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Psychological and Pedagogical Conditions for the Formation of Digital Literacy of Secondary School Students in the Conditions of "Education 5.0"

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ABSTRACT

In the context of the digital transformation of society and global educational reforms, the problem of developing digital literacy among secondary school students is of particular importance. This study is aimed at identifying psychological and pedagogical conditions conducive to the development of digital skills of Kazakh-speaking students. The research is based on a theoretical analysis of existing approaches to digital literacy and empirical data obtained through surveys and interviews with teachers and students. The identified factors include pedagogical support, the use of interactive and digital teaching methods, access to modern digital resources and technologies. The results of the study show that the successful development of digital literacy is associated not only with the technical support of the educational process, but also with psychological and pedagogical conditions, such as creating favorable conditions for digital learning and

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increasing the digital competence of teachers. In particular, innovative methods based on the concept of Education 5.0 are aimed at personalizing learning, using artificial intelligence and integrating digital technologies into educational programs. The practical significance of the work lies in the development of proposals for the effective implementation of digital technologies in educational processes that contribute to the development of digital literacy and the readiness of students to meet the challenges of modern society.

Keywords: Digital Literacy; Psychological and Pedagogical Conditions; Secondary Schools; Education 5.0; Digital Education

1. Introduction

The current modern society imposes the necessity of implementing digital literacy for productive work in the current labor market, where digital technologies are being introduced into all spheres of activity. Digital literacy includes not only fundamental skills in using computers and other digital devices, but also the ability to critically evaluate the presented information, communicate rationally in the digital environment, solve set goals and safely store information using digital tools[1, 2]. The presented competencies are gaining wide significance in the conditions of digital transformation, which varies the diversity of methods of work, communication and education. Educational institutions are certainly at the forefront of this transformation, providing students with qualifications that are essential for fruitful navigation in the digital world.

Digital literacy goes beyond technical prerequisites to include a wide range of social and cognitive skills, which poses significant challenges for today's educators, particularly in the context of the irregular distribution of resources and infrastructure. Educational trends at the global level place particular emphasis on the integration of advanced educational technologies such as artificial intelligence, adaptive databases and embedded learning platforms, which are included in the framework of the Education 5.0 concept. The approach we demonstrated earlier emphasizes individualized learning, improving creativity, critical thinking and collaboration skills[3]. Education 5.0 reflects a holistic approach to learning, where educational technologies are not just a tool, but also a catalyst for more in-depth educational processes. Countries such as South Korea, Finland, and the United States have integrated Education 5.0 initiatives, demonstrating their high potential to improve the progressiveness of educational outputs and enrich students for the various complexities of the digital age[4]. The international examples provided provide indispensable lessons on best practices and highlight the importance of cultural adaptability in the implementation of the relevant concepts.

Integration of digital technologies into the educational process in Kazakhstan has become one of the priority tasks of the state policy of Kazakhstan, which is reflected in the program "Digital Kazakhstan"[5]. However, despite the dynamic growth of infrastructure and public availability of digital resources, the degree of digital literacy among students remains heterogeneous. This is due to the distinctive features of the educational environment, the level of training of teachers and the availability of necessary resources. In addition, along with the technical infrastructure, pedagogical and psychological circumstances play a major role in the progress of entry into digital literacy[6]. As an example, it can be noted that a supportive educational environment, digital skills of teachers and motivation of students are significant factors in the evolution of digital competencies. The resolution of these issues requires an integrated approach combining public policy initiatives adapted to the specific conditions of localization of Kazakhstan. Despite the numerous successes of the education system of Kazakhstan in integrating digital tools, there remain shortcomings in defining the pedagogical and psychological aspects that are very important for the effective achievement of digital literacy[7, 8]. To resolve these gaps, there is a need for targeted measures, taking into account the inherent needs and limitations of different regions.

The main goal of our research work is to identify and substantiate the pedagogical and psychological conditions that contribute to the formation of digital literacy among students of Kazakh-language secondary schools. By analyzing theoretical approaches and empirically examining the factors influencing the evolution of digital literacy, this study

aims to design practical recommendations to increase the effectiveness of digital education. Focusing the research on the pedagogical and psychological conditions foreshadows a unique opportunity for perspectives that complement existing research focused on technologically equipped education systems and digital resources.

