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ORIGINAL

The Impact of Advanced Educational Technologies on Research in the Digital Age

El impacto de las tecnologías educativas avanzadas en la investigación en la era digital

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ABSTRACT

Introduction: against the backdrop of the rapid dynamics of the educational environment, integration of innovative digital technologies into educational processes is gaining special importance. The integration of innovative digital platforms not only allows for maximum individualization of learning but also provides access to the expanded potential of information and communication resources, which contributes to the development of the main competencies from the category of "soft skills" necessary for the implementation of effective research activities in modern conditions of social development.
Objective: analyzing the practical effects of cutting-edge digital solutions in education on the caliber of research endeavors is the purpose of the research.
Method: the research methodology included analysis, systematization and generalization, as well as the method of expert evaluation and statistical tools (one-tailed t-test).
Results: the comparative analysis convincingly demonstrated the effectiveness of the use of digital technologies in the educational sphere in the context of improving the level of research activities. It has been found that the most significant positive impact was experienced by the skills of analytical thinking, independent processing of scientific information, data management and visualization.
Conclusions: statistically significant differences have been identified that demonstrate the potential of digital educational technologies in creating a favorable environment for effective teaching and research activities. It has been proven that innovative teaching technologies stimulate the development of analytical thinking and a number of "soft skills" that expand the ability to process a large amount of information, transform it in the research field and form the latest scientific vision of established processes and phenomena.

Keywords: Education Technologies; Digital Optimization; Innovative Educational Tools; Research Activities; Educational Process.

RESUMEN

Introducción: en el contexto de la rápida dinámica del entorno educativo, la integración de tecnologías digitales innovadoras en los procesos educativos está cobrando especial importancia. La integración de plataformas digitales innovadoras no sólo permite la máxima individualización del aprendizaje, sino que también proporciona acceso al potencial ampliado de los recursos de información y comunicación, lo que contribuye al desarrollo de las principales competencias de la categoría de «habilidades blandas» necesarias para la realización de actividades de investigación eficaces en las condiciones modernas de desarrollo social.
Objetivo: analizar los efectos prácticos de las soluciones digitales de vanguardia en la educación sobre el calibre de los esfuerzos de investigación es el propósito de la investigación.
Método: la metodología de investigación incluyó análisis, sistematización y generalización, así como el método de evaluación de expertos y herramientas estadísticas (prueba t de una cola).
Resultados: el análisis comparativo demostró de forma convincente la eficacia del uso de las tecnologías digitales en el ámbito educativo en el contexto de la mejora del nivel de las actividades de investigación. Se ha comprobado que el impacto positivo más significativo lo experimentaron las habilidades de pensamiento analítico, procesamiento independiente de la información científica, gestión de datos y visualización.
Conclusiones: se han identificado diferencias estadísticamente significativas que demuestran el potencial de las tecnologías educativas digitales en la creación de un entorno favorable para las actividades eficaces de enseñanza e investigación. Se ha comprobado que las tecnologías docentes innovadoras estimulan el desarrollo del pensamiento analítico y de una serie de «habilidades blandas» que amplían la capacidad de procesar una gran cantidad de información, transformarla en el campo de la investigación y formarse la visión científica más reciente de los procesos y fenómenos establecidos.

Palabras clave: Tecnologías Educativas; Optimización Digital; Herramientas Educativas Innovadoras; Actividades de Investigación; Proceso Educativo.

INTRODUCTION

Innovative tools of digital educational solutions are globally expressed in the development of various forms of online learning, as well as the introduction of interactive technologies of information and communication interaction, which simplifies access to significant amounts of scientific knowledge through specialized programs, electronic resources and virtual environments. They improve the quality of research and create prerequisites for an accessible and convenient exchange of information, scientific ideas, and discussion arguments between members of the research community. In view of the above, there is no doubt that an in-depth analysis of the aspects of the chosen problem.

The basis for the global transformation of the research process is currently seen as the integration of remote forms of scientific interaction, online communication, and digital learning tools. Modern scientists pay considerable attention to these processes. For example, Baral and Baral[1] consider the potential of interactive technologies, being convinced that the relevance of a researcher in the scientific field is determined by the quality of the combination of his or her competencies, skills of individual and group activities, skills of discussion practices, in particular, in the online format.

