (see Table 4).

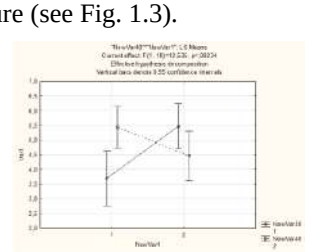
Table 4. Students' evaluations of online-lectures

Parameters	M_1	M_2	M_3	F	p
Interest	4,92	4,91	4,63	0,16	0,86
Readiness to watch such lectures on their own	4,76	4,71	4,26	0,45	0,64
Quality of content	5,07	5,07	4,60	0,64	0,54
Usefulness for future professional activities	4,71	4,53	4,36	0,60	0,56

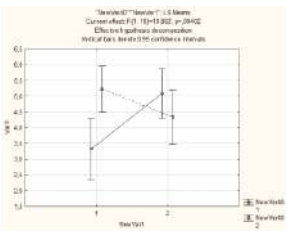
Finally, we conducted analysis of the relations between the students' evaluations of the lectures and the models of verbal and nonverbal communication among male and female lecturers. The lectures of female teachers were evaluated as more interesting in the cases of their open communicative position. Conversely, the lecturers of the male teachers seemed more interesting if the lecturer demonstrated a closed communicative position (see Fig. 1.1). The characteristics of verbal behavior showed another trend: a male teacher's lecture was perceived as more interesting when his speech looked spontaneous and natural, while an interesting lecture from a female teacher involved preliminary drafting (see Fig. 1.2). Similar results were obtained for evaluations the usefulness of an online lecture (see Fig. 1.3).



1.1



1.2



1.3

Fig. 1. Multifactor ANOVA results. Note: Var 1 – "Interest", Var 3 "Usefulness", NewVar 1 – sex (1 – male, 2 – female), NewVar 39 – nonverbal behavior (1 – group 1, 2 – group 2), NewVar 40 –verbal behavior (1 – group 1, 2 – group 2)

4 Discussion

According to the empirical results, we described different types of university teachers' verbal and non-verbal behavior in times of online-lectures. The signs "open pose – closed pose" and "smiles" demonstrated the most distinctive sense among the parameters of non-verbal behavior. These signs are usually considered as characteristics which express the readiness to communication [42]. Therefore we termed corresponding types of lecturers' non-verbal behavior "open communicative position" and "closed communicative position". An open communicative position is characterized by a predominance of open poses and smiles. Closed communicative position includes a tendency to increase the time of closed poses, as well as to reduce the num-

ber of smiles or their absence. Pre-prepared text sup-port (in paper form, smartphone or laptop) and jokes were identified as the distinctive parameters of verbal behavior. The lecturers who used the text support were less likely to joke during the lecture, while the lecturers who did not have any lecture notes, joked significantly more often. As a joke is a sign of spontaneous communication [41], these types of lectures' verbal behavior were called “drafted verbal behavior” and “spontaneous verbal behavior”. Combining these types of lecturers' verbal and non-verbal behavior suggested describing three models of teachers’ behavior throughout online-lectures: “open communicative position with spontaneous verbal behavior”, “open communicative position with drafted verbal behavior” and “closed communicative position with drafted verbal behavior”.

In contrast to our first hypothesis, we did not find the models of the online-lecturers’ behavior, which determined the highest evaluations of lectures by students. Despite the tendency to decrease the ratings of online-lectures of teachers with a closed communicative position and drafted verbal behavior, statistically significant difference was not found. Thus, we cannot conclude, that this model of the teacher’s behavior in terms of online-lecture determines the decrease in students’ evaluations of its content and emotional impression. Probably, the absence of statistically significant differences is determined by the gender heterogeneity of the groups of teachers with different behavior models. Using ANOVA analysis, we ascertained the difference between the models of verbal and non-verbal behavior of male and female lecturers, which associated with students’ high evaluations. The most sensitive to the gender context were estimates of the interest and usefulness of the lecture. Higher rating of interest in the case of online-lecture by a female teacher were associated with open communicative position and drafted verbal behavior. Conversely, the ratings of interest in a male teacher's lecture increased, when closed communicative position was combined with spontaneous verbal behavior. Similarly, the models of verbal behavior significantly determined students’ evaluations of the lecture usefulness: high ratings of the lecture usefulness were associated with the model of drafted verbal behavior in the cases of female teachers, but for male teachers spontaneous verbal communication was more highly rated by students. Thereby, our second hypothesis was confirmed.

