# The impact of innovative technology on shaping digital design skills in primary school students: a case study of Kazakhstan

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**Article Info**

***Article history:***

Received Sep 10, 2024
Revised Mar 10, 2025
Accepted Apr 30, 2025

***Keywords:***

Digital design skills
Impact
Innovative technology
Primary school
Shaping

**ABSTRACT**

The trajectory of digital progress in Kazakhstan has highlighted several challenges within the primary education system. A critical component of developing digital design skills (DDS) lies in the impact of innovative educational technologies on these skills. Despite the potential of such technologies to enhance DDS and engage students in digital literacy, the existing literature falls short in exploring this area comprehensively. The study aims to examine students' DDS and examines how innovative educational learning technology affects these skills. This study used a quantitative research approach to measure innovative educational learning technology's impact on primary school students' DDS. The experiment involved 120 participants and uncovered several key insights. The deficiency in DDS and lack of motivation revealed by the study called for systematic changes in how digital literacy is taught. These changes included restructuring curricula, enhanced teacher training, access to digital resources, and more engaging, practical learning environments. The study demonstrated substantial improvements in students' DDS following the introduction and testing of the author's academic program with the experimental group (EG) participants. The findings from this study can serve as a foundation for developing strategies to enhance DDS in primary school and provide a methodological basis for adapting educational programs to support DDS development.



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## 1. INTRODUCTION

The vector of digital progress in in Kazakhstan has revealed several challenges facing the primary education system. Firstly, the digitization level of primary schools remains low, which is a critical aspect of the overall digitalization of education. Second, there are organizational and legal barriers in the educational environment hindering the digitalization process. Third, there is an important challenge in fostering effective collaboration between educators and learners in the context of educational digitalization [1], [2]. Modern students, being part of the new generation, have already developed digital thinking skills. In contrast, many teachers belong to the older generation, often referred to as the analog thinking generations, who have been compelled to adapt to the digital environment. This generational divide creates a conflict in education: globalization versus localization. Primary schools must navigate this conflict while developing educational programs that adhere to modern standards for training competitive specialists in the digital economy. A key competency to ensure such competitiveness is the ability to work proficiently with contemporary digital technologies [3].

Therefore, primary schools in Kazakhstan face the dual challenge of developing the necessary skills in students and creating educational technologies to facilitate this development. Given the priority of personal development for students, there is a need to personalize the learning trajectory. This necessitates a transformation of the learning process, breaking it into small components or modules, allowing students to independently choose a set of disciplines, or tracks, which enable them to develop specific skills. As the number and complexity of digital design skills (DDS) continue to grow, Kazakhstan needs structured approaches to assess current levels of these skills and plan for future needs. Consequently, DDS have become a prominent topic of discussion among international experts, leading think tanks, and at the governmental level in Kazakhstan [4], [5].

Primary schools in Kazakhstan have been implementing individualized learning trajectories for several years, allowing students to compile a comprehensive portfolio by the end of their studies. However, many primary school students are not adequately prepared to meet the demands of the digital age, lacking the necessary knowledge, competencies, and attitudes to use digital tools effectively and creatively. This presents a major challenge for the future of primary education and digital skills development, but also offers an excellent opportunity to rethink and redesign the curriculum, pedagogy, and assessment methods for DDS in primary schools. Moreover, primary schools need to provide opportunities for learners to develop and demonstrate their DDS through authentic and meaningful projects. These projects might include creating digital products, solving real-world problems, or participating in online communities and networks. There is also a need for more valid and reliable tools and methods for assessing the digital skills of primary school students, as most existing tools are designed for older students or adults and often have a narrower scope. To address these challenges, a comprehensive improvement of the educational environment is required. This includes changes at the macro-level, involving national policies and standards; the meso-level, addressing regional and institutional frameworks; and the micro-level, focusing on the specific practices within individual educational institutions [6].

While the literature extensively discusses the role of digital literacy in education, there is a lack of focused research on DDS in primary school students [7]–[9]. Most studies emphasize basic digital literacy but fail to explore how students can develop more creative and complex skills like design thinking, visualization, and digital content creation at an early age [10]–[12]. There is also a gap in understanding how innovative educational learning technologies contribute to shaping cognitive development through DDS. Theoretical frameworks often address the use of technology for general educational purposes but lack a specific focus on how tools such as interactive design software, digital storytelling platforms, or virtual reality can stimulate cognitive growth and creativity in young learners [13]–[15]. Despite the push for integrating technology into the classroom, few theoretical models explain how digital design technologies can be systematically integrated into the curriculum to enhance primary school students' cognitive competence [16], [17]. This leaves a gap in understanding how such integration can be optimized for skill development in early education. While global studies have examined the impact of educational technology in primary education, there is limited empirical research from countries like Kazakhstan, particularly on how these technologies affect the development of DDS in students. Given the country's ongoing educational reforms and efforts to modernize the system, this study fills a crucial gap by providing region-specific insights [18], [19]. Another empirical gap is the scarcity of studies that use a controlled experimental design to evaluate the direct impact of innovative technology on students' DDS [20], [21].

