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Student Perceptions of Innovative Educational Approaches in the Era of Generative AI

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ABSTRACT

Research background: The rapid development of generative artificial intelligence (AI) and ongoing digital transformation are reshaping higher education and increasing demand for more flexible and competence-oriented educational approaches. Recent studies indicate that students tend to associate educational innovation less with technological novelty itself and more with flexibility, practical learning outcomes, and career relevance.

Purpose of the article: This article aims to identify the key educational and digital factors that positively influence students' perceptions of innovative educational approaches that support critical thinking and personal development in higher education.

Methods: The quantitative research was conducted using a sample of 925 students from a partner university participating in a V4 research project. Students' attitudes were collected through an online questionnaire administered in October 2025. The research hypotheses were tested using correlation analysis and linear regression modelling. The data were analysed using IBM SPSS Statistics.

Findings & Value added: The findings indicate that students place greater value on educational approaches that support practical skills development, flexibility, and preparation for future careers than on technological novelty itself. The strongest positive effects were identified for approaches supporting the development of future career skills and flexible educational systems. By contrast, several variables related to AI and digital resources exhibited weaker or statistically non-significant effects. This may indicate that students increasingly perceive digital technologies as a standard component of higher education rather than as a distinct indicator of educational innovation. The study contributes to current debates on AI and educational innovation by demonstrating that students associate innovation more strongly with competence development and flexibility than with technological novelty alone.

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INTRODUCTION

Digital transformation and the rapid expansion of artificial intelligence (AI) are increasingly reshaping organisational processes and labour market expectations. Technologies such as machine learning, automation, and big data analytics now influence not only operational decision-making but also broader patterns of economic activity and digitalisation (Ji et al., 2023; Cirillo et al., 2023). In this environment, higher education institutions are increasingly expected to prepare graduates for digitally transforming workplaces while continuing to support knowledge creation and professional skills development (Feher et al., 2022; Ho et al., 2023).

Higher education systems are under growing pressure to respond to labour market expectations that place greater emphasis on adaptability, digital skills, and independent problem-solving than on the reproduction of theoretical knowledge alone (Liu, 2023; Idrissi Gartoumi & Tekouabou, 2024). Recent research increasingly associates educational innovation with teaching approaches that enhance flexibility and connect learning experiences more effectively with future professional requirements, rather than with technology adoption alone (Awidi & Paynter, 2024; Otto et al., 2024; Otermans et al., 2025).

The educational value of AI-based tools appears to depend less on their mere availability and more on how they are integrated into everyday teaching practices (Rapanta et al., 2021; Archambault et al., 2022; Prilop et al., 2025).

Universities are also expected to prepare students for work environments characterised by AI-supported technologies, digital collaboration, and increasingly interdisciplinary forms of work (Sun et al., 2026; Xu et al., 2025). At the same time, recent studies suggest that the educational value of technological innovation depends not only on the technologies themselves but also on how they contribute to meaningful learning experiences and preparation for future careers (Rapanta et al., 2021; Archambault et al., 2022; Rispler et al., 2025). From the student perspective, educational innovation may therefore be evaluated less according to the novelty of a technology and more according to whether learning experiences are perceived as useful, flexible, and relevant to future employment (Ho et al., 2023; Rispler et al., 2025; Otermans et al., 2025).

Existing research has examined several dimensions of educational innovation, including digital technology adoption, AI-supported learning, pedagogical innovation, employability, and flexible learning environments (Rapanta et al., 2021; Archambault et al., 2022; Awidi & Paynter, 2024; Ho et al., 2023; Otto et al., 2024; Rispler et al., 2025). However, these studies have generally focused on individual dimensions of educational change rather than examining their relative importance from the student perspective. Consequently, it remains unclear which educational and digital factors students perceive as the strongest contributors to innovative education when multiple dimensions are considered simultaneously within a single analytical framework. In particular, limited empirical evidence is available regarding the relative importance of technological innovation, educational flexibility, career-oriented competence development, theory–practice integration, and access to digital resources in shaping students' perceptions of innovative learning environments (Awidi & Paynter, 2024; Ho et al., 2023; Otermans et al., 2025; Rispler et al., 2025; Schön & Ebner, 2025). This issue appears to be particularly underexplored in the context of Central and Eastern European higher education, where recent studies have generally addressed digital transformation, AI integration, or institutional innovation separately (Feher et al., 2022; Aisulu, 2024; Dvorsky, 2025).

