EMERGING TECHNOLOGIES IN IT EDUCATION FOR INDUSTRY 5.0: STRENGTHENING DIGITAL COMPETENCIES AND CAREER READINESS

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Abstract

Digital technologies have a significant impact on IT education, leading to programs that are aimed at graduating students equipped for Industry 5.0, where working with smart systems is the norm for problem-solving. In this study, we examine how emerging technologies are being integrated into IT education in Albania, a developing economy striving to keep pace with global trends despite resource constraints. This study employs a quantitative research design to evaluate the integration of emerging technologies into IT education and their influence on students' preparedness for Industry 5.0 and digital entrepreneurship. A total of 351 undergraduate and postgraduate students from different universities in Albania participated in the study. We found that artificial intelligence and machine learning strengthen students' preparedness for Industry 5.0 and digital entrepreneurship, but skills in blockchain and digital business remain underdeveloped. Gaining experience through internships and project-based learning turns out to be the most important factor in developing student's confidence and skills. However, the lack of collaboration with industry and poor infrastructure are the main problems that impede skill development and thus career readiness.

The findings indicate clear priorities: expand hands-on AI and ML learning, embed blockchain and digital business content, and invest in stronger collaboration between academia and industry. We offer actionable recommendations in this study for universities and policymakers to fill these gaps and build a future-ready workforce.

Keywords: emerging technologies; IT education; Industry 5.0; digital competencies; career readiness.

Introduction

Relevance of the topic. Emerging technologies are widely presented as the foundation of digital transformation. According to the World Economic Forum (2025), around 86% of employers expect artificial intelligence (AI) and other information-processing technologies to transform their business by 2030. Subsequently, the skill set needed by the labor force in Industry 5.0 will be different from that of Industry 4.0, as the transition between the two is facilitated by the mentioned technologies (Ghobakhloo, et al., 2024). While Industry 4.0 brought about a paradigm shift of automation and efficiency, Industry 5.0 has been characterized by the acknowledgment of human-machine interaction, creativity, and sustainability (Gamberini & Pluchino, 2024; Leng, et al., 2022). The education sector does have a role in equipping students with the necessary multi-disciplinary skills to cope with the changing demand (Leoste, et al., 2021; Li, Kim, & Palkar, 2022).

In Albania, the use of emerging technologies in education is still at an early stage; however, on a positive note, the government is following the Digital Agenda 2022-2026, as well as a Digital Education Action Plan (2025-2030), and may now be ready for progress (Council of Ministers Decision, 2022; Ministry of Education, Sports and Youth, 2025). The continuation of these plans requires more than just policy documents. Rather, the higher education sector requires the development and implementation of curricula that offer active learning, deeper applied experiences, better engagement with industry, and better appreciation of how students frame emerging technologies within their education.

Research problem. Although Albania has adopted national digital strategies and a Digital Education Action Plan (Ministry of Education, Sports and Youth, 2025), it is still unclear whether IT study programs actually equip students with the digital competencies and entrepreneurial skills needed for Industry 5.0. The core research problem is the gap between the rapid spread of emerging technologies in the labour market and the slower, uneven integration of these technologies into IT curricula, practical learning opportunities, and students' preparation for digital careers.

Subject matter of the research. The research focuses on the integration and educational use of emerging technologies in IT higher education in Albania and their implications for students' digital competencies, preparedness for Industry 5.0, and readiness for digital entrepreneurship.

Research aim. The research investigates the role of comprehensive training, practical exposure, and perceptions of technological importance in shaping digital skills and career readiness. This study focuses on IT students, as they represent the future workforce driving Industry 5.0 transformations.

Research objectives:

1. To evaluate IT students' perceptions of emerging technologies in the university curriculum and their readiness for Industry 5.0 and digital business.
2. To determine how comprehensive training and practical experience with emerging technologies relate to IT students' confidence and readiness for careers in Industry 5.0 and digital entrepreneurship.

Research methods:

This study employs a quantitative research design to evaluate the integration of emerging technologies into IT education and their influence on students' preparedness for Industry 5.0 and digital entrepreneurship. The study examined 351 undergraduate and graduate students from universities in Albania. The survey was administered via an online questionnaire from August 2024 to March 2025. Data analysis was carried out with JASP software, version 0.95.0.

Research Questions:

1. What are IT students' perceptions of the emerging technologies present in the university curriculum, and what is their perceived readiness for Industry 5.0 and digital business?
2. Do IT students report practical experience with emerging technologies, and what are the most common levels of confidence and readiness to enter the workforce in Industry 5.0 and digital entrepreneurship?

The study's hypotheses are:

1. H1: IT students who receive comprehensive training in emerging technologies will demonstrate higher levels of preparedness for the challenges of Industry 5.0 and greater proficiency in digital business skills than those who do not receive such training ($\alpha = 0.05$).
2. H2: IT students with significant practical experience in emerging technologies (e.g., through internships or projects) will report greater confidence and readiness for careers in Industry 5.0 and digital business compared to those with limited or no practical experience ($\alpha = 0.05$).