The results of scientific studies by Baird and Parayitam[2] actually demonstrate the correlation between the level of quality of research activities and the use of interactive methods of work. In particular, the method of case-based project-based learning not only improves the academic performance of students but also contributes to the formation of professional competencies of a scientist, developing critical thinking and problem-oriented search for scientific solutions.

The specificity of the modern education system finds practical expression in the integration and development of the humanistic paradigm, which actualizes individual value, increases the importance of independence and freedom of scientific investigations. Many contemporary scholars,[3,4] analyze the potential of interactive educational tools in the context of communication competence, teamwork skills, creativity, and motivation. Some researchers[5] emphasize the impact on the cognitive sphere, information competence, self-management and self-motivation, as well as the expansion of skills in the field of research methodology and methodology.

Some researchers [6] pay special attention to the development of creative potential to improve research activities, which involves mastering strategic management and situational modeling skills. Scholars propose to actively integrate innovative forms of organizing the educational process, including gamification, modeling, online chats and conferences, project work, and testing of research practices.

Contemporary scientists,[7,8] argue that educational digital innovations form an electronic environment based on the potential of the technological and communication process for the competence development and

improvement of researchers. They assimilate the capabilities of the virtual environment, online resources, electronic platforms for access to scientific information and improving the quality of research.

The publications of Dean and Mansour[9] promote the priority of blended learning in the context of academic performance. The researchers emphasize the need to increase the level of motivation, effective structuring of the educational process, development of creativity and emotional intelligence, effective and accessible feedback.

At the same time, a number of aspects of innovative education have not been sufficiently studied. Variations in the digital upgrade of the modern educational process intensify the quality of research activities require in-depth analysis.

The purpose of the research is to analyze the aspects of the practical influence of innovative digital solutions in education on the quality of scientific and research activities.

METHOD

The type of research is empirical. In the course of the research, a number of general scientific methods were used: various types of analysis, synthesis, comparison, generalization, and systematization. The analysis was used to provide a comprehensive theoretical substantiation of the key aspects of innovative educational development. Systematization and generalization were used in the context of identifying the basic principles of research competencies. The comparative analysis was used to identify the dynamics of the level of quality of acquired skills under the influence of digital technologies and traditional teaching methodology.

The method of expert evaluation was applied by the preliminary formation of two representative sample groups: experimental and control. The control group (group 1, 10 respondents) was formed by teachers of the Faculty of Management and Marketing of the National University of Economics in Kharkiv. The experimental group (group 2, 10 respondents) was formed by teachers of economics and business management at the Craigie Rich National University. The research was conducted in real teaching conditions with the knowledge of the management. The criteria for selecting respondents were: representativeness of participants, possibility of ensuring the reliability and completeness of the experiment. The duration of the study was three months, as a necessary condition for the success of experimental research is its connection with practice.

The results of experimental research in the field of education usually require lengthy verification, as they are not immediately apparent. Therefore, three months is the recommended period for implementing significant innovations in pedagogical practice in order to draw conclusions about their effectiveness.

The participants provided their informed consent. The confidentiality of the research results was also ensured.

Group 1 used the traditional theoretical and methodological basis of learning activities during the experiment. Group 2 involved digital educational tools and online resources in the educational process.

RESULTS

The development of innovative technologies creates new opportunities for improving the process of educational and research activities in the context of a personality-oriented concept. This concept within the digital learning environment involves the active development of the cognitive sphere and individual preferences through adaptive educational platforms such as Dreambo or SmartSparrow, which adapt to the individual needs of students. Modern educational platforms allow for personalized learning in the context of tasks, pace of their implementation, level of interactivity, type of control, etc., which contributes to a deeper research process.[10]

In addition, the personality-oriented concept involves the use of online platforms such as Google Classroom for joint project activities and the exchange of researchers' experience, and self-management platforms such as Moodle or Blackboard, which allow for self-assessment and tracking of personal progress. The use of personality-oriented education makes it possible to increase the level of results in research activities by activating individual cognitive abilities, skills of effective self-realization, and management of personal development.[11]

