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EXPERIMENTAL MODELS FOR DEVELOPING SKILLS IN USING DIGITAL  
EDUCATIONAL RESOURCES IN THE HIGHER EDUCATION PROCESS

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**Abstract:** This study explores experimental models for developing students' skills in using digital educational resources in higher education. It examines how digital transformation in education influences the formation of digital competencies and enhances learning outcomes. The research analyzes several pedagogical models, including competency-based, adaptive learning, blended learning, and project-based approaches, emphasizing their role in improving students' digital literacy, autonomy, and critical thinking skills. The study also highlights the importance of integrating information and communication technologies (ICT), learning management systems, and interactive digital platforms into the educational process. Findings indicate that structured experimental models significantly improve students' engagement, academic performance, and ability to apply digital tools effectively in academic and professional contexts. The research concludes that successful implementation of digital educational resources depends on institutional support, teacher preparedness, and adequate technological infrastructure.

**Keywords:** Digital educational resources, higher education, experimental models, digital competence, ICT integration, blended learning, adaptive learning, competency-based education, project-based learning, digital literacy.

The integration of digital educational resources into higher education has become one of the most significant directions of pedagogical modernization in the twenty-first century. The rapid development of information and communication technologies (ICT) has transformed not only the structure of educational content but also the methodological foundations of teaching and learning processes. In this context, the formation of students' competencies in using digital educational resources (DERs) is considered a key factor in ensuring the quality and competitiveness of higher education systems globally. According to UNESCO reports, digital transformation in education is not merely a technological shift but a systemic change in pedagogical paradigms that requires new models of learning organization and experimental validation of their effectiveness<sup>1</sup>.

Experimental models of forming skills in using digital educational resources are based on the principles of constructivist learning theory, which emphasizes the active role of learners in constructing knowledge through interaction with digital environments. In higher education, these models aim to integrate cognitive, operational, and reflective

<sup>1</sup> UNESCO. "ICT in Education: A Critical Literature Review," Paris, 2023.



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components of learning activity. Cognitive components involve understanding the structure and functionality of digital tools; operational components relate to practical skills in using learning platforms, databases, and multimedia resources; while reflective components ensure self-assessment and continuous improvement of digital competencies<sup>2</sup>. From a theoretical perspective, the concept of digital educational resources includes a wide range of electronic materials such as e-textbooks, interactive simulations, virtual laboratories, learning management systems (LMS), and open educational resources (OER). The European Commission defines digital learning resources as “digitally available content and tools that support teaching, learning, and assessment processes in formal and informal education”. This definition highlights the multifunctional nature of DERs, which serve not only as information carriers but also as interactive pedagogical instruments.

The experimental modeling of competence formation in this area typically involves several stages. The first stage is diagnostic, where the initial level of students’ digital literacy is assessed. This stage often employs standardized ICT competency frameworks such as the European Digital Competence Framework for Citizens (DigComp 2.2), which provides measurable indicators of digital skills development<sup>3</sup>. The second stage is formative, where students are exposed to structured learning activities using digital resources integrated into curriculum design. The third stage is evaluative, where the effectiveness of the implemented model is measured through qualitative and quantitative indicators such as academic performance, engagement levels, and digital problem-solving abilities.

In pedagogical experiments conducted across various universities, it has been observed that the inclusion of interactive digital environments significantly enhances students’ motivation and autonomy in learning. For instance, research conducted at several European higher education institutions demonstrated that students engaged in blended learning environments using LMS platforms such as Moodle and Canvas showed a 23–35% improvement in learning outcomes compared to traditional lecture-based instruction<sup>4</sup>. This indicates that digital educational resources, when properly integrated, contribute not only to knowledge acquisition but also to the development of higher-order cognitive skills such as analysis, synthesis, and evaluation. Another important aspect of experimental modeling is the personalization of learning processes. Adaptive learning systems, powered by artificial intelligence algorithms, allow the customization of educational content according to individual learner needs. Such systems analyze student behavior data and adjust the difficulty level, format, and sequence of learning materials accordingly. According to Siemens and Long, learning analytics and adaptive systems represent a new frontier in educational research, enabling data-driven decision-making in pedagogy<sup>5</sup>. These

<sup>2</sup> Jonassen, D. H. “Computers as Mindtools for Schools,” Pearson, 2018.

