

# The current level of competence of schoolteachers on how to use cloud technologies in the educational process during COVID-19

Tetiana A. Vakaliuk<sup>1,2,3</sup>, Oleg M. Spirin<sup>4,2</sup>, Olha V. Korotun<sup>1</sup>, Dmytro S. Antoniuk<sup>1</sup>, Mariia O. Medvedieva<sup>5</sup> and Inesa V. Novitska<sup>6</sup>

<sup>1</sup>Zhytomyr Polytechnic State University, 103 Chudnivsyka Str., Zhytomyr, 10005, Ukraine

<sup>2</sup>Institute for Digitalisation of Education of the NAES of Ukraine, 9 M. Berlynskoho Str., Kyiv, 04060, Ukraine

<sup>3</sup>Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine

<sup>4</sup>University of Educational Management, 52A Sichovykh Striltsiv Str., Kyiv, 04053, Ukraine

<sup>5</sup>Pavlo Tychyna Uman State Pedagogical University, 2 Sadova Str., Uman, 20300, Ukraine

<sup>6</sup>Zhytomyr Ivan Franko State University, 40 Velyka Berdychivska Str., Zhytomyr, Ukraine, 10008

**Abstract.** During the period of total lockdown caused by COVID-19 pandemic, teachers had to move to distance learning to organize a continuous educational process, which is not possible without the active use of modern information and communication technologies, including cloud services. Because of this, at the beginning of the pandemic, Zhytomyr Polytechnic State University conducted several free distance online courses for teachers, which included studying the possibilities of using cloud technologies in teaching in a pandemic. Somewhat later, some secondary schools in Zhytomyr expressed a desire to take the same courses, but in person. 98 teachers of schools of the city of Zhytomyr were covered by training on courses “Cloud technologies in the educational process in the conditions of quarantine”. After face-to-face courses, teachers in Zhytomyr schools have significantly increased their competence in the use of cloud technologies in the educational process in the context of the COVID-19 pandemic. Not only has their level increased in general, but the horizons regarding the variety of cloud services that should be used in distance learning have expanded. Course training, organized according to scientifically sound methods, helps to increase the motivation of students (teachers) to self-study, as well as to the future use of cloud technologies in the educational process.

**Keywords:** competence, cloud technologies, cloud services, distance learning, educational process, COVID-19

✉ [tetianavakaliuk@gmail.com](mailto:tetianavakaliuk@gmail.com) (T. A. Vakaliuk); [oleg.spirin@gmail.com](mailto:oleg.spirin@gmail.com) (O. M. Spirin); [olgavl.korotun@gmail.com](mailto:olgavl.korotun@gmail.com) (O. V. Korotun); [dmitry\\_antonyuk@yahoo.com](mailto:dmitry_antonyuk@yahoo.com) (D. S. Antoniuk); [medvedeva-masha25@ukr.net](mailto:medvedeva-masha25@ukr.net) (M. O. Medvedieva); [inesanovicka@gmail.com](mailto:inesanovicka@gmail.com) (I. V. Novitska)

🌐 <https://sites.google.com/view/neota> (T. A. Vakaliuk);

<http://umo.edu.ua/en/university/leadership/spirin-olegh-mikhajlovich> (O. M. Spirin);

<http://irbis-nbuv.gov.ua/ASUA/1467014> (O. V. Korotun); <http://irbis-nbuv.gov.ua/ASUA/1471030> (D. S. Antoniuk);

[https://informatika.udpu.edu.ua/?page\\_id=3298](https://informatika.udpu.edu.ua/?page_id=3298) (M. O. Medvedieva); <http://irbis-nbuv.gov.ua/ASUA/1190440>

(I. V. Novitska)

🆔 0000-0001-6825-4697 (T. A. Vakaliuk); 0000-0002-9594-6602 (O. M. Spirin); 0000-0003-2240-7891 (O. V. Korotun);

0000-0001-7496-3553 (D. S. Antoniuk); 0000-0001-9330-5185 (M. O. Medvedieva); 0000-0003-0780-0580

(I. V. Novitska)



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## 1. Introduction

With the spread of COVID-19, the educational process is undergoing significant changes [9]. During the period of total lockdown, teachers had to move to distance learning to organize a continuous educational process, which is not possible without the active use of modern ICT, including cloud technologies and services. Many teachers had to simultaneously increase their competence in using such services and teach students to do it. Students and teachers had to cope with many challenges for the proper and effective use of cloud services in the organization of such training.

With this in mind, at the beginning of the pandemic, Zhytomyr Polytechnic State University conducted a series of free distance online courses for teachers, which included studying the possibilities of using cloud technologies in teaching in a pandemic. A scientifically sound methodology was developed, which contained a semantic component with a list of topics and features of forms, methods, and means of conducting such courses were described in the previous work [17]. 1,500 teachers were registered for the course, and 816 people completed the course. Therefore, some institutions of secondary education in Zhytomyr (Ukraine) expressed a desire to go through the same courses, but full-time mode. It was decided to hold such courses for schoolteachers. Before starting the courses, it was necessary to find out the current level of their competence in the use of cloud technologies in the educational process in the context of the COVID-19 pandemic. The courses were held at Zhytomyr Polytechnic State University in August 2020 full-time.

Under **the teacher's competence in the use of cloud technologies in the educational process**, we mean the ability of an individual, confirmed in practice, to use such technologies based on the acquired knowledge, skills, and abilities in cloud technologies to meet their own educational needs and solve professional problems in the educational industry.

## 2. Theoretical background

Throughout the pandemic, scientists from around the world have raised questions about the use of different information and communication technologies in the educational process, the introduction of distance and blended learning, and more. In particular, the COVID-19 pandemic has contributed to the comprehensive development of research in the field of cloud technologies and their use in the educational process.

García et al. [5] conducted a study to identify the key elements of teacher training in the use of the latest ICTs, as well as various methodologies, with the aim of providing improvements in the educational process to overcome deficiencies in their professional training. An experimental study conducted by the authors showed that the education of teachers must necessarily be focused on the practical part, and the work of young teachers must be carried out with the help of teachers with experience. The authors also found that some standards should be approved to monitor the digital competence of teachers [5].

Mosenkis et al. [13], when conducting distance learning courses to improve the skills of teachers, found that cloud technologies can be used to manage the educational process online. As a result of their research, Mosenkis et al. [13] concluded that conducting such courses solves

the problem of interaction that exists in the team, and also helps to ensure the professional orientation of the project tasks of teachers [13].

García-Peñalvo et al. [6] proposed the TRAILER project, demonstrating the possibility of collecting information related to learning activities, regardless of the context or tools used to conduct them. The authors conduct their research in non-formal education [6].

Al Bashaireh [1] explored why and how exactly cloud e-learning improves the quality of education, based on the concept, architecture and characteristics. The author cited the benefits of using cloud-based e-learning for all aspects of the educational process (institutions, students and teachers) during the COVID-19 pandemic [1]. Moravcik, Bridova and Segec [11] demonstrate their own experience of using cloud services in universities (from the user's point of view and from the administrator's point of view).