At the same time, interactive educational methods (in particular, NeawPod, Padlet, or Socrative platforms) create a dynamic environment, develop communication skills, provide a favorable psychological microclimate, and intensify motivation and interest in scientific activities. Creativity is also especially developed when using targeted digital tools (Crello, Music Crab, Crayola Art-Studio, etc.) in the educational process.[12]

The key skills that are formed in the process of interaction with digital technologies in the educational field include critical and non-standard thinking, versatility, and independence in their acquisition. Information and communication interaction in synchronous and asynchronous modes, resources for distance learning allow expansion of the educational material, attracting various resources for the development of the research process. The aspects of the impact of digital solutions on various aspects of research competence are summarized in table 1.

Table 1. The aspects of the impact of innovative educational technologies on the development of research skills

Skills	Features	Means
Critical thinking abilities	The ability to analyze information from a critical perspective, to identify the main patterns	Excel MATLAB
Skills of self-education	The ability to search for, analyze and use information in practice in the context of setting and solving research problems.	Coursera, edX, Google Scholar
Creative approach	The ability to generate innovative approaches to the implementation of diverse scientific problems.	MindMeister, Miro, Trello
Communication skills	The ability to interact with other researchers and effectively present the results of their studies.	Zoom, Microsoft Teams, Slack
Collaboration in project work	The ability to collaborate when working on a project.	Asana, Basecamp
Group communication	Skills of coordinated teamwork.	Microsoft Project, Jira, Trello
Speed of thinking	The ability to respond quickly to the dynamics of the research process and take into account the uncertainty factor.	Notion, Evernote, OneNote
Hard skills	Mastering innovative digital tools that can be potentially used for the research.	Python, SPSS
Analysis of large amounts of information	The ability to interpret large amounts of scientific information	Spark, Tableau
Digital skills	The ability to independently create and use multimedia materials for visualization and presentation of research and scientific tasks in the practice of research.	Camtasia, Adobe Premiere Pro, Audacity

Source: Raja and Lakshmi Priya,[8] Nikukar[5]

Two groups of experts were involved in the experiment: Group 1 – using traditional educational methods and Group 2 – using digital tools. The method of expert evaluation involved assessing the levels of skills of students based on their research activities. The results of calculating are shown in figure 1.