Many studies rely on observational or qualitative data, leaving a need for quantitative analysis that compares outcomes between students exposed to digital design technologies and those not [22], [23]. Additionally, there is little empirical data on whether the skills acquired through innovative technologies are retained over time. Most research focuses on short-term outcomes without addressing whether these skills lead to sustained cognitive improvements or continued use of digital design techniques as students' progress through their education [24], [25]. By addressing these theoretical and empirical gaps, the study not only contributes to the academic understanding of DDS and educational technology, but also offers practical insights into how early exposure to innovative tools can shape students' cognitive abilities and prepare them for future learning.

Therefore, the objective of this study is to examine students' DDS and examines how innovative educational learning technology affects these skills. The research hypothesis posits that the use of innovative educational learning technology will significantly improve students' DDS, serving as a crucial prerequisite for shaping overall cognitive competence. Thus, the research question (RQ) of the study is formulated as: Does innovative educational learning technology have a significant effect on shaping students' DDS?

## 2. LITERATURE REVIEW

One of the goals of digital design is to integrate digital knowledge into the educational process in order to develop effective educational technologies. According to previous studies [26], [27], teachers' understanding of digital concepts which reveal the principles of digital processes such as memory, emotion and contextual learning allows them to plan educational material presentations in a different order. However, research by Gottschalk and Weise [28] indicate that researchers are unable to definitively determine what the true "contribution" of digital to education is, whether or not digital science can be expected to identify effective teaching methods, how and under what circumstances the theory can be tested in children's classrooms and what the limitations of digital imaging methods in teaching in classroom contexts. Similarly, previous research [29]–[31] emphasize the importance of early involvement in exploratory processes for the development of DDS.

Research by Audrin *et al.* [32] claimed that the category "DDS" was defined after considering various approaches to defining the term "skill." Study by Selwyn *et al.* [33] compared "DDS" with categories such as "research behavior," "digital activity," and "educational and digital design activity." Several researches [34], [35] believe that integrating these categories with the following provisions is optimal. Human research, in its phenomenology, is based on research behavior, which is a fundamental need for children; search activity forms the foundation for both research behavior and digital design activity. Le [36] examined the characteristics of junior schoolchildren's DDS at three levels: adaptive, productive, and creative. However, Şengül and Türel [37] argue that attempts to classify the DDS of junior high school students often fail to consider their age-related characteristics and didactic capabilities. Despite recognizing the importance of DDS and sharing ideas about the concept of digital design activity development, many researchers have serious doubts about teachers' ability to achieve these goals.

The concept of stage-by-stage (planned) formation of mental actions is crucial in developing DDS, as it outlines in detail all the necessary stages for forming actions performed in educational research. Bearman *et al.* [38] found that DDS include individual knowledge, skills, and abilities, as well as the willingness to learn new methods and techniques based on the general formulation of digital design abilities. Assimilation and development of the toolkit for experimental activities occur when students experience a genuine need to use specific means to perform these activities. Al-Adwan *et al.* [39] posit that a student's digital design activity involves forecasting (building hypotheses), modeling, and implementing proposed actions, as well as correcting research behavior. Regardless of the organizational form or number of participants—whether individual, group, or conducted in front of the entire class—educational and digital design activities for school children demand substantial motivational, methodological, and organizational support from the teacher, with a lesser extent of information support.

According to Zamiri and Esmaeili [40], the specifics of innovative educational learning technology are best understood through its principles: free choice (allowing students to choose their direction, type of activity, and degree of participation in collective endeavors), objective uniqueness, interactions (fostering partnerships between participants in joint activities to develop strategies for achieving desired outcomes), and psychological comfort (empathic communication between adults and children, eliminating stress). Mhlongo *et al.* [41] found that innovative educational learning technology can enable learners to explore new modes of research action and methods of presenting research results, as well as help teachers build a cognitive trajectory for each child based on their personal experiences. This underscores the core of innovative educational learning technology for students.

In this regard, the strategy to instill DDS in primary school students is paramount in Kazakh education. The significance of this study lies in its conceptualization of DDS as essential for promoting collaboration, creativity, and critical thinking among students and teachers. Furthermore, many researchers claim that the introduction of innovative educational learning technology is a key determinant in the successful advancement of the educational system. This research contributes to the existing literature by examining the impact of innovative educational learning technology on the development of DDS among primary school students.

## 3. METHOD

### 3.1. Research design

This section provides a comprehensive overview of the research strategy, detailing the main stages, data collection methods, survey response selection criteria, and the resources required. The research design outlines the procedures for data collection and the overall approach to conducting the study. An experimental design was chosen as the most appropriate method for assessing the changes resulting from the experimental program. This design involved the creation of two study groups: an experimental group (EG) and a control group (CG). It was essential to ensure that these groups were similar in key characteristics (e.g., gender, age, place of residence, and prior training), except for the variable being studied (i.e., participation in the training program). The conclusions regarding the changes brought about by the program were drawn by comparing the survey results between the EG and CG. This study used a quantitative research approach to measure innovative educational learning technology's impact on primary school students' DDS. This approach provided a clear and measurable understanding of how technology integration in education influences DDS, helping to validate the research hypothesis.