Previously, studies of students’ evaluations of female and male university teachers in terms of communication “face-to-face” in the classroom presented similar results: female teachers are more often expected to warm and open communication, while male teachers – to some communicative detachment with high intellectual potential [10]. Moreover, violation of these expectations can lead to a decrease in their teaching performance ratings [2]. The results of our study confirm that in terms of online-lectures the same trends are reproduced. “Good online-lecture” of female teacher includes demonstration of the readiness to communication and thorough drafting the lecture, while “good online lecture” of a male teacher is determined by his ability to demonstrate fluency in the educational material due to low degree of communicative openness. Therefore, we can state that students’ evaluations of online-lectures are mediated by gender expectations just like in “face-to-face” learning.

Conclusion

The results of our study did not allow us to identify universal models of verbal and non-verbal behavior of the lecturers, which would provide high subjective evaluations of online-lectures by students. At the same time, it was found that these evaluations are determined by the degree of compliance of verbal and non-verbal behavior of female and male teachers with expected gender-specific behaviors. Despite the fact that our study has some limitations, such as the unusual for "face-to-face" learning 10-12-minute lecture format and a great age range of the lecturers, these results could be taken into account for development of training programs, which is aimed at improving the skills of online-lecturers.

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Genesis of Ethical Norms in the Digital Environment as a Factor of Personality Anomie of Generation Z

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Abstract. The socialization of Generation Z takes place in the digital space. Digital socialization provides a special way of constructing the world of life and a specific way of acquiring ethical values among these young people. Socialization in the digital environment also promotes an anomie. The development of anomie in Generation Z leads to deviant behavior, which is manifested in unmotivated aggression, insulting other participants of communication in the digital environment. Along with anomie and deviation, Generation Z digital socialization is also characterized by opposite trends of institutionalization of the ethics of digital interaction. The practices of unethical behavior stimulate the emergence of discussions on the Internet about the limits of permissible and unacceptable behavior. This spontaneous discourse of digital ethics is extremely interesting from theoretical and practical points of view. Based on the natural ideas of individuals about ethical norms, it is possible to formulate a code of ethical conduct in the digital space. Such a code would not be coercive, but the very fact of its existence would have an impact on the behavior of individuals. The features of Generation Z that have been studied can be extremely useful for improving education. Understanding the specifics of these young people's world will allow them to develop more interesting courses and teaching methods. Knowledge of the genesis of ethical norms in the digital environment will allow effective translation of social constructive norms of behavior, ethical values into the young people communication.

Keywords: Generation Z, norms, ethics, anomie, digital environment.

Introduction

In an era of intense ultramodernity, an increasing proportion of interpersonal interaction occur in the digital environment, which in turn has a significant impact on the socialization of the younger generation. In this relation, it is very interesting to study the genesis of ethical norms in Generation Z under the influence of the digital environment. Ever since Durkheim, sociology theorists have paid attention to the existence of a crisis

of normative-value regulation in society - anomie. With the appearance of the new generation, the issue the correlation between the processes of emergence of new ethical norms and the erosion of existing ones was sharply actualized, since Generation Z is the first fully digital generation.

The methods of theoretical synthesis and reconceptualization are suggested to study this research issue. The method of concept reconstruction has a huge heuristic potential by applying classical sociological concepts to explain fundamentally new social phenomena [1, p.68]. The aim of this research is to reveal the essence and peculiarities of the process of constructing social norms in the life world of generation Z and the reasons for the anomaly in the behavior of representatives of this generation. The study is both theoretical and empirical in nature. The epistemological orientation of the research is interpretation. Nominalism and constructivism are the ontological orientations of the research. The research is conducted within the framework of an inductive strategy.

