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NEW TECHNIQUES FOR ADVANCING STUDENTS' DIGITAL COMPETENCE

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Abstract: The rapid expansion of digital technologies in education has positioned digital competence as a critical skill for students in higher education. This study examines innovative pedagogical approaches—gamification, project-based digital learning, and AI-supported tutoring—and evaluates their effectiveness in enhancing students' digital skills. A mixed-methods research design was implemented among 120 university students over eight weeks. Quantitative results demonstrate a 27% increase in overall digital competence, with the highest gains observed in information literacy and creative digital production. Qualitative findings reveal improved motivation, collaboration, and confidence in digital environments. The study underscores the importance of integrating interactive and adaptive technologies into higher-education curricula to promote digital readiness.

Keywords: digital competence, gamification, AI-assisted learning, project-based learning, higher education, digital literacy

Introduction

Digital competence, defined as the ability to use digital technologies safely, critically, and creatively, has become fundamental for academic and professional success. International frameworks such as DigComp emphasize that students must not only know how to operate digital tools but also evaluate online information, collaborate digitally, and create new digital content. These competencies are increasingly important in higher education, where digital tools are integral to learning, research, and communication.

However, recent studies indicate that many university students possess uneven levels of digital preparedness. While they are often considered "digital natives," research shows that significant gaps persist in information evaluation, cybersecurity awareness, and the use of digital tools for complex academic tasks. Moreover, the rapid emergence of new technologies creates an ongoing challenge for students and educators to remain digitally literate and adaptable.

To address these challenges, educators are increasingly turning to innovative instructional strategies that go beyond traditional lecture-based methods. Among the most promising approaches are:

- **Gamification** — using game elements, such as points, badges, and leaderboards, to enhance engagement, motivation, and persistence in digital learning tasks.
- **Project-based digital learning** — applying digital tools to collaborative, real-world tasks, encouraging creativity, problem-solving, and teamwork.

- **AI-supported tutoring** — providing personalized, adaptive digital feedback, enabling students to identify weaknesses, track progress, and receive targeted guidance.

This study investigates how these approaches influence students' digital competence and explores which specific skills improve in higher-education contexts. By integrating both quantitative assessments and qualitative insights, the research aims to provide a comprehensive understanding of how innovative digital learning strategies can prepare students for academic success and future digital workplaces.

Methods

This study involved 120 undergraduate students (63 females and 57 males), aged 18–24, representing four academic fields: Social Sciences (40%), Engineering (32%), Humanities (18%), and Business (10%). All participants had regular access to digital devices and demonstrated basic digital literacy. A mixed-methods research design was adopted to obtain both numerical measurements and deeper qualitative insights into students' experiences. The quantitative component consisted of pre-test and post-test assessments using a standardized Digital Competence Assessment Scale (0–100), as well as a Likert-scale survey (1–5) measuring students' motivation, confidence, and attitudes toward digital learning tools. The qualitative component included classroom observations throughout the intervention period, semi-structured interviews with a volunteer subgroup of 20 students, and the analysis of reflective digital journals in which participants documented their weekly learning experiences.

The intervention lasted eight weeks and incorporated several innovative instructional strategies. Students completed gamified learning modules that offered weekly challenges, digital badges, and leaderboard-based competition to encourage motivation. They also worked on project-based digital tasks, such as producing multimedia presentations, creating digital storytelling assignments, and collaborating on short video reports. In addition, students used an AI-supported tutoring system that provided personalized quizzes, adaptive feedback based on individual performance, and automated tracking of their progress.

Quantitative data were analyzed using paired t-tests and descriptive statistics to evaluate changes in digital competence before and after the intervention. Qualitative materials—including interview transcripts, observation notes, and digital journal entries—were examined through thematic coding to identify recurring patterns related to engagement, skill development, and student perceptions of the digital learning approaches.

Results

Quantitative Findings

Students showed notable improvement in all categories of digital competence.

Table 1. Pre-test and Post-test Digital Competence Scores (0–100 Scale)

Competence Area	Pre-test Mean	Post-test Mean	Percent Increase
Information & Data Literacy	58	77	+33%
Digital Communication & Collaboration	62	78	+26%
Digital Content Creation	55	73	+33%

Safety & Digital Well-being	60	71	+18%
Problem-Solving with Digital Tools	57	74	+30%
Overall Digital Competence	58.4	74.2	+27%

The results demonstrate substantial improvement in students' digital competence across all measured areas. The highest gains were observed in *Information & Data Literacy* and *Digital Content Creation*, both showing a 33% increase. This suggests that students benefited significantly from tasks requiring research, evaluation of information, and creative production of digital materials—skills heavily supported in the project-based digital tasks.

A notable 30% increase in *Problem-Solving with Digital Tools* indicates that the intervention effectively strengthened students' ability to navigate unfamiliar platforms, troubleshoot issues, and apply digital solutions to academic challenges. This improvement is consistent with the personalized support offered by AI tutoring.