Despite the growing importance of innovative and AI-supported education, the present study addresses this gap by examining several educational and digital dimensions simultaneously and identifying the factors that most strongly influence students' perceptions of innovative education. The aim of the article is to identify key educational and digital factors that positively influence students' perceptions of innovative educational approaches supporting critical thinking and personal development in higher education. The empirical research was conducted in one of the V4 countries and represents a direct output of the research project entitled "How Generation Z Perceives Access to Education and Capacities in the V4 Region", supported by the Visegrad Fund.

The paper is structured as follows. The next section reviews the relevant literature, followed by the methodology and empirical results. The subsequent sections discuss the findings and present the practical implications, limitations, directions for future research, and conclusions.

THEORETICAL BACKGROUND

Innovative University Education: Competence Development, Flexibility, and Career Relevance

In higher education, innovation is increasingly discussed in relation to teaching practices, curriculum design, and institutional flexibility rather than digital technology alone. In the context of digital transformation and artificial intelligence, higher education institutions are increasingly expected to prepare students for complex work environments in which digital literacy, critical thinking, adaptability, and career-related competences are essential (Feher et al., 2022; Ho et al., 2023; Otermans et al., 2025). From the student perspective, educational innovation may therefore depend less on the presence of new technologies and more on whether universities help students develop skills that are applicable beyond the classroom (Awidi & Paynter, 2024; Ciolan & Manasia, 2026).

One of the key elements of this transformation is the growing emphasis on AI-related knowledge, digital competences, and interdisciplinary learning within higher education curricula (Sun, 2026). An interdisciplinary approach may also help students connect technological change with broader organisational and managerial challenges, including decision-making and risk-management issues (Xu et al., 2025; Dvorsky, 2025). Graduates are increasingly expected to critically evaluate AI-based systems and recognise where digital technologies can—and cannot—support organisational activities (Xu et al., 2025; Chen, 2025).

Previous research indicates that innovative higher education is strongly associated with interdisciplinarity and labour-market-oriented competence development. Based on a global study of more than 2,700 master's programmes, Feher et al. (2022) show that leading innovative universities increasingly emphasise STEM fields, interdisciplinary programmes, and business-related knowledge in response to changing labour market expectations. This finding is consistent with studies demonstrating that career development learning and skills formation strengthen students' perceived employability and preparedness for future work (Ho et al., 2023; Otermans et al., 2025). Students may therefore associate educational innovation more strongly with practical skills development and career preparation than with technological novelty itself (Dahri et al., 2025; Drydakis, 2025).

Flexibility is another important dimension of innovative education. Flexible educational systems enable universi-

ties to respond more effectively to changing student needs, labour market expectations, and technological developments (Aisulu, 2024; Idrissi Gartoumi & Tekouabou, 2024). This is particularly relevant in the context of Industry 4.0 and digital transformation, where students require adaptable competences and the capacity for continuous learning across changing professional environments (Idrissi Gartoumi & Tekouabou, 2024; Schön & Ebner, 2025). Flexibility therefore affects more than institutional organisation; it also shapes students' ability to adapt to changing professional and learning requirements (Ho et al., 2023; Otermans et al., 2025).

Another important aspect of innovative education is the connection between universities, professional practice, and the research environment. Cooperation with technology companies, student participation in research projects, and digital transformation initiatives create favourable conditions for knowledge transfer and improved graduate employability (Djoundourian & Shahin, 2022; Leal Filho et al., 2025). Djoundourian and Shahin (2022) identify academia–business cooperation as a pathway for developing innovative executive education and strengthening links between higher education and industry. Ressin (2024) similarly highlights interactions among education, science, and business as a driver of regional development. Taken together, these studies suggest that students may value educational approaches more highly when they perceive clearer connections between university learning and workplace expectations (Djoundourian & Shahin, 2022; Ressin, 2024).

Recent studies also support this broader understanding of innovative education. Lehocky and Fabianova (2025) connect quality education with the development of future leaders and personal engagement, which is relevant to the role of modern educational technologies in supporting student development. Malek et al. (2025) emphasise student satisfaction and perceived university reality, underscoring the importance of students' subjective evaluations of institutional innovation and modern pedagogical approaches. The relevance of these studies to the present analysis lies primarily in their focus on how students evaluate institutional and pedagogical change (Lehocky & Fabianova, 2025; Malek et al., 2025).

Digital Technologies and Artificial Intelligence in Higher Education

The growing presence of digital technologies and artificial intelligence in higher education has shifted attention towards how these tools are used in teaching practice. Several studies argue that digital tools improve learning only when they are connected to clearly defined pedagogical objectives and appropriate instructional design (Al Mahdi, 2023; Rapanta et al., 2021; Archambault et al., 2022). Recent research increasingly emphasises that the educational impact of AI is shaped primarily by how instructors and students engage with these tools in practice (Prilop et al., 2025; Tran et al., 2025; Sun et al., 2026). Consequently, digital transformation in universities increasingly involves organisational and pedagogical adaptation alongside technological change (Otto et al., 2024; Aisulu, 2024).