The research question is to reveal features of construction of social norms in the life world of representatives of generation Z, and also factors of occurrence of anomaly as a result of phygital interaction. The main problem of the study is the difficulty of assessing the processes of transformation of ethical values in the new socio-cultural and digital reality, as well as the specificity of deviant behavior of generation Z. The authors of the study believe that the ethical component of the digital space can be regulated through an ethical code of conduct on the Internet, as well as new practices of the educational process of young generations.

1 Literature Review

In order to study the genesis of ethical norms in Generation Z, it is necessary to understand the peculiarities of this generation. The studies devoted to the study of generations are based on the works of Howe and Strauss [2, p. 97], who proposed a classification of generations and justified the thesis that each generation has certain cultural differences. Expanded studies of generational issues are represented by the widely recognized studies of D. Tapscott [3], M. Prensky [4], M. Bauerlein [5], N. Carr [6], [7], G. Small & G. Vorgan [8], D. Stillman [9], and others. In particular, the term "network generation" (NET-generation or N-generation) is associated with D. Tapscott, who described the profile of the network generation in "Growing up in the digital age: the emergence of the network generation" and "Growing up in the digital age: how the network generation changes your world" [3]; the problems of the digital generation genesis are discussed in the book by J. Pelfrey & W. Hasser "Digital Origin: understanding the first generation of digital natives" [10]. These publications are based on a series of sociological studies revealing activity, desire for creativity and innovation, as well as propensity for Internet addiction, acts of aggression, harassment, ignoring copyright and non-critical acceptance of information. The development of Howe and Strauss theory has led to the emergence of synonymous names for the same generations. Thus, the Millennium Generation was named the Next Generation, N-geners, Selfi Generation and the second "Generation Y", which now has a basic citation index. Subsequently, this classification of generations has been supplemented by generation Z

or centennials, number generation, phygital-generation, etc. By different estimates [11, p. 3350] it refers to people born from 1995 - 1996 to 2004-2010. Originally in Tulgan's book Z representatives were defined as the second wave of millennials [12, p.5], but after its publication in the USA TODAY newspaper "High-maintenance Generation Z heads to work" in 2012, generation Z became a separate phenomenon. The publication [13] of the results of the marketing research of generation Z conducted by the company Sparks and Honey in 2014 contributed to the wide spread of this termin. As synonyms for the concept of "Generation Z" in scientific and professional literature can be used the concepts "iGen" and "Post-Millennials". The suitability of Western classifications of generations for studying Russian society is confirmed by actual empirical studies [14], [15]. Moreover, Generation Z, which, thanks to the Internet, was socialized under the constant influence of the Western continent, more than any other generation is similar to their Western counterparts. Within the framework of the generational theme Phygital is defined as the key characteristic of the generation Z, which not only does not see the difference between virtual and real, but also does not think of itself outside the phygital environment, hence its new name - phygital-generation. This civilizational content makes studying the features of this generation even more interesting and allows us to extrapolate our conclusions to other countries to a certain extent. Summarizing, the SPOD-world, which is a stable, predictable, simple and certain world: the world that existed before Generation Z was replaced by VUCA-world. VUCA is an acronym for instability, uncertainty, complexity and ambiguity. The world of VUCA is a world in which the tasks of forecasting are difficult to implement; it is the world of Generation Z.

2 Theoretical Grounding and Methodology

The research has two levels that are theoretical and empirical. On the higher level authors worked in the social constructivism paradigm (P.Berger, T.Luckmann) with the use of phenomenological analysis, grounded theory and reconceptualization. Here we used the epistemological orientations of interpretativism. On the lower level of the research authors used ethnometodolody of H.Garfinkel for the study of the life world of generation Z. We conducted a focus-group for the study general opinion of the generation Y about the generation Z. The sample for the focus group was directed and consisted of nine people from generation Y who were postgraduate students of social science faculties of Saint Petersburg State University. On the last stage in the accordance with the research design we made a survey that allows to reveal the value system of generation Z, their peculiarities in the social norm construction and features of anomie with their possible reasons. The lower limit of the birth for generation Z was chosen as the year 2000 in the accordance with the specifics of our country development. The questionnaire involved working with a random sample of 300 first year students from several St. Petersburg universities.

