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Information and communication and digital technology in education: Some aspects of SMART technology application

Información y comunicación y tecnología digital en la educación: Algunos aspectos de la aplicación de la tecnología SMART

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Abstract

The relevance of the research work is due to the growing interest in the implementation of information and communication and digital technology in the educational process. The article pays special attention to the peculiarities of the impact of smart-technology on the formation of the digital component of professional competence as a mediated indicator of the effectiveness of the implementation of innovative teaching technology. Modern smart technologies in education are designed to make education modern, accessible, and effective. The aim of the work was to identify the impact of implementing smart-technology on students' academic success and the dynamics of the formation of the digital component of professional competence, and then to investigate the features of the proposed innovative educational method. The article investigates and systematizes the peculiarities of the experience of using digital and information and communication technologies, taking into account the need to organize the educational process in the conditions of distance and mixed forms of education. Methods of

Resumen

La relevancia del trabajo de investigación se debe al creciente interés por la implementación de la tecnología de la información y la comunicación y la tecnología digital en el proceso educativo. El artículo presta especial atención a las peculiaridades del impacto de la tecnología inteligente en la formación del componente digital de la competencia profesional como indicador mediato de la eficacia de la aplicación de la tecnología de enseñanza innovadora. Las modernas tecnologías inteligentes en la enseñanza están diseñadas para hacer que la educación sea moderna, accesible y eficaz. El objetivo del trabajo fue identificar el impacto de la implementación de la tecnología inteligente en el éxito académico de los estudiantes y la dinámica de la formación del componente digital de la competencia profesional, y luego investigar las características del método educativo innovador propuesto. El artículo investiga y sistematiza las peculiaridades de la experiencia del uso de las tecnologías digitales y

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mediated research of the effectiveness of the implementation of innovative educational technologies are actualized. Given the multifaceted nature of the topic under consideration, future research should focus on studying the specifics of implementing smart-technologies for training specialists in various educational areas. Also, special attention of researchers is required to analyze the effectiveness of popular tools of smart-technologies.

Keywords: digital environment, educational technology, digital competencies, smart-education, modern education.

de la información y la comunicación, teniendo en cuenta la necesidad de organizar el proceso educativo en las condiciones de la educación a distancia y mixta. Se actualizan los métodos de investigación mediada de la eficacia de la aplicación de las tecnologías educativas innovadoras. Dado el carácter polifacético del tema que nos ocupa, las investigaciones futuras deberían centrarse en el estudio de las particularidades de la aplicación de las tecnologías inteligentes para la formación de especialistas en diversos ámbitos educativos. Asimismo, se requiere una atención especial de los investigadores para analizar la eficacia de las herramientas populares de las tecnologías inteligentes.

Palabras clave: entorno digital, tecnología educativa, competencias digitales, educación inteligente, educación moderna.

Introduction

The modern world is characterized by the rapid saturation of data processing systems in almost all spheres of social life. Information has become a strategic resource for society, leading to the inevitable proliferation of information and communication technologies (hereinafter ICT). In today's competitive market environment, everyone must have the ability to adapt quickly to market conditions that are constantly changing and creating conditions of ontological uncertainty. ICTs are now capable of radically changing the way different institutions and the state as a whole function (Ignatenko, 2022). That is why special attention needs to be paid to the issue of applying ICTs and digital technologies in the educational and pedagogical process in order to develop appropriate professional competence in future professionals (Núñez-Canal, Obesso & Pérez-Rivero, 2021).

Combining information and communication technologies leads to the improvement of the traditional educational sphere, the development of new progressive and innovative teaching methods, as well as the creation of a special ecosystem of educational and digital environment of EHE. Such technologies are a tool for creating new means of managing the educational process, which produce qualitative results both at the level of HEIs and at the level of efficiency of the educational institution as a whole (Tsekhmister, Konovalova, Tsekhmister, Agrawal & Ghosh, 2021).