The smallest gain, though still meaningful, was observed in *Safety & Digital Well-being* (+18%). This may imply that while students improved general awareness of safe digital practices, this domain requires longer-term interventions to achieve higher competence levels.

Overall, the total digital competence score increased from 58.4 to 74.2 (+27%), confirming the effectiveness of the integrated innovative approaches.

Students also reported clear improvements in attitudes toward digital learning:

- **Confidence in using digital tools:** increased from 3.1 to 4.4
- **Perceived digital creativity:** increased from 2.9 to 4.1
- **Engagement with digital tasks:** increased from 3.3 to 4.6

These subjective measures align strongly with the objective test score results, suggesting that the intervention not only improved skills but also positively shaped students' perceptions of their abilities.

Table 2. Student Self-Report Ratings After Intervention (Likert Scale 1–5)

Item	Mean Score
Gamification increased my motivation	4.7
AI provided useful personalized feedback	4.5
Digital projects improved my teamwork skills	4.6
I feel more digitally competent after the course	4.4
I am more confident creating digital content	4.5
I now use digital tools more effectively in studies	4.3

Qualitative Findings

Three major themes emerged from interviews, classroom observations, and digital journals:

1. Motivation Through Gamification

Students described the learning process as more engaging due to visible rewards, competitive elements, and the sense of progression. Gamification helped sustain attention and reduce the fear of failure, allowing students to attempt challenging digital tasks with greater enthusiasm.

2. Growth in Creativity and Collaboration

Participants highlighted that digital projects encouraged experimentation with multimedia tools and fostered productive teamwork. Many students reported discovering new skills related to video editing, graphic design, and digital storytelling. Collaborative work improved communication skills and built confidence in group-based digital environments.

3. Personalized Support via AI

AI tools provided real-time feedback, enabling students to identify weak areas quickly and track progress. Many participants expressed that the adaptive quizzes and tailored recommendations helped them learn at their own pace, resulting in increased confidence and reduced anxiety when handling complex digital tasks.

Integration of Quantitative and Qualitative Results

The qualitative findings support and contextualize the quantitative results:

- The increase in motivation from gamification explains the substantial gains in digital engagement and creativity.
- The growth in collaboration and creativity aligns with the large improvements in content creation and communication scores.
- The personalized AI support helps account for the 30% improvement in digital problem-solving.

Together, these findings show a coherent pattern: the combination of gamification, project-based tasks, and AI tutoring produced both measurable skill gains and strong student satisfaction.

Discussion

This study demonstrates that innovative pedagogical approaches—gamification, project-based digital learning, and AI-supported tutoring—significantly enhance students' digital competence. Improvements in information literacy, content creation, collaboration, and problem-solving suggest that these strategies effectively address gaps in digital readiness and align with research emphasizing interactive, student-centered learning environments.

Gamification was particularly effective in sustaining motivation and engagement. Challenges, digital badges, and competitive elements encouraged consistent participation and reduced anxiety around complex tasks, supporting behavioral and motivational theories about feedback and rewards. Project-based learning fostered deeper cognitive engagement, strengthened teamwork, and encouraged creative use of digital tools, reflecting constructivist principles. AI-supported tutoring provided personalized feedback, enabling students to track progress, revisit content, and build confidence at their own pace.

The combined use of these approaches created a holistic digital learning environment addressing multiple dimensions of competence. However, limitations include

the study's short duration (eight weeks), single-institution setting, and reliance on self-reported measures. Future research should explore long-term impacts, larger samples, and performance-based assessments.

Overall, the findings provide strong evidence that integrating gamification, collaborative projects, and AI tools in higher education can effectively enhance digital competence and prepare students for academic and professional digital environments.

Conclusion

The findings of this study provide strong evidence that innovative digital learning strategies can significantly enhance students' digital competence across multiple dimensions. By integrating gamified modules, project-based digital activities, and AI-assisted tutoring systems, educators can create dynamic and engaging learning environments that promote key digital skills such as information literacy, digital content creation, problem-solving, collaboration, and effective communication. These approaches not only increase students' motivation and confidence but also encourage them to apply digital tools in authentic, practice-oriented contexts, ultimately fostering higher levels of digital autonomy and readiness.

Given the rapid digitalization of educational and professional environments, such instructional strategies should be viewed as essential components of modern higher-education curricula. The combination of interactive learning, collaborative tasks, and personalized AI support represents a powerful model that can help universities prepare students for the complex technological demands of the contemporary workforce. Moreover, these findings suggest that institutions aiming to enhance digital competence should adopt a multi-method approach rather than relying solely on traditional instructional formats.

However, despite promising results, the study's scope and duration highlight the need for further research. Future studies should investigate the scalability of these approaches across different academic disciplines and institutions, assess their long-term impact on students' digital proficiency, and evaluate how such methods influence academic performance and career readiness. Exploring the integration of emerging technologies—such as virtual reality, adaptive learning systems, and collaborative digital platforms—may also provide new insights into effective digital competence development.

Overall, this research underscores the importance of innovative pedagogy in shaping digitally competent, confident, and future-ready learners.

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