Some authors have conducted research to study the readiness to use cloud computing in higher education during the pandemic. In particular, Amron, Noh and Mohamad [2] interviewed teachers and students from universities in Malaysia using certain models (technology susceptibility and technology readiness index). As a result, the authors concluded that optimism and innovativeness have a significant impact on technology adoption factors, while discomfort and insecurity do not affect technology adoption [2].

Utami et al. [16] explored how teachers in Indonesia perceive cloud technologies to facilitate the learning process during a pandemic. Note that the authors also used models for this study. In particular, for this study, a technology acceptability model was used with the inclusion of two original designs [16]. Dutta et al. [3] are not far behind their peers and offer research on the functional relationship between readiness to use, subjective well-being, and intent to implement cloud eLearning in Taiwan [3].

In particular, Nagaraju, Madhavi and Murthy [14] analyzed the effectiveness of online learning during the COVID-19 pandemic. According to an online survey of 683 respondents (teachers and students), 38% did not even start such training, although it is inevitable in such a situation.

Falfushynska et al. [4] identified various ICT tools for the implementation of distance learning, including Zoom, Moodle, Google Meet, BigBlueButton, and Cisco Webex. The study showed the satisfaction of subjects and their positive attitude to distance learning, satisfaction with the quality of such tools. During the pandemic, the readiness of students and pupils to organize independent learning becomes especially important, which requires them to be motivated to learn, keep track of time, can use modern ICT, self-discipline, and control.

Korobeinikova et al. [8] show an example of the use of cloud services in their activities as a means of improving student learning and teaching disciplines, in particular Google Classroom, which allows you to manage the independent work of students while studying disciplines. Korobeinikova et al. [8] emphasize that when organizing the educational process using cloud technologies, it is necessary to move to the application of the model of blended learning in universities.

The issue of professional training of teachers for the organization of learning with the help of cloud services was studied by Velychko et al. [18], who conducted a survey of mathematics teachers on the use of ICT in the educational process. Velychko et al. [18] found that 82% of mathematics teachers who participated in the survey use cloud services in education, implement on their basis modern methods and forms of teaching, use a variety of modern cloud services to teach mathematics.

The professional competence of a teacher according to European standards is described in [12], which presents a model for the development of this competence of information technology teachers, consisting of stages, subjects, and resources. Morze and Glazunova [12] emphasize the need to use existing e-CF and ISTE standards to develop this competence in teachers.

In the conditions of the introduction of cloud services and means of distance learning in the educational process of modern secondary education institutions, one of the main competencies of teachers becomes information and communication competence. The methodology for the development of this competence in teachers of the military education system is presented in [19], in particular, the main tasks of its development are identified. Teaching aids have been identified, among which ICT tools are mandatory: computer-based educational systems in the multimedia versions; laboratory remote workshops; simulators; electronic libraries with remote access, etc. In addition, the expediency of the introduction of active learning methods, which are implemented through the use of computer networks, audio-video, and other telecommunications, including the Internet.

In [10] one of the modern competencies is considered – digital, as one of the factors of formation of the information society in Ukraine. Based on the analysis of the definition of digital competence, its interpretation is given, the didactic conditions of its formation are singled out.

As studied in [15], any individual can move faster in learning a new profession through online courses. Because with such training there is a possibility to combine online and offline courses. Various platforms have recently been used to conduct online courses, such as Coursera, MIT OCW, Prometheus, Udemy, edX, Udacity, Stanford online, etc. Spirin [15] pays special attention to course aggregators. In particular, Course Buffet is an aggregator that allows you to choose a specialization from a certain set of courses. This specialization will correspond to the number of credits in the specializations of different universities around the world. As a result, it is possible to study according to the same subject load as at the university, where the educational process takes place according to traditional teaching.

In the conditions of quarantine in March-April 2020 in general secondary education institutions of Ukraine, the use of the web service Zoom for conducting video lessons in combination with Google Classroom became widely popular. However, the use of the latter imposes some requirements and restrictions, in particular:

- participants must have a Google account;
- the system must be registered as an educational institution, otherwise, the teacher's own disk space is used, which is limited for an individual user;
- Google's children's profile is limited to 13 years for the free use of resources, including no access to videos used for educational purposes on YouTube.

In addition, as of the end of May 2022, the most popular (in terms of trust rating and a number of downloads from Google Workspace Marketplace) digital video conferencing services, webinars, and organizers are: Zoom, MS Teams, Slack, and others [7].

### 3. Methods

98 teachers of schools of the city of Zhytomyr were covered by training on courses “Cloud technologies in the educational process in the conditions of quarantine”. To conduct this study, teachers at the beginning of the courses and at the end of the courses completed a survey to determine the level of competence of teachers in the use of cloud technologies in the educational process. Those questions that served to establish the level of competence of teachers in the use of cloud technologies in the educational process during the COVID-19 period and were investigated before and after the courses were assessed according to the following principle, that teachers could choose only 1 answer out of 5 offered. In particular, the first answer assumes that the teacher chose all subsequent ones except the last one. The second includes all subsequent ones, except the last one, etc. That is, if the teacher chose the first answer, then he chose all 4 answers by default, except for the last one.

### 4. Results

The purpose of training on the courses “Cloud technologies in the educational process in quarantine” was to get acquainted with the basic methodologies of using cloud technologies in education; a general overview of existing cloud technologies and consideration of the main provisions of cloud technologies for use in the educational process. The course was completely identical to the course conducted in the period March-April 2020 [17].

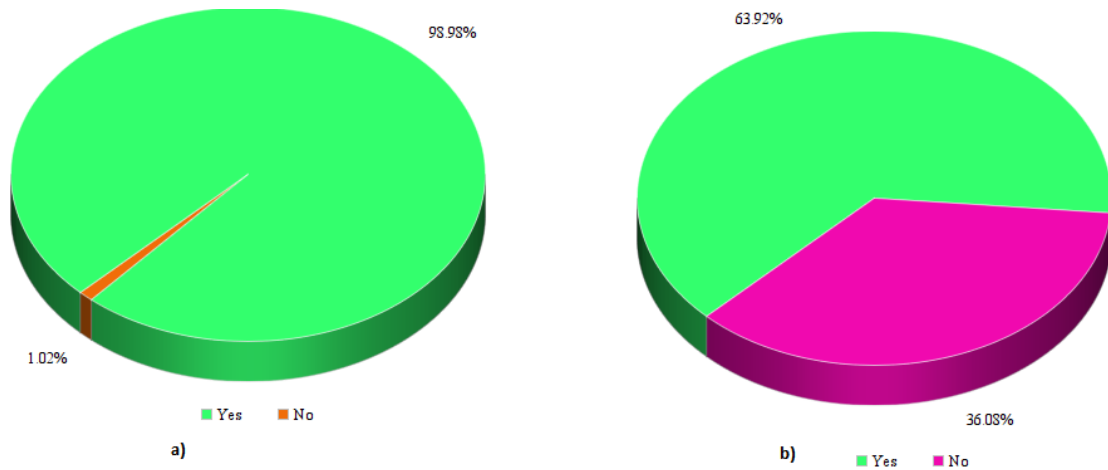
As a **result of the course, teachers could get acquainted with:** basic concepts, models for providing cloud services, offers from leading companies providing cloud services; cloud storage; cloud services for creating documents; cloud services for creating Internet surveys; cloud services for creating presentations; cloud services for creating smart maps; cloud services for creating websites; cloud-based learning management systems (on the example of Google Classroom) [17]. The main difference was that teacher training was conducted traditionally – in the classroom.