The majority of the sample of 300 respondents were teenagers aged 18 years (56%), the gender distribution of the sample was as follows: 45% of the respondents were female and 55% were male. This proportion of sample is in accordance with the gender

structure of Russian inhabitants in the age from 15 to 30 years old [16]. The data of the survey were processing with the aid of frequency analysis with the use of the statistical package SPSS. The questionnaire can be seen upon this link[1]

The study limitations were associated with the specific features of the object. It is difficult to separate the specific factors affecting the entire generation from the specific factors of the youth. There are concerns that specific factors of youth may be mistaken for specific factors of generation Z, and these limitations were understood.

3 Generation Z Social Construction Activity and Anomie

The features of Generation Z are largely due to the special structure of their life world. The younger people are, the less they tend to separate the events of the real and virtual world. The constant exchange of information between young people causes a constant empathy with each other's life events. This generates a feeling of being a participant in the event, even if participation in the event consisted only in the perception of information about it from the Internet. This unique and not characteristic for older generations phenomenon of forming coexistence forces the representatives of Generation Z to form their own communities and weakly contact the representatives of older generations.

The questionnaire survey we conducted among the students of the first year of Saint-Petersburg universities (representatives of generation Z) allowed us to reveal the following system of values at them (Fig. 1).

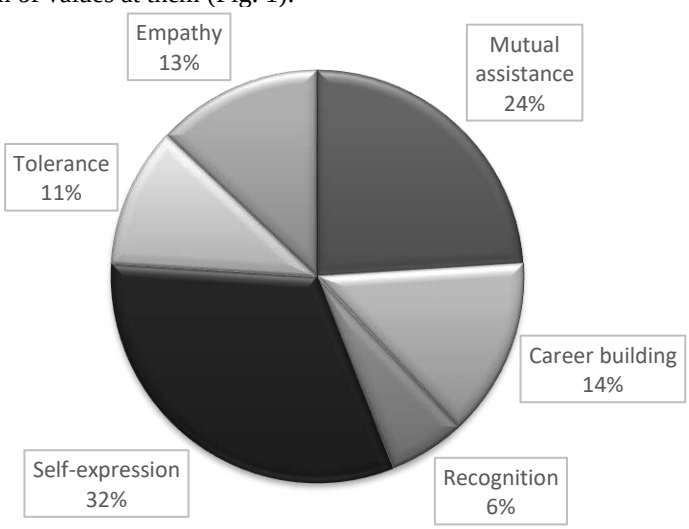

Fig. 1. Generation Z value system

[1] https://vk.com/doc928026_552607993?hash=4b39f01ee44f78c6f4&dl=99495814197a7c36bd

In order to detect the generation Z value system, the data was encoded on the basis of one (yes), zero (no). The unit was assigned to the value, selected first from the set of six proposed values. Thus, of the 302 responses, the following scale of values was obtained for representatives of generation Z: self-expression (32%), mutual assistance (24%), career building (14%), empathy (13%), tolerance (11%), recognition (6%). This construction was tested on a random sample of twenty respondents (five freshmen from each of the four universities participating in the study). A thorough recalculation of the data, with a ranking of the value system of each of the twenty participants, allowed us to build a value profile for the average representative of the digital generation, which completely coincided with the value profile obtained through binary coding. Our empirical results confirmed the prevail of individualistic orientation in the value system like in the generation Z of the western world, however we revealed high score for collectivistic orientation (mutual assistance and tolerance) that are connected with the peculiarities of the Russian culture.

In addition to the survey, focus groups with Generation Y representatives were also conducted during the survey to explore the values of Generation Z. The main value of Generation Z was said by informants to be self-expression. Another important value of this generation is freedom, which is understood in a negative sense as disclaimer of responsibility under conditions of anonymity. Representatives of Generation Y consider Generation Z to be individualists, although representatives of Generation Z themselves paid much attention to collectivist values according to the survey results. According to the informants' opinion, Generation Z values their time, they are practical and able to react quickly to changes in economic and social life.