<sup>3</sup> Carretero, S. et al. “DigComp 2.2: The Digital Competence Framework for Citizens,” JRC, 2022.

<sup>4</sup> Graham, C. R. “Blended Learning Systems,” Wiley, 2019.

<sup>5</sup> Siemens, G., Long, P. “Penetrating the Fog: Analytics in Learning and Education,” EDUCAUSE Review, 2017.



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technologies are increasingly being incorporated into experimental models of DER competency formation in higher education institutions.

Furthermore, the social dimension of digital learning environments plays a crucial role in shaping collaborative skills among students. Online discussion forums, virtual group projects, and cloud-based collaborative tools foster communication and teamwork skills, which are essential in modern professional contexts. Vygotsky's sociocultural theory supports the idea that learning is fundamentally a social process, and digital tools extend the space of social interaction beyond physical classrooms<sup>6</sup>. Therefore, experimental models must also consider the socio-communicative dimension of digital competence formation.

The methodological design of experiments in this field often follows quasi-experimental or mixed-method approaches. Quantitative data are collected through surveys, tests, and learning analytics, while qualitative data are obtained via interviews, observations, and reflective journals. The combination of these methods ensures a comprehensive understanding of how digital competencies are formed and what factors influence their development. According to Creswell, mixed-method research is particularly effective in educational studies where complex human and technological interactions are involved<sup>7</sup>. Despite the advantages of digital educational resources, several challenges remain in their implementation. These include unequal access to digital infrastructure, lack of teacher training in ICT integration, and resistance to pedagogical change. In many developing educational systems, the digital divide continues to hinder the effective use of advanced learning technologies. Therefore, experimental models must also address these contextual barriers by incorporating capacity-building components for both educators and students.

Building upon the theoretical foundations of digital educational resources integration, the experimental modeling of skill formation in higher education can be further elaborated through the classification of pedagogical models that guide empirical implementation. In contemporary educational research, several dominant experimental models are identified, including the competency-based model, the adaptive learning model, the blended learning model, and the project-based digital learning model. Each of these models serves a specific pedagogical purpose while collectively contributing to the development of digital competence among university students. The competency-based experimental model focuses on clearly defined learning outcomes that reflect students' ability to effectively use digital educational resources in academic and professional contexts. This model emphasizes measurable indicators of competence such as information retrieval skills, digital content creation, online collaboration, and data interpretation abilities. According to Mulder, competency-based education ensures alignment between educational objectives and labor market demands by focusing on demonstrable skills rather

<sup>6</sup> Vygotsky, L. S. "Mind in Society," Harvard University Press, 1978.

<sup>7</sup> Creswell, J. W. "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches," SAGE, 2020.



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than theoretical knowledge alone<sup>8</sup>. In experimental settings, this model is typically operationalized through structured tasks where students are required to complete digital assignments using specific platforms, thereby allowing researchers to measure competence acquisition quantitatively.

The adaptive learning model represents a more technologically advanced approach, where artificial intelligence and learning analytics are used to personalize educational content. In this model, experimental conditions are created by dividing students into control and experimental groups, where the experimental group interacts with adaptive systems that continuously adjust learning materials based on performance data. Studies conducted by Holmes and Tuomi indicate that adaptive learning environments significantly improve learner engagement and retention rates by providing individualized feedback and pacing<sup>9</sup>. This model is particularly effective in higher education, where students often exhibit diverse levels of digital literacy and learning autonomy. The blended learning model combines traditional face-to-face instruction with digital learning environments, creating a hybrid educational space that maximizes the advantages of both approaches. Experimental research in this area demonstrates that blended learning increases student engagement and improves academic achievement due to the flexibility and accessibility of digital resources. Garrison and Vaughan argue that blended learning is not merely a mixture of online and offline instruction but a transformative pedagogical approach that restructures the learning process itself. In experimental designs, this model is often tested by comparing traditional lecture-based groups with blended learning groups using identical curriculum content.

Another significant approach is the project-based digital learning model, which focuses on collaborative problem-solving activities supported by digital tools. In this model, students work on real-world projects using online platforms, cloud computing tools, and multimedia resources. The experimental objective is to evaluate how effectively students can apply digital competencies in authentic problem-solving situations. Research shows that project-based digital learning enhances critical thinking, creativity, and teamwork skills, which are essential in modern knowledge economies<sup>10</sup>. Moreover, this model encourages active learning and increases student motivation by connecting academic content with practical applications. In experimental studies, the implementation of these models requires careful methodological design to ensure validity and reliability of results. One commonly used approach is the pre-test/post-test control group design, where students' digital competencies are measured before and after the intervention. The difference in performance between experimental and control groups provides empirical evidence of the effectiveness of the implemented model. Statistical analysis techniques such as t-tests, ANOVA, and regression analysis are often applied to interpret the collected data and determine the significance of observed changes.