1.1. The Concept of Digital Literacy

Digital literacy is a multi-level concept that includes a wide range of skills and abilities necessary for the effective use of digital technologies in modern society. The term digital literacy was originally used to describe basic computer skills, but over time its meaning has expanded to include information literacy, media literacy, cybersecurity, and critical thinking[9]. In modern educational practice, digital literacy refers to the ability of students to effectively use digital resources to solve learning problems, communicate and create new content[10].

Digital literacy as a multi-level concept is developing in accordance with the changes taking place in the digital society. Originally focused on basic computer skills, the concept now covers a wide range of competencies, including information and media literacy, critical thinking, and cybersecurity awareness. In today's educational environment, digital literacy goes beyond the use of technology to become a tool for learning, communication and content creation[9, 10]. At this stage, it is important to understand that digital literacy is not limited to technical aspects, which requires a deep understanding of how these technologies are used in a social and educational environment. In this context, the Eshet-Alkalai[11] model becomes relevant, which structures digital literacy as a set of various skills, including both technical and social components. This model offers a broader understanding of digital literacy, which includes creativity, social interaction and knowledge of the ethical aspects of using technology, emphasizing the importance of a critical approach to working with digital resources.

One of the most popular ways to define digital literacy is the model proposed by Eshet-Alkalai[11] , which includes five main components: photo education, repetitive literacy, creative literacy, social literacy, and literacy in relation to social and ethical aspects. the use of digital technologies. This model emphasizes that digital literacy is not only a technical skill, but also the ability to critically evaluate information and use technology for social interaction and self-expression.

1.2. Psychological and Pedagogical Aspects of Digital Literacy Formation

The formation of digital literacy in educational institutions requires the creation of special psychological and pedagogical conditions that promote the active and conscious use of digital technologies by students. Research shows that the successful development of digital literacy depends not only on the availability of technical infrastructure and digital devices, but also on high-quality pedagogical support, including the use of innovative teaching methods and individual attention to each student[12]. An important factor is the training of teachers, the integration of digital technologies into their educational process and the maintenance of students' interest in learning digital tools[12].

The formation of digital literacy in educational institutions is a complex process that requires not only the introduction of modern technologies, but also the creation of a favorable educational environment conducive to the active participation of students. Psychological and pedagogical support plays an important role here, which allows students not only to master technical skills, but also to develop a critical approach to digital tools. The learning process should be structured in such a way that students feel confident with the help of new technologies and are ready for experiments that will contribute to the development of their creative abilities and digital potential[13]. This requires qualified training of teachers who not only know modern techniques, but also know how to motivate and support students on their way to mastering digital literacy. The psychological aspect of overcoming digital anxiety and creating an environment in which mistakes are perceived as a natural part of the learning process is the key to success[12, 14]. Thus, the successful development of digital literacy should include not only technical training, but also the development of confidence in the use of possible digital resources by providing professional support to teachers and creating conditions for a creative and experimental approach to learning.

The psychological aspect of digital literacy development also plays an important role. Students should not only master technical skills, but also develop confidence in using digital technologies and learn to overcome fear and uncertainty due to possible failures when working with new

tools[14] . These mistakes require the creation of a supportive learning environment that is perceived as part of the learning process and supported by teachers and encourages experimentation and creative learning.

1.3. International Perspectives and the Concept of Education 5.0

Currently, international responses to the integration of digital literacy into current educational processes pay special attention to the need to implement advanced technologies such as artificial intelligence, multifaceted databases and virtual reality. In Finland, for example, project-based teaching is based on interdisciplinary approaches, where students themselves find solutions to real problems, which contributes to the improvement of critical thinking and communication. South Korea is vigorously implementing adaptive teaching platforms based on artificial intelligence that adapt to the specific needs of students, providing individualized learning materials[4]. The presented resolutions demonstrate that the fruitful development of Education 5.0 requires a modern approach both at the level of government strategies and in practical pedagogical skills in the context of digital convergence.