Representatives of Generation Z grew up in an information and communication environment, and therefore have good skills of searching and processing information since childhood. Comparative sociological data show that both Russian and Western youth are aware of the concept of fake and are critical of the official media [17]. The same skills also affect their attitude towards education, since they see no point in memorizing facts that can be easily found by google. Since the search for information on the Internet is quick, dynamic and easily accessible, it generates a negative attitude among young people towards formal educational institutions. From their point of view, there is little point in recording in the academic classroom information that can be easily found on their own if necessary. At the same time, Generation Z values training courses that provide specific skills to start earning right away, here and now. The features of the life world of Generation Z that we have identified contribute to the fact that emotional and visual content of the Internet is much more important for them than for representatives of previous generations. This is clearly demonstrated by the abundant use of smiles, emoji and other graphic tools in social networks that express an emotional attitude. Content text on the Internet is often accompanied by images, sometimes music, which creates a kind of holistic, synesthetic picture.

In general, the construction of the meaning of the world of life for Generation Z is a collaborative process that runs simultaneously in the real and virtual worlds. In essence, "a key feature of the new generation is that they do not see the difference between online and offline life. The emergence of this feature of Generation Z is due to the phenomenon of a new kind of interaction, which unites the physical and virtual worlds,

it is defined as phygital-interaction"[18, p.34]. This feature is of great interest, because it distinguishes generation Z from all previous generations. Another no less interesting feature is that the joint construction of meanings in the digital space takes the form of text and it opens fundamentally new opportunities for researchers. First of all, it concerns ethnomethodology, which studies daily routine interaction [19, p. 82]. From the ethnomethodological point of view, the Internet becomes an extremely promising opportunity to study everyday life, since in this case the influence of a researcher on the research results is completely excluded. For our study, it is of interest to construct on the Internet the concepts of ethical and unethical, which are the basis for social practices.

The Internet becomes a space for transmitting values and experiences from one individual to another. As a result, the personality of Generation Z is more flexible and multifaceted than that of the older generations. A member of Generation Z defines himself ad hoc rather than once and for all unequivocally. The boundaries of his personality may change depending on the influence of the social environment and circumstances.

An extremely important factor strongly influencing the socialization of generation Z is the phenomenon of digital inequality. It is a question of demonstrating not only traditional stratification in the digital environment, but also fundamentally new phenomena. The digital divide is also manifested in young people's possession of expensive digital technology. For example, on social networks, icons may indicate that a user has entered or sent messages from Apple's top-end technology. However, the most destructive form of digital inequality is the broadcast of symbolic consumption practices in the digital environment. Symbolic consumption implies the acquisition of expensive, unnecessary, but emphasizing the status of the owner of things. This pattern of consumption turns even the wealthy individual into a permanently needy, super poor person [20, p.24]. Digital space is actively used by generation Z to demonstrate status consumption. Even after visiting a good restaurant, the individual, with the supernova poor's mind, will probably take a picture of the food and put the picture in Instagram. Without a public demonstration of consumption, eating from his point of view becomes a waste of money. The constant display of symbolic consumption by the most successful members of Generation Z causes the less fortunate to feel irritated and unfair. As a result, a sense of digital inequality causes aggression among young people and this problem is directly linked to ethical issues.

The focus of the study group with Generation Y representatives to study the construction of Generation Z values confirms the huge role of status consumption in the life world of Generation Z. The informants describe the representatives of Generation Z as people "with a bunch of all sorts of devices, with vapes and dressed in prestigious brands". The whole appearance of Generation Z testifies to the people around them about their ability to consume expensive and fashionable things, to lead an active and sporting life.

The status consumption of Generation Z is directly related to their main value - self-expression. It is the ability to express oneself in the digital space that contributes to the increasing role of symbolic consumption for Generation Z.

The result of the socialization of Generation Z in digital space is their best suitability for life in modern society. While previous generations have had to master the digital

environment and its regularities, the Z representatives were born in it and feel "like a fish in water". Mark Prensky successfully conceptualized this phenomenon by calling Generation Z "digital natives"[4, p.1]. The best adaptation of these young people is not only to master digital technology and know the language of the digital society, but also to better adapt to the modern economy, which is characterized by instability, the spread of remote work practices, rapid changes in trends, as well as the need to constantly monitor the huge flows of information.