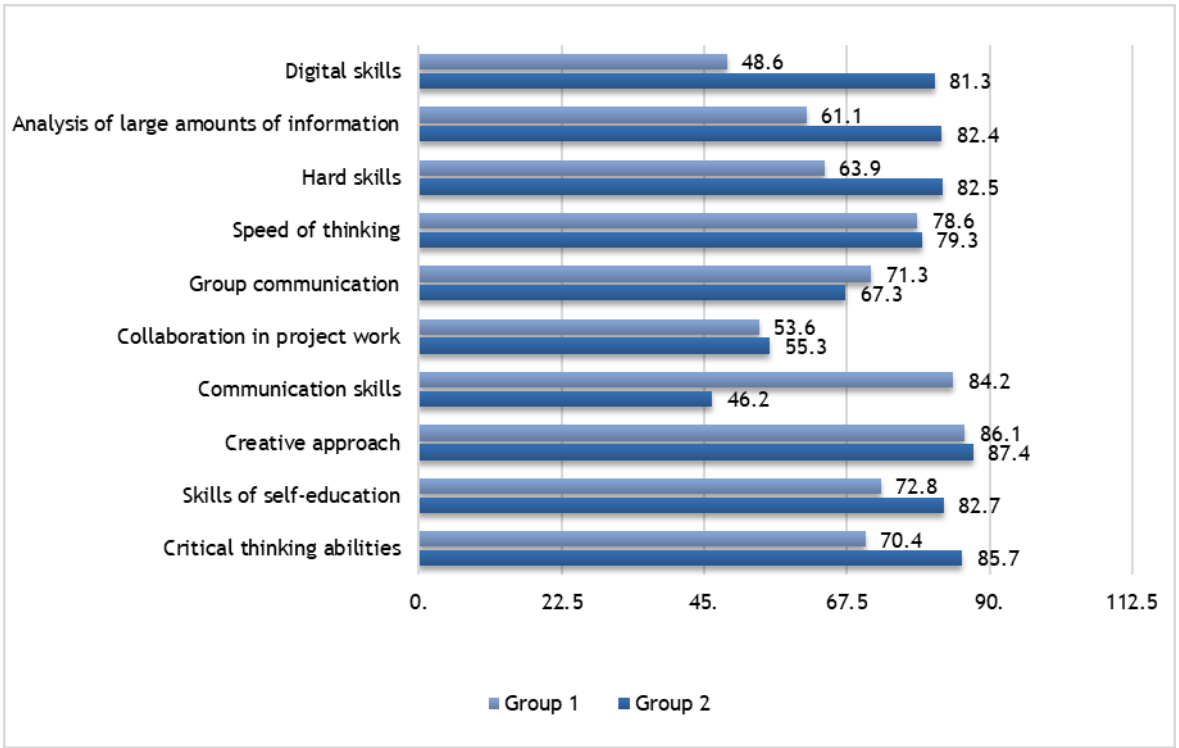

Figure 1. Results of the assessment of respondents' skills in the framework of traditional and innovative approaches

As shown in Figure 1, there is a significant gap between the results of the two groups. Group 2, which involved the use of digital technologies, demonstrates developed analytical thinking, independent knowledge

acquisition skills, and originality of thought. At the same time, the traditional approach in Group 1 demonstrates better development of communication skills and project management. The ability to interact in a team is virtually the same in both groups.

It is expedient to compare innovative and traditional approaches in the environment of modern educational institutions to determine the effectiveness of digital educational innovations. A one-sample t-test as an effective statistical method of analysis makes it possible to evaluate aspects of the impact of digital solutions on the skills of students by comparing the average values of sample data with theoretical or standard indicators (table 2).

Table 2. Statistical Determination of the Impact of Innovative Educational Technologies on the Quality of Research Competencies

One Sample T-Test					95 % CI for Mean Difference	
	t	df	p	Mean Difference	Lower	Upper
Group1			< ,001	85,700	80,303	∞
Critical thinking abilities	29,109	9	< ,001	82,700	72,468	∞
Skills of self-education	14,816	9	< ,001	87,400	82,016	∞
Creative approach	29,757	9	< ,001	46,200	37,980	∞
Communication skills	10,303	9	< ,001	55,300	41,607	∞
Collaboration in project work	7,403	9	< ,001	67,300	55,927	∞
Group communication	10,848	9	< ,001	79,300	69,079	∞
Speed of thinking	14,222	9	< ,001	82,500	73,914	∞
Hard skills	17,614	9	< ,001	82,400	72,965	∞
Analysis of large amounts of information	16,009	9	< ,001	81,300	72,944	∞
Digital skills	17,835	9	< ,001	85,700	80,303	∞
Group2						
Critical thinking abilities	12,444	9	< ,001	70,400	60,030	∞
Skills of self-education	10,609	9	< ,001	72,800	60,222	∞
Creative approach	36,791	9	< ,001	86,100	81,810	∞
Communication skills	38,273	9	< ,001	84,200	80,167	∞
Collaboration in project work	7,389	9	< ,001	53,600	40,302	∞
Group communication	10,887	9	< ,001	71,300	59,295	∞
Speed of thinking	24,187	9	< ,001	78,600	72,643	∞
Hard skills	9,639	9	< ,001	63,900	51,748	∞
Analysis of large amounts of information	7,765	9	< ,001	61,100	46,675	∞
Digital skills	7,308	9	< ,001	48,600	36,409	∞

Note: For the Student t-test, the sample mean difference d gives the location difference estimate.
For the Student t-test, the alternative hypothesis specifies that the mean is greater than 0.
Student's t-test.