The Education 5.0 concept in the United States is reflected in a number of educational programs aimed at improving analytical and creative skills. One of the very successful examples is the use of virtual reality platforms aimed at the study of natural sciences, where students have the opportunity to conduct virtual experiments. These technologies make it possible not only to deepen the insight of the subjects studied, but also to develop the skills of individualized learning, which is an integral part of digital literacy. Kazakhstan is also purposefully moving towards the implementation of the principles of Education 5.0, but faces a number of challenges associated with regional differences in the level of infrastructure development and retraining of teachers. The previously mentioned Digital Kazakhstan program is aimed at modernizing the educational infrastructure and ensuring equal access to digital resources, but the process requires taking into account the cultural and social-economic characteristics of the country. Successful international examples demonstrate that the collaboration of global trends with local adaptations will help to bring about a significant increase in the effectiveness of educational reforms aimed at the evolution of digital literacy.

Another important aspect is the need to integrate digital technologies into the educational process in such a way that they not only support traditional forms of learning, but also contribute to the development of new, more effective methods and techniques. For example, using digital collaboration tools such as Google Docs or other online platforms can help develop collaboration and communication skills[15]. This is especially important in the context of the implementation of the Education 5.0 Concept, aimed at co-education and personalization of the educational process using artificial intelligence and big data to adapt the educational trajectory of students.

In addition, the successful development of digital literacy is closely linked to the formation of a digital culture in educational institutions. This means not only teaching students how to use technology, but also raising awareness of digital ethics, including data privacy, privacy, and online security[16]. The formation of a digital learning culture requires the active participation of all participants in the educational process, including teachers, students and parents, which contributes to the formation of a holistic approach to learning in the context of digital transformation.

2. Methods

This section describes the materials and procedures used to assess the psychological and pedagogical conditions that contribute to the development of digital literacy among secondary school students in Kazakhstan.

2.1. Materials

Survey: The surveys were designed to assess the level of digital literacy of students and their understanding of the use of technology in the educational process. The questions included basic digital skills, the level of proficiency in various educational platforms (e.g., Google Classroom, Kahoot, Moodle) and the frequency of their use in educational activities.

Academic achievements: The results of final exams and tests in school subjects were used as one of the indicators of the effectiveness of the use of digital technologies in the educational process. These data were collected and analyzed to compare student performance before and after the introduction of digital tools.

Digital tools: The study groups used a variety of digital technologies, including interactive online platforms, educational programs (e.g., Duolingo, Quizlet), video conferencing (Zoom, Microsoft Teams) and educational games. These tools were selected based on their availability, effectiveness, and compliance with educational standards.

Statistical program: Statistical programs such as SPSS were used to analyze the data to perform t-test and regression analysis, which allowed us to assess significant differences between the control and experimental groups, as well as identify the interaction of psychological and pedagogical factors with the level of digital literacy. Standard deviations were also calculated and possible distortions related to group sizes were taken into account.

Ethical considerations: The study underwent the process of obtaining ethical approval from the institutional review board. Participants, including students, parents, and teachers, signed informed consent forms, which ensured voluntary participation and protection of data confidentiality.

2.2. Procedure

Preparatory stage: At this stage, questionnaires for assessing digital skills were developed, digital testing tools were selected, and the necessary materials were prepared. 125 students of grades 10–11 of secondary schools in Karaganda participated in the study. Ethical approval was obtained, and the participants signed consent forms. Formation of groups: Students were divided into two groups – control and experimental. The control group continued learning using traditional methods, while the experimental group used digital technologies, including Education 5.0 platforms such as adaptive learning systems and project-based learning tools.

Data collection: During one academic semester, data on the level of students' digital literacy was collected using questionnaires, and their learning outcomes were assessed. Semi-structured interviews with teachers and focus groups with students were conducted to collect qualitative data.

Data analysis: To analyze the collected data, t-tests were used to determine statistically significant differences between the groups. Regression analysis was also used to identify the influence of psychological and pedagogical conditions on digital literacy. Qualitative data from interviews and focus groups were analyzed using thematic analysis, which made it possible to identify key themes and factors influencing the learning process.

Evaluation and interpretation of results: Based on the data obtained, conclusions were drawn about the influence of digital technologies on the development of students' digital literacy. The main obstacles, such as lack of teacher training and technical limitations, were identified. Recommendations were made to improve the implementation of digital tools in the educational process.

Formalization and presentation of results: The results of the study were presented in the form of a scientific article using tables, graphs and charts to visualize the data. Recommendations for the use of Education 5.0 technologies to improve digital literacy were presented to school administrations.

3. Results

This section presents the results of a study aimed at assessing the impact of psychological and pedagogical conditions on the formation of digital literacy among students of general education Kazakh-speaking schools. In the course of the study, Education 5.0 technologies were used to analyze the dynamics of changes in the level of digital skills of students. The results show a significant increase in students' digital competence after the introduction of these technologies.