At the institutional level, digital transformation is connected with stakeholder engagement, visibility, and governance. Based on research involving Italian universities, Albergo et al. (2025) show that public and larger institutions are more likely to use social media for stakeholder engagement. Spilotro et al. (2026) examine how Italian universities disclose their digital and green transition efforts and identify considerable heterogeneity in institutional approaches. These findings indicate that institutional digitalisation alone is insufficient to transform educational practices. Universities appear to benefit more when technological initiatives are integrated into broader organisational and educational strategies (Albergo et al., 2025; Spilotro et al., 2026).

The spread of generative AI has also renewed discussions concerning the relationship between digital tools and teaching methods. Recent studies indicate that AI-supported learning can contribute to creativity, writing development, lesson planning, and personalised learning when guided by appropriate pedagogical frameworks (Fadhillah et al., 2025; Tran et al., 2025; Prilop et al., 2025). Fadhillah et al. (2025) demonstrate that guided writing models integrating generative AI and digital novels can enhance creative writing and creative thinking skills. Their findings suggest that students benefit more from AI-supported learning activities when these activities are embedded in structured classroom tasks and feedback processes (Fadhillah et al., 2025).

Chen (2025) identifies a fundamental divergence between human and generative AI judgement in entrepreneurial evaluation, showing that AI-generated outputs may tend towards more centralised and conservative assessments, whereas human evaluators contribute contextual depth and interpretative judgement. In the context of higher education, this study underscores the continuing importance of human interpretation and contextual judgement in AI-assisted decision-making (Chen, 2025). The findings also highlight the need for students to evaluate AI-generated outputs critically rather than relying on them unreflectively (Xu et al., 2025; Sun et al., 2026).

Students' responses to AI in higher education also appear more mixed than many institutional discussions imply. Rispler et al. (2025) show that students' perceptions of generative AI are connected with pedagogy and graduate employability, while Strzelecki (2025) examines bachelor's and master's students' expectations regarding ChatGPT in higher education. Stone (2025) highlights uncertainty, ambiguous use cases, and pragmatic attitudes towards generative AI among students. Overall, students appear to evaluate AI tools primarily according to their practical usefulness for studying, coursework, and preparation for future careers (Rispler et al., 2025; Strzelecki, 2025; Stone, 2025).

The broader organisational relevance of AI further strengthens the need to develop AI-related competences in higher education. Dvorsky (2025) examines the impact of

artificial intelligence on enterprise risk management in the Slovak SME sector. Although the study focuses on enterprises rather than universities, it is relevant to higher education because it demonstrates that AI has become an important factor in organisational decision-making and risk management. Higher education institutions therefore face growing pressure to help students understand how AI influences organisational decisions and professional practice (Dvorsky, 2025; Chen, 2025; Xu et al., 2025).

Digital resources and open educational practices also contribute to students' learning opportunities and lifelong learning. Schön and Ebner (2025) emphasise the importance of open educational resources for legal clarity, sustainability, and digital sovereignty within European university alliances. The educational value of digital resources depends not merely on their availability, but on whether students can integrate these materials into their learning practices over time (Schön & Ebner, 2025; Otto et al., 2024). This perspective is relevant to the present study because access to digital resources constitutes one of the dimensions examined in relation to students' perceptions of digital technology use in higher education.

Recent research increasingly associates positive evaluations of educational change with flexibility, career preparation, and the practical application of digital technologies in teaching. These findings provide the conceptual basis for the present study, which examines how students evaluate different dimensions of digital technology use and educational innovation in higher education.

AIM, DATA COLLECTION, METHODS AND STRUCTURE OF RESPONDENTS

The aim of the article is to identify key educational and digital factors that positively influence students' perceptions of innovative educational approaches supporting critical thinking and personal development in higher education.