The perfect adaptation of Generation Z to modern society also raises new ethical challenges. To the traditional conflict of fathers and children is added what can be called the paradox of awareness. While throughout history the younger generations have received knowledge from the elders, Generation Z itself is able to tell the elders a lot about the features of digital society and modern economy. As Tapscott, a researcher of digital socialization, noted, "For the first time in history, children are more capable, knowledgeable and literate than their parents in the field of innovations that play a central role in society. This is achieved through the use of digital media, which the "online generation" will continue to develop and incorporate into the culture of society as a whole. Baby boomers are left behind. Now these children are learning, playing, communicating, working and building social relationships differently from their parents. They are the driving force behind the social transformation to come." [3, p.2]. This paradoxical situation leads to a strong intergenerational gap, and as a result, Generation Z prefers to communicate in their environment.

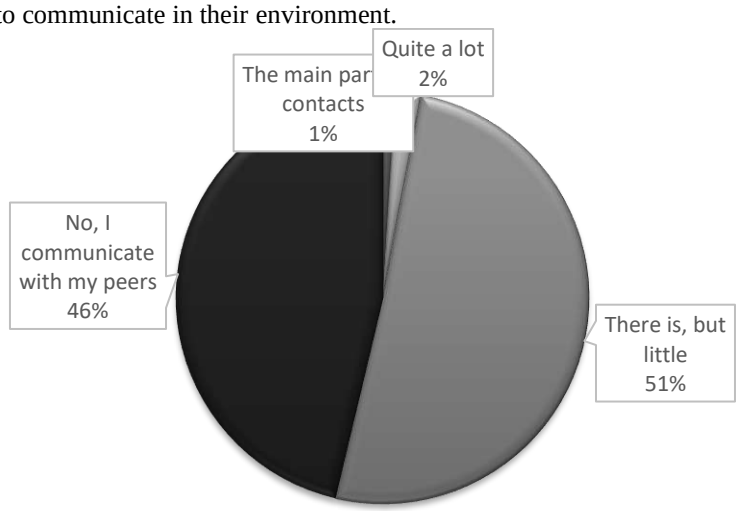

Fig. 2. Conversation partners over 40 years old

The results of the survey (Fig. 2) confirm the theoretical conclusions that better knowledge of digital technologies and special behavior practices on the Internet of Generation Z contribute to the intergenerational gap, alienation of Generation Z from previous generations.

Such compartmentalization of Generation Z makes it difficult for them to assimilate generally accepted norms and values, including ethical ones. It should be noted that the older generation has always been apt to criticize the young and their new fashion. In the case of Generation Z, this tendency is even stronger, as digital technologies have generated many specific features of their behavior. Excessive criticism of young people can be found even in scientific publications. A large part of scientific articles about the digital generation is devoted to clip thinking, young people's misadaptation and other negative phenomena. This situation was well described by Lythcott-Haims, who was Dean of Stanford University and conducted a large-scale study of Generation Z: "We see the negative in the fact that they do not go out into the street, can not look people in the eye, do not make an effort to call on the phone. There are many disadvantages of this generation that social media show us, but there are also obvious advantages" [21, p. 196].

The opposite trend hindering the genesis of social norms is the development of a value and normative crisis - anomie. Beginning from the end of the 20th century, numerous cross-cultural studies testify to the growth of its level [13], [22], which leads to the weakening of normative regulation and inconsistency of normative requirements themselves. Although empirical studies of the anomie began as early as in the 19th century, the period of the end of the 20th century - the beginning of the 21st century was the time when interest in the anomie revived. At present, we can state not only an increase in the level of anomie, but also its qualitative change. The presence of anomie in society has become the norm for the sociological community, as well as deviant behavior and increased crime rate caused by it. Young people are always the most exposed to the state of anomie because they have not yet formed strong values. For our study, the anomie resulting from the digital environment is of most interest.

A feature of communication in the digital environment is the instantaneous transmission of information to any part of the world, resulting in free communication between representatives of all cultures. However, it must be borne in mind that different cultures have different, and sometimes mutually exclusive, values. This leads to the fact that the socializing representative of Generation Z is influenced by the values of several cultures, and this may lead to value disorientation - anomie.