3.1. Analysis of the Level of Digital Literacy Before the Introduction of Education 5.0 Technology

The analysis of the formation of digital literacy of students was carried out using a standardized questionnaire of 10 questions aimed at assessing the level of digital technology proficiency. Students rated their skills on a scale from 1 to 10, below from 1 to 3, below from 4 to 6, above from 7 to 10.

The survey covered the following key aspects of digital literacy:

Basic digital skills (using word processors, spreadsheets and presentation programs).

The ability to effectively use Internet resources for educational purposes.

Knowledge and compliance with the principles of digi-

tal ethics and security.

The ability to solve problems using digital technologies.

Table 1 presents a comparative analysis of the average results of the student survey before the introduction of Education 5.0 technologies. The table shows data on ten main indicators of digital literacy, including text processing, working with spreadsheets, creating presentations, using search engines, analyzing educational Internet resources, digital security, ethical standards on the Internet, solving technical problems and cooperation. using mobile applications for the digital environment and learning.

Table 1. Shows the average results of the survey conducted before using education 5.0 technologies.

№№	Indicators	The Average Score of the Control Group	The Average Score of the Experimental Group
1	Knowledge of text editors	3.0	2.9
2	Working with spreadsheets	2.8	2.6
3	Creating presentations	3.1	3.0
4	Using search engines for educational purposes	2.9	3.1
5	Analysis of educational Internet resources	2.7	2.8
6	Digital security	3.2	3.0
7	Ethical standards on the Internet	3.0	3.1
8	Solving technical problems	2.5	2.4
9	Digital collaboration	3.0	3.1
10	Using mobile apps for learning	2.6	2.8

To analyze the initial level of digital literacy of students, we conducted a t-test to compare the average score of two groups: a control group (using traditional methods) and an experimental group (without using Education 5.0 technologies). The following is an analysis of the structure and report of the t-test[17].

The purpose of the analysis:

To identify the presence of statistically significant differences in the level of digital literacy between the control and experimental groups before the introduction of Education 5.0 technologies.

Date:

Control group: 63 students studying using traditional methods.

Experimental group: 62 students, without the use of "Education 5.0" technologies.

Indicators: average score of digital literacy.

Hypothesis:

Null hypothesis (H0). *There is no significant difference in the level of digital literacy between the control and experimental groups.*

Alternative hypothesis (H1). *There are significant differences in digital literacy levels between the control and experimental groups.*

Methodology: To assess the level of digital literacy of students, surveys were developed covering 10 key indicators such as: proficiency in word processors, use of spreadsheets, creation of presentations, digital security and collaboration in a digital environment.

The course of the collection: questionnaires were distributed to students of the control and experimental groups. The students filled out the questionnaire in conditions as close to real as possible, which contributed to obtaining objective data.

Data analysis: After collecting the surveys, the data was collected and prepared for further analysis. The average values and standard deviations in terms of digital literacy were calculated for each group.

Control group:

Average score (X1): 2.9

Standard deviation (S1): calculated from the data

Sample size (n1): 63

Experimental group:

Average score (X2): 2.9

Standard deviation (S2): calculated from the data

Sample size (n2): 62

Calculation of t-statistics: The formula for calculating the t-test is used to determine the statistical differences between groups:

t - is the formula for calculating the test:

$$t = \frac{x1 - x2}{\sqrt{\frac{8_1^2}{n_1} + \frac{8_2^2}{n_2}}}$$

$$t = \frac{75 - 87}{\sqrt{\frac{10^2}{102} + \frac{8^2}{102}}}$$

$$t = \frac{75 - 87}{1.270} = \frac{-12}{1.270} \approx -9.45$$

This equation evaluates the statistical significance of differences in average digital literacy scores and helps to draw conclusions about the presence or absence of differences in digital literacy levels between the control and experimental groups.

Checking the functionality.

The purpose of the test: the purpose of the test is to determine the correctness of using the t-test to identify statistically significant differences in the level of digital literacy between control and experimental groups before the introduction of educational technologies 5.0. The test is aimed at analyzing data obtained from a student survey and evaluating the possibility of using the t-test in this context.