At the beginning of the course, a survey was conducted to clarify general issues. To the question “Do you have a computer (laptop) at home?”, 98.98% of respondents answered in the affirmative.

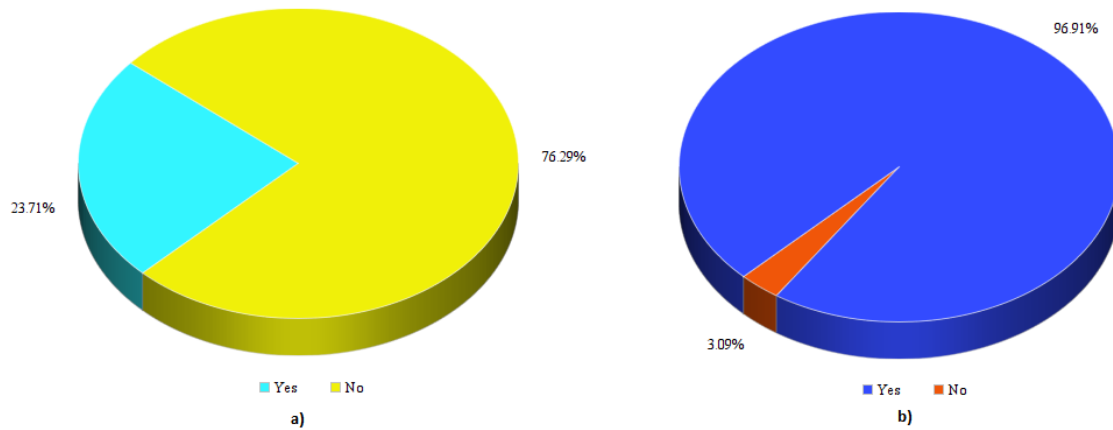
The same answer was given to the question “If you have a computer at home, is it connected to the Internet?” and “Can you find the information you need on the Internet?” (figure 1a). Interestingly, 100% of respondents indicated that “the Internet is necessary for his / her professional activity”.

In response to the question “Are you able to choose and use software to optimally present the different types of materials needed for the learning process?”, 63.92% of respondents indicated that they know how to choose and use software for optimal presentation of different types of materials, necessary for the learning process, while all the others answered that they do not know how (figure 1b).

The next question of the general unit was whether teachers have their website or blog. In response to this question, only 23.71% of respondents answered that there is, and 76.29% do not (figure 2a). At the same time, 96.91% of respondents indicated that they had a website for their



**Figure 1:** Survey results to the question “If you have a computer at home, is it connected to the Internet?”, “Can you find the information you need on the Internet?”, and “Are you able to choose and use software to optimally present the different types of materials needed for the learning process?”.



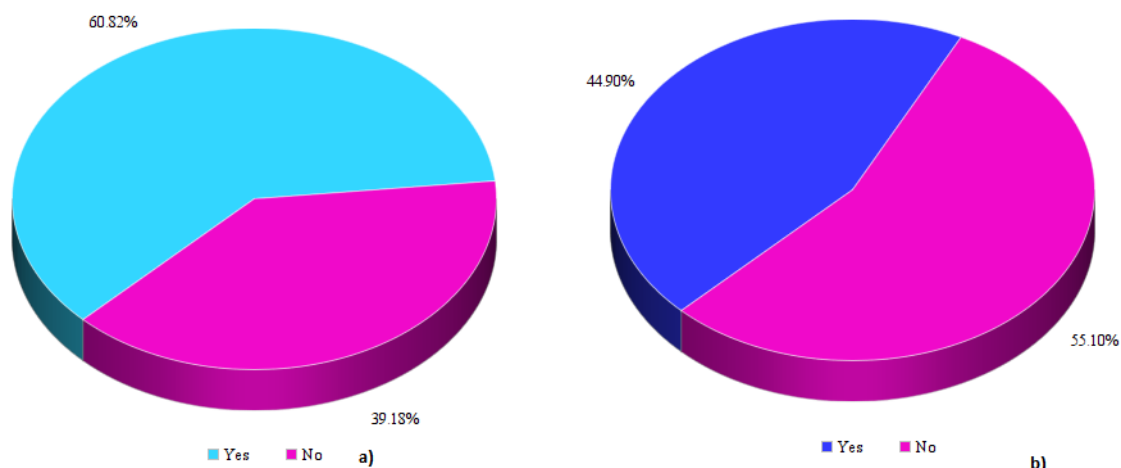
**Figure 2:** Survey results to the question “Are you have their website or blog?” and “Are you have a website for your school?”.

school, and only 3.09% said “no” (figure 2b).

The following questions were about whether the course participants know what cloud technologies and services are, to which 60.82% of respondents answered in the affirmative, 39.18% answered “no” (figure 3a). At the same time, only 44.9% used cloud technologies in teaching their subject before taking the courses, and 55.10% did not use them before taking the courses (figure 3b).

The following questions served to establish the competence of teachers on the use of cloud technologies in the educational process during COVID-19 and were studied before and after the courses that included the acquisition of basic competencies for working with cloud technology in the educational process in the conditions of a pandemic.

When finding out what motives motivate teachers to use cloud technologies in the educational



**Figure 3:** Survey results to the question “What is cloud technologies and services?” and “Do you used cloud technologies in teaching your subject?”.

process (see table 1 and figure 4), it was found that more than 50% of respondents in both cases chose the need to be able to use different cloud technologies (at the end of the experiment respondents who chose this type of motive increased by 4.2%), the need for self-study using various cloud technologies at the beginning of the experiment was chosen by 25.54% of respondents, at the end – 22.10%. Regarding the other two motives – there was an interesting dynamic: the need to be acquainted with cloud technologies before the experiment chose 10.2%, after – 5.81%, when choosing the need to study the main types of cloud technologies – the situation was the opposite – at the beginning of the experiment 6.12%, at the end – 11.63%. Accordingly, at the beginning of the experiment 2.04% and at the end of 1.16% of respondents did not see the need to use cloud technologies in the educational process in general.

