

The Current State of using the Cloud-based Systems of Open Science by Teachers of General Secondary Education

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Keywords: Cloud-Oriented Methodological System, Teacher Training, Science and Mathematics Subjects, Scientific Lyceums.

Abstract: The article presents the analysis of the results of the ascertaining stage of the pedagogical experiment “Design of a cloud-oriented methodological system of training teachers of natural and mathematical subjects to work in a scientific lyceum”. An analysis of recent research and publications has shown that scholars have sufficiently considered the problem of reforming teachers’ training. A valuable trend is revealed in Ukrainian research on the design of cloud-based systems, it is devoted to the systems of open science, but the proposed systems relate exclusively to certain specialties, or are entirely scientific. Currently, there is no cloud-based system that would become a tool in the teachers of science and mathematics training to prepare them to work in the scientific lyceum. The current state of the art of using open science services by teachers of natural and mathematical subjects during the preparation of educational materials was clarified; the readiness of teachers to perform their own research and teach students to conduct research work is analyzed and the level of teachers’ awareness of the functions and requirements of scientific lyceums is determined. The analysis of the conducted survey showed that most teachers recognize the need in scientific activities for a teacher of a scientific lyceum. Most respondents do not use English language resources and services due to their low level of language proficiency. It has been found that one of the most important ways to get involved in science, as for the math teachers’ view, is the participation in scientific conferences. Analysis of the results of the ascertaining stage of the pedagogical experiment shows that there is a problem of preparing teachers of natural sciences and mathematics for work in the scientific lyceum. It needs further solution through preliminary testing and implementation of a specially created cloud-based methodological system that would support the introduction of the open science systems and services in teachers’ training and educational process.

1 INTRODUCTION

Nowadays, teachers of science and mathematics are faced to quite high demands concerning the mastery of the subject and the professionalism of teaching the younger generation. The modern teacher should study throughout life, be interested in innovations in the field of information technology in order to diversify and improve the presentation of educational material. This is an objective necessity nowadays. However, in 2020, due to the epidemiological situation in Ukraine, in order to implement the Resolution of the Cabinet of Ministers of Ukraine No. 211 of March 11, 2020 “On preventing the spread of coronavirus disease COVID-19” in Ukraine, a letter was approved by the Ministry of Education and Science of Ukraine, No. 1/9-173

of March 23, 2020. The letter states that: “Under quarantine conditions, teachers work with students at home by using distance learning technologies, taking into account the material and technical opportunities of the educational institution”. That is, a modern teacher of natural sciences and mathematics must be ready to organize distance learning for students and have all the necessary techniques for its effective implementation. It should be noted that the Regulation on distance learning was adopted on April 30, 2013 by the Ministry of Education and Science of Ukraine (MON, 2013). There is the only ways to implement distance learning: the use of distance learning technologies. Therefore, there is a need to fill possible gaps in teacher education, in particular, through the introduction of cloud technology in the training process.

The advantages of using cloud services in ed-

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ucation have been repeatedly discussed in (Bondarenko et al., 2019; Lytvynova, 2016; Shyshkina, 2015; Vakaliuk, 2019). Among them: saving computing resources of the device; simultaneous work of online user groups; study and work anywhere and anytime; performing tasks from any device (the need is only to connect to the Internet); organization of distance learning online.

The use of the cloud-based systems of open science in the process of teachers' training is now poorly studied and elaborated and needs further investigation.

2 LITERATURE REVIEW

The system of forms of teacher training in accordance with the requirements of the New Ukrainian School were described in (Marchenko, 2019). It was identified that the basis of modern teachers' training courses is the development of creativity, creativity, professional abilities and skills. The cloud technologies are briefly reviewed as a means to be familiar with certain topics of the subject area and perform individual practical tasks.

Krutova (Krutova, 2019) studied the problem of using information and communication technologies in the system of professional development of teachers. Krutova (Krutova, 2019), in particular, provides a list of Ukrainian and foreign platforms (distance learning courses) for teacher training.