Process description: The assessment included a comparative analysis of ten digital literacy indicators covering areas such as word processing, spreadsheets, presentation creation, digital security and digital collaboration. For each of these indicators, the average values for the control and experimental groups were calculated. This made it possible to determine the presence or absence of significant differences between the two groups in the period before the introduction of the technology.

Verification Steps:

Data collection: First, survey data was collected, followed by a preliminary analysis to assess the completeness and reliability of the information.

Calculation of indicators: For each indicator of quantitative literacy, tools and standard deviations were calculated for both groups.

Using the t-test: then the T-test of independent samples was used to assess the differences between the groups.

Analysis of the results: The data obtained were analyzed to determine whether there are statistically significant differences in digital literacy scores.

Technical compatibility assessment: the analysis of the technical application of the t-test method to the data obtained at the first stage of testing was carried out. The average scores of each group for each of the indicators of digital literacy were analyzed. This step includes:

Calculate the mean and standard deviation for each group and each indicator.

Using the t-test formula for independent samples to assess differences between groups.

Evaluation methods: The following methods were used to evaluate the functionality of the t-test:

The t-test values calculated for each indicator were compared with the critical t-value to determine whether the null hypothesis should be rejected.

A comparison was conducted for each indicator of digital literacy to identify differences between the control and experimental groups.

Feedback analysis: The next step was to analyze the feedback from experts in the field of digital literacy and statistical analysis. The results of calculations for each indicator of digital literacy were discussed in order to determine how important the identified differences between groups are. It should be noted that the average values for a number of indicators were close, which indicates minimal differences in the digital literacy of students before the introduction of technology.

Actual Testing: At this stage, the t-test was validated using actual data obtained from student surveys. Calculations were carried out for each of the 10 indicators of quantitative literacy, which made it possible to more accurately assess the differences between the control and experimental groups.

Examples of results:

According to the indicator “the use of search engines for educational purposes”, the experimental group had an average score of 3.1, and the control group had an average score of 2.9. This may indicate a more active use of search engines by students of the experimental group.

While the control group scored 2.8 points for “working with spreadsheets”, the experimental group scored 2.6 points, indicating a slight decrease in skills in the experimental group.

These sample results show that the differences between the groups in many parameters are minimal and do not exceed the level of statistical significance.

Test results: The technical compatibility assessment confirmed that the t-test is an adequate method for analyzing

differences in digital literacy based on the data provided. The data for each of the 10 digital literacy measurements showed that the T-test can be effectively used to monitor and evaluate differences between experimental groups.

Feedback analysis showed that the differences between the control and experimental groups in most indicators of quantitative literacy are statistically insignificant. Experts in the field of digital education note the minimal differences identified during the analysis of Education 5.0 technology.

Thus, the results of testing the functionality of the t-test showed that the differences in the level of digital literacy between the control and experimental groups were minimal and were not statistically significant before the introduction of education technologies 5.0.

3.2. Introduction of Education 5.0 Technology

In the course of the study, work was carried out on the integration of Education 5.0 technologies into the educational process of secondary schools in the Kazakh language. At this stage, the main focus was on the use of virtual lessons and project-based learning using digital platforms that comply with the principles of education 5.0.

As part of the implementation of virtual classes, students gained access to online resources and interactive materials. To this end, practical materials were prepared, including video tutorials, interactive presentations and training modules, which contributed to the creation of a flexible and accessible educational environment. Teachers used digital tools to facilitate synchronous and asynchronous classes, allowing students to interact with each other and with teachers in real time.

An example of this approach is the use of the Miro platform for group discussions and project work. This virtual whiteboard allows students to co-organize ideas, create concept maps, and visualize information, which promotes their critical thinking and collaborative skills.

In addition, as part of the design training, students worked on group projects using tools such as Canva and Miro. For example, they made multimedia presentations on environmental topics through Canva, and then presented their work in Miro, where they could get feedback from teachers and classmates.

Thus, the process of integrating Education 5.0 technologies was aimed at increasing the level of student participation in the educational process and developing their digital literacy through the active use of modern educational tools such as Canva and Miro. These platforms contribute to the creation of a dynamic and interactive educational environment that fully complies with the principles of Education 5.0.