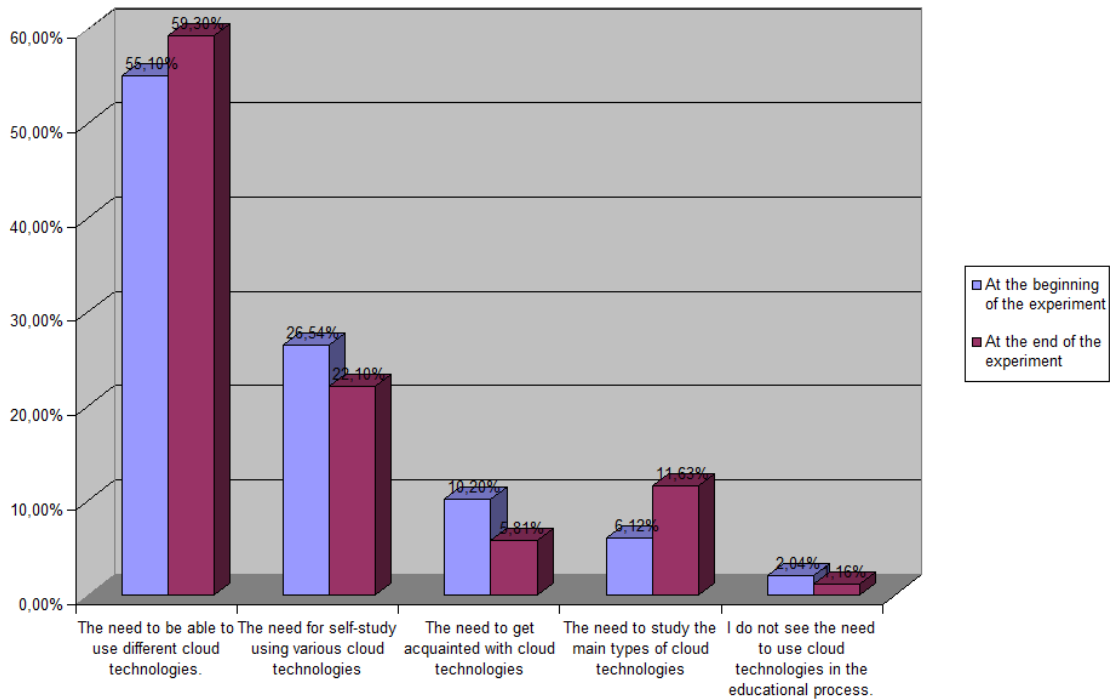
**Table 1**

Respondents’ answers to the question “Which of the following motives motivate you to use cloud technologies in the educational process?”.

Answer	At the beginning of the experiment	At the end of the experiment
The need to be able to use different cloud technologies	55.10%	59.30%
The need for self-study using various cloud technologies	26.54%	22.10%
The need to get acquainted with cloud technologies	10.20%	5.81%
The need to study the main types of cloud technologies	6.12%	11.63%
I do not see the need to use cloud technologies in the educational process	2.04%	1.16%

In general, according to the results of the survey, after the courses, the motivation of teachers to use cloud technology in the educational process has increased.

Determining which of the proposed motives motivate teachers to self-study using cloud services, it was found that 76.54% (before the experiment) and 69.88% (after the experiment) of



**Figure 4:** Respondents’ answers to the question “Which of the following motives motivate you to use cloud technologies in the educational process?”.

respondents chose the need for self-improvement and self-development in future professions; the need to understand the significance of the acquired skills before the experiment was chosen by 12.24% and after – 16.87%; the need to understand the significance of the acquired knowledge was chosen by 10.2% and 7.23%, respectively (see table 2 and figure 5).

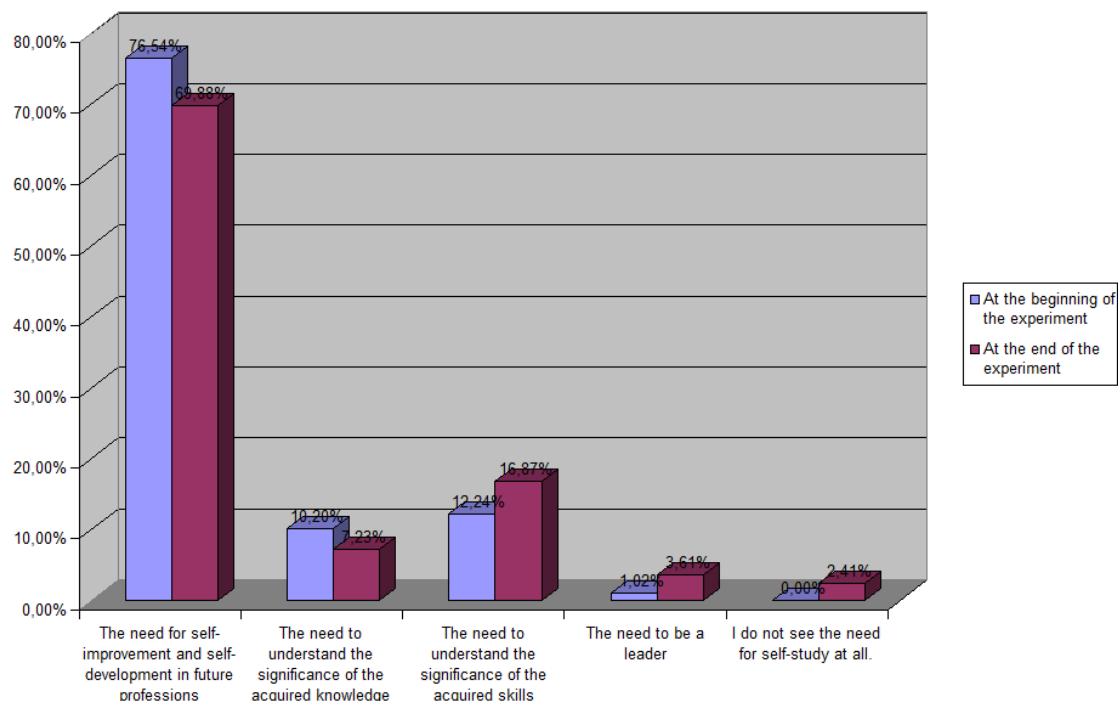
The need to be a leader was not a priority, and some respondents did not see the need for self-study at all.

**Table 2**

Respondents’ answers to the question “Which of the following motives motivate you to self-study using cloud services?”.