Data collection

The research was conducted in four Central European countries: the Slovak Republic (SR), the Czech Republic (CR), Hungary (HU), and Poland (PL), as part of the scientific project "How Generation Z perceives access to education and capacities in the V4 region." The primary guarantor of the project is the Alexander Dubček University of Trenčín (SR), alongside the following partner institutions: Rzeszow University of Technology (PL); University of Szczecin (PL); Mendel University in Brno (CR); AMBIS University (CR); University of Žilina (SR); Slovak University of Technology in Bratislava (SR); University of Pannonia (HU). While the project operates at the V4 level, the empirical analysis presented in this paper is based on data collected from a single partner institution. Accordingly, the findings should be interpreted as institution-specific rather than representative of the entire V4 region

The respondent was defined as a student of a college or university from one of the participating institutions of the research project. Data collection took place in October 2025. The questionnaire was developed by the project investigators based on: i. a critical literature review; ii. the professional experience and pedagogical knowledge of the investigators within the teaching process at their respective universities; iii. Online meetings of the research collective. The total number of respondents who completed the questionnaire at one of the partner universities

Table 1: Items formulation in the questionnaire

TV	Signs	Formulation of items	Literature sources
DPV	IE	Innovative teaching approaches foster my critical thinking and personal development.	Rosyada et al. (2026), Fadhillah et al. (2025), Haubrock et al. (2024)
IPV	UDT1	The integration of modern technologies (e.g., digital tools, e-learning) significantly enhances the quality of my education.	Lehocky & Fabianova, 2025)
	UDT2	My university promotes innovation and modern pedagogical approaches.	Malek et al. (2025), Zhu et al. (2025)
	UDT3	Compared to traditional methods, flexible educational systems are key to preparing students for a dynamic job market.	Idrissi Gartoumi & Tekouabou (2024), Herbst et al. (2020)
	UDT4	The use of digital technologies, such as artificial intelligence and virtual reality, significantly improves my learning process.	Mah et al. (2025), Dvorsky (2025)
	UDT5	The current lecture format at my university effectively maintains my focus and concentration.	Cirillo et al. (2023), Trushkina et al. (2020)
	UDT6	Modern educational methods and technologies enable me to develop essential skills for my future career.	Aisulu (2024), Bresciani et al. (2026)
	UDT7	I find teaching that integrates theoretical knowledge with practical experience to be the most effective.	Adeeko & Treanor (2022)
	UDT8	I have sufficient access to digital resources that support my lifelong learning.	Spilotro et al. (2026)

Note: TV – Type of Variable, DPV – Dependent Variable, IPV – Independent Variable, IE – Innovative Education, UDT – Use of Digital Technology. Source: own research collaboration

(University of Žilina, Slovakia) was 925 (hereinafter n = 925) students. The questionnaire was configured by the lead coordinating institution in the respondent's native language to ensure a better understanding of the formulated questions. Furthermore, the questionnaire was secured against automated computer completion (bot protection).

Questionnaire and items

The questionnaire consisted of more than 40 questions (specifically 42). It included four questions focused on the demographic characteristics of the students:

- Respondent's age (open-ended question);
- Respondent's gender (closed-ended question; response options: male, female);
- Type of university (closed-ended question; response options: public, private);
- Field of study (open-ended question).

The subsequent statements were closed-ended, utilizing a 5-point Likert scale (1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, 5 – strongly agree). The questionnaire was anonymous, and respondents could decide to withdraw from the survey at any point. The sample includes only fully completed questionnaires—i.e., respondents who answered every question and statement formulated in the survey.

The formulation of statements (items) in the questionnaire is shown in the Table 1.

The UDT variables capture different aspects of students' perceptions of digital and pedagogical environments rather than a single latent construct. Therefore, they are treated as conceptually distinct but related predictors in the regression model. This allows the identification of which specific educational and technological factors contribute most strongly to students' perceptions of innovative educational approaches supporting critical thinking and personal development. While some conceptual overlap may exist, the aim of the analysis is not to reduce these variables into a single dimension, but to examine their individual effects on students' perceptions of innovative educational approaches supporting critical thinking and personal development.

Statistical hypotheses and methods

The following statistical hypotheses were formulated:

- H1: The integration of modern technologies has a positive effect on students' perceptions of innovative educational approaches supporting critical thinking and personal development.
- H2: Institutional support for innovation and modern pedagogical approaches has a positive effect on students' perceptions of innovative educational approaches supporting critical thinking and personal development.
- H3: Flexible educational systems have a positive effect on students' perceptions of innovative educational approaches supporting critical thinking and personal development.
- H4: The use of digital technologies, such as artificial intelligence and virtual reality, has a positive effect on students' perceptions of innovative educational approaches supporting critical thinking and personal development.
- H5: Lecture formats that effectively maintain students' focus and concentration have a positive effect on students' perceptions of innovative educational approaches supporting critical thinking and personal development.
- H6: Modern educational methods and technologies supporting future career skill development have a positive effect on students' perceptions of innovative educational approaches supporting critical thinking and personal development.
- H7: Teaching that integrates theoretical knowledge with practical experience has a positive effect on students' perceptions of innovative educational approaches supporting critical thinking and personal development.
- H8: Access to digital resources supporting lifelong learning has a positive effect on students' perceptions of innovative educational approaches supporting critical thinking and personal development.