The question about the peculiarities of the anomie arising under the influence of digital communication has not been studied and has the characteristics of real scientific novelty. In addition, in the Russian literature, when considering the anomie it is studied only as a social phenomenon and does not take into account the personal aspects of the anomie. Robert Agnew has substantiated that on the level of personality anomie is not just a reflection of social process, but an independent, multidimensional, socio-psychological phenomenon, which can be caused by different reasons [23]. In this sense, anomie is first and foremost a crisis of the individual. Anomie in Generation Z leads to difficulties in socialization and deviant behavior [24]. The interrelation of deviation and anomie, which was justified by Durkheim, in Generation Z manifests itself in the development of deviant practices. The most revealing of these is the practice of "hate", where an identified user is subjected to harassment and insults by anonymous users.

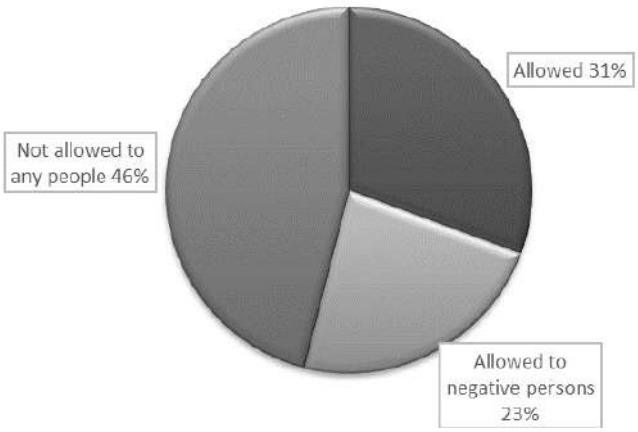

Fig. 3. Generation Z to network trolling ratio

The results of the answer to the question (Fig. 3) about the acceptability of trolling in the network indicate a wide spread anomie among Generation Z, which also leads to the type of deviation such as trolling. When interpreting this data, it should also be taken into account that some respondents tend to give socially acceptable answers so as not to show themselves in a negative light.

Hate practices have become part of the culture of Internet communication and are perceived by Generation Z as an option for normal behavior. However, part of the users condemns such practices, which leads to spontaneous discussion of acceptable and ethically unacceptable behavioral options. Users who insist on the inadmissibility of hates, especially anonymous ones, propose to observe the same rules on the Internet as in real communication and believe that anonymous insults are the result of psychological problems of the offending people.

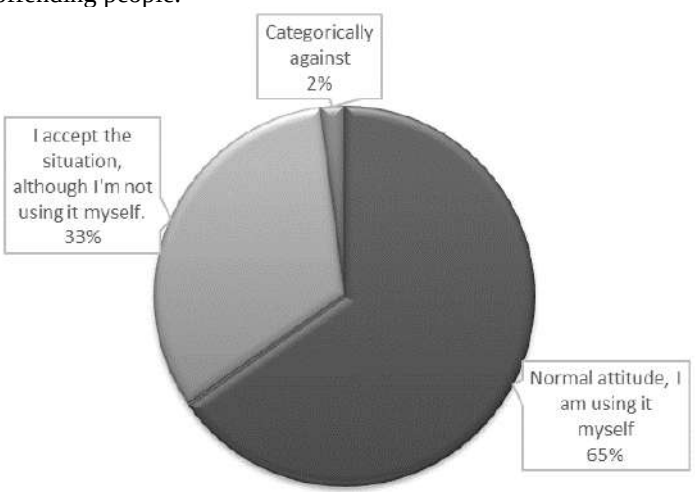

Fig. 4. The attitude to obscene vocabulary among representatives of Generation Z

The results of the answer to the question about the acceptability of obscene language in communication (Fig. 4) show a large spread of anomia and deviation. The foul language as an element of culture is completely borrowed by generation Z from the previous generations, and its frequency of use is a consequence of the anomie in the environment of generation Z.

