

Smart education in the prospective teachers' training

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Abstract. The article reveals the features of smart education as a leading concept in the development of professional training of future teachers. The main components of smart education, such as a smart student, smart pedagogy and smart environment were characterized. The main principles of smart education and the ideas that formed the basis of this concept of education (mobile access, formation of new knowledge, creation of a smart environment) were defined. The features of smart education were substantiated. The peculiarities of the implementation of smart education in the conditions of the COVID-19 pandemic and military events in Ukraine were revealed. The functions of the smart system (site management system) in the process of studying the disciplines of the pedagogical cycle, its content and technological components, and facilities of the smart complexes for students and teachers in the process of training future teachers were defined. The criteria of smart complexes (automation, sequencing, assessment, data collection in real time, self-organisation) were singled out. The distance learning systems for creating smart complexes in the process of training prospective teachers were considered. The results of students' survey as for using smart complexes in the educational process were analyzed. Due to the results, the advantages and disadvantages of using smart technologies in educational process were determined. The ways of further research work regarding the introduction of smart education into the educational process were outlined.

Keywords: smart education, professional training of prospective teachers, fundamentals of smart education, principles of smart education

1. Introduction

Wide implementation of information and communication technologies (ICT) and digitization of all fields of social life is considered in the majority of countries of the world as one of the strategic tasks of the progressive development. The use of ICT in society is changing to a new quality of communication between consumers and producers, citizens and authorities, students and universities. The education system needs the transformation of educational

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technologies that are able to ensure rapid adaptation, coordination and strategic orientation to the integration of the domestic education system into the international educational space. Educational technologies are designed not only to accumulate the educational content, but to serve as a vector for the transformation of the content, methods and forms of education in the conditions of the modernization of electronic learning and the accumulation of human capital. Therefore, technologies that were previously based on knowledge and information are being transformed into technologies related to interaction and exchange of experience in off-line and online modes. Such technologies are aimed at creating an effective innovative educational environment by promoting progressive innovations, introducing the most modern teaching methods, professional mobility and rapid adaptation to changes in the socio-cultural sphere, management system and labor organization in the conditions of a market economy. The transformation of educational technologies under such conditions led to the emergence and development of smart education in the system of training students.

Smart education is a concept that involves comprehensive modernization of all educational processes, as well as methods and technologies used in these processes. The concept of “smart” in the context of education is associated with the emergence of such technologies as smart boards, smart screens, and access to the Internet from anywhere. Each of these technologies allows to organize the process of content development and its updating in a new way. For example, learning becomes possible not only in the classroom but also in any other place: public places such as museums, cafes, etc. The main element that connects the educational process is active educational content, on the basis of which unified repositories are created, which allow to remove time and space restrictions, which is gaining relevance in connection with the COVID-19 pandemic and military events in Ukraine [25, 28].

The purpose of the article is the theoretical substantiation and practical implementation of the elements of smart complexes in the educational process of the disciplines of the pedagogical cycle by students in the conditions of the COVID-19 pandemic and military events in Ukraine. The hypothesis of the study is that creating and using the smart complexes in the pedagogical discipline environment will improve the students’ level of smart technology using skills and intensify the educational process.

2. Theoretical background

According to Iqbal et al. [19], the term “smart education” is a unique pedagogical concept that entitles and facilitates the educational process in the digital age. Hoel and Mason [14] distinguish the essence of smart education as the creation of an intelligent environment using smart technologies to facilitate smart pedagogy and provide personalized learning services and empower students.

Demir [9] defines smart education as an effective way of using ICT in order to reach learning outcomes using a suitable pedagogical approach.

Zhu, Yu and Riezebos [38] characterize smart education as learning that includes formal (learning that takes place in an educational organization) and informal learning (learning implemented through informal channels: social networks, the Internet, massive open online courses, game-based learning, etc.), social and collaborative learning, personalized learning,

and app and content focused learning.