Each hypothesis was tested separately in the regression model by examining the statistical significance and direction of the corresponding regression coefficient.

In the first phase of evaluating the formulated hypotheses, descriptive statistics (see Table 3) and the Kolmogorov-Smirnov test (see Table 4) were employed to verify the assumptions for using linear regression modeling. In the second phase, the dependency between the two variables was quantified and verified using a correlation matrix (see Table 5) and a t-test to verify their significance. The third phase focused on linear regression analysis (LRA) and the creation, quantification, and verification of linear causal relationships (see Table 6) between the independent variables (UDTs) and the dependent variable (IE). Given that all examined variables are linearly scaled and positively formulated, LRA is an appropriate statistical method for verifying the formulated hypotheses. Verification of the assumptions of negative effect of multicollinearity was using with Variance Inflation Factor (VIF) values. If the VIF value less than 5, than multicollinearity is not present in the linear regression model (LRM). The general form of linear regression function (LRF) is as follows:

$$LRF: IE = \beta 0 + \beta 1 \times UDT1 + \beta 2 \times UDT2 + \beta 3 \times UDT3 + \beta 4 \times UDT4 + 0\ \beta 5 \times UDT5 + \beta 6 \times UDT6 - \beta 7 \times UDT7 + \beta 8 \times UDT8 + \varepsilon i$$

where IE – Dependent variable, β0 – intercept, β1- β8 – regression coefficients, UDTs – Independent variables, εi – error terms.

RESULTS

The basic demographic structure of respondents – students are presented in the Table 2.

The following Table 3 presents the empirical results of descriptive characteristics of variables (dependent variable – DV (IE statement), independent variables – IVs (UDT statements)).

Table 2: Structure of respondents = students

Age of respondents			Gender			Study field		
Type	**AV**	**RV**	**Type**	**AV**	**RV**	**Type**	**AV**	**RV**
0-18	108	11.68%	Male	328	35.46%	E-T	101	10.92%
19	170	18.38%	Female	597	64.54%	E-M	481	52.00%
20	186	20.11%	n	925	100.0%	H-S	148	16.00%
21	157	16.97%				H-M	104	11.24%
22	133	14.38%				OF	91	9.84%
23-24	171	18.49%				N	925	100.0%
N	925	100.0%						

Note: AV – Absolute value, RV – Relative value, E-T – Engineering a Technology, E-M – Economics and Management, H-S – Humanities study field, H-M – Health and Medical Sciences, OF – Others study field. Source: own research collaboration

Table 3: Evaluation of descriptive statistics of dependent and independents variables

DS	IE	UDT1	UDT2	UDT3	UDT4	UDT5	UDT6	UDT7	UDT8
Mean	4.004	4.122	3.952	4.072	4.231	3.022	4.118	4.446	3.919
Standard Error	0.024	0.026	0.026	0.025	0.027	0.032	0.022	0.024	0.027
Standard Deviation	0.728	0.777	0.784	0.765	0.817	0.972	0.673	0.729	0.816
Sample Variance	0.530	0.603	0.615	0.585	0.667	0.945	0.453	0.531	0.665
Kurtosis	0.761	1.104	0.763	0.679	0.866	-0.457	0.381	2.178	0.761
Skewness	-0.580	-0.854	-0.686	-0.647	-0.986	0.013	-0.464	-1.386	-0.737
Minimum	1	1	1	1	1	1	2	1	1
Maximum	5	5	5	5	5	5	5	5	5

Note: DS – Descriptive statistics. Source: own research collaboration

Table 4: Verifications of assumptions in the process of LRM model

Assumptions		IE	UDT1	UDT2	UDT3	UDT4	UDT5	UDT6	UDT7	UDT8
NDI	KST	1.384	1.684	1.684	1.681	1.686	1.484	2.051	2.021	1.835
	p-val	0.299	0.273	0.299	0.266	0.259	0.195	0.294	0.337	0.301
	Eval.	A	A	A	A	A	A	A	A	A

Note: A – Accepted, NDI – Normal Distribution of Item, KST – Kolmogorov-Smirnov test. Source: own research collaboration

Table 5: Quantification and verifications of dependences between items

CM	IE	UDT1	UDT2	UDT3	UDT4	UDT5	UDT6	UDT7	UDT8
IE	1	0.286***	0.241***	0.353***	0.208***	0.157***	0.492***	0.178***	0.214***
UDT1		1	0.314***	0.299***	0.234***	0.114***	0.327***	0.213***	0.270***
UDT2			1	0.186***	0.124***	0.270***	0.230***	0.141***	0.351***
UDT3				1	0.261***	0.026	0.354***	0.286***	0.178***
UDT4					1	-0.094*	0.311***	0.114***	0.080**
UDT5						1	0.077*	-0.050	0.207***
UDT6							1	0.305***	0.242***
UDT7								1	0.176***
UDT8									1

