Results of Applying a Technology for Developing Students' Digital Culture and Digital Competence in Practice

TURAEVA GULNOZ [1], TURGUNOVA ZILOLA[2].

[1]PhD, Department of Primary Education Methodology, Termiz University of Economics and Service, Uzbekistan.
e-mail: gulnoz_turaeva@tues.uz
ORCID: 0009-0005-9524-1230
[2]Termiz University of Economics and Service, Uzbekistan.
turgunovaz159@gmail.com

Abstract. *The article reports the results of a pedagogical experiment in which a technology for developing students' digital culture and digital competence was introduced into the higher-education learning process. The experiment involved 122 undergraduate students, of whom 62 formed the experimental group and 60 the control group. Diagnostics covered the five areas of the DigComp 2.2 framework and four criteria: motivational-value, cognitive, activity-based and reflective-ethical. By the end of the experiment, the share of students at the high level in the experimental group rose from 14.5% to 43.5%, while in the control group it changed only from 15.0% to 20.0% ($\chi^2 = 12.5$; $p < 0.01$). The findings confirm the effectiveness of the proposed technology.*

Keywords: *digital culture, digital competence, DigComp, digital learning environment, pedagogical experiment, diagnostics, effectiveness.*

Introduction

The digital transformation now under way in every sphere of society places new demands on higher education. Today's graduates are expected not only to have professional knowledge but also to evaluate information critically in a digital environment, collaborate online, create digital content and protect personal data. Presidential Decree No. PF-6079 approving the "Digital Uzbekistan – 2030" strategy [1] and the Concept for the Development of the Higher Education System until 2030 [2] set the digitalisation of education as a national priority.

International research treats digital competence as an integrated unity of knowledge, skills and attitudes [3; 4]. The European DigComp 2.2 framework describes it across five areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving [3]. Digital culture is a broader notion that also covers the values, ethical norms and responsible behaviour people show in digital environments [5; 6].

In practice, students use digital devices intensively, yet their skills often remain at the level of consumption. Social media use is high, while skills in verifying sources, creating digital content and staying safe online are weak [7]. This suggests that the digital competence of the so-called "digital natives" does not develop on its own and must be built through a purposeful pedagogical technology.

The aim of the study was to introduce into the

learning process the technology for developing students' digital culture and digital competence designed in the theoretical part of this research, and to evaluate its effectiveness through a pedagogical experiment. To achieve this aim, the study first determined students' initial level of digital culture and competence through diagnostic analysis, then implemented the technology in the experimental group, and finally compared the outcomes with the control group and tested their statistical significance.

The study tested the following hypothesis: if the development of digital culture and competence is organised step by step in a digital learning environment on the basis of an integrated model comprising goals, content, methods, tools and assessment, students' digital competence will be significantly higher than under traditional teaching.

Methods

The experiment was conducted during the 2025–2026 academic year in the pedagogy and information technology programmes of two higher education institutions. Participants were 122 second- and third-year bachelor's students: 62 in the experimental group (EG) and 60 in the control group (CG). The groups were matched by age, year of study and academic performance.

The study ran in three stages. The ascertaining stage (September–October) involved baseline diagnostics and a check that the groups were equivalent. During the formative stage (November–May, two semesters), the technology was implemented in the EG, while the CG continued with conventional teaching. The control stage (June) comprised the final diagnostics and the comparative and statistical analysis of results.

Digital culture and competence were assessed against four criteria. The motivational-value criterion covered interest in digital activity and a sense of responsibility; the cognitive criterion covered knowledge of digital technologies and norms; the activity-based criterion covered practical skills; and the reflective-ethical criterion covered self-assessment and digital ethics. Each criterion was described at three levels: low, intermediate and high.

The diagnostic toolkit combined several instruments. A 40-item test built on the five DigComp 2.2 areas scored each area from 0 to 100. A 24-item Likert questionnaire measured digital culture (Cronbach's $\alpha = 0.86$). Practical case tasks asked students to check the reliability of a source, create a digital product and resolve a safety incident. Students' digital portfolios and observation sheets completed the picture.

The distribution of students across levels was compared with Pearson's χ^2 test (df = 2, $\alpha = 0.05$, critical value 5.99), and mean scores with Student's t-test. Effect size was estimated with Cohen's d. All calculations were performed in SPSS 26.

Results

Diagnostic analysis

The ascertaining stage showed that about 41% of students were at the low level of digital competence, while no more than 15% reached the high level. The weakest areas were problem solving (EG 44.1, CG 45.3 points) and digital content creation (46.3 and 47.0 points). Communication and collaboration scored relatively highest (58.7 and 57.9 points). Students thus used digital tools mainly for communication, while creative and safe digital practice remained underdeveloped.