Jang [20] defines smart education as “an educational system that allows students to learn by using up-to-date technology and it enables students to study with various materials based on their aptitudes and intellectual levels”. Shoikova, Nikolov and Kovatcheva [29] state that smart education represents a new wave of educational systems that involves an effective and efficient interaction of pedagogy and IT and their fusion towards the improvement of educational process.

Alajmi, Al-Sharafi and Abuali [3] discuss the benefits, challenges, and solutions of smart education implementation in higher education institutions. Aker and Pentón Herrera [1] note the gap between education and the workplace which can be filled in by smart education. The scholars ground that the key scientific and technological advancements with particular reference to the smart educational systems, smart learning devices, and smart pedagogy technologies have facilitated maintaining a healthy and smart learning environment, regardless of the educational level. Such developments in smart learning environments significantly support the students with new approaches, learning technologies, learning processes, and learning strategies [7].

Summarizing the views of scientists on the essence of the concept of “smart education”, we can conclude that it is a self-governing, motivated, flexible, resource-enriched, technological educational system that unites smart students, smart pedagogy and smart environment, including both formal, and non-formal learning, as well as a personalized approach to students in order to acquire the required knowledge, skills, abilities and competencies. The main aspects of smart education are 1) the use of current information of the curriculum for solving educational problems; 2) organization of independent cognitive, research, and project activities of students; 3) implementation of the teaching approaches in a multi-aspect educational process environment; interaction of students with the professional community; flexible educational trajectories, individualization of education; multifaceted educational activity.

The main elements of this system are a smart student, smart pedagogy and smart environment. A smart-oriented educational process should be aimed at acquiring the 21st century skills and competencies necessary for effective use at work and in personal life. So that, the goal of smart education is to develop smart learners, and prepare them for functioning in a modern dynamic environment [37]. The smart pedagogy provides students with personalized services that contribute to the expansion of their capabilities, the development of abilities and creative thinking. Zhu, Yu and Riezebos [38] observe smart pedagogy in the implementation of four learning strategies: class differentiated learning; group collaborative learning; individual learning based on personal interests; interactive mass generative learning. These strategies are closely related to each other. Each of them in its own way is aimed at providing students with educational services that contribute to their personal development.

Uskov, Bakken and Pandey [34] study smart pedagogy from a technological position of using it in the next generation Smart Classroom systems, classify it as practice-based learning, collaborative, project-based, gaming, e-learning, as well as advanced technology-based learning and flipped learning. It should be noted that some researchers consider technological type of smart pedagogy as a smart technology, which confirms the conclusions of Zhu, Yu and Riezebos [38] that the conceptual apparatus of the topic has not been clearly formed and systematised yet.

The smart environment is an educational environment supported by various technologies that enable students to use digital resources and interact with learning systems anywhere, anytime,

and proactively provide them with the correct learning guidance, aids, and learning offerings in the proper place, time and form [38]. Bajaj and Sharma [5] state that smart environment delivers personalized learning, anytime and anywhere. The smart environment includes applications of the latest smart technologies in collaboration with advanced educational practices, means and techniques [11] for the effective implementation of education services.

The smart learning environment is considered as a technology-oriented learning environment that support the quick adaption of the entire educational process and proper interaction between learners and the environment in a sophisticated manner [19]. The smart educational environment facilitates individual learners' needs, i.e., guidance, feedback, hints, or tools. The learning performance can be determined by analyzing their learning behaviours, performance, and online and real-world contexts [17]. Based on the smart learning environment framework [16], the following aspects should be considered while designing the smart learning environment: (1) smart learning environment and context awareness, (2) smart learning environment with instant adaptive support from different perspectives, i.e., learning performance, learning behaviours, profiles, and personal factors, and (3) overall capabilities of a smart learning environment to adapt the user interface to encounter the personal factors, i.e., learning styles and preferences, and learning status, i.e., learning performance, quality and the outcome of individual learners [13]. The learners should be able to interact with the learning environment through digital devices, such as smartphones, tablets, computers, etc. [11, 13, 15, 16, 27, 30, 33]. The smart environment includes space, place, time, technology, devices, control and interaction. Therefore, it, being one of the main elements of smart education, provides an opportunity for smart learners to interact with personalized educational resources and systems used on the basis of special methods.