<sup>8</sup> Mulder, M. "Competence-Based Education and Training." Springer, 2019.

<sup>9</sup> Holmes, W., Tuomi, I. "State of the Art and Future Directions in Smart Learning," OECD Publishing, 2022.

<sup>10</sup> Bell, S. "Project-Based Learning for the 21st Century," Routledge, 2020.



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Furthermore, qualitative methods play an essential role in understanding the subjective experiences of learners within digital educational environments. Interviews, focus groups, and reflective journals provide insights into students' perceptions, challenges, and attitudes toward digital learning tools. These qualitative findings complement quantitative data and contribute to a more holistic understanding of competency formation processes. According to Patton, mixed-method evaluation enhances the depth and credibility of educational research by integrating numerical evidence with contextual interpretation<sup>11</sup>.

An important dimension of experimental modeling is the role of the educator as a facilitator in digital learning environments. Teachers are no longer merely transmitters of knowledge but become designers of learning experiences and guides in the digital space. This shift requires a new set of professional competencies, including digital pedagogy skills, instructional design abilities, and familiarity with educational technologies. Research indicates that the success of digital educational resource integration largely depends on teachers' readiness and continuous professional development<sup>12</sup>. In addition, institutional support plays a critical role in the effective implementation of experimental models. Universities must provide adequate infrastructure, including high-speed internet access, digital libraries, learning management systems, and technical support services. Without these foundational elements, even the most well-designed pedagogical models may fail to achieve desired outcomes. Therefore, experimental studies often include institutional readiness as a variable influencing the success of digital competence formation programs. Cross-cultural studies further reveal that the effectiveness of experimental models varies depending on socio-economic and cultural contexts. In technologically advanced educational systems, students tend to adapt more quickly to digital learning environments, whereas in developing contexts, additional training and support are required. This suggests that experimental models must be context-sensitive and adaptable to local educational conditions rather than universally standardized.

### **Conclusion**

The study of experimental models for developing skills in using digital educational resources in higher education demonstrates that digital transformation is no longer an optional component of modern pedagogy but a fundamental requirement for ensuring educational quality and competitiveness. The integration of digital educational resources (DERs) into teaching and learning processes significantly enhances students' cognitive engagement, autonomy, and problem-solving abilities, while also fostering critical 21st-century competencies such as digital literacy, collaboration, and self-regulated learning. The analysis of different experimental models—competency-based, adaptive learning, blended learning, and project-based digital learning—shows that each model contributes uniquely to the development of digital skills. Competency-based models ensure

<sup>11</sup> Patton, M. Q. "Qualitative Research & Evaluation Methods," SAGE, 2015.

<sup>12</sup> Mishra, P., Koehler, M. J. "Technological Pedagogical Content Knowledge Framework," Teachers College Record, 2017.



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measurable learning outcomes aligned with professional standards, while adaptive systems personalize learning trajectories based on individual student needs. Blended learning models effectively combine traditional and digital environments, increasing flexibility and accessibility, whereas project-based learning enhances practical application of knowledge in real-world contexts.

Experimental research findings indicate that students exposed to structured digital learning environments consistently demonstrate higher academic performance and stronger digital competencies compared to those in traditional instruction settings. Moreover, the use of learning analytics, artificial intelligence, and interactive platforms contributes to continuous feedback mechanisms that improve learning efficiency and engagement. However, the successful implementation of these models depends on several critical factors, including institutional readiness, teacher digital competence, infrastructure availability, and equitable access to technologies. Without addressing these challenges, the potential benefits of digital educational resources may remain limited. Therefore, higher education institutions must prioritize strategic investment in digital infrastructure and continuous professional development programs for educators.

In conclusion, experimental modeling of digital competency formation represents a scientifically grounded approach to understanding and improving the integration of digital technologies in higher education. It provides a systematic framework for evaluating pedagogical innovations and ensures that digital transformation leads to meaningful improvements in learning outcomes and educational quality.

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