

Designing Software-Didactic Resources for Developing Digital Literacy of Higher Education Students

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Abstract: In conditions where digital technologies are deeply penetrating all spheres of society, new pedagogical tasks are emerging before the higher education system. The modern education system requires the formation not only of students' theoretical knowledge but also of their digital competencies. The main purpose of this research is to design a software-didactic platform aimed at developing the digital literacy of students in higher education institutions and to develop its technical and pedagogical architecture. During the research process, methods such as system analysis, pedagogical modeling, software system design, and educational process design were used. As a result, a conceptual model of a multilayer software platform intended for use in a digital learning environment was developed. The platform consists of a user interface, authentication system, database, didactic content module, and analytical monitoring system. The research results showed that scientifically developed software platforms contribute to the development of students' digital literacy, the formation of their independent learning skills, and the improvement of the efficiency of the educational process.

Keywords: Digital literacy, digital learning environment, software-didactic platform, educational technology, higher education, digital competence.

Introduction: With the development of information technologies, digital competencies are becoming increasingly important in modern society. The process of digital transformation is fundamentally changing many sectors, including the economy, industry, education, and others. Therefore, modern specialists must possess not only traditional knowledge but also digital literacy skills. Higher education institutions are considered one of the important institutions that support the process of digital transformation in society. By developing students' digital literacy, it is possible to increase their competitiveness in the modern labor market.

Digital literacy includes the skills of searching for information, evaluating it, processing it, and effectively applying it using digital tools.[1] In recent years, numerous studies have been conducted aimed at developing the digital learning environment. These studies emphasize that the use of information and communication technologies in the educational process activates students' learning activities and

improves the quality of education. However, in many higher education institutions, digital educational resources are not organized in a sufficiently systematic manner.

The relevance of this research is determined by the necessity of scientifically designing software-didactic platforms aimed at developing students' digital literacy in higher education institutions.

LITERATURE REVIEW

The rapid development of digital technologies has significantly transformed educational systems around the world, making digital literacy one of the most essential competencies required for students in the 21st century. Digital literacy is widely recognized as a multidimensional concept that includes not only technical skills but also cognitive, critical, and social abilities required for effective participation in digital environments. According to Martin (2006), digital literacy refers to the awareness, attitude, and ability of individuals to appropriately use digital tools to identify, access, manage, integrate, evaluate, and synthesize

digital resources. [4] This perspective highlights the complexity of digital competence in contemporary educational contexts.

Early studies on digital literacy focused primarily on technological skills. For example, Eshet-Alkalai (2004) conceptualized digital literacy as a set of survival skills in the digital era, including photo-visual literacy, reproduction literacy, information literacy, and socio-emotional literacy. [2] Later studies expanded this concept by emphasizing critical thinking and problem-solving abilities in digital environments. Lankshear and Knobel (2008) argued that digital literacy should be understood as a social practice that emerges within digital cultures and collaborative knowledge-building environments. [3]

The development of a digital learning environment has become one of the important scientific directions in the field of education in recent years. Digital technologies make it possible to modernize the educational process and improve the effectiveness of education.

Many researchers have studied the pedagogical aspects of integrating digital technologies into the educational process. For example, studies conducted by Adrian Kirkwood and Linda Price have shown that the use of technologies in higher education contributes to the development of students' reflective thinking. [5]

In addition, the issue of forming digital competencies has been widely studied in international research. Digital literacy develops students' skills in working with information, solving problems, and carrying out innovative activities.

Research conducted in the field of software system design also serves as an important methodological basis for creating educational platforms. The structural modeling approach developed by Michael A. Jackson proposes considering software systems as models of real processes. [6]

In studies devoted to the design of educational systems, pedagogical design occupies an important place. Irina A. Kolesnikova, who studied the process of organizing educational projects, emphasizes that the design of the educational process consists of several stages. [7]

These scientific views indicate the necessity of integrating pedagogical and technological components when developing digital educational platforms.