### 3.2. Collection of research samples

The study was conducted at Secondary School No. 49 and Gymnasium No. 159 Y. Altynsarin, Almaty, Kazakhstan. To achieve the purpose of the experiment, two groups were determined through random sampling: one group served as the CG, and the other as the EG. In total, the experiment involved 120 respondents. This equal distribution is essential for maintaining balance and comparability between the two groups. Ensuring an equal age distribution helps control for age-related factors, making them consistent across the EG and CG. The EG consists of students from Secondary School No. 49, while the CG consists of students from Gymnasium No. 159 Y. Altynsarin. This distinction allows for the comparison of school-related factors that might affect the study's outcomes. All participants are fourth-grade students, ensuring a consistent educational level across both groups. This consistency is crucial for accurately comparing the effects of the educational interventions under study. Table 1 presents the descriptive information provided by the respondents.

Table 1. Descriptive information provided by the respondents

| Descriptive information about a respondent's | | Quantity | Sample (%) |
|---|---|---|---|
| Gender | Female | 64 | 100 |
| | Male | 56 | 100 |
| Age | 10-Sep | 120 | 100 |
| Classroom | 4th grade | 120 | 100 |
| EG | Secondary School no. 49 | 60 | 50 |
| | Male | 22 | 26 |
| | Female | 38 | 74 |
| CG | Gymnasium No. 159 Y. Altynsarin | 60 | 50 |
| | Male | 26 | 28 |
| | Female | 34 | 72 |

### 3.3. The procedure of the experiment

#### 3.3.1. Preparation phase

Teachers were encouraged to experiment with various digital tools and share their experiences and best practices with colleagues during peer-review sessions. This collaborative approach helped foster a supportive professional learning community, further enhancing the overall effectiveness of the training program. Additionally, teachers were given opportunities to receive ongoing support through online forums and one-on-one consultations with digital design experts. This ensured that they felt confident and well-equipped to incorporate these tools into their teaching practices effectively. Integrating digital design into teaching:

- Selection of schools: confirmed that Gymnasium No. 159 and Secondary School No. 49 would serve as the experimental sites.
- Training for teachers: conducted a training session for teachers on using digital design software and integrating it into their teaching.

The training program was implemented over two months, with sessions scheduled after school hours and on weekends to accommodate teachers' availability. This time frame allowed for comprehensive coverage of key topics, practical hands-on activities, and sustained support throughout the process. The training also included collaborative lesson planning sessions, where teachers created digital learning materials tailored to their subject areas. Continuous feedback was provided to ensure teachers developed confidence and competence in applying digital tools within real classroom settings.

#### 3.3.2. Baseline data collection

The integration of digital design tools into the curriculum allowed students to explore creative solutions to real-world problems, enhancing their critical thinking and problem-solving skills. As the project progressed, teachers observed a noticeable increase in student engagement and collaboration, as well as improved technical proficiency in using design software. Implementing digital design integration:

- Pre-study survey: prior to the commencement of the experimental study, both the EG (n=60) and the CG (n=60) were assessed for their digital skills. The primary goal of the initial diagnostic phase was to ensure that both the CG and EGs were balanced in all relevant indicators before the experiment began.
- Initial skill assessment: had students complete a simple digital design task to establish a baseline for their skills.

**3.3.3. Implementation phase**

Both groups have an equal number of participants, ensuring a balanced comparison. The duration is consistent for both groups, allowing observation within the same time frame. Both groups receive the same total amount of instructional time. EG receives dedicated time for digital design, while CG follows the regular curriculum. EG benefits from direct exposure to digital design tools, while CG does not. EG experiences progressive skill-building in digital design, while CG continues with traditional learning methods.

The lessons in the EG were tied to specific learning outcomes aimed at developing DDS progressively. Early sessions focused on basic tool usage, such as navigating the software interface and creating simple designs. Mid-program sessions introduced more complex design concepts, like layering, color theory, and spatial awareness (in the case of 3D design). Final sessions challenged students to complete independent projects, where they applied the skills learned in earlier sessions to create original digital designs. During each session, students engaged in guided digital design projects. These projects were structured to gradually build their skills, starting from basic tasks (e.g., creating simple shapes and layouts) and progressing to more complex designs (e.g., 3D modeling in Tinkercad or creating infographics in Canva).

The software included built-in tutorials that provided step-by-step instructions; ensuring students were able to follow along independently. The tutorials were age-appropriate, tailored to the skill level of primary school students. Students worked on tablets or laptops equipped with the necessary design software, ensuring that each student had access to a dedicated device during practice sessions. The students used user-friendly, educational software like Tinkercad for 3D modeling and Canva for graphic design. These applications were chosen for their intuitive interfaces and their ability to support the development of core DDS in a primary school setting.