Anttila and Jussila [4] shows the development of society diversely through the applications of various smart technologies influence the education. In study of Gomede et al. [12], the educators and institutions are concerned about retaining students to make learning effective, efficient and interesting by means of smart technology. Al-Majeed, Mirtskhulava and Al-Zubaidy [2] substantiate the necessity to improve the development of smart technology.

When considering the structure of smart education, most scholars focus on the special position of smart technologies in this system. This is justified by the fact that the effectiveness of the entire educational process largely depends on the set and quality of the used technologies. Smart technologies (computer programs, online resources, learning games and game situations, intelligent educational applications, virtual reality, MOOCs, interactive interfaces, etc. [24, 26, 35, 36]) are adaptive, flexible technologies that contribute to the organization of a personalized training in accordance with the personal differences of students. Such technologies, according to Spector [31], also take into account the context, respond to the interests and characteristics of individual students, and are likely to improve with the use. The smart technology provides communicative interaction between groups of people, makes it possible to simplify the process of obtaining information in various fields, and also makes the material more accessible for perception, leads to the development of personal qualities of students. Smart technologies make it possible to form individual learning trajectories for students (offline, distance and mixed learning), to optimize the use of electronic resources from around the world. Due to such training, students receive new opportunities for: 1) integration of educational institutions into the international educational space; 2) attraction of additional categories of students, including

foreign students; 3) stimulating the emergence and development of innovative educational technologies and tools; 4) creation of new guidelines for teachers, training and assessment of knowledge; 5) strengthening of scientific research in certain fields of knowledge; 6) ensuring the development of effective models of administration and management [30].

It should be noted that discussions regarding the prospects for introducing smart technologies into the educational process are constantly being conducted by the professional community. According to Dmitrenko and Voloshyna [10], Karakose, Polat and Papadakis [21], Karakose, Yirci and Papadakis [22], Spector [31] the competent application of smart technologies allows:

1) a teacher:

- increase the effectiveness and efficiency of training;
- build an individual educational trajectory for each student;
- develop independence, involvement, and motivation among students;
- to support the independent research of students;
- involve students in active joint activities;
- improve problem-solving, assimilation of information;
- accelerate the pace of mastering the material, cover a larger number of topics, and content;
- reduce anxiety among students;

2) students:

- acquire a greater set of skills;
- increase motivation, and activity;
- develop independent learning skills, ingenuity, and strategy;
- improve learning outcomes etc.

Klichowski et al. [23] demonstrated an attempt to introduce elements of smart education in the educational environment. They believed that the results obtained positively represent the prospects for the further introduction of smart technologies in the content of education. In particular, they describe the experience of using the CyberParks technology, which made it possible to obtain a number of interesting results, namely, the teacher was relieved of the burden of explaining the material and assigned the role of a conductor and assistant, which allowed to motivate students while studying.

The COVID-19 pandemic and military events in Ukraine have led to serious changes in education – the replacement of traditional face-to-face education by remote forms [6, 8, 32]. Such changes contributed to the implementation of smart technologies in the training of prospective teachers. The use of smart technologies does not involve “ready-made” knowledge, but the creation of conditions for the youth to acquire their personal experience and skills. It means, according to the concept of smart education, that the teacher’s function is not to transfer ready-made truths, but to provide high-quality content navigation.

Smart complexes make it possible to implement the main trends of the smart education concept. A smart complex is an information and educational system, which is designed to optimize the learning process using digital technologies, as well as the automation of feedback processes, management within the framework of the educational process for the interaction of

participants in the educational process and enriching student's personal experience by searching and processing of educational content on the Internet.

