Virtual Laboratories In Kazakhstan: Current State, Comparative Analysis, Problems And Development Prospects

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ABSTRACT

At the present stage of ICT development, it is obvious that digital technologies have become frequently used in the life and professional activities of teachers. Virtual laboratories more often are being used by teachers of various subjects.

Our research was aimed at studying the readiness of teachers to use virtual laboratories in their teaching activities. The survey of secondary school teachers allowed us to highlight the following results: there is a significant relationship between learning and the introduction of digital technologies in teaching practice, as well as the use of virtual laboratories and the pedagogical competence of teachers in the use of digital technologies. The results obtained indicate that the readiness of teachers to use virtual laboratories in their pedagogical activities is interconnected with the growth of pedagogical competence and digital literacy of teachers. The further growth of the digitalization of education and its improvement makes the use of virtual laboratories promising.

KEYWORDS: information and communication technologies, virtual laboratory activities, modern educational technologies, training in Kazakhstan.

INTRODUCTION

The widespread use of computer and information technologies contributed to the entry of the world economy into the digitalization era. Digitalization, which Kazakhstan has embarked on, is one of the leading trends in the process of reforming the education sector. The process of introducing digital technologies has become an integral part of the educational process in Kazakhstan. The education digitalization reform consists in equipping educational institutions with high-quality software, such as information systems that allow access to educational resources, the results of modern scientific research and development, and electronic scientific libraries in various languages of the world.

Online textbooks, a cloud learning system, virtual laboratories, a personal ID for each student, open educational content - all this awaits the education of Kazakhstan in the nearest future.

The powerful growth of information potential, high-speed access to the latest science and technology achievements, the spread of intelligent tools for information search and its processing leads to a change in the technology and content of education. First of all, the goals and content of education are changing, the educational process is being improved [1].

The dynamics of change, which set the task of teaching something that does not yet exist, but that which tomorrow will become the leader in one or another sphere of life, requires the formation of special conditions for the learning organization.

In Kazakhstan, the digitalization process is one of the key vectors for the development of the educational process and is implemented as part of the Digital Kazakhstan program [2].

For the Kazakh education system, the widespread introduction of distance learning is the most UpToDate goal. The main goal of its implementation is to ensure equal access of all participants in the educational process to the best educational resources and technologies [3].

Kazakhstan, adopting the experience of colleagues, is implementing some projects that involve the use of modern technologies in education. In Kazakhstan, there is also a single platform with electronic educational content BILIMLand.kz, created in 2014. This system is used not only by students of schools and colleges, but also by children of preschool age. Educational resources are presented in three languages (Kazakh, Russian and English). Resources are available both online and offline. More than 1 million multimedia material has been proposed for most school subjects. It is planned to further enrich the interactive content of the BILIMLand platform [4]. A virtual laboratory "Gene Engineering - Chromosome Laboratory" has been created, where complex processes and phenomena in the specified field of knowledge are studied [5]. Attempts are being made to use a biological virtual laboratory and develop methods for its use in the learning process [6, 7, 8].

The impact of the digitalization process on the education system and the active search for new teaching methods are being studied in the Kazakhstan scientific community. Teachers believe that the introduction of information technologies into the educational process will be justified if they effectively complement existing teaching technologies or have additional advantages compared to traditional forms of education [9].

Kazakh specialists raise problems and analyze such aspects as modern innovative technologies and the digital revolution, foreign experience in the field of creating a modern digital economy, damage from distance learning under quarantine and other areas [10, 11]. As conclusions in the analytical studies of Kazakhstani authors, the university model of online education was presented in terms of maintaining competitiveness in a new technological era [12, 13].

In the analytical review of another Kazakh expert Cherkashin R., the problem of social inequality that takes place in modern conditions of applying technological innovations in the educational process is acutely posed. The expert analyzes the conclusions drawn from the World Bank report that such a problem exists in a number of Central Asian countries, and the COVID-19 pandemic and the resulting shift to distance education have exacerbated the problem of inequality [14].

Sailau, K., and Ramazanova, A. focused their research on the degree of satisfaction with the distance education system among students, parents and teachers [15]. A special place in the studies of Elubay E.K et al. is given to improving the digital literacy of teachers [16].