**3.3.4. Description of experimental conditions**

Both groups consisted of 60 students and participated in 32 class hours; however, their exposure to digital design instruction differed. The EG engaged in two structured practice sessions per week, each lasting 45 minutes, where digital design projects were integrated into the curriculum. In contrast, the CG followed the standard curriculum without additional digital design sessions.

Technology integration played a key role in distinguishing the groups. The EG received structured lessons that progressively introduced various features of digital design software, providing a guided learning experience aimed at building students' proficiency over time. Conversely, the CG continued with standard lessons that did not focus on digital design, serving as a baseline for comparison. This structured intervention enabled an assessment of how digital design integration influenced students’ skills and learning outcomes.

**3.3.5. Monitoring and support**

Weekly check-ins: conducted brief weekly check-ins with teachers to discuss progress, challenges, and any adjustments needed. These meetings provided an opportunity to address any technical difficulties, ensure that the curriculum was being effectively implemented, and offer additional support where necessary. Teachers shared feedback on student engagement and skill development, allowing for timely modifications to instructional strategies. Additionally, these sessions fostered collaboration among educators, enabling them to exchange best practices and refine their teaching approaches throughout the intervention period.

**3.3.6. Post-implementation phase**

The follow-up survey and skill assessments allowed for a comprehensive evaluation of the impact of digital design tools on students' learning outcomes. By comparing pre- and post-study results, it was possible to measure the effectiveness of the integration in enhancing students' digital competencies and engagement. Additionally, feedback from both students and teachers helped identify areas for improvement and future training needs. Evaluating the outcomes of digital design integration:

- Post-study survey: administered a follow-up questionnaire to teachers and students to measure changes in students' familiarity and comfort with digital design tools.
- Final skill assessment: students in the EG completed a more complex digital design task to assess skill improvement.

### 3.4. Research instrument

To determine the initial level of DDS and the dynamics of their fostering, two separate structured questionnaires were created: one for students and one for teachers. The student questionnaire focused on self-assessed familiarity, confidence, and frequency of using digital design tools, while the teacher version assessed perceptions of student progress and classroom integration of these tools. Both instruments included a mix of closed and open-ended questions to allow for quantitative analysis and qualitative insights. The questionnaires were validated through expert review and piloted with a small sample to ensure clarity and reliability.

#### 3.4.1. Student questionnaire

The questionnaire aimed to capture not only students' technical abilities but also their attitudes toward the use of digital design in learning contexts. The data collected provided a comprehensive understanding of how digital tools influenced student participation, creativity, and overall engagement in the classroom.

- DDS: assessed students' self-reported proficiency in using digital design tools (e.g., drawing software, multimedia creation tools).
- Technology use: evaluated the frequency and types of technology used in the classroom.
- Engagement and motivation: measured students' interest and motivation in using digital design tools.

#### 3.4.2. Teacher questionnaire

The questionnaire aimed to identify gaps in teachers' readiness and confidence in using digital tools effectively in their classrooms. It also provided insights into the types of support teachers feel they need, whether through additional training, resources, or time for implementation.

- Technology integration: examined the extent and way innovative technologies are incorporated into the curriculum.
- Training and support: evaluated the availability and effectiveness of professional development programs aimed at integrating technology into teaching.

Both questionnaires employed Likert scales (e.g., 1=strongly disagree to 5=strongly agree) to quantify responses, facilitating statistical analysis.

### 3.5. Data analysis

The study compared the results of the pre- and post-study surveys and skill assessments using statistical methods to determine important changes in DDS. Techniques such as t-tests and analysis of variance (ANOVA) were employed to compare DDS and technology usage between different groups (EG vs. CG). Statistical data were processed using SPSS Statistics (version 26.0 for Windows).

## 4. RESULTS

Table 2 presents the results of the pre- and post-tests to measure changes in DDS. The study results clearly present that the integration of innovative technology had a significantly positive impact on DDS in EG. While CG also showed some improvement, it was much less significant compared to the EG. This suggests that the specific technology integration interventions used with the EG were effective in enhancing DDS. Table 3 presents the results of the ANOVA.

The ANOVA results demonstrate significant differences between EG and CG across all measured variables: i) EG students exhibited higher proficiency (DDS); ii) EG students used technology more frequently (technology usage); iii) EG students were more engaged and motivated (engagement and motivation). These study findings reveal that the integration of innovative technology has a positive impact on developing DDS, increasing technology usage, and improving student engagement and motivation. The results obtained prove that innovative educational learning technology has a significant impact on fostering learners' DDS, thereby confirming the hypothesis put forward.