In the system of education, with the increase of online services and the possibility of obtaining knowledge remotely, such systems as site management systems (CMS – Content Management System) are rapidly developing, which, at the same time, provide for the development of smart complexes for managing the educational process. Among them: LMS – Learning Management System; CMS – Course Management System; LCMS – Learning Content Management System; MLE – Managed Learning Environment; LSS – Learning Support System; LP – Learning Platform; VLE – Virtual Learning Environments.

The main advantages of smart complexes are 1) immediate response to external changes, openness; 2) expansion due to the integration of new functionality; 3) easy access to educational material; mobility; 4) ensuring compatibility between software for different operating systems; 5) lack of dependence on time and place; 6) continuous updating of the content, the possibility of self-assessment and evaluation of the knowledge of students.

3. Methodology

In order to implement smart complexes in the educational process, we determined the facilities of the smart complex for students and teachers in the process of studying the disciplines of the pedagogical cycle using LMS learning management systems (table 1, 2).

Table 1

Facilities of the smart complex for organizing the students' educational activities in the process of studying the disciplines of the pedagogical cycle.

N	Facilities
1.	Log in (registration / password verification)
2.	Ability to view: personal individual educational trajectory of learning; personal success in the student's journal of success; information on changes in one's cognitive abilities (characteristics), necessary for analyzing the success of studying pedagogical disciplines; information about your mode of interaction with the system.
3.	The formation of an individual educational trajectory for the study of pedagogical disciplines and its adjustment, depending on the acquired level of knowledge of the prospective teacher
4.	Obtaining educational material (lectures, assignments, methodological instructions, practical tasks, tests, laboratory works, etc.) by students in accordance with the individual educational trajectory.
5.	System of self-assessment and verification of knowledge acquisition
6.	Communication with other students, teachers, pedagogical community on forums, chats, video conferences, online consultations.
7.	The possibility of independent development of educational material for the discipline to fill or update the content
8.	Obtaining assistance for the processing of educational material
9.	Taking into account the students' state and their capabilities in the process of working with the system

Based on the analysis of the scientific works, criteria of the smart complex in the educational process were singled out. Among them:

Table 2

Facilities of the smart complex for organizing the activity of a teacher / tutor / coach in the process of organizing the study of the disciplines of the pedagogical cycle.

N Facilities
1. Log in (registration / password verification)
2. Development. Revision and correction: individual learning trajectories in pedagogical disciplines for students; students' journal of success; characteristics of acquired cognitive skills (characteristics) of prospective teachers; setting parameters for different modes of interaction of students with the system.
3. Control over: system operation; software settings; training results (information about the state of the training process and the student's activity); as participants in the educational process.
4. Availability of analytical tools for information analysis in order to optimize the learning process and its personalization (creation of a psychological portrait, identification of possible mistakes during training, etc.)
5. Management of educational material
6. Knowledge verification system
7. Communication with students on forums, chats, video conferences, online consultations, etc.
8. Protection against unauthorized access

- automation: the possibility of creating automated processes that reduce the number of routine operations during assessment, training and achievement of educational goals;
- sequencing: the possibility of ensuring the consistent progression of the student's competencies, defined in the final goals, in a fixed or non-fixed unit of time;
- assessment: the possibility of applying a number of criteria, diagnostic and formative assessment on the basis of greater immediacy and continuity;
- data collection in real time: the ability to collect, calculate and evaluate data from an array of resources using defined methods in real or approximately real time;
- self-organization: the ability of the system to use the results for the continuous formation of feedback in the educational process.

The interdependence of the criteria can provide a number of functional features of the smart complex in the organization of the educational process by all its participants: wide possibilities of control and management of the educational process; easiness of use; intuitive interface; maximum automation of the educational process; support for SCORM 2004, SCORM 1.2 formats; possibility of integration with other educational resources; the possibility of studying autonomously; low requirements for software and hardware configuration of the server and client terminal [18].