1. Literature review

Emerging technologies are transforming education to develop adaptive, flexible, and interactive learning environments. These technologies such as blockchain, AI, machine learning (ML), Internet of Things (IoT), virtual reality and augmented reality (VR/AR), and quantum computing offer students personalized learning experiences, greater interactivity, and different pedagogies (Mena-Guacas, López-Catalán, Bernal-Bravo, & Ballesteros-Regaña, 2025). AI and ML have introduced personalized learning paths, predictive analytics, and decision-support systems to improve educational delivery (Leoste, et al., 2021). These tools identify gaps in knowledge so that interventions can be made to increase engagement and comprehension (Ivanashko, Kozak, Knysh, & Honchar, 2024). AI-based platforms such as intelligent tutors and automated grading/feedback systems help transform IT curricula so that students are prepared for work in data-driven industries (Ghobakhloo, et al., 2024).

Cloud computing is still the mainstay of IT education because it is ubiquitous relative to modern IT operations generally. As Qasem, Abdullah, Jusoh, Atan, and Asadi (2019) point out, cloud computing is often adopted by industry sectors, making it vital that academic programs incorporate cloud computing concepts. Including cloud computing in a program's curriculum increases a student's level of technical capabilities when entering the professional scene as well as preparing them for positions in DevOps, cybersecurity, and data management (Almufarreh & Arshad, 2023). Blockchain also offers transformative potential to educational institutions that go beyond cryptocurrency, for example in credentialing systems (Alam & Benaida, 2020) or as a trustless method of managing academic records.

Blockchain technology offers trust and efficiency to processes that struggle with credibility while providing opportunities for student autonomy over digital management systems (Kuleto, et al., 2022; Alam & Benaida, 2020). But, despite the potential impact of blockchain on academic institutions, the adoption of blockchain in education is limited, and constrained by lack of infrastructure and expertise (Sabiteka, Yu, & Sun, 2025). Introducing blockchain education and hands-on courses may diminish these gaps by preparing students with key skills for the decentralized digital economy (Leng, et al., 2022).

Similarly, IoT provides students with experiences within distributed systems to apply in real-world applications such as smart devices, sensor networks, and real-time data (Ghashim & Arshad, 2023). Unfortunately, IoT is often undervalued in many educational disciplines, leaving graduates unprepared for roles requiring connected systems experience. Increasing the presence of IoT content in IT programs could benefit students in terms of getting opportunities in a field that is constantly changing (Ghashim & Arshad, 2023). One of the areas where quantum computing can make the most impact is cryptography, which can also affect the way data is processed and the making of decisions for problems that are very complex, among other things. The students, even when they get only a little bit of exposure to quantum computing, will be able to understand the basics and begin to engage professionally with the industries of software development in healthcare, finance, and cybersecurity, which are the areas, among others, that will be affected (Arute, et al., 2019; Lu, Sigov, Ratkin, Ivanov, & Zuo, 2023). Also, VR/AR educational tools foster immersive learning experiences such as collaborative problem-solving, allowing students to have advanced experience valued in the context of human-machine interaction in Industry 5.0 (Lampropoulos G. , 2023). These technologies help students build technical skills while also developing critical thinking and creativity skills required in the workforce (Garzón, 2021; Lampropoulos G. , 2023).

The digital economy creates a demand for IT professionals who have technical expertise and entrepreneurial skills, which prepare people for a rapidly changing business environment (Lee, Cortes, & Joo, 2021; Sitaridis & Kitsios, 2024). Digital entrepreneurship includes areas such as e-commerce, digital marketing, and innovation management, and prepares people for a rapidly changing business environment (Lee, Cortes, & Joo, 2021; Sitaridis & Kitsios, 2024). Nevertheless, IT curricula are predominantly technical rather than balanced between technical and entrepreneurial development, which leaves students underprepared for entering the digital economy. Project-based learning applied learning in technologies such as blockchain and VR/AR, or experiential learning opportunities such as internships are essential for learning the interplay of theory with practice (Mena-Guacas, López-Catalán, Bernal-Bravo, & Ballesteros-Regaña, 2025). For example, blockchain projects, like secure credentialing systems, enable students to use their abilities in relevant and productive environments (Kuleto, et al., 2022; Alam & Benaida, 2020). This technology can be beneficial to their technical skill application in project-based learning but could also benefit from critical thinking and creativity, allowing skill application to enable success in the modern workforce (Garzón, 2021; Lampropoulos G. , 2023; Lampropoulos & Kinshuk, 2024).

2. Methodology

This study employs a quantitative research design to evaluate the integration of emerging technologies into IT education and their influence on students' preparedness for Industry 5.0 and digital entrepreneurship. The analysis focuses on the relationship between exposure to emerging technologies, practical experience, and confidence in navigating the digital economy.