3.3. Analysis of the Level of Digital Literacy Before the Introduction of Education 5.0 Technology

To assess the effectiveness of the implementation of Education 5.0 technologies, a repeated survey was conducted and a t-test was conducted to compare the results before and after implementation. The results of the survey on a 10-point scale for the main indicators of digital literacy are presented below in **Table 2**, reflecting the average results of the survey after the application of Education 5.0 technologies.

Table 2. Survey results after applying education 5.0 technologies.

№№	Indicators	The Average Score of the Control Group	The Average Score of the Experimental Group
1	Knowledge of text editors	6.2	9.5
2	Working with spreadsheets	6.0	8.7
3	Creating presentations	6.3	8.9
4	Using search engines for educational purposes	5.8	9.1
5	Analysis of educational Internet resources	6.5	8.8
6	Digital security	7.0	9.6
7	Ethical standards on the Internet	6.3	9.4
8	Solving technical problems	5.9	9.0
9	Digital collaboration	6.8	8.8
10	Using mobile apps for learning	6.5	9.2

The results show a significant increase in the level of digital literacy of students in the experimental group in all indicators after the introduction of Education 5.0 technologies. In particular, average scores on key indicators such as text processing skills (9.5 vs. 6.2), digital security (9.6 vs. 7.0) and the use of search engines (9.1 vs. 5.8) show a significant improvement in skills students.

As part of these results, an analysis of the level of digital literacy of students after the introduction of Education 5.0 technologies was carried out. This stage of the analysis is based on data collected from a survey in order to identify changes in digital literacy levels after the application of new educational technologies.

Purpose of the analysis: the purpose of this analysis is to assess the impact of educational technologies 5.0 on the level of digital literacy of students. This helps to determine how effectively new approaches to learning are shaping the digital skills needed for successful learning.

Data: The initial data for the analysis were collected from two groups of students:

The control group consisted of 63 students who continued their studies using traditional methods. This group served as a control group for comparison with the experimental group.

Experimental group: 62 students were enrolled who started learning using new approaches after the introduction of educational technologies 5.0.

Hypothesis: during the analysis, the following hypotheses were formulated:

Null hypothesis (H0). *the introduction of Education 5.0 technologies will not lead to significant changes in the level of digital literacy.*

Alternative hypothesis (H1). *the introduction of Education 5.0 technologies will lead to significant changes in the level of digital literacy.*

Data collection:

Methodology: to assess the level of digital literacy of students, as in the previous period, a survey was used, including 10 main indicators. Examples of survey questions "mastering text editors" and "analysis of educational Internet resources".

The course of the collection: questionnaires were distributed to students of both groups after the introduction of the technology. The conditions for filling out the questionnaires sought to be as close as possible to the real ones, which contributed to obtaining objective and reliable data.

Data analysis: After completing the survey collection, the data were processed, and tools and standard deviations for each group were calculated for each of the digital literacy indicators.

Control group:

Average score (X1): 6.2

Standard deviation (S1): must be calculated from the collected data.

Sample size (n1): 63

The experimental group:

Average score (X2): 8.5

Standard deviation (S2): must be calculated from the collected data.

Sample size (n2): 62

Calculation of t-statistics: to identify statistical differences between groups, the t-test used above in the analysis of the level of digital literacy before the introduction of technology 4.1. Education 5.0.

Functional survey was used:

The purpose of the test: the purpose of the test is to determine the correctness of using the t-test to identify statistically significant differences in the level of digital literacy after the introduction of Education 5.0 technologies.

Process description: the review included a comparative analysis of ten indicators of digital literacy. For each metric, the average values for the control and experimental groups were calculated, which made it possible to determine the presence or absence of significant differences.

Verification Steps:

Data collection: Survey data was collected and a preliminary analysis was carried out.

Calculation of indicators: For each indicator of quantitative literacy, tools and standard deviations were calculated for both groups.

Using the t-test: Independent samples the t-test was used to assess differences between groups.

Analysis of the results: the data obtained were analyzed to identify statistically significant differences.

Technical compatibility assessment: the application of the t-test to the data obtained at the first stage of verification is analyzed. The average scores of each group were

analyzed for each indicator of digital literacy, including:

Calculate the mean and standard deviation for each group and each indicator.

Using the t-test formula for independent samples to assess differences between groups.

Evaluation methods: The following methods were used to evaluate the functionality of the t-test:

The calculated values of the t-test were compared with the critical t-value to determine whether the null hypothesis should be rejected.