The rapid development of information and communication technologies requires increased concentration in the processes of their implementation and use. Ignoring the management of information and communication technologies leads to a set of different technologies that are not compatible with each other, thus leveling their effectiveness. In fact, it has become clear that in the course of the ICT evolution decisions are made mainly not based on the analysis of the needs to improve the methodology of the educational process, but under the influence of external factors of the rapid development of socio-economic spheres (Palanivel, 2020).

The social changes of the late 20th and early 21st centuries caused by the technological revolution have led to the emergence of a new generation for whom information technology and the digital environment are a natural part of their life-world, an everyday reality. These technologies make everyday life itself more comfortable, many actions and decisions more simple, open, and accessible, but at the same time require creativity, the ability to benefit from information abundance and excess, often not based on traditional knowledge, but through intuition (Gokbulut, 2020).

Today's educational institution must orient its student in a changing ocean of innovative digital change. Consequently, we can say that the modern education system should be the flagship of the implementation of the most advanced ICT and digital technologies in society. These are the features of a Smart society, the norms of Smart culture, in which new generations are born and

socialized. The education system should also naturally change, acquiring the characteristics of Smart. The influence of human capital is not enough for the development of modern education (Hoel & Mason, 2018).

The very content of education, its forms, methods, practices, spaces, and environments require changes. To implement such changes, the concept of smart-universities was developed, which in general provides an interactive educational environment, flexibility, and personalization of education along with free access to the necessary content. Theoretical sources on smart-education began to appear relatively recently and are not yet of a systematic, analytical nature. There is no unambiguous definition for the term "smart-education" yet. But summarizing the existing definitions, the following definition can be given (Rosida, Muin & Sakka, 2021). "Smart education is the association of educational institutions and faculty for joint educational activities on the Internet based on common standards, agreements, technologies, and a common repository of educational materials" (Cattaneo, Antonietti & Rauseo, 2021). Today it can be noted that there is a lack of comprehensive research on the topic of implementing smart technologies in teaching practice. At the same time, the topic of ICTs and digital technologies in education is actively disclosed. The concept of a digital environment is widely consumed (Ahmed & Ganapathy, 2021).

Information and educational technologies, among which Smart technologies stand out, are technologies "that have a particular universality and dramatically increase the degree of virtualization of not only educational interactions but also other communicative relationships. With the help of this kind of technology, it is possible to improve the efficiency of the educational process and the quality of education".

Thus, the topic of a "smart" educational environment, education, technologies, and even universities is relevant and in demand among scientists and practitioners, but it has not been studied sufficiently and requires research and systematization (Bouchrika, Harrati, Wanick & Wills, 2019).

The purpose of the study is to identify the impact of the use of information and communication and digital technology on the educational process. The study analyzes the impact of the application of smart-technology on academic performance

and the formation of the digital component of professional competence.

The hypothesis of the study is the impact of the introduction of smart technology on academic success and the formation of the digital component of professional competence. The task was to investigate the peculiarities of the impact of smart technologies on the results of the learning process.

Theoretical Framework or Literature Review

The intensive introduction of digital technologies into the life of modern society, the formation of information space, and the development of electronic educational systems, as noted by Achilovich (2021), leads to the formation of new scientific and pedagogical ideas about the organization of the educational process of EHE students, a qualitative rethinking of approaches to education, as well as the acceleration of its development. The intensive introduction of digital and information technologies into the education system and educational process, according to Movlonovich (2022), is a global trend and one of the most significant processes that have occurred in the education system over the past decades.

Poddubnaya, Zadneprovskaya, Dhum, & Khatit (2020) posit that the concepts of "communication" and "information" are closely interconnected and mutually complementary. Specifically, "information" refers to any data that is transmitted, whereas "communication" refers to the transmission of this data through specific channels. It is important to distinguish between the concepts of "literacy" and "competence" as well. The initial step in developing the information and communication competence of a higher education institution student is the acquisition of information and communication literacy. This encompasses the ability to navigate the information space and effectively utilize information and communication technology tools to facilitate social and professional interactions.