Yevtushenko (Yevtushenko, 2018) identified the goals and objectives of advanced training of teachers of natural sciences and mathematics in terms of reforming education in Ukraine. In another study Yevtushenko (Yevtushenko, 2019) examines the problem of teachers' information culture, which he considers as the ability to perceive and learn something new.

Shyshkina (Shyshkina, 2015) studied the problem of designing a cloud-based educational and scientific environment of higher education. The main problem outlined in (Shyshkina, 2015) are: the considering of methodological principles of creation and development of educational and scientific environment of higher education institution based on cloud technologies, determination of criteria for its formation and evaluation.

The research (Lytvynova, 2016) is devoted to the cloud-based learning environments as a tool for solving problems related to the learning mobility of all participants in the learning process. Vakaliuk (Vakaliuk, 2019) defines the meaning of the concept of "cloud-based learning environment for bachelors of computer science" and provides a description of

the structural model of cloud-based learning environment for bachelors of computer science.

Kuzminska (Kuzminska, 2020) researched theoretical and methodical bases of designing and application of digital educational environment of scientific communication of masters-researchers.

Mayer (Mayer, 2015) studied the problems of open science, e.g. the terminological apparatus and areas of use of open science.

Marilyn and Edrick (Marilyn and Edrick, 2012) considered using the Science-Forums.net platform for scientific collaboration.

Researchers have considered the problem of teachers' training in accordance with the basic provisions of the New Ukrainian School Conception and put forward the idea that the program of teachers' training courses should include the study of cloud technologies. However, this is not a comprehensive study for the further use of the system of cloud services that will help teachers in preparing for work in the scientific lyceum. There are also some studies on the use of ICT in the educational process, the features of ICT and their shortcomings. However, the problem is very widely disclosed, it is not specified and is not focused on a specific target group. Also, some studies have considered the issue of updating advanced training courses for teachers of natural sciences and mathematics in connection with the reform of education in Ukraine.

Scientists have sufficiently considered various models of organization of the educational process using information and communication technologies (ICT). In addition, scientists have developed models of cloud-based environment, in particular for the training of relevant profiles. However, the problem of designing a cloud-oriented methodological system for preparing teachers of science and mathematics to work in a scientific lyceum remains insufficiently studied.

The current state of preparation of teachers of natural sciences and mathematics for work in the scientific lyceum requires additional research and analysis. In particular, the skills of the use of the relevant ICT tools or cloud services at each stage of research should be considered. These prerequisites caused the need to launch a scientific and pedagogical experiment "Designing a cloud-oriented methodological system for training teachers of science and mathematics to work in a scientific lyceum" in 2019.

The main task of the research is to analyze and interpret the results of the ascertaining stage of the pedagogical experiment "Design of the cloud-oriented methodical system of training teachers of natural and mathematical subjects to work in a scientific lyceum",

revealing the readiness of the Ukrainian teachers for using the cloud-based systems of open science in the educational process.

3 METHOD

In a previous study (Shyshkina and Marienko, 2020) outlines the term “adaptive cloud-based system of open science”: “it is a cloud-based system (based on a cloud platform), which in its parameters can be automatically adjusted by the goals and objectives of the scientific cooperation process, different individual features and educational and scientific needs of the participants of the virtual research team” (Shyshkina and Marienko, 2020). Since this study is not about adaptability, we can say that the technology of cloud-based systems of open science means purposeful, specially organized sets of information processes using cloud-based systems that meet all the principles of open science.

The pedagogical experiment on “Designing a cloud-oriented methodological system for training teachers of natural sciences and mathematics to work in a scientific lyceum” was launched in 2019 as part of the planned research “Adaptive cloud-based system of training and professional development of teachers of general secondary education” (DR No. 0118U003161, 20182020), conducted at the Institute of Information Technologies and Learning Tools of the National Academy of Educational Sciences of Ukraine. Research work is carried out on the basis of 6 institutions of higher education of Kherson State University, Kryvyi Rih State Pedagogical University, Ternopil Volodymyr Hnatiuk National Pedagogical University, Rivne Regional Institute of Postgraduate Pedagogical Education, Bogdan Khmelnytsky Melitopol State Pedagogical University and Zhytomyr Polytechnic State University. Experimental work on the design and use of a cloud-based system of training and professional development of teachers of scientific lyceums is planned as a natural, cross-pedagogical experiment, which consists of the following stages: preparatory and research. Thus, the research stage is divided into: ascertaining, forming and control.