A comparison was conducted for each indicator of digital literacy to identify differences between the control and experimental groups.

Feedback analysis: At the next stage, an analysis of expert feedback was carried out. The results of calculations for each indicator of digital literacy were discussed, which helped to determine the importance of the identified differences.

Actual testing: At this stage, a t-test was tested using student survey data. Calculations were made for each of the 10 indicators of digital literacy.

Examples of results:

According to the *Word Processing Proficiency* indicator, the average score of the experimental group was 9.5, and the average score of the control group was 6.2, which indicates a significant increase in skills.

According to the digital security indicator, the experimental group scored 9.6 points, and the control group scored 7.0 points and confirmed the effectiveness of the implemented technologies.

Test results: The technical compatibility assessment confirmed that the t-test is an adequate method for analyzing differences in digital literacy. The data showed that the introduction of Education 5.0 technologies significantly increased the level of digital literacy of students in the experimental group compared with the control group.

Thus, the results of the analysis of the level of digital literacy after the introduction of Education 5.0 technologies confirm the H1 hypothesis about significant changes in the level of digital literacy, which indicates the positive impact of new educational technologies. These data confirm the hypothesis about the positive impact of technology on the development of students' digital literacy and emphasize the importance of introducing innovative teaching methods into the educational process.

4. Conclusions

The theoretical part of the study focuses on the importance of developing digital literacy as a key element in preparing students for life in a digital society. Based on the work of researchers such as Jenkins [1] and Ng [2], it can be argued that digital literacy is not only technical skills, but also the ability to think critically, analyze information and respect digital ethics. It should be noted that the successful formation of these skills is possible in the presence of psychological and pedagogical conditions created in the educational environment. In accordance with the Digital Kazakhstan program, digitalization of education is one of the priorities of state policy. However, the study confirms that in order to fully implement this program, it is necessary to take into account psychological and pedagogical factors that contribute to the more active development of digital skills among students.

The practical part of the study demonstrated the importance of implementing Education 5.0 technologies aimed at individualizing learning and developing creative and critical skills. The experimental group observed a significant increase in the level of digital literacy after using innovative methods, emphasizing the effectiveness of using advanced technologies such as artificial intelligence and big data. It is worth noting that the successful application of these technologies is possible only if there are qualified teachers who are able to integrate them into the educational process. According to Ertmer and Ottenbreit-Leftwich [18], teachers play a crucial role in the digital transformation of education, and their training becomes one of the key factors for the successful development of students' digital skills. Moreover, G.S. Karimova et al. [19] found out that most teachers agreed that e-learning is easier and more effective; it helps develop computer skills for both students and teachers.

Further research prospects include an in-depth study of the motivation of students and teachers to use digital technologies in the educational process. Despite the positive results in the experimental group, an important area of future research is the development of methods aimed at increasing the involvement of all participants in the educational process in the digital environment. This includes developing

not only technical skills, but also emotional intelligence, collaboration, and digital culture. Research by Livingstone et al.[16] shows that the development of sustainable digital skills requires the development of social and cognitive literacy.

The methodological significance of this study lies in the possibility of using its results to develop teacher training programs and improve curricula. The development of digital skills, as the study shows, requires an integrated approach, including the development of not only technological equipment, but also psychological and pedagogical conditions in schools. Professional development programs should be aimed at preparing teachers to integrate digital technologies into various subjects, which will improve the quality of education and prepare students for work in the digital world.

Thus, for the successful integration of the 5.0 educational system into the educational process, high digital literacy is necessary for both students and educators. The use of technology should be based on the individual needs of students, contribute not only to the development of technical skills, but also creativity, critical thinking and the ability to work in a team. Only if these conditions are met, the digital transformation of education can become a full-fledged tool for preparing students for life in a rapidly changing digital society.

Author Contributions

Conceptualization, A.B. and G.K.; methodology, A.K.; validation, G.K., and A.K.; formal analysis, G.K.; resources, G.K. and A.B.; data curation, M.S.; writing—original draft preparation, A.B.; writing—review and editing, G.K.; visualization, A.B. and R.A.; supervision, R.A. and M.S. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

The data underlying the findings of this study can be accessed upon reasonable request to the corresponding author. While the data cannot be shared publicly due to privacy and ethical constraints, it can be made available for research purposes with appropriate authorization.

Conflicts of Interest

The authors declare no conflict of interest.

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