ICT competencies in the scientific literature, in particular, Chisango, Marongwe, Mtsi & Matyedi (2020), are defined as receiving, processing, and giving out information, skills of working with multimedia and mass-media technologies, as well as possession of skills of working with Internet resources. All definitions reflect the component composition of ICT competence, but none of them shows the specificity of a particular academic discipline,

which would allow us to consider these definitions as universal. Thus, according to Vincent-Lancrin (2022), ICT competences are among the leading key competences and can be singled out as a separate group of competencies requiring targeted formation in the process of students' mastering different disciplines.

According to Järvis, Tambovceva & Virovere (2021), information and communication competence refers to a set of knowledge, skills, and abilities that are acquired through learning and self-education in computer science and information technology. This competence encompasses the ability to effectively use information technology in performing professional tasks, including tasks related to information management, analysis, and transfer. Additionally, this competence includes the ability to model and design one's own professional activities, as well as the activities of a team, using modern ICT tools. This proficiency in modern ICT enables individuals to navigate the organizational environment effectively and enhances labor productivity. These definitions underscore the importance of developing ICT and digital competencies among students to prepare them for their future professional pursuits, as noted by Abdurahimovna (2020). In general, ICT competence, as noted in Wojciech, Sobczyk, Waldemar & Pochopień, (2022) understand the ability to collect, assess, transfer, search, analyze information, model processes, objects through the use of the capabilities of communication and information technology.

Recently, the term "smart education" has become popular. According to Kopotun, Durdynets, Teremtsova, Markina & Prisnyakova (2020), it explains the new development strategy, the main feature of which is the maximum availability of knowledge. The new motivation to acquire knowledge is created through the active use of materials placed in open educational resources. Accordingly, this knowledge, in turn, becomes available to more and more people.

As Schomakers, Lidynia & Ziefle (2022) point out, smart education is flexible learning in an interactive educational environment through freely available content from around the world.

Methodology

Numerous systems exist for evaluating the impact of digital technology on the learning process. However, many of these systems solely focus on assessing the knowledge and activities that comprise professional competence.

Therefore, relying solely on exam scores and ratings does not provide a comprehensive evaluation of the level of digital competence achieved - the primary goal of integrating information and communication technology (ICT) into education.

To address this issue, monitoring the formation of digital competence can be achieved through various components of a methodological complex. These components may include a cyclogram for monitoring a discipline or professional module, a summary sheet for monitoring a discipline or professional module, and a set of measuring and control materials. Assessing the level of digital competence formation is based on levels of expression, which are determined by activity criteria. The criterion for the basic level is the ability to perform reproductive activities based on a given algorithm, which involves understanding and reproducing professional actions.

The study of information-communicative and digital technologies was carried out in several stages.

1. The first stage (2021): development of indicators of digital and information-communication competence of students as indicators of the effectiveness of digital technology application during training; development of generalized characteristics of levels of formation of each competence component; selection and development of diagnostic tools to assess the degree and dynamics of development of levels of formation of digital competence.

2. In 2022, the second stage of the study was carried out, which involved examining the initial level of students' digital competencies. The experiment was designed to determine the effectiveness of the educational interventions on digital competency formation. To assess the formation of the digital component, a test was administered at the end of the experiment containing 16 closed-type questions, with four questions for each of the four competencies of the block. Each correct answer was given one point, and the maximum score for the test was 16 points, four for each competence. Additionally, the activity component was assessed by a panel of 25 experts, all of whom were teachers at the Department of Cultural Studies at Taras Shevchenko National University.

The study involved 180 students studying cultural studies and art criticism at Taras Shevchenko National University. A stratified cross-section sample was used to allow for more objective research and analysis of the impact of augmented reality technologies on educational performance. The participants were divided into two groups: experimental and control, with 90 students in each group. The experimental group received instruction using smart technologies during the academic year 2021/2022, while the control group followed the standard curriculum. Formal statistical analyses, including Wilcoxon's criterion and Student's t-criterion, were used to check the conformity of the data to the normal law of distribution.