2.1. Sample

The study examined 351 undergraduate and graduate students from universities in Albania, selected from a cross-disciplinary sample (Information Technology 30%, Computer Engineering 30%, Business Informatics 25%, and Applied Informatics 15%). These disciplines were chosen because they collectively represent the principal areas driving technical innovation and digital transformation and are therefore

essential to understanding how emerging technologies are integrated into education and how they affect student readiness for the workforce in an Industry 5.0 context. The areas of study also provide a student sample that captures a broad orientation to curricula from related disciplines, as well as a substantial worldview of how graduates have been prepared for digital entrepreneurship and professional opportunities as the technology landscape continues to evolve. Recruitment of participants was conducted through social media. All participants were given information about the purpose of the study, their rights, the maintenance of anonymity, and the confidentiality of participants' information in relation to personal data. Informed consent was obtained from all respondents, and the data were stored in compliance with Albanian Law No. 124/2024 "On Personal Data Protection" (Parliament of Albania, 2024).

2.2. Survey design and data collection

We designed the survey instrument by adapting items from established studies to assess key variables related to students' perceptions, preparedness, and practical experiences with emerging technologies such as AI, ML, Blockchain, IoT, and VR/AR (Almufarreh & Arshad, 2023; Garzón, 2021; Mena-Guacas, López-Catalán, Bernal-Bravo, & Ballesteros-Regaña, 2025; Kuleto, et al., 2022). The survey also looked at students' digital skill development and entrepreneurship confidence (Ghobakhloo, et al., 2024; Gamberini & Pluchino, 2024). To allow for more specific points of agreement with each item and to convey it in degrees of agreement, we incorporated Likert-scale items (1 = Strongly Disagree; 5 = Strongly Agree).

The survey was administered via an online questionnaire from August 2024 to March 2025. The questionnaire demonstrated excellent internal consistency (Cronbach's $\alpha = 0.955$). This high value indicates that the instrument measured the intended constructs in a consistent way. Although the study focuses on IT students in Albania, the experience can inform other countries with similar educational and technological contexts. The geographic limitation is offset by the depth of analysis and the actionable insights derived from the data, which can help guide policymakers and educators in similar transitional economies.

2.3. Statistical analysis

Data analysis was carried out with JASP software, version 0.95.0. We conducted the following statistical methods on the data analysis to provide both reliability and robustness:

- Mann-Whitney U Test: This is a non-parametric test to compare two independent groups of students: those with extensive practical experience and those with limited practical experience. It was used to assess the extent of differences in their preparedness for Industry 5.0 roles and their confidence in a digital entrepreneurship venture. The Mann-Whitney U test is used on Likert-scale data and does not presume normal distributions in the data. Its use here means we can see whether or not practical exposure has a significant relationship with these key outcomes.
- Bayesian Analysis: Bayes Factors (BF_{10}) were calculated to provide the relative evidence for the alternative hypothesis (H_1) compared to the null hypothesis (H_0). Bayes Factors differ from p-values, as they provide continuous evidence, with results classified as anecdotal, moderate, strong, or very strong based on the value of the Bayes Factor. Bayes Factors allow for a graded interpretation of differences in groups as well as a superior evaluation of findings beyond using the traditional form of significance testing.

A 95% confidence interval was used to ensure statistical significance, with all tests set at $\alpha = 0.05$.

3. Research findings

What are IT students' perceptions of the emerging technologies present in the university curriculum, and what is their perceived readiness for Industry 5.0 and digital business?

The data present a clear curriculum-capability gap (Table 1). While 76.1% of students indicate

agree or strongly agree that they should expand the curriculum to include more AI and ML, under half (50.7%) of students confirm they feel prepared to tackle the challenges they will encounter in the industry. This difference indicates that while students recognize the significance of advanced technologies, they are moderately confident in their own preparedness.

High levels of neutral responses across numerous indicators support this conclusion: 14.53% for AI/ML expansion; 31.91% for preparedness; 27.07% for practical skills; 37.04% for Industry 5.0; and 33.05% for critical thinking. In so many cases, the neutral response is often caused by insufficient exposure, lack of clarity, or inconsistent models for valuable practice.

The data also suggest that conceptual gaps are significant. Fewer than half (42.5%) of students reported that they feel confident with the concepts associated with Industry 5.0, while 20.52% of students openly disagreed (disagree and strongly disagree) and 37.04% were neutral. This indicates that students are exposed to individual tools, such as AI, IoT, or robotics, but never receive a systems approach that introduces the individual tools as a collective, as envisioned in Industry 5.0. A similar weakness is evident in the promise of transferable competencies. Only 47.3% of students agree that their curriculum has enhanced one of the most important transferable competencies, critical thinking and problem-solving skills, while the remainder are neutral or dissatisfied.