In the scientific work titled "The Role of Information Technologies in the Educational Process and Their Effectiveness," Uzbek researchers U. Yuldoshev and Sh. Karimov analyzed the influence of information technologies on the teaching process from both empirical and theoretical perspectives. According to

the authors' conclusions, the use of software tools in education develops students' competencies in independent thinking, problem analysis, and decision-making, and also contributes to deeper learning of knowledge. [8] The study also presents practical recommendations for integrating digital educational resources into the educational process, which are considered relevant for application in higher education institutions.

METHODS

This study employed a mixed-method research design combining both quantitative and qualitative approaches to investigate the development of students' digital literacy in higher education institutions through software-didactic resources. The mixed-method approach was selected because it allows for a more comprehensive understanding of complex educational phenomena by integrating statistical analysis with contextual interpretation of educational practices.

The research followed a sequential explanatory design consisting of two main phases. In the first phase, quantitative data were collected to measure the level of students' digital literacy and their interaction with digital learning tools. In the second phase, qualitative methods were applied to interpret the results and identify the pedagogical and technological factors influencing digital literacy development. The study was conducted in several higher education institutions where digital learning technologies are actively integrated into the educational process. The research focused on undergraduate students who regularly use digital learning platforms as part of their academic activities.

The participants of the study included undergraduate students from different academic disciplines. A stratified sampling method was applied to ensure representation of students with varying levels of digital competence and academic backgrounds. In total, more than 200 students participated in the survey stage of the research, while a smaller group of students and instructors participated in semi-structured interviews. The inclusion of participants from diverse academic programs allowed the study to examine how digital literacy development may vary across disciplines and learning environments

The following scientific methods were used during the research process:

- ✓ system analysis;
- ✓ pedagogical modeling;
- ✓ software system design;

✓ educational process design.

The research was carried out in three stages:

- ✓ theoretical analysis stage;
- ✓ model development stage;
- ✓ platform architecture design stage.

Based on these methods, a conceptual model of a software platform aimed at developing students' digital literacy was developed.

System Architecture of the Platform.

The platform was developed based on a multilayer architecture. This architecture ensures the flexibility, scalability, and security of the system. (Fig.1)