Table 2. The mean scores and standard deviations for both pre-and post-tests

| Group | Test | Mean (M) | Standard deviation (SD) | Mean difference | t-value | p-value |
|---|---|---|---|---|---|---|
| EG | Pre-test | 2.5 | 0.6 | 1.7 | 15.30 | <0.001 |
| | Post-test | 4.2 | 0.5 | - | - | - |
| CG | Pre-test | 2.4 | 0.7 | 0.5 | 4.20 | <0.001 |
| | Post-test | 2.9 | 0.6 | - | - | - |

Table 3. The results of the ANOVA

| Variable | Group | Sum of squares (SS) | Degrees of freedom (df) | Mean square (MS) | F-value | p-value |
|---|---|---|---|---|---|---|
| DDS | Between groups | 15.75 | 1 | 15.75 | 27.92 | <0.001 |
| | Within groups | 66.30 | 118 | 0.5627 | | |
| | Total | 82.05 | 119 | - | | |
| Technology usage | Between groups | 19.23 | 1 | 19.23 | 35.62 | <0.001 |
| | Within groups | 63.70 | 118 | 0.5398 | | |
| | Total | 82.93 | 119 | - | | |
| Engagement and motivation | Between groups | 20.07 | 1 | 20.07 | 38.57 | <0.001 |
| | Within groups | 61.43 | 118 | 0.5206 | | |
| | Total | 81.50 | | 119 | | |

## 5. DISCUSSION

The findings of this study confirm the RQ that innovative educational learning technology improves students' DDS, which are essential for the development of their overall cognitive competence. Given these results, a targeted program was developed to foster DDS in junior school children. This program was implemented during class time for the participants in the EG as part of the initiative to cultivate their digital design capabilities [42].

The project method allowed participants to achieve didactic goals through detailed problem development, resulting in practical, real-world outcomes. Additionally, the didactic game method provided a psychologically comfortable and emotionally positive environment, enhancing the digital design activities for EG participants. This agrees with what was reported in earlier research [43].

Using the case method, research scenarios were crafted to allow experiment participants to identify the essence of a problem, propose potential solutions, and select the best options. These findings align with previous research [44], [45]. These methods were integrated into various forms of digital design activities for EG participants, such as lesson research, educational games, research projects, and conferences, all utilizing modern information and communication technologies. This flexible and differentiated approach was tailored to accommodate the unique research experiences of individual students. The students applied the skills they learned in educational activities, which was evident in the learning outcomes: i) proficiency in using personal computers as information sources; ii) quick adaptation to the process of searching for information on the internet; iii) adherence to safety rules and principles when working with network resources; and iv) positive dynamics in students' cognitive activity.

For DDS, the sum of squares (SS) between groups was 15.75, with an F-value of 27.92 and a p-value of <0.001, indicating a significant difference between the groups. Similarly, significant differences were observed for the use of technology ($F=35.62$, $p<0.001$) and engagement and motivation ($F=38.57$, $p<0.001$). These results confirm that the EG benefited significantly more from technology integration than CG.

Thus, the use of innovative educational learning technology has a significant positive effect on improving primary school students' DDS, as demonstrated by the EG superior performance in post-assessment tests compared to the CG. Furthermore, the development of these DDS is shown to be a crucial foundation for shaping students' overall cognitive competence, as the students exposed to technology displayed enhanced creativity, problem-solving abilities, and critical thinking skills, which are essential components of cognitive growth. This result validates the research hypothesis, highlighting the importance of integrating innovative technology into the classroom to foster both skill-specific and broader cognitive development in young learners.

### 5.1. Study limitations

Although the study includes 120 students from two schools in Almaty, Kazakhstan, the sample size may limit the generalizability of the findings to a broader population. Results may not be fully applicable to all primary schools in Kazakhstan, particularly rural or under-resourced areas that may not have access to the same technology. In addition, the study measures the impact of innovative educational technology on students' DDS over a relatively short period. This may limit the ability to assess long-term retention of the skills and the sustained impact of technology on cognitive competence beyond the experimental phase.

Despite efforts to balance the control and EGs through random sampling, external factors such as students' access to technology at home, prior exposure to digital tools, and socio-economic background could influence the development of DDS, potentially affecting the results. The study focuses on a specific set of DDS, which may not capture the full breadth of competencies required for success in today's digital world. As a result, the findings may only partially reflect how technology affects students' broader digital literacy or other creative abilities.

Furthermore, the success of innovative educational technology largely depends on how effectively it is implemented. Variations in teacher expertise in using digital tools and differences in the quality or availability of technology could introduce inconsistencies in the outcomes. Teacher training and technology support may also impact the results but were not the primary focus of this study. The tools used to assess DDS may have limitations in capturing all aspects of student progress, particularly in creative and cognitive areas. While quantitative data provides valuable insights, certain nuances in creativity and problem-solving might require complementary qualitative approaches. Lastly, the educational technology examined in the study may be designed with global standards in mind, but its integration into the specific cultural and curricular context of Kazakhstan could affect its efficacy. The study does not account for potential cultural biases in how DDS are taught or evaluated.

### 5.2. Recommendations for further research

This study provided novel insights into the use of innovative educational learning technology, highlighting its potential to foster students' DDS. While we thoroughly examined the effectiveness of integrating innovative technology into teaching strategies to train students in DDS, several gaps remain. Future research could address these gaps to further our understanding and refine our approach. We propose the following suggestions for future research:

- Future research could investigate the conditions that facilitate the development of DDS in young school children, both during class and in extracurricular activities.
- Additional methodological work is needed to enhance subject mastery by organizing young children's independent actions using heuristic cognitive methods.