Thus, the main principles of the functioning of smart complexes include: ensuring compatibility between the software of different operating systems; mobility, continuity and free access to any information; autonomy of the teacher and student; definition and application of various motivational models; assessment of changes and competence; change of education due to individual capabilities and interests of the student.

Therefore, in the process of designing and creating the smart complex, it is important that the presented criteria and principles are interdependent, that can adapt the smart complex to

the requirements of prospective teachers' professional.

On the basis of literary sources and our personal experience, we consider distance learning systems for creating smart complexes in the process of training students in higher education institutions. The distance learning system Moodle is a system created for distance learning. Moodle is a free and open source system. This allows developers to download, modify, create add-ons, and customize the software to their personal needs.

The Edmodo software product is a Web site that allows you to organize lectures and laboratory classes. The content of which is presented in the form of texts, files, tests, tasks and surveys. The system allows you to import information from various online resources. The distance learning system Google Classroom is a product of one of the leaders of the digital industry. Google Classroom is a free service for educational institutions and non-profit organizations. It is also available to anyone with a personal Google account. The distance learning system iSpring Online is a system for organizing distance learning, provides the possibility of registration, storage and collection of information online. It does not require resources for installation, it works in online format. It is worth noting that such listed systems are appropriate for the creation and design of smart complexes.

We described the peculiarities of the organization of the educational process when studying the disciplines of the pedagogical cycle in the conditions of distance learning. At the department of pedagogy, professional education and management of educational institutions, the content of the disciplines of the pedagogical cycle was successfully tested. A peculiar feature of the organization of teaching of these disciplines was a significant volume of students' independent work. We understood that for the effectiveness and quality of the independent educational activity of prospective teachers, the work had to be carefully thought out, structured and optimized taking into account the main didactic principles: accessibility at the required degree of complexity, consistency and systematicity, clarity, connection between theory and practice, students' activity. We also took into account the knowledge control and assessment mechanism.

To implement these conditions, an electronic educational system was created as part of the general educational environment, which also included a traditional lecture component. The electronic learning environment was created in the form of a website.

The structure and content of the site allowed prospective teachers to get not only access to educational materials, to the educational environment of the discipline, but also full methodological information on its acquisition. The site was designed according to the modular principle: each module included a video recording and a plan of a thematic lecture, a set of educational materials and tasks, the implementation of which involved independent study by students of education, critical analysis and annotation, as well as discussion of the topics studied in practical classes.

3.1. Instruments

To achieve the goal, the following methods were used in the study:

- theoretical: systematic analysis and generalization of pedagogical and methodical literature on the problem of implementing smart education; synthesis, abstraction, systematization of theoretical provisions for comparison, comparison of different views regarding the definition of the concepts of "smart education" and "smart complexes");

- empirical: methods of collecting empirical material (questionnaires, testing, conversations, interviews) with the purpose of studying the problem of designing and creating smart complexes in future professional activities in order to test the effectiveness of the developed methodology).

Pedagogical practice took place in the educational process of professional training of future teachers. Students of the specialty 015.39 Vocational education (Digital technologies) were surveyed during their pedagogical practice in order to assess the state of readiness of future teachers for the use of smart complexes in their professional activities.

3.2. Participants

In order to obtain experimental data in the process of researching the issue of designing and creating smart complexes based on distance learning systems, a pedagogical experiment took place in the professional training of future teachers. In the process of studying the disciplines of the pedagogical cycle for students of the specialty 015.39 Professional education (Digital technologies) at Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, a questionnaire was conducted regarding the organization of distance learning by students using smart complexes while studying the disciplines of pedagogical cycle. The number of respondents was 18. Questionnaire questions related to the choice of platforms for creating smart complexes, the choice of online tools, educational resources and electronic learning tools for creating the educational content of a smart complex. The participants were informed about the purpose and the structure of the study and assured that students' names would not be used in the study result reports. The participation in the study was voluntary.