Note: CM – Correlation matrices, *** α = 0.001, **α = 0.01, *α = 0.05. Source: own research collaboration

Table 6: Causal relationships between dependent and independent variables

Verification of linear regression model					
ANOVA	**DF**	**SS**	**MS**	**F**	**Significance F**
Regression	8	149.806	18.726	50.423	1.23E-67
Residual	916	340.177	0.371		
Total	92	489.983			

Quantification and verification of linear regression coefficients								
V	**Regression Coeff.**	**SE**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95,0%**	**Upper 95,0%**
INT	0.787	0.194	4.053	0.000	0.406	1.168	0.406	1.168
UDT1	0.064	0.029	2.195	0.028*	0.007	0.122	0.007	0.122
UDT2	0.058	0.029	1.995	0.046*	0.001	0.115	0.001	0.115
UDT3	0.169	0.030	5.736	0.000***	0.111	0.227	0.111	0.227
UDT4	0.027	0.027	0.995	0.320	-0.026	0.079	-0.026	0.079
UDT5	0.071	0.022	3.234	0.001**	0.028	0.114	0.028	0.114
UDT6	0.403	0.035	11.57	0.000***	0.334	0.471	0.334	0.471
UDT7	-0.014	0.030	-0.47	0.635	-0.073	0.044	-0.073	0.044
UDT8	0.029	0.027	1.052	0.293	-0.025	0.082	-0.025	0.082

Note: V – Variable, INT – Intercept, DF – Degree of Freedom, SS – Sum of Square, MS – Mean of Square, F- F-ratio, SE – Standard Error, *** α = 0.001, **α = 0.01, *α = 0.05. Source: own research collaboration

The highest mean score was recorded for variable UDT7 (Mean = 4.446; see Table 3), indicating the most positive perception among students. The highest standard deviation (SD) score was recorded for variable UDT5 (SD = 0,972; see Table 3), indicating the most variability perception among students. Th

e values of kurtosis and skewness are in the range from value -2 to 2. These results confirm that the variable has a normal distribution. This assumption is exactly confirmed in the next table 4 (with using Kolmogorov-Smirnov test).

The following Table 4 presents the empirical results of verification of assumptions on the realization and application of linear regression modeling (LRM) – normal distribution of items and homoscedasticity.

Kolmogorov-Smornov test was used. The results are positive (see Table 4). The assumption of normal distribution of each variable in the research was accepted.

Table 5 presents the results of correlations between items using correlations matrices. The correlation matrices present the pairwise coefficients of correlation. The verification of significance of pairwise coefficient of correlation is with using t-test. If the p-value is less than level of significance (less then α = 0.05), then the pairwise coefficient of correlation is statistically significant.

There is a highly statistically significant, moderate positive relationship (r = 0.492; see Table 5) between innovative education (IE) and future career skill development (UDT6). Students who report more positive perceptions of innovative educational approaches also tend to report stronger perceptions of future career skill development. The only inverse relationship is between UDT4 and UDT5 (r = -0.094). This is a very weak negative correlation. As one variable increases, the other slightly decreases.

Table 6 presents the results of causal relationships between independent variables (UDTs) and dependent variable (IE). The basic regression characteristics: Multiple coefficient of correlation = 0.553, Coefficient of determination = 0.306, Adjusted coefficient of determination = 0.300, Standard error = 0.609, Observation = 925.

The LRM is statistically significant (F = 50.423, p-value = 0.000; see Table 6). The independent variables (UDTs) explain 30.0% (Adj. R2 = 0.300) of variability dependent variable (IE). The following independent variables are statistically significant: i. on the α = 0.001: UDT3, UDT6; ii. on the α = 0.01: UDT5; iii. on the α = 0.05: UDT1, UDT2. Others independent variables are not statistically significant on the α = 0.05 (UDR4, UDR7, UDR8). Each statistically significant independent variable has a positive effect on the dependent variable (IE). The linear regression function (LRF) has a shape:

$$LRF: IE = 0.787 + 0.064 \times UDT1 + 0.058 \times UDT2 + 0.169 \times UDT3 + 0.027 \times UDT4 + 0.071 \times UDT5 + 0.403 \times UDT6 - 0.014 \times UDT7 + 0.029 \times UDT8$$

The results of VIF-values of verification of multicollinearity are as follows: UDT1: VIF = 1.289; UDT2: VIF = 1.288; UDT3: VIF = 1.266; UDT4: VIF = 1.183; UDT5: VIF = 1.35; UDT6: VIF = 1.363; UDT7: VIF = 1.181; UDT8: VIF = 1.230. These results are less than 5.000. The negative effect of multicollinearity was not confirmed for each independent variable (UDTs).