Answer	At the beginning of the experiment	At the end of the experiment
The need for self-improvement and self-development in future professions	76.54%	69.88%
The need to understand the significance of the acquired knowledge	10.20%	7.23%
The need to understand the significance of the acquired skills	12.24%	16.87%
The need to be a leader	1.02%	3.61%
I do not see the need for self-study at all	0.00%	2.41%





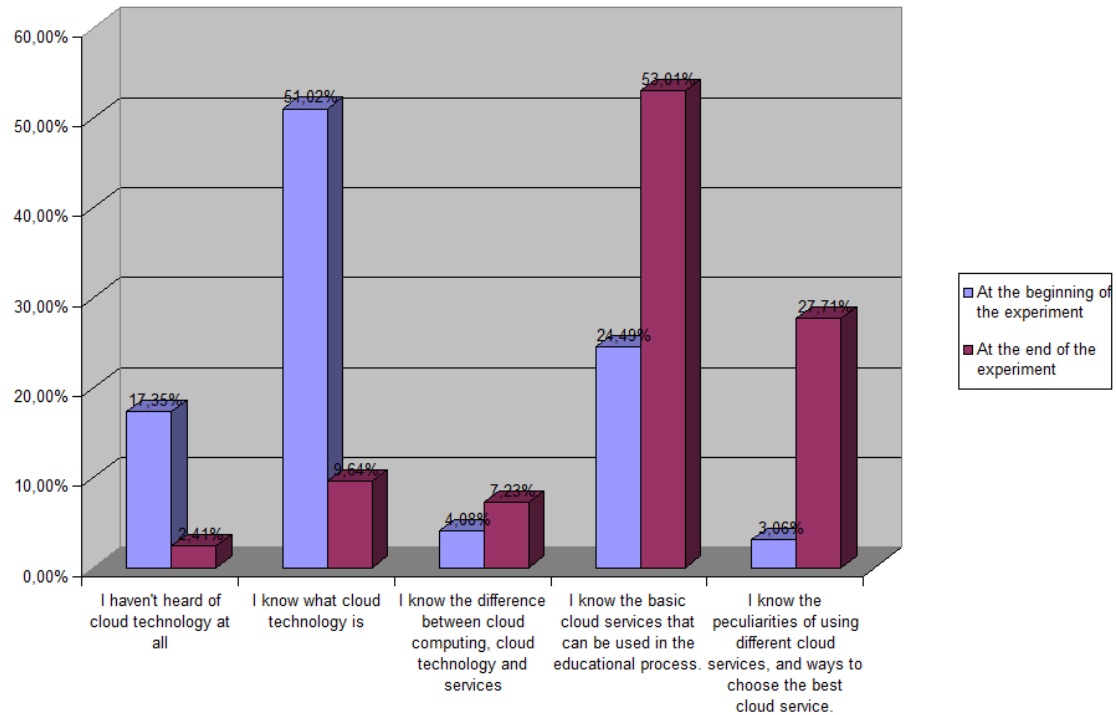
**Figure 5:** Respondents’ answers to the question “Which of the following motives motivate you to self-study using cloud services?”.

**Table 3**

Respondents’ answers to the question “What is the level of your mastery of cloud technology knowledge?”.

Answer	At the beginning of the experiment	At the end of the experiment
I haven’t heard of cloud technology at all	17.35%	2.41%
I know what cloud technology is	51.02%	9.64%
I know the difference between cloud computing, cloud technology, and services	4.08%	7.23%
I know the basic cloud services that can be used in the educational process	24.49%	53.01%
I know the peculiarities of using different cloud services, and ways to choose the best cloud service	3.06%	27.71%

Regarding the level of teachers’ knowledge of cloud technologies, at the beginning of the experiment, 51.02% of respondents only knew what cloud technologies were (while after the experiment the share of respondents was 9.64%), at the end of the experiment 53.01% of respondents already knew basic cloud services that can be used in the educational process (at the beginning of the experiment, this percentage was 24.49%). It should be noted that 17.35% did not hear about cloud technologies at the beginning of the experiment, while this figure decreased to 2.41% at the end of the experiment (see table 3 and figure 6).



**Figure 6:** Respondents’ answers to the question “What is the level of your mastery of cloud technology knowledge?”.

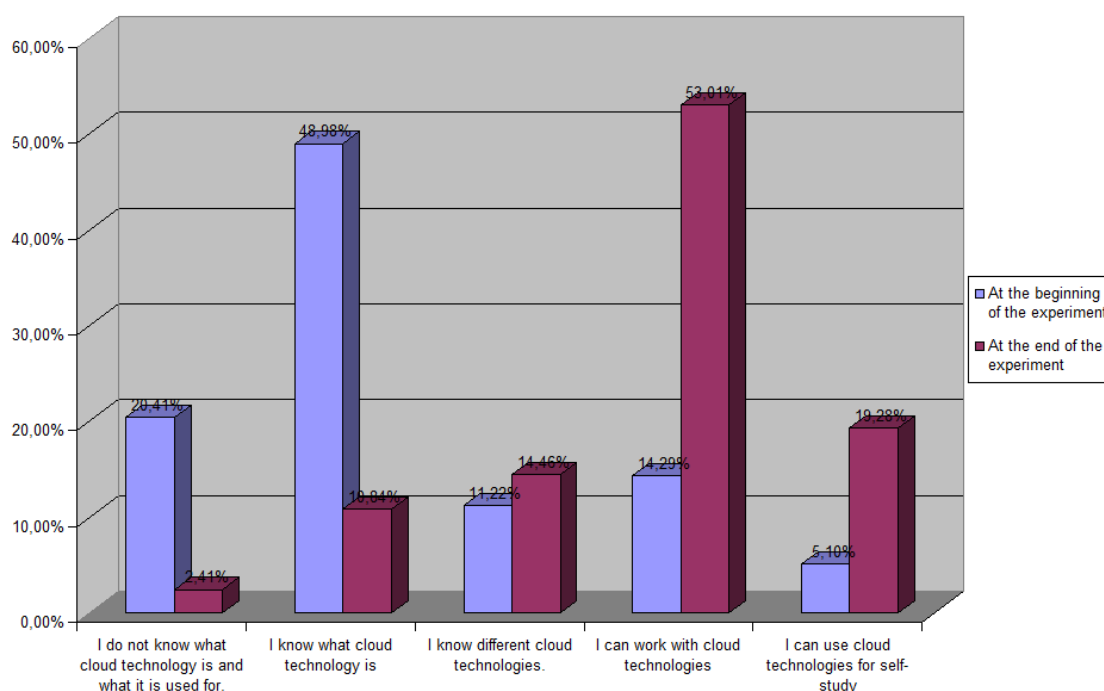
Regarding the level of teachers’ mastery of the ability to use cloud technologies, the following was found: 53.01% of teachers after the courses (compared to 14.29% before the courses) can work with cloud technologies, while at the beginning of the course 48.98% only knew what cloud technology was; from 5.1% to 19.28% increased the number of teachers who can use cloud technology for self-study. It is worth noting that the percentage of those teachers who do not know what cloud technologies are and what they are used for has decreased from 20.41% (before the courses) to 2.41% (after the courses).

A detailed presentation of the level of teachers’ mastery of the skills to use cloud technologies is presented in the table 4 and figure 7.