Practical opportunities also appear inequitable. Of those students surveyed, 55.6% reported a level of exposure to digital tools and technologies which meant 44.4% of students had an attitude of neutrality or dissatisfaction, implying that access to laboratories, projects or mentorships was most likely not scaled.

Table 1. IT students' perceptions of the influence of emerging technologies

Statement		Frequency	Percent
Expanding advanced AI and ML training in university curricula is essential to prepare students for future industry demands.	Strongly Disagree	17	4.84%
	Disagree	16	4.56%
	Neutral	51	14.53%
	Agree	94	26.78%
	Strongly Agree	173	49.29%
	Total	351	100
My university has equipped me with the necessary skills to meet IT industry challenges effectively.	Strongly Disagree	24	6.84%
	Disagree	37	10.54%
	Neutral	112	31.91%
	Agree	100	28.49%
	Strongly Agree	78	22.22%
	Total	351	100
My educational experience has provided extensive opportunities to develop practical skills with digital tools and technologies.	Strongly Disagree	24	6.84%
	Disagree	37	10.54%
	Neutral	95	27.07%
	Agree	116	33.05%
	Strongly Agree	79	22.51%
	Total	351	100
I am well-versed in Industry 5.0 concepts, including automation, robotics, and advanced digital technologies essential for the future workforce.	Strongly Disagree	30	8.55%
	Disagree	42	11.97%
	Neutral	130	37.04%
	Agree	94	26.78%
	Strongly Agree	55	15.67%
	Total	351	100
My curriculum has effectively strengthened critical thinking and problem-solving skills, which are vital for success in Industry 5.0 environments.	Strongly Disagree	27	7.69%
	Disagree	42	11.97%
	Neutral	116	33.05%
	Agree	91	25.93%
	Strongly Agree	75	21.37%
	Total	351	100

Source: compiled by the authors on the basis of the research data, 2025

A significant gap exists in the integration of entrepreneurial training within IT curricula, as only 26% of students report feeling fully supported in developing digital business skills (Figure 1).

Additionally, 48% of students report that improvements are necessary, while 26% express uncertainty, highlighting the underrepresentation of entrepreneurial education in academic programs despite its critical importance in digital business ecosystems.

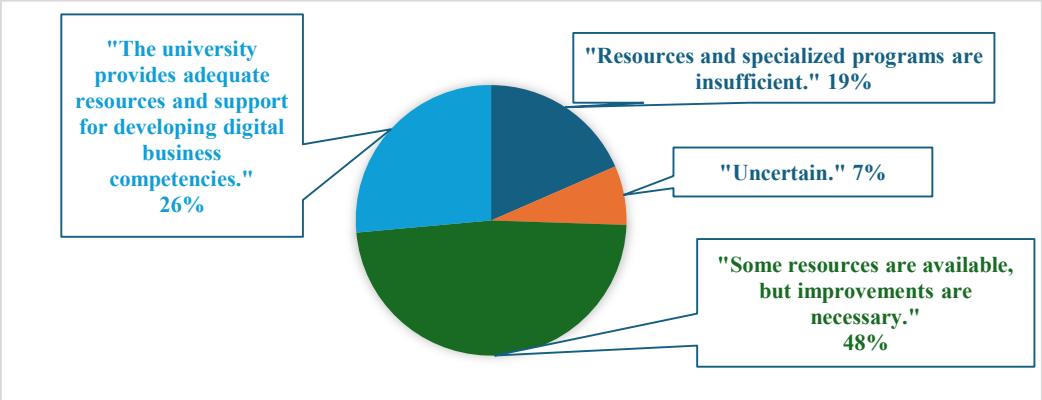

Figure 1. Student Perspectives: "University Support for Digital Business Skills"
Source: compiled by the authors on the basis of the research data, 2025

Do IT students report practical experience with emerging technologies, and what are the most common levels of confidence and readiness to enter the workforce in Industry 5.0 and digital entrepreneurship?

The value of practical experience with new technologies is important when it comes to equipping students for Industry 5.0. Data from the survey suggest that while many students are starting to have some level of confidence, there are substantial gaps in what students know that will lead to limited readiness for the next workforce environment. Just over half of the respondents (50.1%) were confident in using advanced technologies in a professional setting (Table 2), while one-third (34.2%) were undecided, and nearly 15.7% reported low confidence. These responses show that confidence seems to come from the amount of hands-on and real-world practice students receive.

Confidence in AI and ML was even less optimistic. The data revealed that fewer than half (40.5%) believed they were competitive in the AI/ML workforce, while more than a third (38.5%) were ambivalent, and over one-fifth were unprepared. This demonstrates that students have few chances to apply AI and ML knowledge to noticeable real-world issues. At the same time, just over half (52.4%) agreed that they were well-prepared to apply AI methods in real-world projects, with one third (32.8%) remaining neutral and about 14.8% disagreeing. These findings are consistent with the fact that only about one quarter of respondents (26.2%) had completed formal coursework in AI or ML, while nearly three quarters (73.8%) had not.