In the questionnaire, 63% of students admitted using online information without checking its source, and 58% reported reusing the same password across several services. Knowledge of copyright and digital ethics was also low. At baseline there was no statistically significant difference between the EG and the CG ($\chi^2 = 0.05$; $p = 0.98$), so the groups started from equal conditions.

Implementation of the technology

In the EG the technology was delivered over two semesters in four stages. The motivational-introductory stage opened with problem-based discussions of digital footprints, online reputation and responsibility, together with a self-assessment task titled "My digital profile". In the theoretical-informational stage, an integrated 36-hour module, "Digital Culture and Information Security", was taught on the Moodle platform using a flipped-classroom model with video lectures, interactive quizzes and discussion forums.

The practical-activity stage was built on project-based learning, web quests and fact-checking cases. Working in teams, students produced digital products such as infographics, instructional videos and interactive presentations in Canva, Padlet, Miro and Google Workspace. The final reflective-evaluative stage relied on electronic portfolios, peer review and rubric-based reflection.

Each topic was linked to one of the DigComp areas, and the lecturer acted as facilitator and tutor. Gamified sessions run through Kahoot and Quizizz increased student engagement. In the CG, teaching followed the existing curriculum without the special module.

Effectiveness of the technology

In the final diagnostics, the share of EG students at the low level fell from 41.9% to 9.7%, and the share at the high level rose from 14.5% to 43.5%. Changes in the CG were much smaller (Table 1).

Table 1. Distribution of students by level of digital competence, n (%)

Level	EG, baseline (n = 62)	EG, final (n = 62)	CG, baseline (n = 60)	CG, final (n = 60)
High	9 (14.5)	27 (43.5)	9 (15.0)	12 (20.0)
Intermediate	27 (43.5)	29 (46.8)	27 (45.0)	29 (48.3)
Low	26 (41.9)	6 (9.7)	24 (40.0)	19 (31.7)
χ^2 (EG vs CG)	0.05; p = 0.98	12.5; p = 0.002	–	–

The final χ^2 value (12.5) exceeds the critical value (5.99), so the difference between the groups is statistically significant. Across the DigComp areas, the mean score rose from 50.6 to 76.5 in the EG (+25.9) and from 51.2 to 57.8 in the CG (+6.6) ($t = 8.1$; $p < 0.001$; Cohen's $d = 1.46$). The largest gain was in digital content creation (Figure 1).

Positive change was also seen across the criteria. On the reflective-ethical criterion, the share of EG students at the high level grew from 12.9% to 38.7%. This shows that the value dimension of digital culture, namely responsibility and digital ethics, also developed. The effectiveness coefficient, the ratio of the final mean scores of the EG and the CG, was 76.5 / 57.8 = 1.32.

Discussion

The results support the research hypothesis: a technology organised on the basis of an integrated model develops students' digital competence considerably more effectively than traditional teaching. The mean gain in the EG (+25.9 points) was almost four times that in the CG (+6.6 points). The modest gain in the CG can be explained by students' everyday digital experience and the influence of other courses. However, it was not enough to reduce substantially the share of students at the low level (from 40.0% to 31.7%).

The largest gains were in digital content creation (+28.6) and in safety and problem solving (+27.4 each). These were precisely the weakest areas at baseline. The result can be attributed to project-based learning and case

tasks, in which students do not receive knowledge passively but create real digital products and resolve problem situations. This is consistent with studies that regard an activity-based approach as the key condition for developing digital competence [4; 8].