The *purpose* of the experiment is to design and verify experimentally the cloud-based methodological system of training teachers of natural sciences and mathematics to work in a scientific lyceum.

The use of cloud technologies and cloud services in the educational process is a promising trend of modern Ukrainian and foreign research. The methodological principles of the cloud-based learn-

ing and research environment design are well investigated by the Ukrainian scientists in the recent years (Vakaliuk, 2019; Lytvynova, 2016; Shyshkina, 2015). At the same time, the cloud services are purposefully used both the educational process of institutions of higher education and general secondary education institutions. Cloud-oriented learning environments have some advantages for educational institutions in the organization of the educational process and the use of learning technologies.

The cloud-based system can provide services such as remote access to learning tools for higher education institutions to save on local and public funding in a cost-effective way. Students can access classes on a laptop, tablet, or phone from anywhere and use them freely. At the same time, the student can ask and answer questions and share what has been learned to help others. Access to analysis and user data means that such a system can be adapted to ensure maximum efficiency for both users and the education system. But most importantly, it helps young people access to access to learning anywhere, anytime, from any experienced teacher.

It turns out that most teachers of pedagogical schools are familiar with cloud services and express their intention to use cloud-based systems in the educational process. It was found that teachers who use a particular cloud service in the learning process fully involve all its possible tools. However, due to the lack of methodological developments, the use of cloud-oriented systems calls into question the effectiveness of their pedagogical use.

The purpose of the *ascertaining stage* of the pedagogical experiment is: to find out the current state of use of services by teachers of natural and mathematical subjects during the preparation of educational materials; to find out the readiness of teachers to perform personally and teach students to conduct research; to determine the state of awareness of teachers about the functions and requirements in scientific lyceums.

At the ascertaining stage, the experimental work was conducted in cooperation with Rivne Regional Institute of Postgraduate Pedagogical Education (2019) and Zhytomyr Polytechnic State University (2020). The following methods were used: questionnaires, interviews and observations. At the stage when the experimental sites were identified, two questionnaires were developed for each institution separately. The primary quantitative analysis of the experimental data is provided and the obtained results are summarized by means of distribution diagrams, tables and their interpretation is fulfilled. The quantitative analysis is to describe the current state of this problem. The reliability of the results is confirmed by the

involvement of teachers from all regions of Ukraine.

4 RESULTS

4.1 Rivne Regional Institute of Postgraduate Pedagogical Education

The questionnaire, developed for students of two groups of mathematics teachers of Rivne Regional Institute of Postgraduate Pedagogical Education, consisted of 13 closed questions (2 dichotomous and 11 alternative multivariate) and one open, short. At the beginning of the questionnaire, the respondent indicates in which city he / she works (teachers were from different cities of Rivne region, in order to determine the territorial distribution) and his / her educational institution. The next point is to indicate which subjects the respondent reads, because at school a mathematics teacher can additionally teach other subjects. Thus, out of 45 respondents, not only mathematics teachers, but also 2 methodologists and 4 teachers were among the respondents. The aim was to find out the knowledge of mathematics teachers about the basic provisions and conditions of work in the scientific lyceum, how much teachers are interested in conducting research (one of the main requirements of work in the scientific lyceum) and involving students in research.

One of the key questions was to determine whether respondents understand how important is it for a science high school teacher to be engaged into research, as this is a basic requirement. It was found that the majority of teachers (43 respondents out of 45 respondents, which is 96%) believe that a teacher of a science lyceum should be engaged in scientific activities. At the same time, teachers who took part in the survey, in particular, submit articles to professional publications in Ukraine only for certification – 34 respondents (76%).

Only 10 teachers (22%) submit an article to a professional publication at least once a year. This is evidence that teachers are reluctant to publish their own research or do not have enough time to do so. Another possible reason is that teachers underestimate the necessary to be engaged in scientific research. These reasons were established during the interviews and clarification of certain issues related to the survey.