Blockchain showed the widest gap. Only 36.2% of students felt they could apply any blockchain technologies, while 41.03% were neutral. This suggests that most students have little to no experience with applying blockchain despite its growing presence in secure transactions, decentralized systems, and digital finance. Consistently, two thirds (66.1%) reported having no practical, hands-on experience with blockchain, such as smart contracts or cryptocurrency applications, and only one third (33.9%) had such experience. Around half of the students (51.0%) agreed or strongly agreed that they had participated in internships or project-based learning that directly prepared them for work in emerging technology sectors, whereas roughly 19.1% disagreed and 29.9% were neutral.

The area in which students were the least prepared was digital entrepreneurship. Almost half of the students (44.44%) reported no experience at all, and only a small minority (7.69%) reported extensive experience in entrepreneurship.

H1: IT students who receive comprehensive training in emerging technologies will demonstrate higher levels of preparedness for the challenges of Industry 5.0 and greater proficiency in digital business skills than those who do not receive such training ($\alpha = 0.05$).

Table 2. Practical experience with emerging technologies

Statement		Frequency	Percent
I am confident in my ability to utilize cutting-edge technologies in a professional environment.	Not Confident at All	12	3.42%
	Somewhat Unconfident	43	12.25%
	Neutral	120	34.19%
	Somewhat Confident	110	31.34%
	Very Confident	66	18.80%
	Total	351	100
I feel competitive and well-prepared to enter the AI and ML job market.	Not Prepared at All	28	7.98%
	Somewhat Unprepared	46	13.11%
	Neutral	135	38.46%
	Somewhat Prepared	92	26.21%
	Very Prepared	50	14.25%
	Total	351	100
I possess the technical skills and knowledge to execute blockchain-based projects.	Strongly Disagree	34	9.69%
	Disagree	46	13.11%
	Neutral	144	41.03%
	Agree	82	23.36%
	Strongly Agree	45	12.82%
	Total	351	100
I have undertaken formal coursework in Artificial Intelligence (AI) or Machine Learning (ML), providing foundational expertise in these transformative technologies.	No	259	73.79%
	Yes	92	26.21%
	Total	351	100
I possess practical, hands-on experience with blockchain technology, including the development of smart contracts and applications in cryptocurrency.	No	232	66.10%
	Yes	119	33.90%
	Total	351	100
I have actively participated in internships or project-based learning experiences that directly prepared me for employment in emerging technology sectors.	Strongly Disagree	25	7.12%
	Disagree	42	11.97%
	Neutral	105	29.91%
	Agree	99	28.21%
	Strongly Agree	80	22.79%
	Total	351	100
I feel well-prepared to apply Artificial Intelligence (AI) methodologies within diverse real-world project contexts.	Strongly Disagree	15	4.27%
	Disagree	37	10.54%
	Neutral	115	32.76%
	Agree	111	31.62%
	Strongly Agree	73	20.80%
	Total	351	100
I have practical experience in developing or managing a digital business, equipping me with essential competencies for digital entrepreneurship.	No, I have no experience	156	44.44%
	Yes, I have extensive experience	27	7.69%
	Yes, I have moderate experience	88	25.07%
	Yes, I have limited experience	80	22.79%
	Total	351	100

Source: compiled by the authors on the basis of the research data, 2025

The Mann-Whitney U test showed a significant difference in Industry 5.0 preparedness between groups (Table 3). Students in the Trained group (M = 1.52) reported higher preparedness than those in the Untrained group (M = 1.29), W = 7201, $p < .001$. For digital business skills, students with comprehensive training (M = 3.49) also outperformed their peers without such training (M = 3.20), W = 7909.5, p = .033. Bayesian analysis reinforced these findings (Figure 2). Evidence for H_1 in Industry 5.0 preparedness was very strong ($BF_{10} \approx 113$), while support for H_1 in digital business skills was moderate to strong ($BF_{10} \approx 14.5$).

Table 3. Mann-Whitney U test

Variable	Group	Mean	W	p
Preparedness for the challenges of Industry 5.0	Trained	1.520	7201	< .001
	Untrained	1.288		
Proficiency in digital business skills	Trained	3.493	7909.5	0.033
	Untrained	3.2		