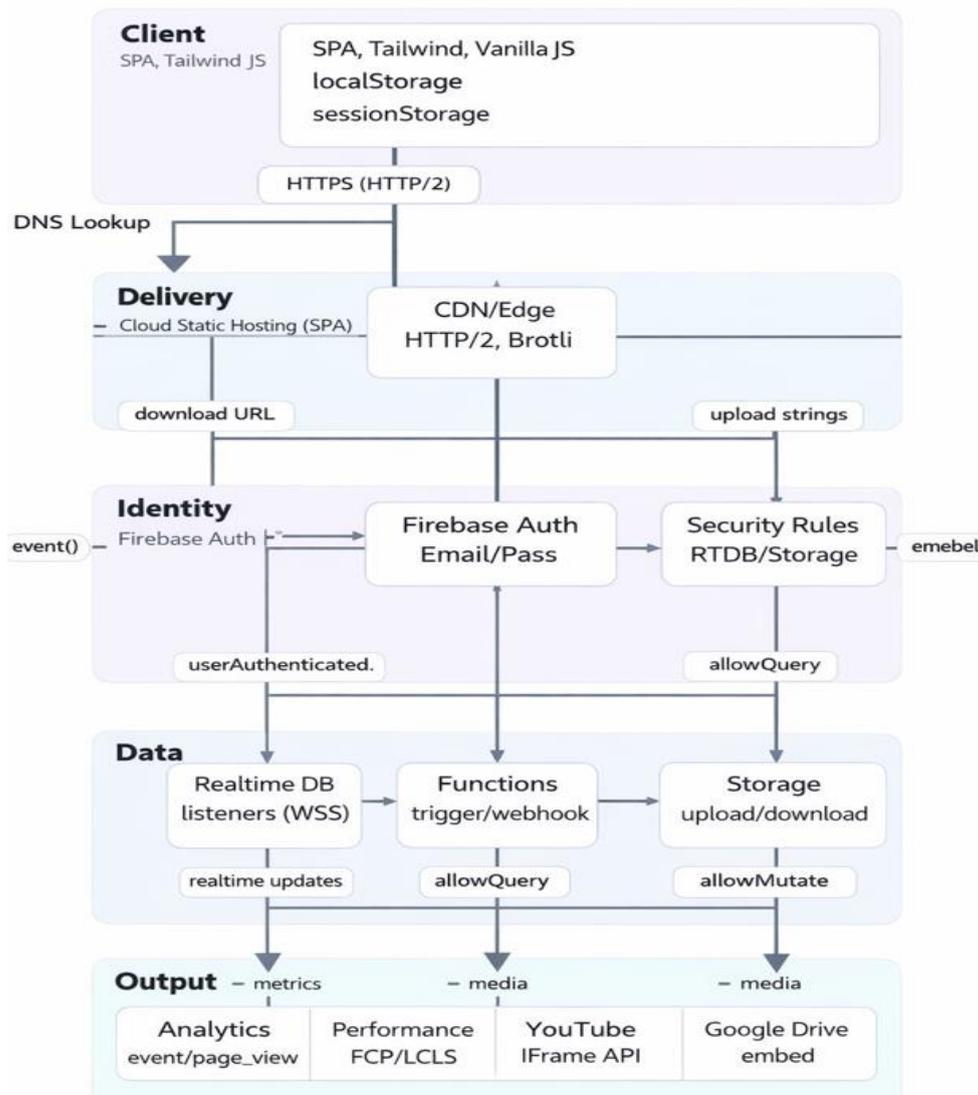


Figure 1. Simplified technical architecture of the platform.

The platform consists of the following layers:

Client Layer – the user interface was developed based on SPA technology.

Delivery Layer – CDN technology is used to ensure fast content delivery.

Identity Layer – Firebase Authentication is used for user authentication.

Data Layer – Realtime Database and Cloud Functions services are used for storing and processing data.

Output Layer – the analytical system enables monitoring of users' activities.

RESULTS

As a result of the research, a conceptual model of a platform aimed at developing students' digital literacy was developed.

The platform provides the following capabilities:

- ✓ interactive educational materials;
- ✓ online testing system;
- ✓ digital competence assessment;
- ✓ monitoring of user activities.

There are three main users in the platform: administrator, teacher, and student. Access rights in the system are managed based on the Role-Based Access Control model.

DISCUSSION

The results of this study demonstrate that the development of students' digital literacy in higher education institutions is strongly influenced by the integration of software-based didactic resources within the digital learning environment. The empirical findings indicate that students who actively engage with digital learning platforms, educational software tools, and collaborative online environments demonstrate significantly higher levels of digital competence compared to students who rely primarily on traditional learning methods. These findings confirm that digital literacy development is not solely dependent on access to technology but rather on the pedagogical design and systematic use of digital educational resources.

The obtained results are consistent with previous research emphasizing the importance of digital learning environments in developing digital competence. For example, earlier studies have shown that students' digital literacy significantly improves when digital technologies are integrated into teaching and learning processes through structured pedagogical approaches. The findings of this research align with studies that highlight the relationship between technology-enhanced learning environments and students' digital competence development. In particular, the results support the argument that digital competence is a multidimensional construct that requires the integration of technological, cognitive, and social skills.

In addition, the cluster analysis conducted in this study revealed three main groups of students according to their digital literacy levels: high, medium, and low competence groups. Students in the high-competence cluster demonstrated strong abilities in information search, digital communication, and digital content creation. In contrast, students in the low-competence group experienced difficulties in evaluating digital information and solving problems in digital environments. These findings confirm previous studies suggesting that although many students are frequent users of digital technologies, they do not necessarily possess advanced digital literacy skills. Another important finding of this study is related to the role of software architecture and instructional design in supporting digital literacy development. The research shows that well-structured digital platforms that integrate educational content, assessment tools, and collaborative learning environments significantly contribute to improving students' digital competence. This observation supports the theoretical perspective that digital learning systems should be designed as integrated educational ecosystems rather than isolated technological tools.