In the content of the cloud-oriented methodological system of training teachers of natural and mathematical subjects to work in the scientific lyceum there is a need to use English-language resources and services (specialized and general purpose). Therefore,

the goal was to determine whether teachers were able to use English-language resources (not necessarily cloud-based). However, the results were not comforting enough: 35 respondents (78%) do not use any English-language resources or services. This is the evidence that in order to test and further implement a cloud-based methodological system of training teachers of science and mathematics to work in the scientific lyceum should develop detailed organizational instructions using certain tools and services (including English).

If the teacher uses only printed resources in English, some research may be needed to determine the level of skills in using cloud services. During the interview, it was found that teachers want to work with English-language services, however, they first need to master the skills of working with an online translator or installing plug-ins and applications to speed up the work and make it more comfortable. Such preparatory moments will not distract from the learning process and save time and effort (the teacher does not need to translate each menu or button with a printed dictionary, because, unfortunately, there are such situations). In order to find out the skills and abilities of conducting research work, the respondents answered the following questions: research of the state of the scientific problem, participation in scientific activity and implementation of the obtained research results.

A rather interesting result was that respondents are familiar with open science services (21 people, which is 47%). 22 respondents (49%) answered that they rely on their own experience to formulate and study the state of a scientific problem, but this is not enough, because in this case the scientific problem will not be fully investigated. Questionnaire answer options were designed to cover every aspect of the problem and to consider as many possible life options as possible.

The most common ways for teachers to participate in scientific activities were: participation in conferences (24 respondents, 53%) and individual scientific activities (21 respondents, 47%). Perhaps this will be enough for the secondary school (at least participation in conferences), however, if a teacher plans to work in a scientific lyceum, then cooperation with higher education institutions and project activities will play a significant role. Individual scientific activity, without combination with other ways of participation in scientific activity, will generally give a rather weak result, because in this case there are no discussions, exchange of experience and constructive criticism (discussion of existing methods, establishing new connections).

Among the ways of implementation and use of the obtained research results the most common are:

publication of methodical materials (selected by 22 respondents, 49%) and self-implementation (selected by 19 respondents, 42%).

At the same time, self-implementation is not a very effective way, because one teacher will not be able to cover a geographically large enough number of participants. Therefore, this implementation will be local and available only to a narrow circle of participants (especially if the teacher does not sufficiently publish the results of their work, showing previous survey results).

4.2 Zhytomyr Polytechnic State University

The questionnaire “Skills of working with cloud services”, developed for four groups of students of the distance course of educators on the basis of Zhytomyr Polytechnic State University, consisted of 13 closed questions (3 dichotomous and 10 alternative multivariate) and one open, short. Some questions of the questionnaire are duplicated with those that were in the questionnaire for mathematics teachers of Rivne Regional Institute of Postgraduate Pedagogical Education. As in the previous survey, the respondent indicates in which city he works (educators from all regions of Ukraine took part in the survey) and his educational institution. Mandatory field to fill in – it is necessary to indicate which subjects the respondent reads (it was necessary to cover not only mathematics teachers, as the target group is teachers of natural sciences and mathematics). Thus, among the 824 respondents surveyed were teachers of computer science, mathematics, Ukrainian language and literature, English, history, biology, physics, foreign literature, geography, chemistry.

If you analyze the questions that are present in both questionnaires, you can trace certain patterns. The majority of respondents (789 people) believe that a teacher of a scientific lyceum should be engaged in scientific activity (95.8%). If we evaluate the use of English-language resources (services) by teachers, we can say that 66.9% (551 respondents) do not use, 31.8% (262 respondents) use such resources and 1.3% (11 people) use only printed English resources.

One of the main issues during the ascertaining stage of the pedagogical experiment is to determine the most common services among teachers that they use in preparation for the lesson. This issue is extremely important, because for the further implementation of a cloud-based methodological system, you need to have at least basic knowledge for the use of cloud services and their principles of operation. As can be seen from the results of the survey, only 548

respondents use cloud services in preparation for the lesson (66.5%). 574 (69.7%) – still used a local ICT tools. That is, teachers can not even assess the benefits of cloud services and their use in organizing group work of students.