Source: compiled by the authors on the basis of the research data, 2025

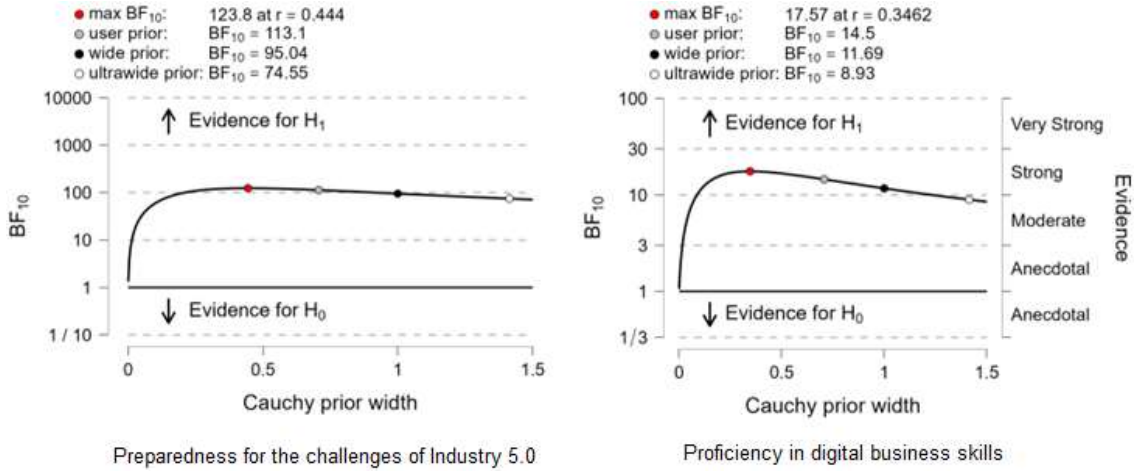

Figure 2. Bayes Factor Robustness Check

Source: compiled by the authors on the basis of the research data, 2025

H2: IT students with significant practical experience in emerging technologies (e.g., through internships or projects) will report greater confidence and readiness for careers in Industry 5.0 and digital business compared to those with limited or no practical experience ($\alpha = 0.05$).

The Mann-Whitney U test (Table 4) showed a significant difference in confidence and readiness for Industry 5.0 careers between students with High Practical Experience (M = 3.722) and those with Low/No Practical Experience (M = 3.244), W = 8833, $p < .001$. For digital business careers, students with High Practical Experience (M = 3.778) also outperformed those with Low/No Practical Experience (M = 3.373), W = 9267, p = .001. Bayesian analysis confirmed these findings (Figure 3). Evidence for H_1 was very strong in Industry 5.0 career readiness ($BF_{10} \approx 53$) and moderate to strong for digital business careers ($BF_{10} \approx 9.3$).

Table 4: Mann-Whitney U test

Variable	Group	Mean	W	p
Confidence and readiness for careers in Industry 5.0	High Practical Experience	3.722	8833	< .001
	Low/No Practical Experience	3.244		
Digital Business Careers	High Practical Experience	3.778	9267	0.001
	Low/No Practical Experience	3.373		

Source: compiled by the authors on the basis of the research data, 2025

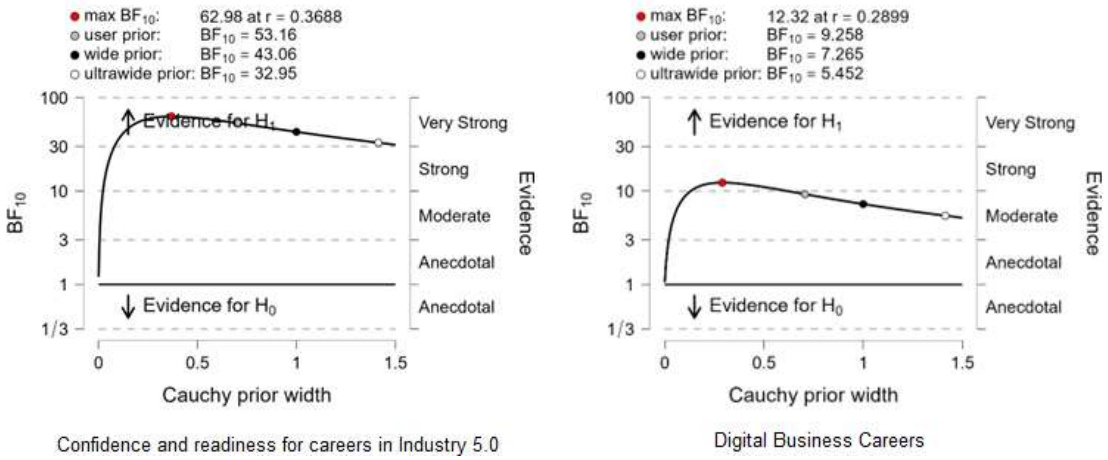

Figure 3. Bayes Factor Robustness Check
Source: compiled by the authors on the basis of the research data, 2025