According to the results presented in table 2, a comparative analysis of the skills of respondents from both groups demonstrates a statistically significant higher level in many skills of Group 2. In particular, in the context of developing analytical thinking ($t = 29,11$, $p < 0,001$), technical skills ($t = 17,61$, $p < 0,001$), and independent knowledge acquisition skills ($t = 14,82$, $p < 0,001$). At the same time, Group 2 respondents demonstrate significantly better results in communication skills ($t = 38,27$, $p < 0,001$).

Despite the identity of the scores of both groups in teamwork skills (Tgroup 1 = 7,4; Tgroup 2 = 7,39, $p < 0,001$) and project management (Tgroup 1 = 10,85; Tgroup 2 = 10,887, $p < 0,001$), the results of the t-test show higher scores in most skills in the group where digital educational methods were used. Thus, it can be argued that the initial hypothesis of the study is confirmed.

DISCUSSION

In the scientific field, there are controversial moments of discussion of the process of integrating modern educational technologies into the research sphere. In particular, Raja and Lakshmi Priya,[8] Balceraite et al.[13] analyze the potential of artificial intelligence for improving the process of scientific studies. The scientists emphasize the need to integrate such tools as online exams, immersive technologies, and educational targeted platforms. Researchers note that modern teaching staff is not fully prepared for the upgrade of the educational environment and needs proper methodological, technical, and informational support.

At the same time, Nurtanto et al.[14] link the effectiveness of innovative education to the possibility of introducing high-speed Internet connections. Bauman and Lucy[15] offer their own understanding of the

digitalization of the educational process: adaptability, feedback, openness to innovation, readiness for limited conditions.

Nikukar[5] highlights online lectures in an open format as particularly important among innovative digital solutions to improve the quality of scientific and research activities, which provide a favorable atmosphere for the development of scientific thought. By contrast, Rebukha and Lailmchuk[16] insist on the need to maintain a balance between theoretical and practical training in the educational process, in the process of partially replacing the traditional offline learning format with the virtual educational field.

In continuation, Sanabria,[17] Kilag et al.[18] update the methodology of interactive video lectures as a method of effective interaction between participants in the scientific and research activities with the advantage of being able to adapt to the pace of learning and the personal needs of each student. In addition, video lectures make it possible to choose the order of mastering the material, provide instant feedback, and enable the correction of one's own mistakes.

Finally, Greene et al.[19], Mae et al.[20] is convinced that virtual online laboratories allow students to practice equipment skills in an online environment, eliminating space and time constraints. At the same time, the variability of the formation of research scenarios and the availability of different levels of complexity make it possible to form sustainable competence skills. According to McKenna et al.[21], where special emphasis is placed on the level of development of responsibility for learning activities, adaptability and time management, motivation of students, comfort of the learning environment, methodology and level of motivation.

Based on the results of the present research and the main messages of the current scientific position on the feasibility of integrating digital educational tools, it can be argued that today the latter have a decisive influence on the development of competencies necessary for research activities.

CONCLUSIONS

Innovative educational technologies determine the dynamics of the modern research field. The priority is currently given to a personality-oriented approach and individualization of curricula. The research field is acquiring significantly new qualitative features due to interactive learning technologies that complement the dynamics of the learning environment and the development of discussions, while developing communication competence, teamwork skills and forming a favorable psychological foundation.

Digital technologies stimulate the development of analytical thinking and a number of "soft skills" that expand the ability to process a large amount of information, transform it in the research field, and form the latest scientific vision of established processes and phenomena. According to the results of the experiment, innovative digital educational solutions guarantee the creation of a solid foundation for high-quality research activities in the current conditions of social development.

The study revealed statistically significant differences that demonstrate the potential of digital educational technologies in creating a favorable environment for effective teaching and research activities. It has been proven that innovative teaching technologies stimulate the development of analytical thinking and a range of "soft skills," which makes it possible to expand the capabilities for analyzing large amounts of information and forming new scientific views of established processes and phenomena.

According to the results, a comparative analysis of the skills of respondents from both groups demonstrates a statistically significant higher level of development of analytical thinking, technical skills, and independent learning skills. Despite the identical results of both groups in teamwork and project management skills, the t-test results show higher scores for most skills in the group where digital learning methods were used. Thus, it can be concluded that the initial hypothesis of the study was confirmed.

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