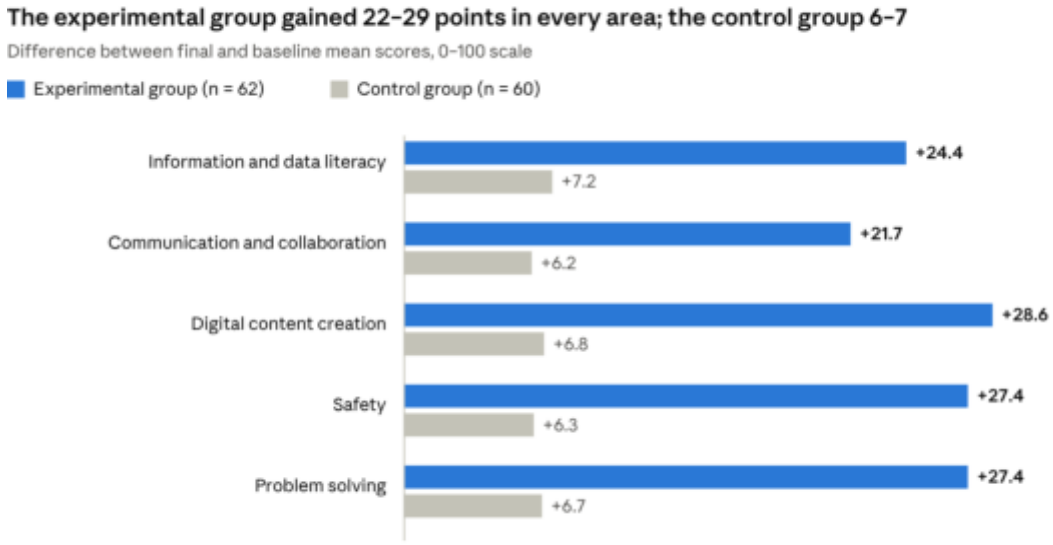


Figure 1. Gain in mean scores across the DigComp 2.2 areas (experimental data, 2025–2026 academic year)

Growth in communication and collaboration was comparatively smaller (+21.7), which reflects its higher starting level. At the same time, the reflective-ethical component of digital culture developed markedly. The technology therefore builds not only technical skills but also responsibility and ethical norms in the digital environment. This supports approaches that interpret digital culture as a broader, value-based phenomenon than digital competence [5; 6].

The study has several limitations. The sample was limited to two institutions, and the groups were not randomly assigned, which makes the design quasi-experimental. No delayed post-test was conducted, so the durability of the results remains a task for future research. It would also be useful to test the technology in other fields of study and to take teachers' own digital competence into account, for example through DigCompEdu [9].

Conclusion

The diagnostic analysis showed that students' digital competence was largely at the level of consumption: about 41% were at the low level, and the weakest areas were digital content creation and problem solving. The technology, delivered through motivational-introductory, theoretical-informational, practical-activity and reflective-evaluative stages, was successfully implemented in a digital learning environment built on Moodle, cloud collaboration tools and electronic portfolios.

In the EG the share of students at the high level rose from 14.5% to 43.5%, and the share at the low level fell from 41.9% to 9.7%. The difference from the CG is statistically significant ($\chi^2 = 12.5$; $p < 0.01$; $d = 1.46$), and the effectiveness coefficient was 1.32. Alongside the technical side of digital competence, the technology also develops the value and ethical components of digital culture. It can be recommended for use in pedagogical and other programmes of higher education institutions, as well as in professional development courses for university teachers.

References

1. Decree of the President of the Republic of Uzbekistan No. PF-6079 of 5 October 2020 “On approval of the ‘Digital Uzbekistan – 2030’ strategy and measures for its effective implementation”.
2. Decree of the President of the Republic of Uzbekistan No. PF-5847 of 8 October 2019 “On approval of the Concept for the Development of the Higher Education System of the Republic of Uzbekistan until 2030”.
3. Vuorikari R., Kluzer S., Punie Y. DigComp 2.2: The Digital Competence Framework for Citizens. Luxembourg: Publications Office of the European Union, 2022. 133 p.
4. Ilomäki L., Paavola S., Lakkala M., Kantosalo A. Digital competence – an emergent boundary concept for policy and educational research // Education and Information Technologies. 2016. Vol. 21, No. 3. P. 655–679.
5. Gilster P. Digital Literacy. New York: Wiley, 1997. 276 p.
6. Soldatova G.U., Nestik T.A., Rasskazova E.I., Zotova E.Yu. Tsifrovaya kompetentnost’ podrostkov i roditeley. Rezul’taty vserossiyskogo issledovaniya [Digital competence of adolescents and parents: Results of an all-Russian study]. Moscow: Internet Development Foundation, 2013. 144 p.
7. Kirschner P.A., De Bruyckere P. The myths of the digital native and the multitasker // Teaching and Teacher Education. 2017. Vol. 67. P. 135–142.
8. van Laar E., van Deursen A.J.A.M., van Dijk J.A.G.M., de Haan J. The relation between 21st-century skills and digital skills: A systematic literature review // Computers in Human Behavior. 2017. Vol. 72. P. 577–588.
9. [Redecker C. European Framework for the Digital Competence of Educators: DigCompEdu. Luxembourg: Publications Office of the European Union, 2017. 95 p.
10. [Ferrari A. DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe. Luxembourg: Publications Office of the European Union, 2013. 50 p.