4. Results and discussion

Currently, there are a lot of educational platforms for organizing and conducting classes in the domestic educational space. The results of the survey show that the Classroom platform is the most popular among prospective teachers for creating smart complexes (17%), the Edmodo platform is used by 6% of respondents, the Meet platform is used by 28% of students, the Zoom platform is used by 17%, combined platforms – by 33% of respondents.

Receiving educational materials and communication between distance learning participants is ensured through the transmission of video, audio, graphic and text information in synchronous or asynchronous mode. Therefore, the question was devoted to online resources that were used by future teachers to visualize educational content in their personal smart complexes, the following resources gained the most percentage: Canva – 11%; Genial.ly – 17%; Prezi – 22%; Venngage – 17%; Infogram – 6%, combined online services – 28% of respondents.

Due to the results, the following online tools were used by future teachers for interaction of participants in their personal smart complexes: ThingLink – 11.11%; Glosster – 16.67%; Jamboard – 22.22%; Padlet – 16.67%; combined interactive services – 33.33%.

An integral component of the educational process is the monitoring of the knowledge of students. The following services for creating tests scored the most p%; LearningApps – 22.22%;

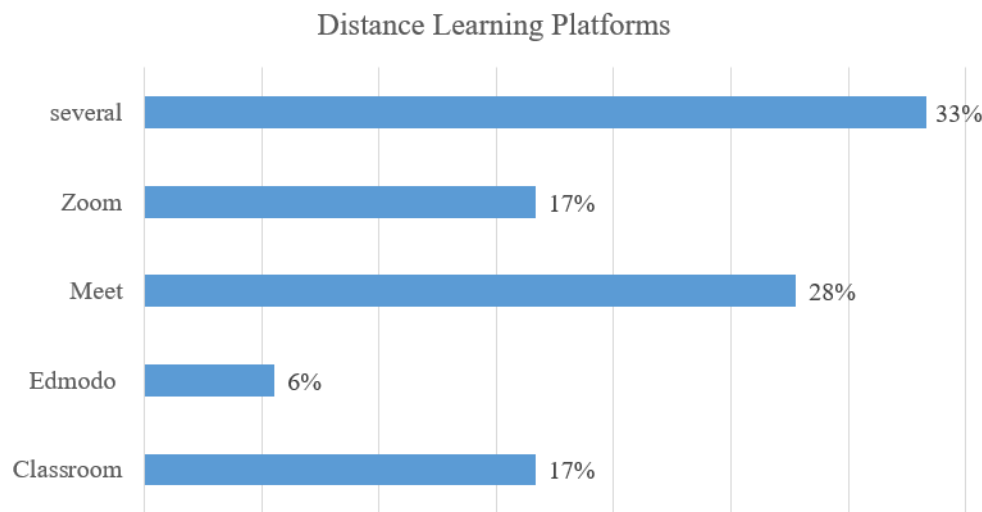


Figure 1: The use of distance learning platforms for creation of smart complexes.

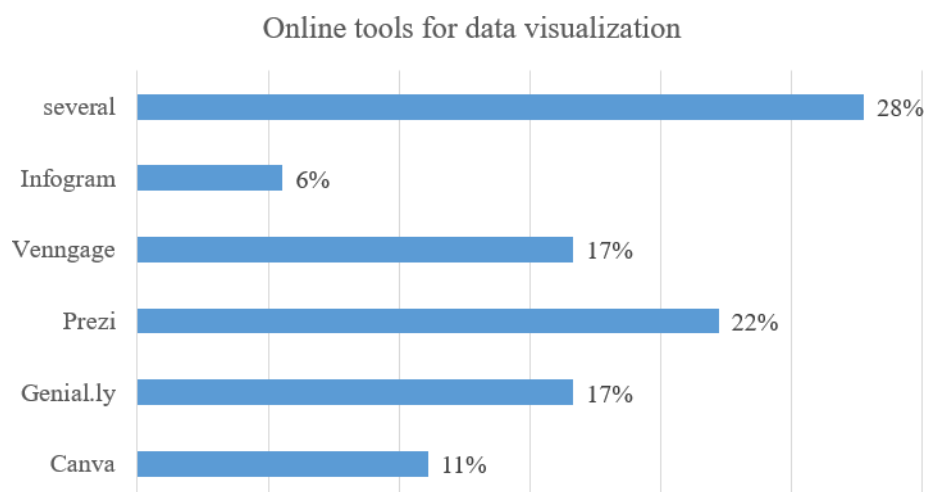


Figure 2: The use of online tools for data visualization for creation of smart complexes.