Based on the regression results, H1, H2, H3, H5, and H6 were accepted, while H4, H7, and H8 were rejected. Significant positive effects were identified for modern tech-

nologies, institutional innovation, educational flexibility, lecture formats, and career-related skill development, whereas AI and virtual reality, theory–practice integration, and access to digital resources did not demonstrate statistically significant independent effects.

DISCUSSION

The results indicate that students do not evaluate innovative education primarily on the basis of the presence of digital technologies, but rather according to the educational value they associate with their learning experiences. Among the variables examined, career-related competence development (UDT6) emerged as the strongest predictor of students' perceptions of innovative education, followed by educational flexibility (UDT3). By contrast, several technology-related variables showed weaker or statistically non-significant effects. Overall, the pattern of results suggests that students distinguish between technological availability and educational usefulness when evaluating innovation in higher education.

The strongest effect was identified for career-related competence development (UDT6). This result indicates that students associate innovative education primarily with the acquisition of skills that enhance future employability and professional preparedness. Although modern technologies are frequently presented as central drivers of educational innovation, the present findings indicate that students place greater emphasis on whether educational approaches contribute to future career success. The dominant role of UDT6 in the regression model highlights the importance of competence-oriented learning environments and is consistent with previous studies emphasising the contribution of career development learning and skills formation to students' perceptions of employability and preparedness for future work environments (Ho et al., 2023; Otermans et al., 2025). The observed pattern indicates that students place greater value on the developmental outcomes of education than on technological novelty itself.

The second strongest predictor was educational flexibility (UDT3). Flexible educational systems appear to be valued not because they are inherently innovative, but because they enable students to adapt to changing labour market conditions and evolving professional requirements. One plausible explanation is that ongoing digital transformation has increased the importance of continuous learning, adaptability, and the capacity to respond to uncertain professional environments. The results indicate that students evaluate educational innovation not only through curriculum content, but also through the ability of educational systems to prepare them for changing career contexts. This interpretation is broadly consistent with studies emphasising the importance of flexibility, lifelong learning, and adaptive competences in digitally transforming societies (Aisulu, 2024; Idrissi Gartoumi & Tekouabou, 2024).

Several additional variables showed statistically significant but considerably weaker effects. The integration of modern technologies into education (UDT1), institutional support for innovation and modern pedagogical approaches (UDT2), and lecture formats supporting concentration and engagement (UDT5) all contributed positively to students' perceptions of innovative educational approaches that support critical thinking and personal development. However, their effects were substantially smaller than those observed for competence development and flexibility. For UDT1, the results indicate that students recognise the educational value of modern technologies, which is consistent with earlier studies highlighting the contribution of digital technologies to learning experiences (Awidi & Paynter, 2024; Otto et al., 2024; Archambault et al., 2022; Ciolan & Manasia, 2026; Haubrock et al., 2024; Herbst et al., 2020). At the same time, the relatively modest coefficient suggests that technology alone is not a dominant driver of perceived innovation. The positive effect of UDT2 indicates that institutional support for innovation remains relevant to students' perceptions of innovative education, although its explanatory power is considerably lower than that of competence development and educational flexibility. Engaging lecture formats also contributed positively to students' evaluations; however, their role appears substantially less pronounced than that of competence development and flexibility.

A particularly noteworthy finding concerns the role of artificial intelligence and virtual reality (UDT4). Although students evaluated these technologies positively at the descriptive level, the variable did not emerge as a statistically significant predictor in the regression model. While previous studies emphasise the educational potential of AI-supported learning, the present findings indicate that students do not regard AI technologies alone as sufficient indicators of innovative education. Instead, students appear to assess these technologies according to the value they add to learning outcomes and future career preparation. Rather than contradicting earlier research, this result extends studies arguing that the educational value of AI and digital technologies depends primarily on their pedagogical integration and practical application rather than on their mere presence within educational environments (Rapanta et al., 2021; Archambault et al., 2022; Otto et al., 2024; Prilop et al., 2025).

A similar pattern was observed for digital learning resources (UDT8), which also failed to demonstrate an independent effect in the regression model. Although students appear to value access to digital resources, the results indicate that access alone may be insufficient to shape perceptions of innovative education. One possible interpretation is that digital resources have become an expected component of contemporary higher education. Consequently, access itself may no longer function as a distinguishing characteristic of educational innovation. This interpretation is consistent with arguments suggesting that the educational value of digital resources depends less on their availability and more on how learners integrate them into meaningful learning activities and long-term learning processes (Schön & Ebner, 2025; Otto et al., 2024).