## 6. CONCLUSION

The study examined students' DDS and how innovative educational learning technology affects these skills. The findings demonstrate significant advances in students' DDS following the introduction and testing of the author's academic program with EG participants. The study indicates that using innovative educational learning technology is an effective way to improve students' DDS. According to the study's findings, integrating innovative educational learning technology significantly enhances students' DDS, which are essential for shaping overall cognitive competence. The changes made to the innovative learning pedagogical system focused on the content, means, methods and forms of the training of the technological subsystem. The interaction allowed the student to interact both between the student and the educational material, as well as the interactive interaction of the students with each other. New forms of events were implemented (seminars and discussions on innovative technologies introduced into the educational process of mobile learning; organizing Internet conferences; mastering webinar tools for text, audio, and video communication; using presentation materials; holding master classes for innovative teachers in mobile learning systems). Therefore, the advantage of organizing the innovative educational learning technology process for students using a well-founded algorithm for the formation of DDS compared to traditional learning has been revealed, serving as a crucial prerequisite for shaping overall cognitive competence.


## FUNDING INFORMATION

This study received no specific financial support.


## AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration. All authors contributed equally to the conception and design of the study.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

## CONFLICT OF INTEREST

Authors state no conflict of interest.

## ETHICAL APPROVAL

The Ethical Committee of the Academic Council, Abai Kazakh National Pedagogical University, Kazakhstan has granted approval for this study 14 September 2023 (Ref. No. 3).

## DATA AVAILABILITY

The corresponding author may provide study data upon reasonable request.

## REFERENCES


[1] S. Nurgaliyeva, A. Bolatov, S. Abildina, S. Zeinolla, B. Kurbonova, and U. Kyyakbayeva, "COVID-19 online learning challenges: Kazakhstan secondary schools case study," *Frontiers in Education*, vol. 9, p. 1448594, 2024, doi: 10.3389/feduc.2024.1448594.

[2] S. Abildina, Z. Sarsekeyeva, A. Mukhametzhanova, K. Kopbalina, and S. Nurgaliyeva, "Enhancing reading literacy among elementary school learners in Kazakhstan: the application and effectiveness of modern teaching techniques," *Journal of Infrastructure, Policy and Development*, vol. 8, no. 8, p. 5905, 2024, doi: 10.24294/jipd.v8i8.5905.

[3] Z. Zhumash, S. Nurgaliyeva, A. Zhumabaeva, L. A. Lebedeva, G. Saduakas, and S. B. Zhoraeva, "Professional teaching competence in preservice primary school teachers: structure, criteria and levels," *World Journal on Educational Technology: Current Issues*, vol. 13, no. 2, pp. 261–271, May 2021, doi: 10.18844/wjet.v13i2.5699.

[4] S. Nurgaliyeva, Z. Iztleuova, S. Maigeldiyeva, Z. Zhussupova, G. Saduakas, and G. Omarova, "Examining the relationships between teachers' job satisfaction and technological competencies," *International Journal of Education in Mathematics, Science and Technology*, vol. 11, no. 4, pp. 898–912, Jun. 2023, doi: 10.46328/ijemst.3375.

[5] Y. Ospankulov, A. Zhumabayeva, and S. Nurgaliyeva, "The impact of folk games on primary school students," *Journal of Education and e-Learning Research*, vol. 10, no. 2, pp. 125–131, Feb. 2023, doi: 10.20448/jeelr.v10i2.4473.

[6] B. Nagima, N. Saniya, Y. Gulden, Z. Saule, S. Aisulu, and M. Nazigul, "Influence of special learning technology on the effectiveness of pedagogical ethics formation in future teachers," *Journal of Education and e-Learning Research*, vol. 10, no. 1, pp. 1–6, Nov. 2022, doi: 10.20448/jeelr.v10i1.4313.

[7] G. Falloon, "From digital literacy to digital competence: the teacher digital competency (TDC) framework," *Educational Technology Research and Development*, vol. 68, no. 5, pp. 2449–2472, Oct. 2020, doi: 10.1007/s11423-020-09767-4.

[8] F. Pettersson, "On the issues of digital competence in educational contexts–a review of literature," *Education and Information Technologies*, vol. 23, no. 3, pp. 1005–1021, May 2018, doi: 10.1007/s10639-017-9649-3.

[9] D. H. Suwarto, B. Setiawan, and S. Machmiyah, "Developing digital literacy practices in Yogyakarta elementary schools," *Electronic Journal of e-Learning*, vol. 20, no. 2, pp. pp101-111, Feb. 2022, doi: 10.34190/ejel.20.2.2602.

[10] K. Hutchison, L. Paatsch, and A. Cloonan, "Reshaping home–school connections in the digital age: challenges for teachers and parents," *E-Learning and Digital Media*, vol. 17, no. 2, pp. 167–182, Mar. 2020, doi: 10.1177/2042753019899527.

[11] H. Woodhouse, D. Passey, and J. Anderson, "Using digital technologies to build connections between families and schools as children transition to school," *Education Sciences*, vol. 14, no. 5, p. 520, May 2024, doi: 10.3390/educsci14050520.