The growth of the anomie follows from the progressive world trend of individualism [25]. People today can provide for themselves, which leads to a decrease in interest in collective values, marriage, the desire to work in the office, etc.. In post-communist countries the world tendency of individualism is superimposed on the indicators of distrust, fear of being used by others and conviction that people care only about themselves, which are annually recorded by the "European social research". Finally, the individualistic trend is consolidated in a rapidly growing digitalization. Generation Z, as can be seen from the plot (Fig. 5), is as ready to work individually and remotely as it is in the office.

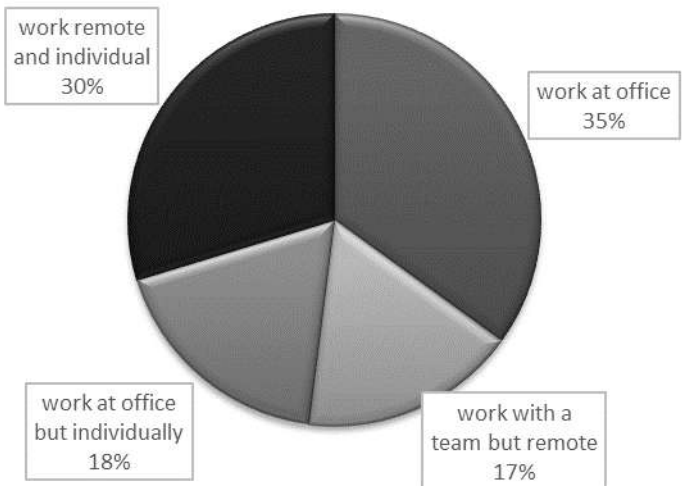

Fig. 5. Preferred forms of work in generation Z

Spontaneous discussions that arise in the digital space when discussing permissible behavior patterns are the natural basis for creating an ethical code of conduct on the Internet. The obvious advantage of such a code is that it is not created artificially, but on the contrary, is the result of generalization of real existing social practices. Of course, a code of ethics is not a law, and it is not binding. But the very existence of such a document will definitely influence the behavior of individuals in the digital space.

The proposed strategy of building digital ethics from the bottom, from the micro level of social interaction, is extremely relevant today. In fact, "modern society is at the initial stage of understanding virtual reality" [26, p. 172]. The unification of the world into a single digital space not only poses new ethical challenges, but is also capable of "becoming a starting point in the search for common ethical principles based on the preservation, interpretation and application of the peculiarities of individual cultures" [27, p.221]. A single digital space essentially means the formation of a single world

culture. This culture is based on the use of English language and includes common universal cultural elements: memes, smiles, special notions and so on.

4 Discussion, Conclusion and Outlook

As "digital natives", members of Generation Z not only transmit the norms and values of the Internet space and socio-cultural reality, but also change the process of value and normative construction themselves. The "new individualists" are also prone to new forms of anomie - deviations approved by the digital community (hit, trolling, etc.). However, it should be noted that the gap in communication between Generation Z and older generations in Russia can also be explained by the civilizational shift, the collapse of the Soviet Union and the formation of a specific socio-cultural space.

This civilizational shift may have changed not only values, but also the space-time dimension. Values based on the experience of the past or the perspective of the future, it is believed, push the society towards joint action and unification; in turn, individualistic attitudes speak about the readiness to live "without the past and the future", here and now. Specific forms of deviant behavior of Generation Z only confirm this thesis, since they are based on the pleasure and approval of the Internet audience. The growth of consumer opportunities only reinforces these trends.

Socialization in the digital environment has formed a specific way of constructing the world of life for Generation Z, where virtual interaction is perceived as well as real. The presented results are interesting both for theory, as they reveal unexplored features of Generation Z, and for practice, as they can serve as a basis for developing effective educational programs. Effective learning programs can not only interest young people in knowledge and facilitate learning, but can also create and incorporate ethical values and practices of ethical interaction in virtual spaces. Non-formal, non-institutionalized educational communities have great potential in improving education. The most effective model of building education for generation Z is a real virtual joint construction of knowledge based on the Socratic method. An important part of this education will be the transmission of ethical values to the younger generation. Taking into account the role of ethical values in the construction of education will not only lead to more ethical practices of behavior among Generation Z, but will also contribute to overcoming the anomie. Reducing the level of anomie can very significantly reduce the number of deviant and criminal behavior.

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