The next stage of research was to assess the skills and abilities of teachers to use individual resources and services at different stages of research. After all, if the teacher has sufficient skills to work with services, he will later be able to teach this and his students by offering them as an alternative, such as spreadsheets. What resources are used by teachers to search for scientific (educational and methodological) literature are shown in Fig. 1. Among the answer options, the most common services were chosen, those that are available to teachers. Also, the list included open science services, as they can act as separate components of the cloud-oriented methodological system of training teachers of natural sciences and mathematics to work in the scientific lyceum.

As can be seen from the chart, 98.9% of respondents (815 respondents) use Google search. Almost half of the respondents (424 people, which is 51.5%) use printed materials to find the right material. At the same time, repositories (16.5%), journal systems (14%) and Google Scholar (14.9%) remain almost unnoticed. It is clear that a rather small number of teachers use open science services (4.4%), as a quarter (only 26.8%) of respondents are familiar with the concept of open science. This is 221 respondents (26.8%) out of 824.

Even fewer respondents know about the European Open Science Cloud – 191 (out of 824 respondents), which is 23.2%. These questions were necessary to clarify the state of awareness of teachers with the latest scientific trends. After all, the use of individual components of the European Open Science Cloud can be quite useful for preparing teachers to work in a scientific lyceum. In addition, the European Open Science Cloud contains about 220 cloud services that teachers can successfully use in the learning process (the main advantage is free and open access). But this is possible only with the appropriate techniques.

Teachers of scientific lyceums must not only bring the scientific component into the educational process, but also be able to organize each stage of research work of students using modern ICT tools. Apparently, one of the leading services can be considered cloud services, because they are focused on the use of anywhere and anytime (on any device) and do not restrict students to use only sufficiently powerful devices (do not depend on the technical characteristics of a device). Therefore, the use of teachers of a service to organize the joint work of students was studied

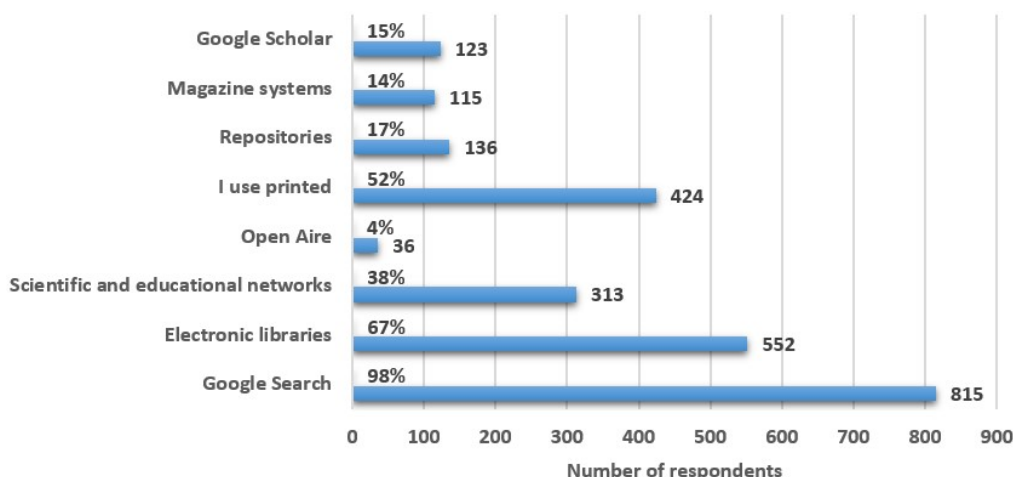


Figure 1: Teachers use services to search for literature.