Perhaps the most intriguing result concerns theory–practice integration (UDT7). This variable achieved the highest mean score among all examined items, indicating that students strongly value educational approaches that connect theoretical knowledge with practical experience. Previous studies consistently emphasise the importance of linking theory and practice and highlight its contribution to employability, competence development, and educational effectiveness (Adeeko & Treanor, 2022; Djoundourian & Shahin, 2022; Ressin, 2024; Fadhillah et al., 2025; Rosyada et al., 2026). The present findings do not contradict this view. On the contrary, the exceptionally high mean score confirms the importance students attach to this dimension. However, the statistically non-significant regression result suggests that theory–practice integration may increasingly be perceived as a standard expectation of high-quality higher education rather than as a distinctive feature of educational innovation. For many students, the connection between theory and practice may already represent a basic characteristic of effective university education rather than a specific sign of innovation. This may explain why a highly valued educational characteristic does not necessarily distinguish innovative educational environments from other forms of higher education.

Overall, the results indicate that students evaluate innovative education primarily in terms of its developmental and career-related value. They place greater emphasis on competence development, flexibility, and preparation for future careers than on the presence of advanced technologies alone. The findings suggest that investments in AI tools and digital infrastructure are unlikely to strengthen perceptions of educational innovation unless they are accompanied by teaching practices that support employability, adaptability, and meaningful learning experiences. Universities seeking to enhance innovative educational environments may therefore benefit more from integrating digital technologies into competence-oriented and flexible learning systems than from focusing primarily on technological implementation.

CONCLUSION

The aim of this article was to identify the key educational and digital factors that positively influence students' perceptions of innovative educational approaches supporting critical thinking and personal development in higher education.

The findings indicate that students tend to value educational approaches that support practical skills development, flexibility, and preparation for future careers more highly than the mere presence of new technologies. Among the factors examined, support for career-relevant skills and greater flexibility within the educational system showed the strongest associations with positive evaluations of innovative education. These results suggest that students are less concerned with technological novelty itself and more interested in whether educational practices help them adapt to future workplace expectations and develop competences relevant to their careers.

The results further suggest that students value digital tools primarily when these tools support meaningful learning experiences rather than represent technological innovation in isolation. Overall, perceptions of innovative education appear to be shaped more strongly by the developmental value of learning experiences than by the availability of advanced technologies alone.

From a practical perspective, the findings highlight the importance of career-related competence development and educational flexibility in shaping students' perceptions of innovative education. These dimensions demonstrated substantially stronger effects than technology-oriented factors. The results also suggest that the educational value of AI tools and digital infrastructure depends largely on how these technologies are embedded in teaching and learning processes. Investments in digital technologies are therefore likely to be more effective when they support competence development, employability, and flexible learning opportunities. For higher education institutions, this underscores the importance of aligning technological initiatives with pedagogical practices that strengthen students' preparedness for future professional environments.

The findings should be interpreted in light of several limitations. First, the study is based on students' self-reported perceptions and does not include objective measures of learning outcomes or competence development. Second, although the sample was relatively large (n = 925), the data were collected at a single institution. The findings should therefore be regarded as institution-specific and cannot be generalised to the wider V4 region.

Future research could examine whether the observed relationships are replicated across different universities and national contexts. It may also be valuable to investigate which career-related competences students associate most strongly with innovative education and future employability. The finding that theory–practice integration received the highest overall evaluation but did not emerge as a statistically significant predictor of innovative education also warrants further investigation. In addition, future studies could examine why students tend to evaluate AI-supported technologies positively while not perceiving them as independent indicators of educational innovation.

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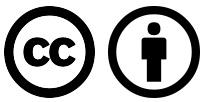

AUTHOR CONTRIBUTIONS STATEMENT

Conceptualization, A.C.; methodology, A.C.; software, A.R.; formal analysis, A.R.; investigation, A.R.; data curation, A.R.; writing—original draft preparation, A.C. and A.R.; writing—review and editing, A.C.; literature review extension, discussion development, interpretation of findings, and manuscript refinement, A.C.; supervision, A.R. All authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY STATEMENT

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

AI DISCLOSURE

During the preparation of this manuscript, the authors used ChatGPT to improve language quality, grammar, and stylistic clarity of the text. After using these tools, the authors carefully reviewed, revised, and approved all content and take full responsibility for the accuracy and integrity of the published work.

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