The study was conducted using digital survey tools. All respondents were informed about the goals, objectives, and subject matter of the study and gave consent to process personal data and use the results in a scientific publication.

The main limitations of the study are the lack of a clear and transparent methodological framework for analyzing the impact of a particular educational technology on the learning process. Consequently, conclusions about the impact of information and communication and digital technology can be obtained indirectly.

Results and Discussion

The general results of diagnostics of the formation of the block of digital competencies are reflected in Fig. 1.
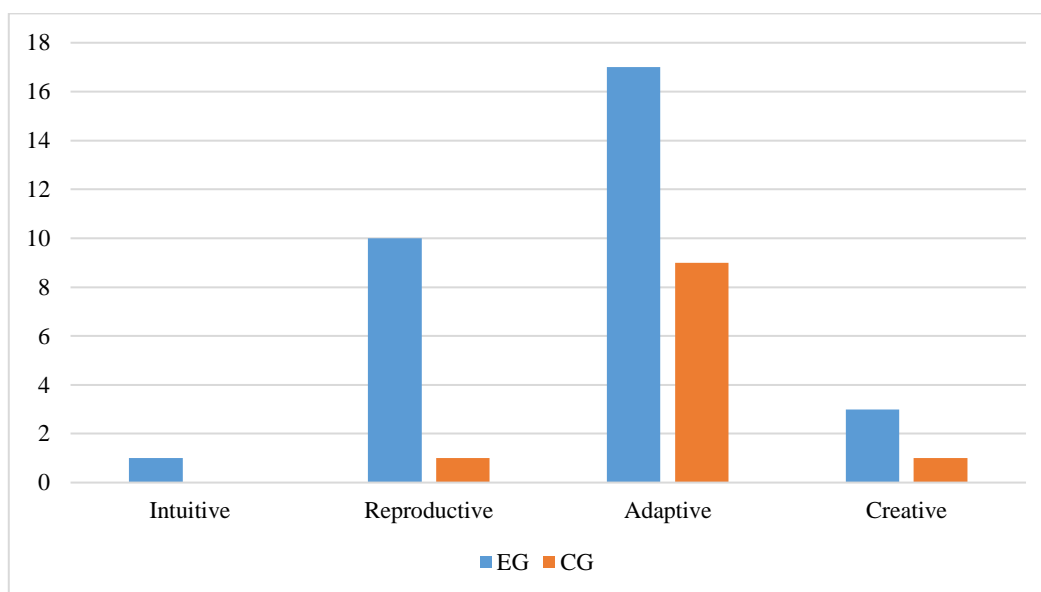

Figure 1. Comparative diagram of the levels of digital competence of future culturologists
Source: Compiled by the authors of the study based on the results of the experiment

The illustration depicts a notable contrast in the level of digital competence development between EG and CG students. To determine the significance of the variance in proficiency levels, we will employ the nonparametric statistical Mann-Whitney test, which enables the identification of differences in the measured attribute between two independent samples of small size (less than 100 values). The experimental data fulfills the criteria for using this test, with each sample consisting of values ranging from 3 to 100, represented by scores that reflect the overall outcomes of the digital competence block formation.

To evaluate the significance of differences in the levels of personal elements and psychological attitudes formation from the competencies composition in the EG before and after the formative experiment, we will utilize the Wilcoxon criterion. This criterion enables the comparison of changes in indicators between two different conditions on the same sample of subjects. It can help determine whether the shift of an indicator in one direction is more significant than in the other and establish the direction and severity of change.

To satisfy the condition for the sample size, which is $5 \leq n \leq 50$, we have 24 sample elements. The Wilcoxon criterion's empirical value is determined by summing up the ranks corresponding to atypical shifts. In this case, there is only one such shift, which corresponds to

a rank of 5, resulting in an empirical value of Temp=3.