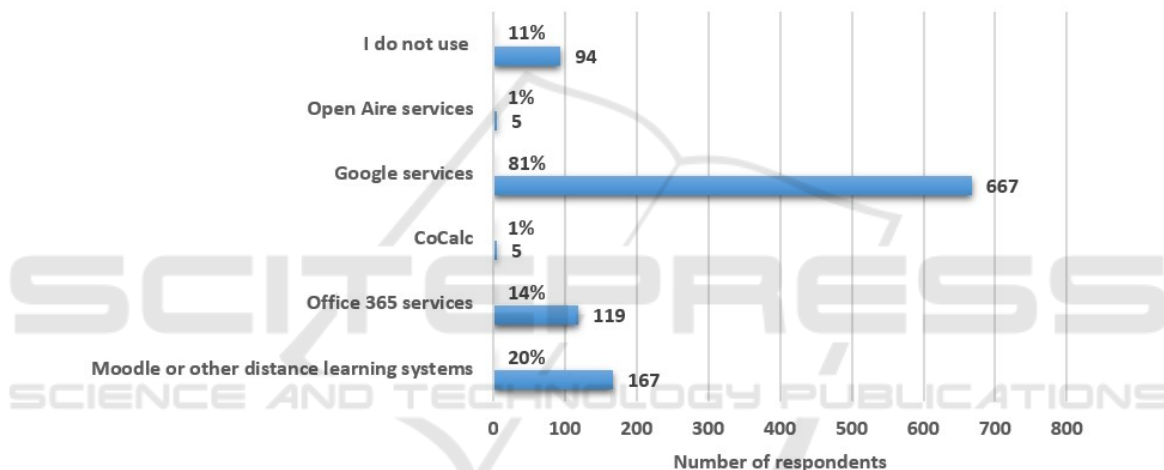


Figure 2: The use of services by teachers to organize the joint work of students.

(figure 2). As can be seen from the chart, Google services are the most popular among teachers, they were chosen by 667 respondents (80.9%). Only 20.3% of respondents (167 people) use a system of distance learning courses such as Moodle to organize joint work of students in the classroom. It is unfortunate that 94 respondents (out of 824 respondents, 11.4%) do not use any services to organize group work of students.

The analysis of the answers (figure 2) shows a low level of use by teachers of distance learning systems, specialized cloud services and some tools of the European Open Science Cloud (0.6%). This indicates that there are some problems in preparing teachers of science and mathematics to work in the scientific lyceum, because this situation makes it impossible to fully organize the educational process using modern cloud services, ICT tools at a high, scientific level.

5 CONCLUSIONS

Analysis of the results of the ascertaining stage of the pedagogical experiment “Designing a cloud-oriented methodological system of training teachers of science and mathematics to work in a scientific lyceum” showed that there is a problem of training teachers of science and mathematics to work in a science lyceum. Although most of the participants in the statement phase of the pedagogical experiment are aware of the need of a teacher of a scientific lyceum in scientific activity, but teachers are not ready to work in a scientific lyceum. In particular, most respondents submit articles to professional publications in Ukraine only for certification and do not always use rational ways to pose and study the state of a scientific problem. Observations and individual interviews have found that teachers generally do not consider it necessary to engage in science, let alone encourage students to do so.

According to teachers, one of the main ways to participate in scientific activities is to participate in conferences and individual scientific activities. Publication of methodical materials and self-implementation, according to teachers, are one of the most promising ways to implement and use the results of the study. Teachers' use of lesson preparation services is mostly limited to online services and ICT tools on the local computer (cloud services are also used, but to a lesser extent). Most respondents use scientific and methodological literature to search: Google search, electronic libraries and printed sources. Only a quarter of respondents are familiar with the concept of open science and the European Open Science Cloud. And most teachers use Google services to help students work together. Thus, it turns out that most respondents use only localized resources and services, which significantly narrows the range of possible cloud services in the learning process, in particular, to organize collaboration, data processing, search for literature and information and more. In addition, among the possible variety of cloud services of open science, the most famous of them are practically not used. As a prospect for further research is the experimental implementation of a model of cloud-based methodological system of training teachers of natural sciences and mathematics to work in the scientific lyceum in the educational process of Kherson State University, Zhytomyr Polytechnic State University and Kryvyi Rih State Pedagogical University. The final stage of research and experimental work is the statistical processing and analysis of the results of the formative stage of the pedagogical experiment.

ACKNOWLEDGEMENTS

The material of the article is a part of the research carried out within the project of the National Research Fund of Ukraine "Cloud-oriented systems of open science in teaching and professional development of teachers".

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