Since in the course of the courses attention was paid to certain types of cloud tools, it was important to ask how many teachers have learned to use different tools in the learning process. In particular, the level of teachers’ mastery of the ability to use cloud-based smart cards in the educational process can be described as follows. They did not know at all what smart cards were and what they were used for – 51.02% at the beginning of the experiment, and this percentage dropped to 1.2% after the experiment; 41.84% of respondents knew what smart cards were before the courses, and there were isolated cases of knowledge of different cloud-based smart cards, skills to work with cloud-based smart cards and the ability to use cloud-based smart cards for self-study. After the experiment, the number of those who knew different cloud-based smart cards increased from 2.04% to 12.05%, as well as those who knew how to work with cloud-based smart cards – from 3.06% to 48.19%. The percentage of those who were able to use cloud-based

**Table 4**  
 Respondents’ answers to the question “What is the level of mastery of your skills to use cloud technologies?”.

Answer	At the beginning of the experiment	At the end of the experiment
I do not know what cloud technology is and what it is used for	20.41%	2.41%
I know what cloud technology is	48.98%	10.84%
I know different cloud technologies	11.22%	14.46%
I can work with cloud technologies	14.29%	53.01%
I can use cloud technologies for self-study	5.10%	19.28%



**Figure 7:** Respondents’ answers to the question “What is the level of mastery of your skills to use cloud technologies?”.

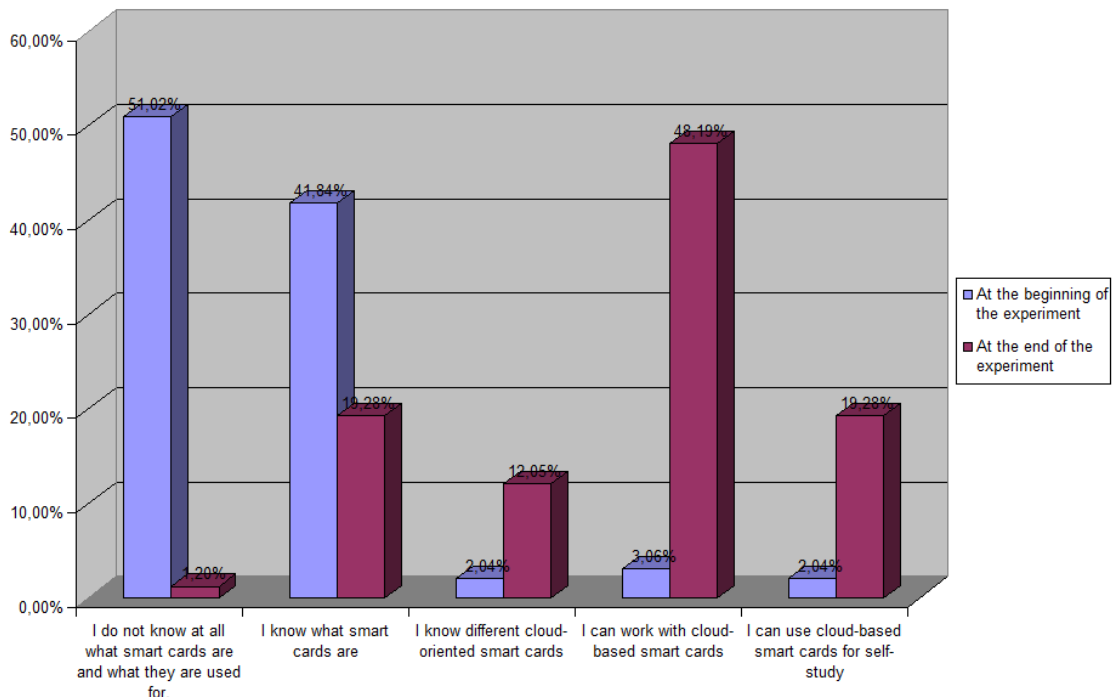
smart cards for self-study increased from 2.04% to 19.28%. A detailed presentation of the level of teachers’ mastery of the ability to use cloud-based smart maps is presented in the table 5 and figure 8.

Working on a joint project plays an important role in distance learning, as well as in blended learning. Therefore, establishing the level of mastery of teachers’ ability to work on a joint project in the use of cloud technologies was also important. As a result, it was found that 42.86% of teachers (at the beginning of the experiment) did not know what a joint project was and how to work on it in the conditions of using cloud technologies, and after that, the percentage

**Table 5**

Respondents' answers to the question "What is the level of mastery of your skills to use cloud-based smart cards in the educational process?"

Answer	At the beginning of the experiment	At the end of the experiment
I do not know at all what smart cards are and what they are used for	51.02%	1.20%
I know what smart cards are	41.84%	19.28%
I know different cloud-oriented smart cards	2.04%	12.05%
I can work with cloud-based smart cards	3.06%	48.19%
I can use cloud-based smart cards for self-study	2.04%	19.28%



**Figure 8:** Respondents' answers to the question "What is the level of mastery of your skills to use cloud-based smart cards in the educational process?"

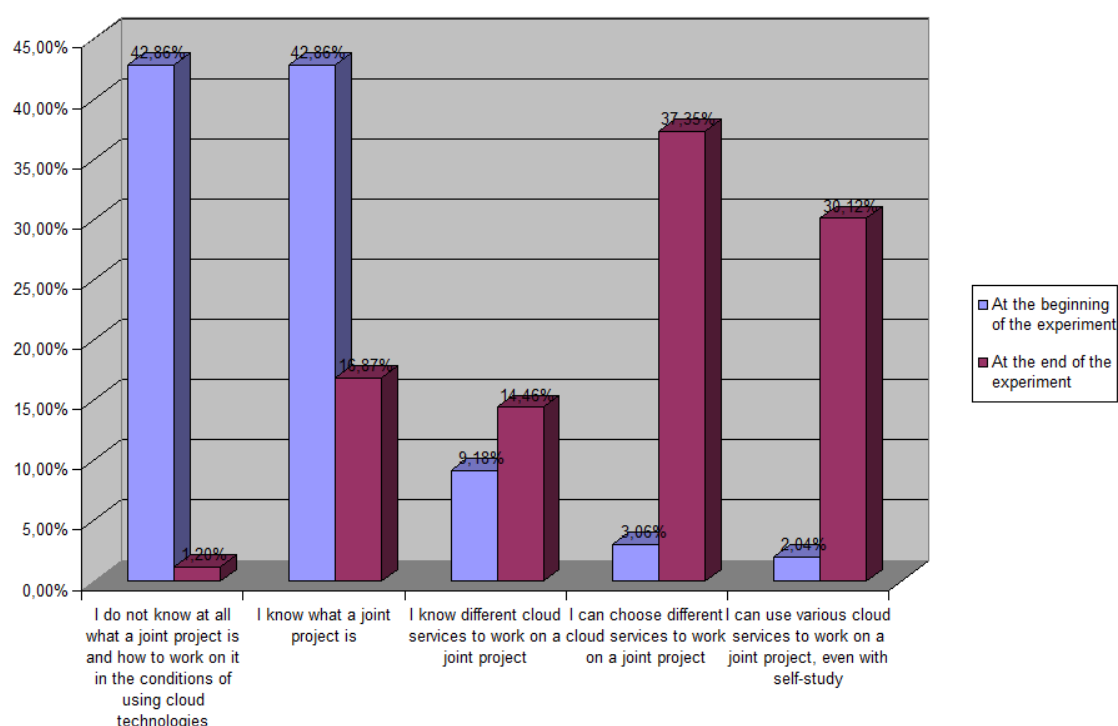
significantly decreased to 1.20%. Among teachers, 42.86% also knew what a joint project was before the courses.