4. Discussion

This study has established the critical need for Albanian IT education reform to meet the demands of Industry 5.0. Emerging technologies are transforming the workforce globally. One key finding from this study is the critical importance of training in higher education with emerging technologies. For example, the Mann-Whitney U test demonstrates that students with training in emerging technologies had a higher level of preparedness compared to those without training ($p < .001$). The Bayesian analysis confirmed this finding and indicated very strong evidence for H_1 ($BF_{10} \approx 113$). In other words, the difference we observed is more than fifty times more likely to be true under the alternative hypothesis than the null. The results from the Mann-Whitney U statistic and Bayesian analysis support the assertion that structured training in emerging technologies is statistically significant, and there is strong evidence to substantiate the findings. These findings support the work in the academic literature on the incorporation of emerging technologies into higher education so that students are prepared for the workforce of the future (Gamberini & Pluchino, 2024). These technology components are key pillars of the human-centric paradigm of Industry 5.0, where human-technology collaboration is fundamental. Integrating these technologies into educational programs is fundamental to developing technical and business competencies associated with future market demands (Gamberini & Pluchino, 2024). At the same time, the study identifies a gap in digital business education ($p = 0.033$), suggesting that IT curricula must reach beyond the technical training of students (Ghobakhloo, et al., 2024) and include modules on innovation, digital strategy, and business management. Adopting such an integrated approach would prepare students more comprehensively for leadership in the digital transformation process by being technically proficient, innovative, and entrepreneurial.

Another significant finding was the impact of experiential learning. Results for H2 indicated that students with a large amount of experiential learning, such as internships and applied projects, reported greater confidence and readiness for Industry 5.0 careers ($p < .001$, BF_{10} very strong). Also, students reported having insufficient practical experience. Universities must strengthen partnerships with industry to support authentic learning opportunities and enhance student competitiveness in the global digital economy (Ghashim & Arshad, 2023; Qasem, Abdullah, Jusoh, Atan, & Asadi, 2019).

There were also specific technology gaps. For example, only 36.2% of students reported confidence in blockchain projects, and 26% of the students felt "adequately" trained in digital entrepreneurship. Curriculum and content must reflect the priorities of entrepreneurial skills that are important for future industry leaders, and include modules for e-commerce, innovation management, and digital business (Lee, Cortes, & Joo, 2021). Collaborative opportunities with industry leaders may help students put their learning into practice, improve their technology skills, and develop an innovative mindset and entrepreneurial approach to their work. This study shows that offering training for Industry 5.0 cannot be just about technical knowledge alone. It is recommended that universities in Albania work

to incorporate AI and ML training more substantially through industry co-op–based learning projects, while also increasing practical education, internship, and work-based opportunities. Practice with new technologies is especially necessary in blockchain, IoT, and other technologies that are starting to enter the market but are not yet reflected in the learning outcomes. At the same time, universities must also integrate digital entrepreneurship more meaningfully into IT programs so students can graduate with both technical know-how and innovation and leadership skills for the digital economy.

Future research could include many more institutional settings and regions in future studies to better understand how emerging technologies are being infused into IT education across the world.

Conclusions

1. The study shows that IT students clearly recognise the importance of emerging technologies in their studies, especially the need for stronger AI and ML content, but many do not feel fully prepared for Industry 5.0 or digital business. Only about half of the respondents report feeling ready for future industry challenges, and a large share remain neutral about their understanding of Industry 5.0 and about the development of critical thinking and problem-solving skills. This points to a gap between what is included in the curriculum and how confident students feel about using these technologies in their future careers.

2. The findings also show that comprehensive training and practical experience with emerging technologies are closely linked to higher confidence and readiness for careers in Industry 5.0 and digital entrepreneurship. Students who received structured training and who had substantial hands-on experience through internships or project-based learning reported significantly greater preparedness and stronger digital business skills than those with little or no such experience, which supports both H1 and H2. At the same time, many students still lack sufficient practical and entrepreneurial opportunities, which suggests that IT curricula in Albania should combine emerging technology content with more real-world projects, internships, and explicit digital business training.

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BESIFORMUOJANČIOS TECHNOLOGIJOS IT STUDIJOSE PRAMONEI 5.0: SKAITMENINIŲ KOMPETENCIJŲ IR PASIRENGIMO KARJERAI STIPRINIMAS

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Santrauka

Sparčiai besivystančios skaitmeninės technologijos keičia darbo rinką ir kelia naujus reikalavimus aukštajam mokslui. Albanijoje patvirtintos nacionalinės skaitmenizacijos strategijos ir Skaitmeninio švietimo veiksmų planas numato ambicingus tikslus, tačiau vis dar neaišku, ar informacinių technologijų (IT) studijų programos iš tikrųjų suteikia studentams skaitmenines kompetencijas ir verslumo įgūdžius, reikalingus Pramonės 5.0 kontekste. Šiame straipsnyje nagrinėjama, kaip besiformuojančios technologijos integruojamos į IT studijas ir kaip jos siejasi su studentų pasirengimu skaitmeninei ekonomikai ir skaitmeniniam verslumui.