The work of Kenzhebaeva Z.S. et al. is devoted to the analysis of international experience in the implementation of digital education. [17].

It is worth noting that new technologies and resources introduced into the process of school education can captivate students much more than simple lectures. One of such resource is virtual labs, which have been used as a complementary learning resource to lab activities for both teachers and students since the early 2000s. There is experience in creating virtual excursions to nature, when students can see seasonal changes in the studied objects in one excursion (for example, an excursion to the forest in autumn, winter and spring) [18].

Kennepoh believes that virtual laboratories are a technology that is being introduced into the education system to improve modern teaching methods [19].

Virtual laboratories provide wide access to the scientific and educational resources of mankind, the creation of maximum conditions for the development of potential, an array of knowledge, regardless of the study place and level of education.

A distinctive feature of the traditional experiment is the study of some biological objects and phenomena, the observation of which is long in time and has little visibility. And here a virtual experiment with good dynamic graphics and sound is the only way to show them visually.

Virtual laboratory work allows a student who missed some topics to fill in the gaps, regardless of the teacher presence at the workplace, to complete it at the time when it is being done at an educational institution, but while being at home. This type of laboratory work allows you to independently consider those phenomena and objects that are categorized for independent study. Also, an independent home virtual experiment is a help in studying theoretical material in the classroom.

In addition, virtual laboratories are the most important computer simulation used to study the natural sciences [20]. It has been defined as “a programmed laboratory experiment using a computer to simulate operations in a real laboratory, which helps students to easily find the connection between theoretical and practical aspects” [21].

An analysis of of remote and distance learning usage has shown the adaptability of such learning platforms to overcome the limitations of classroom learning and use virtual labs as the next generation interactive textbook for blended and distance learning [22].

In discussions about the effectiveness of virtual education, supporting arguments come from the fact that modern virtual learning is approaching individual in many respects. This is a virtual presence in the classroom at a webinar, and multimedia and interactive course content, the execution of practical tasks of any complexity on virtual machines [23]. N.B. Auzhanova believes that the use of virtual laboratories is justified by stimulating motivation and interest in the subject being studied, the impossibility of conducting laboratory work in the office and the small amount of time allotted for a distance lesson [24]. The use of virtual laboratory work is advisable not only in case of emergencies, with distance learning, but also when working with students who do not attend classes for a long time for various reasons [25]

Favale, T., et al. [26] and Vasiliadou, R. [27] found that teachers consider virtual labs to enhance their teaching skills and help students complete lab practices without sacrificing learning quality.

Virtual labs replace the teaching and demonstration phase of conventional labs, reducing reliance on instructions more effectively. Research has reported how virtual labs catalyze student approaches to offline learning and self-learning in blended classroom settings. The use of virtual labs in procedural and conceptual learning has proven the ability of students to improve their problem solving and analytical skills. An interactive user platform in virtual labs provided students with the satisfaction of learning laboratory skills by combining theory and practical approach [28, 29].

Using the experience of abroad colleagues and under realization of state Digital Kazakhstan program (12.12.2017) [2] local biology teachers started to use virtual labs for education goals achievement [30, 31].

In teaching practice, there are various options for using virtual laboratories in the classroom (Fig. 1) [32].