Assuming a significance level of α=0.01, the critical value is Tcr(0.01)=61. If the critical value is not greater than the empirical value, then at this level of significance, there is no reason to reject the null hypothesis of the significance of differences. On the other hand, if the critical value exceeds the empirical value, then the null hypothesis is rejected.

In this instance, Temp=3<10, so the null hypothesis should be rejected. Therefore, there is evidence to suggest that there is a significant difference between the levels of personal elements and psychological attitudes formation from the competencies composition in the EG before and after the formative experiment.

Fig. 2 displays the changes in learning outcomes for both the experimental group (EG) and control group (CG). Petal diagrams were used to illustrate the percentage of students who achieved basic and advanced levels of competency, indicating a "productive" level of learning, at the beginning and end of the study. The largest variations in learning outcomes were observed in the cognitive, praxiological, and reflexive criteria. The improvement in the cognitive component can be attributed to the implementation of strategies to adapt the educational content and monitor students' self-learning progress. The significant increase in the praxiological component was a result of the heightened participation of students in the educational process, which correspondingly developed their activity component. The improvement in the reflexive component was attributed to the regular use of self-assessment methods and the inclusion of mechanisms for ongoing monitoring of their educational progress. The growth of the axiological component was facilitated by the incorporation of a control action block into the educational process management submodel, which enhanced students' motivation and engagement in the learning process.
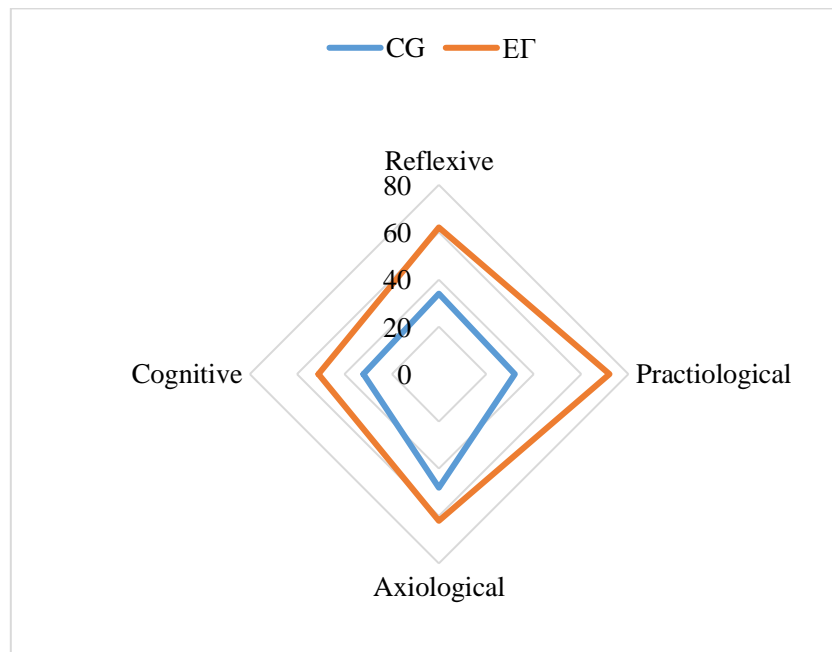

Figure 2. Dynamics of the formation of digital competence in the CG and EG
Source: Compiled by the authors of the study based on the results of the experiment

Assessment of the authenticity of the results of the experimental work was carried out using methods of statistical analysis of data. To check the applicability of the parametric one-factor analysis of variance, we checked the data for normality and homogeneity.

Since the results of the applicability of classical analysis of variance, we obtained the fulfillment of the normality and homogeneity conditions, therefore, to assess the effectiveness of the pedagogical study, we can use the criteria of parametric analysis of variance, such as Student's t-criterion for comparison of independent samples of experimental and control groups (Table 1).