Classtime – 16.67%, Google forms – 16.67%, Quizlet – 5.56%, Quizalize – 5.56%, combined services for creating tests.

The analysis of the survey results showed that the platforms and services mentioned above allow future teachers to create smart complexes of educational disciplines. The smart complex of the educational discipline acts as an individual personalized online program environment (on the website/portal/e-platform), which allows the teacher to accumulate his personal educational digital resources or links to them, provide access to them, and also see the current results of students in real time.

As the survey results showed, future teachers use platforms and services in combination, strengthening the interactive component of the smart complex of pedagogical disciplines. In the

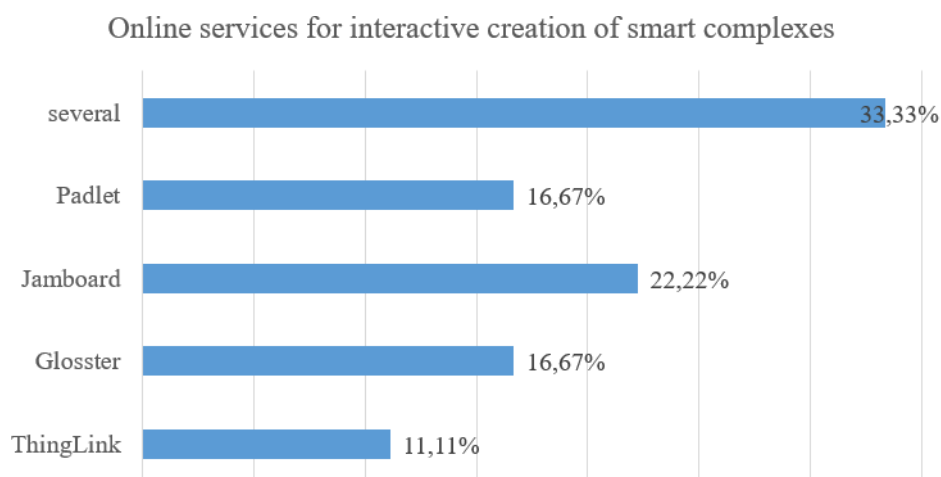


Figure 3: The use of online services for interactive creation of smart complexes.