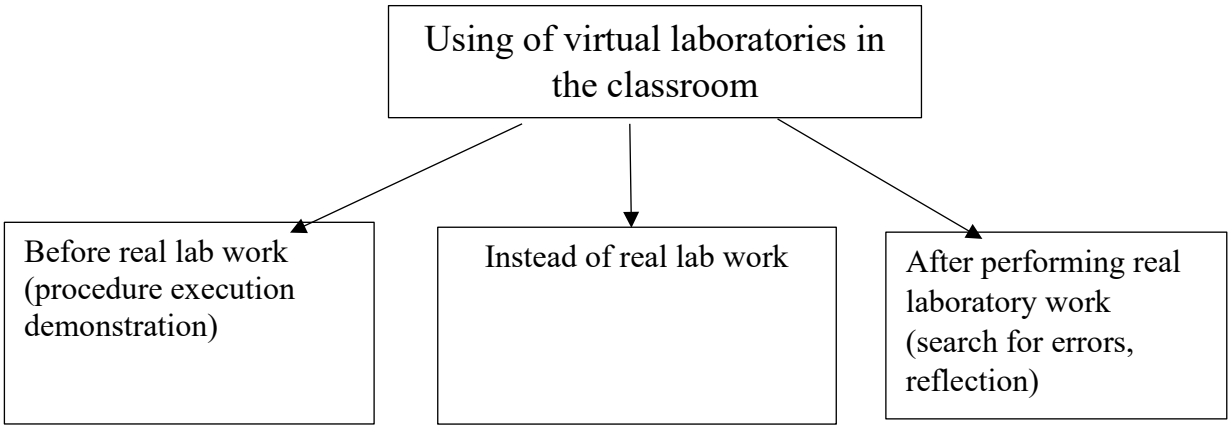

Figure 1: Options for using virtual labs in the classroom

The effectiveness of information technologies usage in education largely depends on how methodically and pedagogically competently their inclusion in the structure of the learning process is justified. In each specific case, the teacher independently has to determine the purpose of using information technology tools of various digital educational resources in accordance with the topic of the lesson, the objective need to apply the appropriate methodology and the complexity of the material presented. This requires work experience, special knowledge and skills in the application of such technologies and resources [33].

Whatever option the teacher chooses to work in a virtual laboratory, virtual laboratory work helps to increase students' interest in the subject. Among other things, it is assumed that virtual laboratory work has the potential to become one of the foundations for the development of independence and critical thinking of pupils [34].

However, despite the obvious advantages in the use of virtual laboratory work in the classroom, some teachers do not use such an educational resource in their activities.

Thus, there is a contradiction between the Government expectation to education and the teachers' readiness to use digital technologies in the form of virtual laboratories.

The purpose of our study is to study the readiness of teachers to use virtual laboratories in teaching activities.

MATERIALS AND METHODS

The study was conducted amidst 25 secondary school teachers in the Pavlodar region (Republic of Kazakhstan). Two questionnaires were used to achieve our research goals. The first questionnaire was developed by us and contained five questions. Its purpose was to identify what digital resources and devices teachers use to conduct the educational process, and how often they use them, i.e. we wanted to find out how competent the teacher is in the use of digital technologies. The respondent was required to answer the question and give one of three suggested answers: "never", "occasionally", or "regularly". For the answer "never" 0 points were assigned, for the answer "occasionally" - 1 point, for the answer "regularly" - 2 points. The conclusions were made on the basis of the points scored as a result of the questionnaire.

The second questionnaire was aimed at identifying the readiness of teachers to use digital technologies in the educational process actively. The basis for identifying the readiness of teachers to use digital technologies is the described European Digital Competence Framework for teachers (DigCompEdu), which includes 22 competencies grouped into six blocks [35].

Block 1: Professional responsibilities

Block 2: Digital Resources

Block 3: Teaching and learning

Block 4: Student Assessment

Block 5: Empowering students, providing opportunities, and independence in the learning process,

Block 6: Development of digital competence of students

Competencies correspond to six levels of pedagogical experience in the use of digital technologies: Newcomer, Explorer, Integrator, Expert, Leader and Pioneer.

The distribution into groups is based on the points scored as a result of passing the questionnaire. Based on the total points scored, each respondent was assigned to one of 6 groups. Group assignment rule (in points out of 88 possible):

0–19 Group A1 Newcomer

20–33 Group A2 Explorer

34–49 Group B1 Integrator

50–65 Group B2 Expert

66–80 Group C1 Leader

81–88 Group C2 Pioneer

All results for the two questionnaires were entered into the SPSS Statistic 26.0 program and a correlation analysis was carried out in order to identify significant relationships.

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RESULTS AND DISCUSSION

Teachers with different teaching experience and different levels of computer and information technology proficiency took part in our study.

As we can see from the results of the study shown in Figure 2, most often teachers use digital resources such as word processing (for example, Word), Internet browser (for example, Google Chrome. Mozilla), email, video conferencing (Google meet, zoom) presentation software. For this purpose, a projector, a teacher's computer and an interactive whiteboard, as well as students' mobile devices are used. In addition, the use of video conferencing remains very limited. The use of virtual laboratory work does not occur. Most teachers consider themselves competent in the use of digital resources and are sufficiently trained in this area.