[12] S. Delacruz, "Building digital literacy bridges: connecting cultures and promoting global citizenship in elementary classrooms through school-based virtual field trips," *TechTrends*, vol. 63, no. 4, pp. 428–439, Jul. 2019, doi: 10.1007/s11528-018-0350-1.

[13] M. Palioura and C. Dimoulas, "Digital storytelling in education: a transmedia integration approach for the non-developers," *Education Sciences*, vol. 12, no. 8, p. 559, Aug. 2022, doi: 10.3390/educsci12080559.

[14] M. A. Rojas-Sánchez, P. R. Palos-Sánchez, and J. A. Folgado-Fernández, "Systematic literature review and bibliometric analysis on virtual reality and education," *Education and Information Technologies*, vol. 28, no. 1, pp. 155–192, Jan. 2023, doi: 10.1007/s10639-022-11167-5.

[15] D. Hamilton, J. McKechnie, E. Edgerton, and C. Wilson, "Immersive virtual reality as a pedagogical tool in education: a systematic literature review of quantitative learning outcomes and experimental design," *Journal of Computers in Education*, vol. 8, no. 1, pp. 1–32, Mar. 2021, doi: 10.1007/s40692-020-00169-2.

[16] C. Wang, X. Chen, T. Yu, Y. Liu, and Y. Jing, "Education reform and change driven by digital technology: a bibliometric study from a global perspective," *Humanities and Social Sciences Communications*, vol. 11, no. 1, p. 256, Feb. 2024, doi: 10.1057/s41599-024-02717-y.

[17] J. Su and W. Yang, "A systematic review of integrating computational thinking in early childhood education," *Computers and Education Open*, vol. 4, p. 100122, Dec. 2023, doi: 10.1016/j.caeo.2023.100122.

[18] Y. Sarmurzin, N. Amanzhol, K. Toleubayeva, M. Zhunusova, and A. Amanova, "The impact of OECD research on the education system of Kazakhstan," *Asia Pacific Education Review*, vol. 22, no. 4, pp. 757–766, Dec. 2021, doi: 10.1007/s12564-021-09715-8.

[19] Z. Egeubayeva, A. Alzhanov, G. Akhmetova, and A. Serikkazy, "Optimization of the book management and automation system in school libraries in Kazakhstan," *E-Learning and Digital Media*, Jul. 2024, doi: 10.1177/20427530241270266.

[20] C. M. Färber, M. Lemos, and S. S. Yekta-Michael, "Effect of an endodontic e-learning application on students' performance during their first root canal treatment on real patients: a pilot study," *BMC Medical Education*, vol. 22, no. 1, p. 394, Dec. 2022, doi: 10.1186/s12909-022-03463-y.

[21] N. Jaftha, M. Zahra-Micallef, and T. Chircop, "The impact of gamified instruction on students' learning outcomes: systematic review of experimental studies," *International Journal of Education*, vol. 13, no. 4, pp. 55–85, Nov. 2021, doi: 10.5296/ije.v13i4.19193.

[22] C. Maher, M. Hadfield, M. Hutchings, and A. de Eyto, "Ensuring rigor in qualitative data analysis: a design research approach to coding combining NVivo with traditional material methods," *International Journal of Qualitative Methods*, vol. 17, no. 1, pp. 1–13, Dec. 2018, doi: 10.1177/1609406918786362.

[23] G. Rao *et al.*, "Methodological standards for meta-analyses and qualitative systematic reviews of cardiac prevention and treatment studies a scientific statement from the American Heart Association," *Circulation*, vol. 136, no. 10, pp. e172–e194, Sep. 2017, doi: 10.1161/CIR.0000000000000523.

[24] M. K. Afify, "Effect of interactive video length within e-learning environments on cognitive load, cognitive achievement and retention of learning," *Turkish Online Journal of Distance Education*, vol. 21, no. 4, pp. 68–89, Oct. 2020, doi: 10.17718/tojde.803360.

[25] L.-M. Putz, F. Hofbauer, and H. Treiblmaier, "Can gamification help to improve education? Findings from a longitudinal study," *Computers in Human Behavior*, vol. 110, p. 106392, Sep. 2020, doi: 10.1016/j.chb.2020.106392.

[26] M. Sailer, J. Murböck, and F. Fischer, "Digital learning in schools: what does it take beyond digital technology?" *Teaching and Teacher Education*, vol. 103, p. 103346, Jul. 2021, doi: 10.1016/j.tate.2021.103346.

[27] R. Schmid, C. Pauli, and D. Petko, "Examining the use of digital technology in schools with a school-wide approach to personalized learning," *Educational Technology Research and Development*, vol. 71, no. 2, pp. 367–390, Apr. 2023, doi: 10.1007/s11423-022-10167-z.

[28] F. Gottschalk and C. Weise, "Digital equity and inclusion in education: an overview of practice and policy in OECD countries," *OECD Education Working Papers*, No. 299, 2023, doi: 10.1787/7cb15030-en.