The percentage of those who knew different cloud services to work on a joint project, knew how to choose different cloud services to work on a joint project, and knew how to use different cloud services to work on a joint project, even in self-study, was too small at the beginning of the experiment (9.18%, 3.06%, 2.04%, respectively). At the same time, after the courses, these indicators increased significantly – 14.46%, 37.35%, and 30.12%, respectively.

A detailed presentation of the level of mastering the skills of teachers to work on a joint

**Table 6**  
 Respondents’ answers to the question “What is the level of mastering your skills to work on a joint project in the use of cloud technologies?”.

Answer	At the beginning of the experiment	At the end of the experiment
I do not know at all what a joint project is and how to work on it in the conditions of using cloud technologies	42.86%	1.20%
I know what a joint project is	42.86%	16.87%
I know different cloud services to work on a joint project	9.18%	14.46%
I can choose different cloud services to work on a joint project	3.06%	37.35%
I can use various cloud services to work on a joint project, even with self-study	2.04%	30.12%



**Figure 9:** Respondents’ answers to the question “What is the level of mastering your skills to work on a joint project in the use of cloud technologies?”.

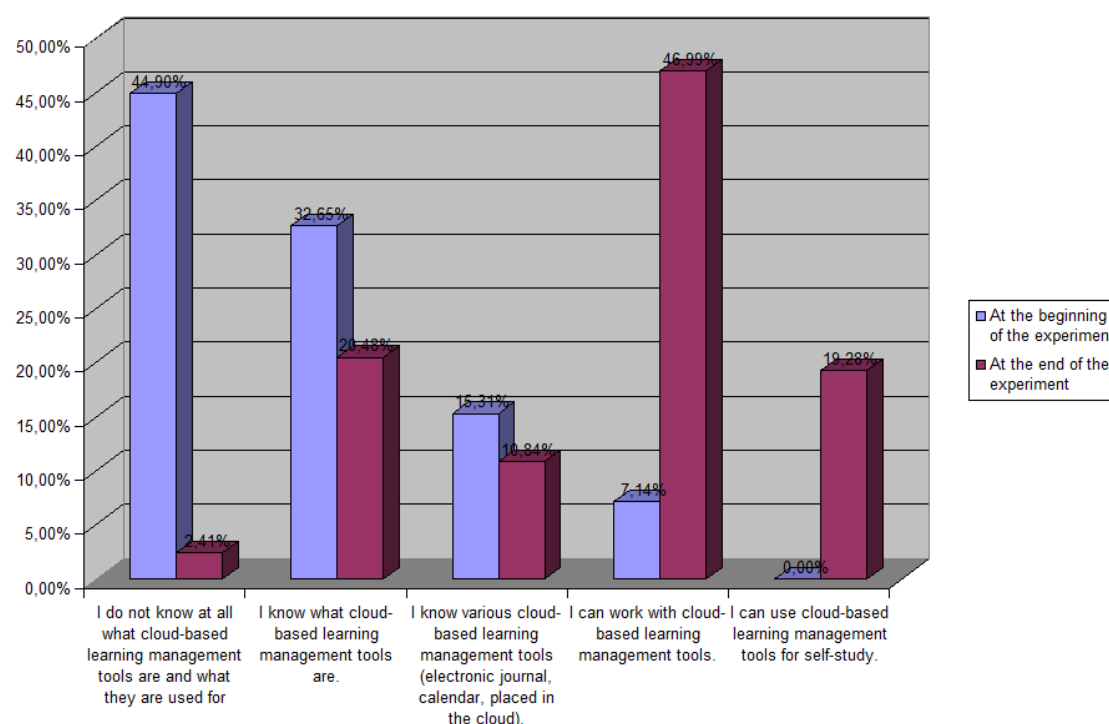
project in the use of cloud technologies is presented in the table 6 and figure 9.

The next indicator that was evaluated was the level of teachers’ mastery of the skills of using cloud-based learning management tools. Again, before the courses, 44.9% did not know what cloud-based learning management tools were and what they were used for, while after the experiment, this percentage dropped to 2.41%. At the beginning of the experiment, 32.65% of teachers knew what cloud-based learning management tools were, and there were few cases

**Table 7**

Respondents' answers to the question "What is your level of mastery of the skills of using cloud-based learning management tools?".

Answer	At the beginning of the experiment	At the end of the experiment
I do not know at all what cloud-based learning management tools are and what they are used for	44.90%	2.41%
I know what cloud-based learning management tools are	32,65%	20,48%
I know various cloud-based learning management tools (electronic journal, calendar, placed in the cloud)	15.31%	10.84%
I can work with cloud-based learning management tools	7.14%	46.99%
I can use cloud-based learning management tools for self-study	0.00%	19.28%



**Figure 10:** Respondents' answers to the question "What is your level of mastery of the skills of using cloud-based learning management tools?".

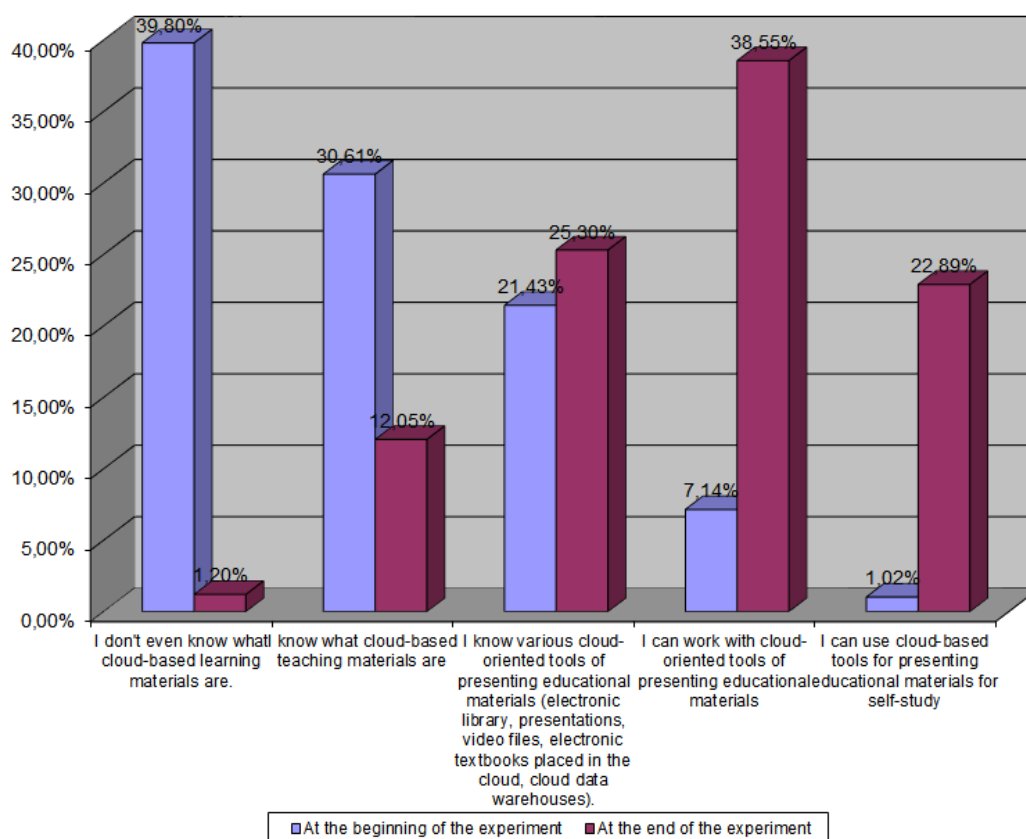
when teachers knew different cloud-based learning management tools (15.31%), we're able to work with cloud-based learning management tools (7.14%). At the same time, no teacher was able to use cloud-based learning management tools for self-study before the experiment. After the courses, 46.99% of teachers knew different cloud-based learning management tools, 19.28% were able to use cloud-based learning management tools for self-study.