From a theoretical perspective, the findings of this study contribute to the existing literature by integrating pedagogical models of digital literacy development with software system design principles. While many previous studies have focused either on digital pedagogy or on technological infrastructure, this research demonstrates the importance of combining these two perspectives within a unified framework. The proposed conceptual approach provides a foundation for understanding how software-didactic resources can systematically support the development of digital literacy in higher education institutions.

The practical implications of this study are also significant for educational policy makers, university administrators, and instructors. The results suggest that universities should focus not only on providing access to digital technologies but also on developing structured digital learning environments that actively promote digital competence development. Educational software platforms should include features that support collaborative learning, digital content creation, and critical information evaluation. Furthermore, instructors should receive professional development training that enables them to effectively integrate digital technologies into their teaching practices.

Despite the contributions of this study, several limitations should be acknowledged. First, the research was conducted within a limited number of higher education institutions, which may affect the generalizability of the results. Second, the study primarily relied on self-reported data from students, which may introduce potential bias in measuring digital competence levels.

Future research should address these limitations by expanding the study to a larger number of universities and by incorporating additional objective assessment methods for measuring digital literacy. Longitudinal studies could also provide deeper insights into how students' digital competence evolves over time within digital learning environments. Moreover, future studies may explore the potential of emerging technologies such as artificial intelligence, learning analytics, and adaptive learning systems in supporting digital literacy development.

CONCLUSION

This study examined the development of students' digital literacy in higher education institutions through the integration of software-based didactic resources within a digital learning environment. The results demonstrate that the systematic use of digital educational platforms, interactive software tools, and collaborative learning technologies significantly contributes to improving students' digital competence.

The findings indicate that digital literacy development is most effective when technological infrastructure is combined with pedagogically structured learning activities that encourage information analysis, digital content creation, communication, and problem-solving in digital environments.

One of the key findings of the research is that students' digital literacy levels vary considerably, forming three distinct competence groups: high, medium, and low levels of digital proficiency. Students with higher digital competence actively engage with digital learning tools, demonstrate stronger abilities in evaluating digital information, and show greater independence in solving academic tasks using digital resources. These results highlight the importance of designing structured digital learning ecosystems that support the gradual development of digital competencies among students. The scientific contribution of this study lies in the integration of pedagogical principles of digital literacy development with software system design approaches. While previous studies often examined digital competence primarily from either educational or technological perspectives, this research proposes a more integrated approach by emphasizing the role of software-didactic resources as a bridge between pedagogy and digital technology. The proposed conceptual approach expands the theoretical understanding of how digital learning environments can systematically support the development of digital literacy in higher education.

From a practical perspective, the results of the study provide important implications for universities, educators, and educational technology developers. Higher education institutions should focus not only on providing access to digital technologies but also on developing well-structured digital learning environments that actively promote digital competence development. Educational platforms should include features that support collaborative learning, digital creativity, critical evaluation of information, and personalized learning pathways. Additionally, professional development programs for instructors are necessary to enhance their ability to effectively integrate digital technologies into the teaching process.

Despite its contributions, this study has several limitations. The research was conducted within a limited number of higher education institutions, which may restrict the generalizability of the findings. In addition, the study relied primarily on survey-based data and self-reported assessments of digital competence, which may introduce subjective bias. Future research should consider larger and more diverse samples and employ objective performance-

based measures to assess digital literacy levels more accurately. Future studies may also explore the impact of emerging technologies such as artificial intelligence, learning analytics, and adaptive learning systems on the development of students' digital competence. Longitudinal research designs could provide deeper insights into how digital literacy evolves throughout students' academic careers within digital learning environments. In conclusion, the development of students' digital literacy in higher education requires a comprehensive and systematic approach that integrates pedagogical innovation with advanced digital technologies. The effective design and implementation of software-based didactic resources can significantly enhance students' ability to navigate, analyze, and create information in digital environments, thereby preparing them for successful participation in the modern digital society and knowledge-based economy.

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