[29] Y. Li, M. Kim, and J. Palkar, "Using emerging technologies to promote creativity in education: a systematic review," *International Journal of Educational Research Open*, vol. 3, p. 100177, 2022, doi: 10.1016/j.ijedro.2022.100177.

[30] M. Carroll, S. Lindsey, M. Chaparro, and B. Winslow, "An applied model of learner engagement and strategies for increasing learner engagement in the modern educational environment," *Interactive Learning Environments*, vol. 29, no. 5, pp. 757–771, Jul. 2021, doi: 10.1080/10494820.2019.1636083.

[31] B. Thornhill-Miller *et al.*, "Creativity, critical thinking, communication, and collaboration: assessment, certification, and promotion of 21st century skills for the future of work and education," *Journal of Intelligence*, vol. 11, no. 3, p. 54, Mar. 2023, doi: 10.3390/jintelligence11030054.

[32] B. Audrin, C. Audrin, and X. Salamin, "Digital skills at work–conceptual development and empirical validation of a measurement scale," *Technological Forecasting and Social Change*, vol. 202, p. 123279, May 2024, doi: 10.1016/j.techfore.2024.123279.

[33] N. Selwyn, T. Hillman, A. B. Rensfeldt, and C. Perrotta, "Digital technologies and the automation of education—key questions and concerns," *Postdigital Science and Education*, vol. 5, no. 1, pp. 15–24, Jan. 2023, doi: 10.1007/s42438-021-00263-3.

[34] W. F. Crittenden, I. K. Biel, and W. A. Lovely, "Embracing digitalization: student learning and new technologies," *Journal of Marketing Education*, vol. 41, no. 1, pp. 5–14, Apr. 2019, doi: 10.1177/0273475318820895.

[35] Y. Li, D. Chen, and X. Deng, "The impact of digital educational games on student's motivation for learning: the mediating effect of learning engagement and the moderating effect of the digital environment," *PLOS ONE*, vol. 19, no. 1, p. e0294350, Jan. 2024, doi: 10.1371/journal.pone.0294350.

[36] S. Le, "Team-based learning in online education: the development of students' creative thinking skills in digital art," *Education and Information Technologies*, vol. 28, no. 11, pp. 14967–14986, Nov. 2023, doi: 10.1007/s10639-023-11808-3.

[37] M. Şengül and Y. K. Türel, "Teaching Turkish as a foreign language with interactive whiteboards: a case study of multilingual learners," *Technology, Knowledge and Learning*, vol. 24, no. 1, pp. 101–115, Mar. 2019, doi: 10.1007/s10758-017-9350-z.

[38] M. Bearman, J. H. Nieminen, and R. Ajjawi, "Designing assessment in a digital world: an organising framework," *Assessment & Evaluation in Higher Education*, vol. 48, no. 3, pp. 291–304, Apr. 2023, doi: 10.1080/02602938.2022.2069674.

[39] A. S. Al-Adwan, N. Li, A. Al-Adwan, G. A. Abbasi, N. A. Albelbisi, and A. Habibi, "Extending the technology acceptance model (TAM) to predict university students' intentions to use metaverse-based learning platforms," *Education and Information Technologies*, vol. 28, no. 11, pp. 15381–15413, Nov. 2023, doi: 10.1007/s10639-023-11816-3.

[40] M. Zamiri and A. Esmaeili, "Methods and technologies for supporting knowledge sharing within learning communities: a systematic literature review," *Administrative Sciences*, vol. 14, no. 1, p. 17, Jan. 2024, doi: 10.3390/admsci14010017.

[41] S. Mhlongo, K. Mbatha, B. Ramatsetse, and R. Dlamini, "Challenges, opportunities, and prospects of adopting and using smart digital technologies in learning environments: an iterative review," *Heliyon*, vol. 9, no. 6, p. e16348, Jun. 2023, doi: 10.1016/j.heliyon.2023.e16348.

[42] S. Dogan, N. A. Dogan, and I. Celik, "Teachers' skills to integrate technology in education: two path models explaining instructional and application software use," *Education and Information Technologies*, vol. 26, no. 1, pp. 1311–1332, Jan. 2021, doi: 10.1007/s10639-020-10310-4.

[43] J. M. Fernández-Batanero, M. Montenegro-Rueda, J. Fernández-Cerero, and I. García-Martínez, "Assistive technology for the inclusion of students with disabilities: a systematic review," *Educational Technology Research and Development*, vol. 70, no. 5, pp. 1911–1930, Oct. 2022, doi: 10.1007/s11423-022-10127-7.

[44] J. Batista, H. Santos, and R. P. Marques, "The use of ICT for communication between teachers and students in the context of higher education institutions," *Information*, vol. 12, no. 11, p. 479, Nov. 2021, doi: 10.3390/info12110479.

[45] A. Erkan, "Impact of using technology on teacher-student communication/interaction: improve students learning," *World Journal of Education*, vol. 9, no. 4, pp. 30–40, Jul. 2019, doi: 10.5430/wje.v9n4p30.


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