Table 1.
Test results according to Student's test

	Start of the experiment	End of the experiment
Statistics	t = 0.82634	t = -5.7036
Level of significance	0,05	
p value	0.5214	3.315e-08
Interpretation	No statistically significant differences were found between the groups	Statistically significant differences were found between the groups

Source: Compiled by the authors of the study based on the results of the experiment

The analysis showed the absence of statistically significant differences before the beginning of the experiment between CG and EG students. Since the t-test statistic is less than the critical value and is in the zone of insignificance, we accept the null hypothesis and reject the alternative hypothesis.

Difficulties arising in the implementation of ICT and digital technologies are associated with difficulties in attracting and retaining students in the educational process, reduction of motivation to learn in the conditions of increasing the volume of independent work. The transition to a hybrid model of learning requires a radical transformation of traditional technologies and the development of models for the organization of learning activities in an electronic environment, ensuring the achievement of learning outcomes.

But despite the existing problems and risks, this direction is actively developing and today is a phenomenal cardinal shift in the paradigm of modern learning. Organization of learning with the help of smart-technology comes down to the development of new educational methods, disciplines, and navigation mechanisms, the formation of a system of control and monitoring of knowledge, competencies and learning outcomes, feedback mechanisms. The body of research methods for this is very broad, which is due to the fact that smart-technologies are at the intersection of digital and pedagogical technologies. The approaches used are based on the methodology of systems analysis, the technology of operational and intelligent data analysis, machine learning, methods of sociological research, analysis and processing of empirical data. The scope of smart-technology application in the educational process is constantly growing.

Relying on the data of modern pedagogy on the development of the digital component of professional competence, as well as on the results obtained by summarizing and analyzing the existing experience of applying smart-

technology, the following advantages can be noted: increased accessibility of education by erasing territorial and temporal borders, the possibility of implementing individual educational trajectories, economic benefits, the reduced labor intensity of teachers by freeing them from routine processes, nurturing with.

Analyzing the psychological and pedagogical aspects of building the educational process in HEI in an electronic environment, we can conclude that the active use of smart-technology in learning will contribute to the integration of online learning methods with offline best practices and approaches, which have proven their ability in learning and development of students. Using the possibility of combining effective pedagogical and modern digital educational technologies will provide mass availability of education; personalization of learning; the possibility of online analysis of educational results and the learning process; technological capabilities of providing educational content and active management of the educational process.

Thus, we can infer that education today faces new challenges that will seriously change the education system. The retrospective analysis of studies devoted to the development of the problem of building the educational process in the electronic environment allowed to highlight the features of its construction taking into account the psychological and pedagogical features of the modern generation, to specify the concept of using smart technologies in the educational process in the electronic environment, to determine the model of blended learning as the most promising model in terms of mass training of HEI students. The scientific significance of modernization and the development of the use of smart technologies is manifested in the form of innovative pedagogical approaches and teaching methods that can be used as a basis for creating a methodological system of learning in the conditions of digitalization of higher education. The scientific

significance of modernization and development of the use of smart technology is manifested in the form of innovative pedagogical approaches and teaching methods that can be applied in the basis of creating a methodological system of learning in the conditions of digitalization of higher education.

Conclusions

Thus, we can conclude that education today faces new challenges that will seriously change the education system. Retrospective analysis of studies devoted to the development of the problem of building an educational process in the electronic environment, allowed to highlight the features of its construction, taking into account the psychological and pedagogical features of the modern generation, to specify the concept of using smart-technology in the educational process in an electronic environment, to determine the model of blended learning as the most promising model in terms of mass training of HEI students. Today, digital and information and communication technologies in education are becoming increasingly popular. This is due, first of all, to the rapid development of technology. Modern man today cannot imagine his life without gadgets, the Internet, social networks, and streaming platforms. Education today becomes the flagship of the introduction and assimilation of modern information technologies. Among all ICTs and digital technologies in particular need smart-technology in learning. The study of the formation of the digital component of professional competence during the training in HEI showed high efficiency of the use of smart-technology.

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