A detailed presentation of the level of mastering by teachers of the skills of using cloud-based

**Table 8**

Respondents' answers to the question "What is your level of mastery of the skills of using cloud-based teaching materials?"

Answer	At the beginning of the experiment	At the end of the experiment
I don't even know what cloud-based learning materials are	39.80%	1.20%
I know what cloud-based teaching materials are	30.61%	12.05%
I know various cloud-oriented tools for presenting educational materials (electronic library, presentations, video files, electronic textbooks placed in the cloud, cloud data warehouses)	21.43%	25.30%
I can work with cloud-oriented tools of presenting educational materials	7.14%	38.55%
I can use cloud-based tools for presenting educational materials for self-study	1.02%	22.89%

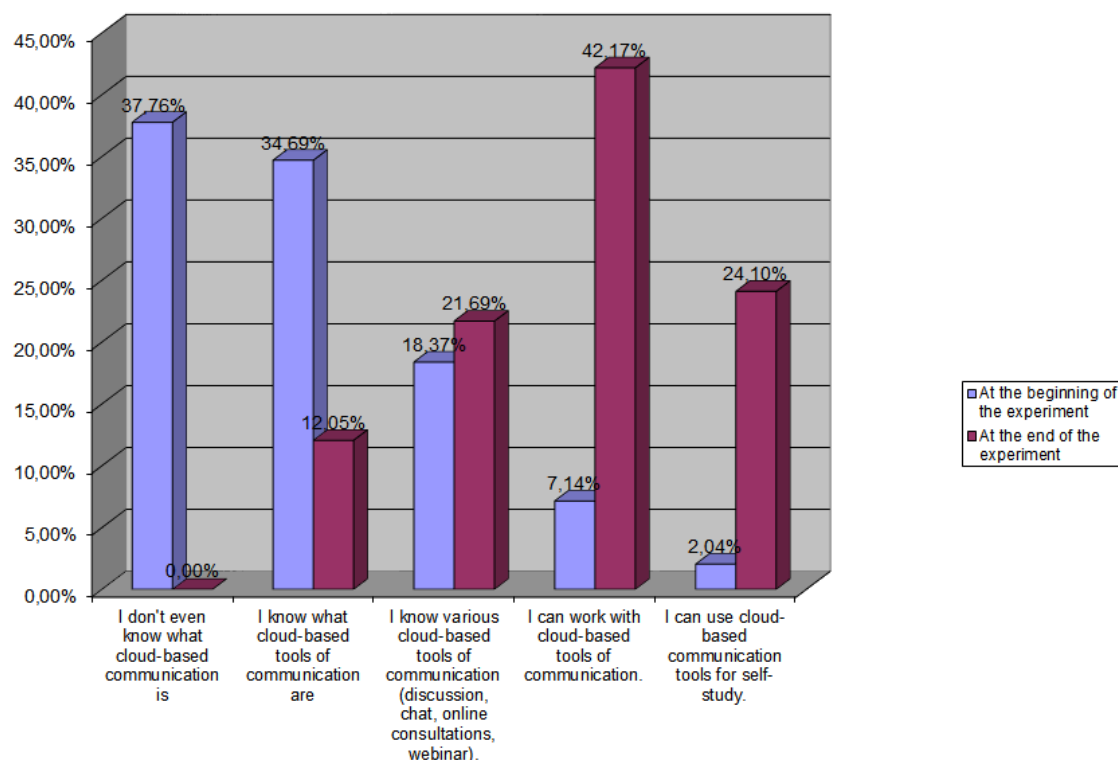


**Figure 11:** Respondents' answers to the question "What is your level of mastery of the skills of using cloud-based teaching materials?"

**Table 9**

Respondents' answers to the question "What is your level of mastery of cloud-based communication skills?"

Answer	At the beginning of the experiment	At the end of the experiment
I don't even know what cloud-based communication is	37.76%	0.00%
I know what cloud-based tools of communication are	34.69%	12.05%
I know various cloud-based tools of communication (discussion, chat, online consultations, webinars)	18.37%	21.69%
I can work with cloud-based tools of communication	7.14%	42.17%
I can use cloud-based communication tools for self-study	2.04%	24.10%



**Figure 12:** Respondents' answers to the question "What is your level of mastery of cloud-based communication skills?"

learning management tools is presented in the table 7 and figure 10.

The level of teachers' mastery of the skills of using cloud-based means of presenting educational materials after the courses have significantly increased (see table 8 and figure 11).

Also, the level of mastering by teachers of skills of using cloud-oriented means of communication has significantly increased, which is presented in the table 9 and figure 12).



## 5. Discussion

The teachers involved in the courses are interested in their own self-development, since the challenges posed by the pandemic to teachers are obvious. And it is simply impossible not to use ICT, including cloud technologies in the educational process. As the study showed, scientists around the world raise this problem and study it locally (within their own university or within the country). What they all agree on, and our research confirms that the use of cloud technologies in the educational process is simply necessary during a worldwide pandemic.

## 6. Conclusions

After face-to-face courses, teachers in Zhytomyr schools have significantly increased their competence in the use of cloud technologies in the educational process in the context of the COVID-19 pandemic. It is worth noting that not only their level, in general, has increased, but also the horizons regarding the variety of cloud services that should be used in distance learning have expanded. Course training, organized according to scientifically sound methods, helps to increase the motivation of students (teachers) to self-study, as well as to the future use of cloud technologies in the educational process.

Finally, it should be noted that the advantages of full-time education include: clarity, accessibility, comprehensibility, and the advantages of distance learning include: mass, no need for classrooms, no need to transfer university teachers, and school teachers' classes.

Prospects for further explorations include a comparison of the level of growth of the relevant competence during face-to-face and distance learning courses and the identification of more significant results.

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