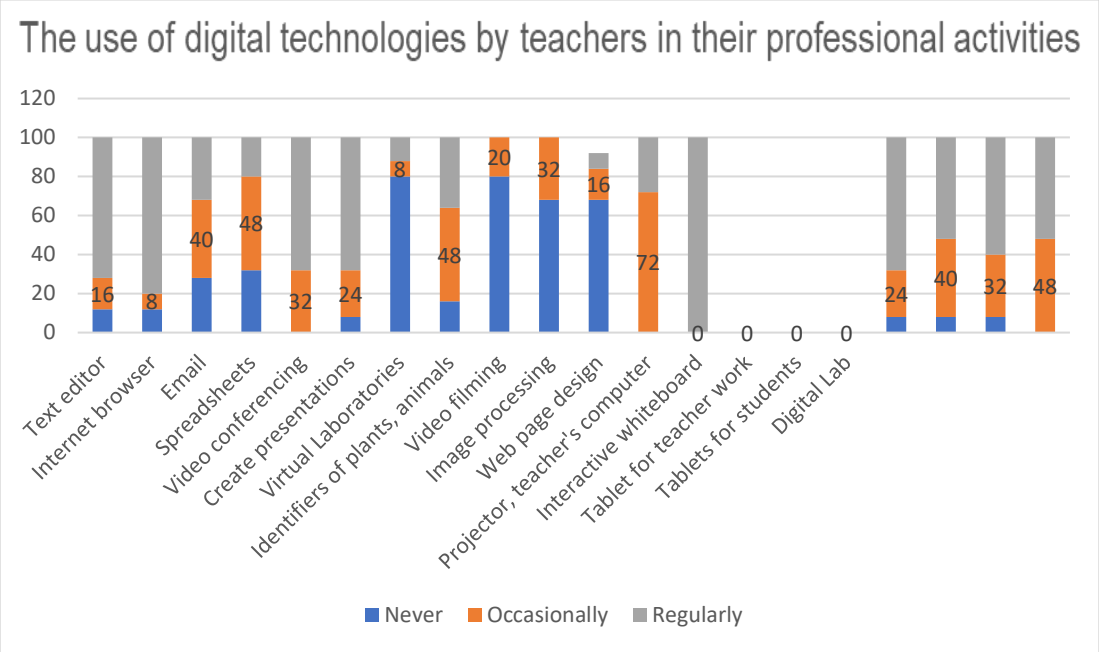

Figure 2: The use of digital technologies by teachers in their professional activities

An analysis of the readiness of teachers and lecturers for the active use of digital technologies in the educational process showed that all teachers participating in the study belong to different groups in terms of the degree of mastery of digital technologies and their readiness to actively use them in the educational process (Table 1, Figure 3).

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Table 1 The readiness of teachers and lecturers for the active use of digital technologies in the educational process

Points	Name of the group	Number of people (%)
0–19 group A1	Newcomer	2 (8%)
20–33 group A2	Explorer	11 (44%)
34–49 group B1	Integrator	8 (32%)
50–65 group B2	Expert	3 (12%)
66–80 group C1	Leader	1 (4%)
81–88 group C2	Pioneer	0