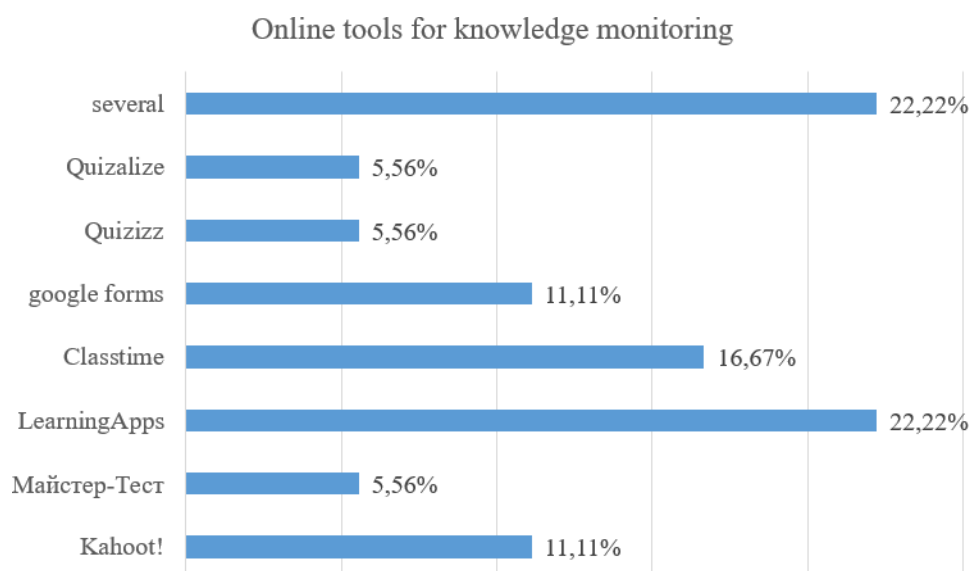


Figure 4: The use of online tools for knowledge monitoring in creation of smart complexes.

smart complex environment, the teacher can present educational content, communicate with participants in the educational process, visualize data, assign tasks individually, for separate groups or for the entire class at once; instantly receive results after students complete tasks; save and view performance statistics.

In the survey, the students were asked about the problems that they had in the process of creating smart complexes of pedagogical disciplines. The most frequent mentioned problems were:

- lack of experience in methodical organization of training using smart complexes – 11%;

- limited access to the Internet – 6%;
- lack of digital devices – 1%;
- insufficient digital infrastructure of the educational institution – 11%;
- unreliable/slow Internet connection at school – 15%;
- limited/absent technical support of the distance learning organization – 17%;
- teachers and mentors helped solve problems quickly – 22%;
- no problems with the creation of a smart complex – 33%.

The results of the survey made it possible to highlight several advantages and disadvantages of the use of smart technologies in the educational process that can allow intensifying the process of using these technologies.

The respondents also noted a number of advantages of smart technologies that create a certain basement for their further intensive use. Among them we can highlight time saving, visibility, and efficiency of use in distance learning conditions.

For further development students' smart technology skills, it can be recommended to apply some additional courses into the educational process of future teachers, that could allow to eliminate or minimize the identified shortcomings, and to increase the level of students' readiness for the use of smart technologies.

5. Conclusions

In general, the research showed that the implementation of smart education was able to ensure a high level of education, which met the goals and objectives of distance learning in the conditions of the COVID-19 pandemic and military events in Ukraine.

The conducted theoretical analysis of the research problem showed that the concept of smart education is a new paradigm of education that can improve the quality of education, focused on contextual, personalized and continuous learning that contributes to the development of the students' intelligence and develops the students' ability to solve problems in a modern "smart environment".

It was concluded that the competent application of smart education allowed the teacher to increase the effectiveness and efficiency of education; to develop an individual educational trajectory for each student; to motivate prospective teachers and support their independent research; to involve in active joint activities; to improve and speed up the rate of assimilation of the material, to cover a larger volume of content; to reduce anxiety among students. For students, smart education allowed to increase motivation and activity; to develop self-study skills, resourcefulness, and improve academic results; to lighten the academic load; to plan time more carefully.

Smart complexes made it possible to introduce the main trends of smart education into the educational process. The smart complex is an information dynamic educational and methodological system with certain smart criteria: automation, sequencing, assessment, data collection in real time, self-organisation.

The facilities of the smart complex for students and teachers in the educational process of the disciplines of the pedagogical cycle using the learning management systems (LMS) were

determined. It was stated that the following distance learning systems are appropriate for creating smart complexes: Moodle, Google Classroom, iSpring Online, and Edmodo.

The survey results showed that the smart education system model is being actively implemented at Vinnytsia Mykhailo Kotsiubynskyi Pedagogical University. The respondents noted the advantages of smart education (saving time, visibility, efficiency of use in distance learning conditions), and demonstrated the understanding of the importance of its application in their further professional pedagogical activities.

Further research should be concentrated on the study of the methodology of the organization of smart training, the didactic principles of the creation of smart complexes, the students' activation in the development of electronic educational content of pedagogical disciplines.

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