Tyrimo objektas – besiformuojančių technologijų, tokių kaip dirbtinis intelektas (DI), mašininis mokymasis (MM), blokų grandinės technologijos, daiktų internetas (IoT), virtualioji ir papildytoji realybė (VR/AR) bei kvantinė kompiuterija, integracija į IT studijas Albanijos universitetuose ir jos poveikis studentų skaitmeninėms kompetencijoms, pasirengimui Pramonei 5.0 bei skaitmeniniam verslumui. Tyrimo problema siejama su neatitikimu tarp spartaus naujų technologijų plitimo darbo rinkoje ir lėtesnės, fragmentiškos jų integracijos į studijų programas, ypač praktinio mokymosi ir skaitmeninio verslo ugdymo galimybių.

Tyrimo tikslas – empiriškai ištirti, kaip išsami teorinė ir praktinė besiformuojančių technologijų mokymo patirtis, taip pat studentų požiūris į šių technologijų svarbą lemia jų skaitmeninius įgūdžius, pasitikėjimą savimi ir pasirengimą karjerai Pramonės 5.0 bei skaitmeninio verslo srityse. Tyrimas orientuotas į IT studijų studentus kaip būsimą darbo jėgą, kuri kurs ir diegs Pramonės 5.0 sprendimus. Taikytas kiekybinis tyrimo dizainas: duomenys rinkti naudojant internetinę anketą, kuri buvo administruojama nuo 2024 m. rugpjūčio iki 2025 m. kovo mėn. Tyrime dalyvavo 351 bakalauro ir magistro studijų studentas iš Albanijos universitetų, studijuojantis informacines technologijas, kompiuterių inžineriją, verslo informatiką ir taikomąją informatiką. Likerto skalės klausimynas, apimantis požiūrį į besiformuojančias technologijas, pasirengimą Pramonei 5.0, praktinę patirtį, skaitmeninių įgūdžių ugdymą ir pasitikėjimą skaitmeniniu verslumu, pasižymėjo labai aukštu vidiniu suderintumu (Cronbach $\alpha = 0{,}955$). Duomenys analizuoti JASP 0.95.0 programa, taikant aprašomąją statistiką, Mano–Vitnio (Mann–Whitney U) kriterijų ir Bayeso veiksnius (BF_{10}).

Rezultatai atskleidė aiškų skirtumą tarp suvokiamos besiformuojančių technologijų svarbos ir studentų įsivertinamo pasirengimo. Dauguma studentų pritarė, kad DI ir MM turėtų užimti svarbesnę vietą studijų programose ir stiprinti pasirengimą Pramonei 5.0 bei skaitmeniniam verslumui, tačiau tik maždaug pusė jautėsi pasirengę būsimoms profesinėms užduotims. Didelis neutralių atsakymų procentas, ypač kalbant apie Pramonės 5.0 sampratą ir kritinio mąstymo bei problemų sprendimo gebėjimus, rodo nepakankamą sisteminį išmanymą ir fragmentišką atskirų technologijų taikymą. Nors literatūroje pabrėžiama kvantinės kompiuterijos reikšmė ateities IT profesijoms, studentų atsakymai parodė, kad ši sritis studijų turinyje beveik neatsispindi.

Praktinės patirties analizė parodė, kad studentų pasitikėjimas savimi ir pasirengimas karjerai dažnai priklauso nuo realių praktikos galimybių. Nors dalis respondentų jautėsi pakankamai užtikrintai naudodami pažangias technologijas, daug studentų nurodė stokojantys praktinių įgūdžių, ypač blokų grandinės technologijų ir skaitmeninio verslo srityse; beveik pusė neturėjo jokios skaitmeninio verslumo patirties, o tik nedidelė dalis teigė turintys išsamią tokią patirtį. Mann–Whitney U testas ir Bayeso analizė patvirtino, kad išsamus mokymas ir praktinė patirtis su besiformuojančiomis technologijomis statistiškai reikšmingai susiję su didesniu pasirengimu Pramonei 5.0 ir tvirtesniais skaitmeninio verslo įgūdžiais, taip pat patvirtino abi tyrimo hipotezes.

Straipsnyje daroma išvada, kad Albanijos IT studijų programos turi nuosekliau integruoti besiformuojančias technologijas – įskaitant DI, MM, blokų grandines, IoT, VR/AR ir kvantinę kompiuteriją – su praktiniu mokymusi ir skaitmeninio verslumo ugdymu. Rekomenduojama plėsti praktinius DI ir MM kursus, įtraukti taikomus blokų grandinės, IoT ir (ten, kur įmanoma) kvantinės kompiuterijos aspektus, stiprinti universitetų ir verslo bendradarbiavimą bei užtikrinti daugiau realiomis situacijomis paremtų mokymosi galimybių. Nors tyrimas apsiriboja viena šalimi ir yra skerspjūvio pobūdžio, jo įžvalgos yra aktualios ir kitoms pereinamosios ekonomikos šalims, siekiančioms rengti darbo rinkai pasirengusią, Pramonei 5.0 pritaikytą IT specialistų kartą.

Pagrindiniai žodžiai: besiformuojančios technologijos; IT studijos; Pramonė 5.0; skaitmeninės kompetencijos; skaitmeninis verslumas.