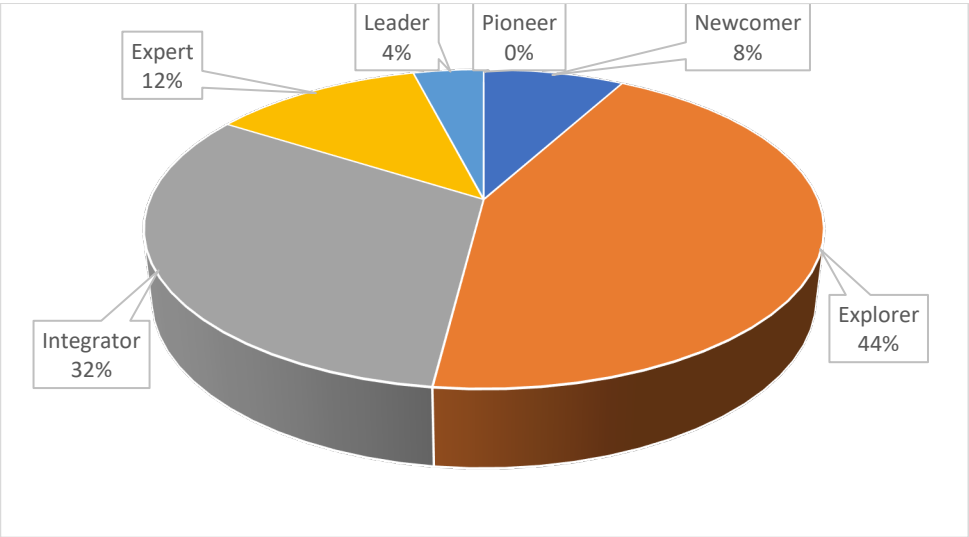

Figure 3: The readiness of teachers and lecturers for the active use of digital technologies in the educational process

All the results obtained for the two questionnaires were subjected to correlation analysis in order to identify significant parameters and relationships. Significant two-way significant correlations were obtained, which are shown in Table 2.

Analyzing the obtained correlations, we see that there are significant features of the use of virtual laboratories. So the ability to use image processing programs, e.g. Photoshop, is important in using of virtual labs. Another important aspect of the use of virtual laboratories is the level of digital technology proficiency, i.e. a teacher who does not have such skills will not be able to use virtual laboratories in their activities. The next feature of the use of virtual laboratories is the level of pedagogical competence in the use of digital technologies, i.e. a teacher with a low level of pedagogical competence will not be able to work correctly with virtual laboratories. An important aspect of the use of virtual laboratories is also the general level of digital technology proficiency, i.e. having no idea about such a digital resource as a virtual laboratory, respectively, and does not own digital technologies and cannot be ready to use virtual laboratories in their pedagogical activities.

Table 2 Correlation significant relationships

Communication parameters	r	p
between word processing (e.g. Word) and email usage	,419*	P< 0,05
between e-mail usage and video conferencing (Google meet, zoom ...)	-,454*	P< 0,05
between email usage and digital proficiency	-,465*	P< 0,05
between the using of virtual laboratories and image processing (e.g. Photoshop)	,473*	P< 0,05
between the use of virtual laboratories and the level of digital proficiency	,424*	P< 0,05
between the use of video conferencing (Google meet, zoom ...) and pedagogical competence in ICT	,468*	P< 0,05
between word processing (e.g. Word...) and the use of presentations, virtual labs	,742**	P< 0,01
between word processing (e.g. Word...) and pedagogical competence in the application of digital technologies	742**	P< 0,01
between word processing (e.g. Word) and digital proficiency	,597**	P< 0,01
between the use of virtual laboratories and pedagogical competence in the application of digital technologies	,606***	P< 0,01
between the use of virtual laboratories and the level of digital proficiency	,575**	P< 0,01
between the use of video conferencing (Google meet, zoom ...) and the level of digital proficiency	,704**	P< 0,01
between image processing (e.g. Photoshop...) and digital proficiency	,567**	P< 0,01
between pedagogical competence in the application of digital technologies and the level of proficiency in digital technologies	,729**.	P< 0,01

Thus, from the results of the study, we can conclude the following:

1 The process of introducing digital technologies is an integral part of the educational process in Kazakhstan.

2 The use of virtual laboratories in teaching activities contributes to the improvement of knowledge in the field of digital technologies.

3 The use of virtual laboratories depends on pedagogical competence in the application of digital technologies in the educational process.

4 The willingness of a teacher to use virtual laboratories in their activities depends on the level of digital technology proficiency in the educational process.

CONCLUSION

The study carried out in the work shows that the use of digital technologies and, in particular, virtual laboratory work has a direct impact on the content and forms of teaching in the classroom.

The increase in the use of virtual laboratories in the learning process contributes to the growth of pedagogical competence in the field of digital technologies and the readiness of teachers to actively use them in the educational process. The use of virtual laboratory work is a comprehensive way to develop digital technologies and the competence of a teacher, increase their level of proficiency and, as a result, increase the willingness and ability of teachers to develop in the field of digital education. Therefore, in order for teachers to use virtual laboratories in their activities, it is necessary to increase their ability to learn how to work with this digital resource and improve their competence. Virtual Labs enhance teaching skills and help students complete digital labs without compromising the quality of their learning. And this fact suggests that the use of virtual laboratories in the educational process is promising.

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