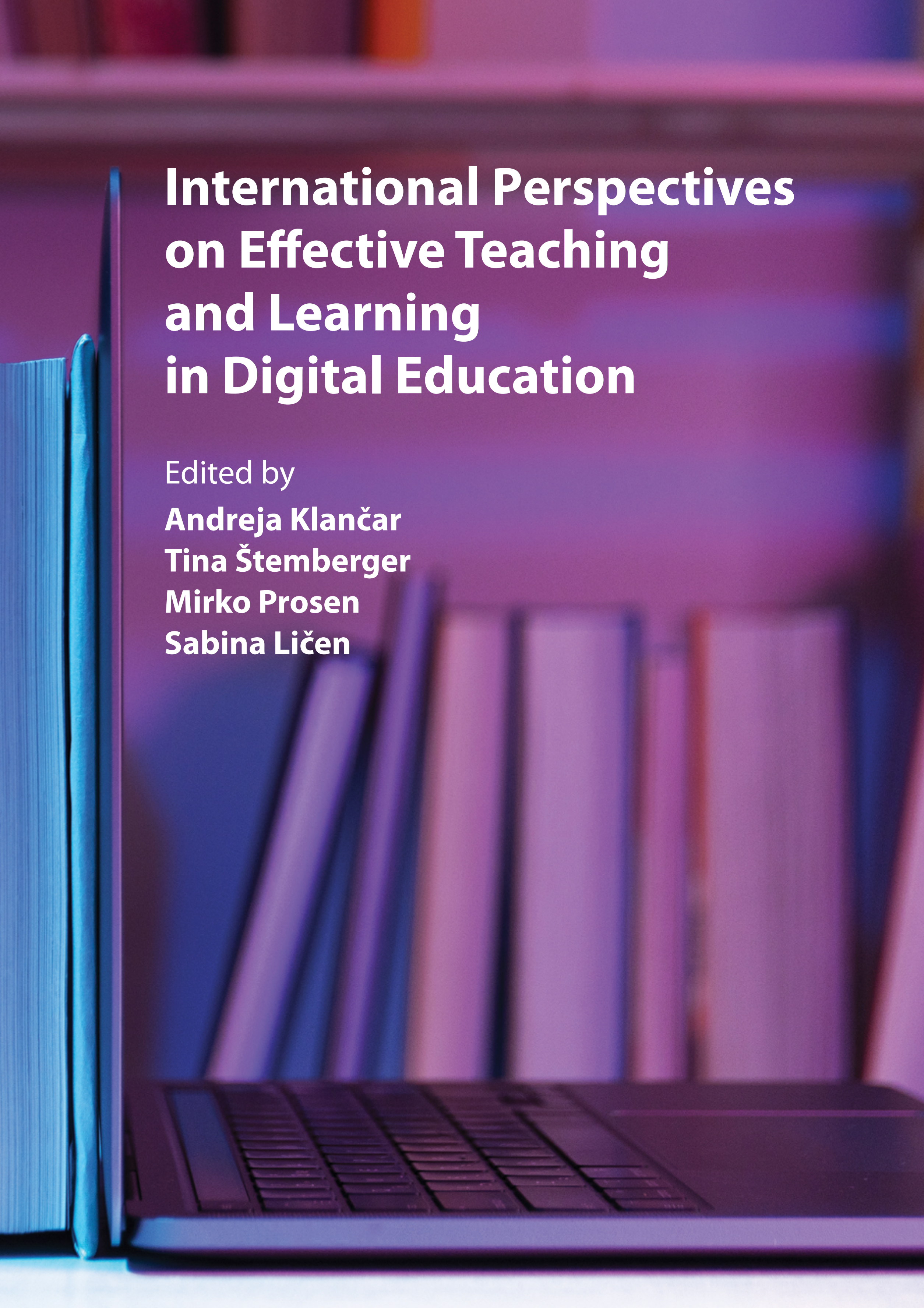

International Perspectives on Effective Teaching and Learning in Digital Education

Edited by

Andreja Klančar
Tina Štemberger
Mirko Prosen
Sabina Ličen

Univerza na Primorskem
Università del Litorale

Fakulteta za vede o zdravju
Facoltà di Scienze della Salute

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Edited by · Andreja Klančar, Tina Štemberger,
Mirko Prosen, and Sabina Ličen
Reviewers · Sonja Čotar Konrad and Jasna Mažgon

Technical editing · Tajda Senica and Davorin Dukič
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Foreword

Andreja Klančar
University of Primorska, Slovenia
andreja.klancar@pef.upr.si

Mirko Prosen
University of Primorska, Slovenia
mirko.prosen@fvz.upr.si

Tina Štemberger
University of Primorska, Slovenia
tina.stemberger@upr.si

Sabina Ličen
University of Primorska, Slovenia
sabina.licen@fvz.upr.si

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The accelerating integration of digital technologies into higher education is not just a gradual process of technical improvement, but a fundamental transformation of pedagogical paradigms, institutional practices and academic culture. The monograph *International Perspectives on Effective Teaching and Learning in Digital Education* provides a timely, detailed, and multifaceted exploration of how digital technologies are transforming pedagogical practices across diverse disciplines, and institutional frameworks. In assembling contributions from international higher education teachers and researchers, this monograph not only maps the contours of digital education but also engages critically with the challenges, possibilities, and ethical considerations it entails.

The opening chapter by Maša Černelič-Bizjak and Sabina Ličen offers an in-depth psychological perspective on digital learning, foregrounding the importance of self-regulated learning, metacognition, motivation, and cognitive load in shaping student engagement and academic outcomes in online environments. Pedro Tadeu and Carlos Brigas follow with a panoramic overview of digital education in the twenty-first century, highlighting global trends and examining both the opportunities and limitations of emerging technologies such as artificial intelligence, gamification, and extended reality. The third chapter, authored by Tina Štemberger and Andreja Klančar, presents a study from the University of Primorska, detailing the adoption of innovative teaching practices in higher education and discussing structural and cultural obstacles to digital innovation. Vesna Ferk Savec and Sanja Jedrinović explore how artificial intelligence can support the green transition in higher education, providing a critical analysis of pedagogical applications and sustainability implications.

In a conceptual contribution, Sabina Ličen and Mirko Prosen synthesise research on inclusive instructional design through an integrative literature review, proposing a digital standard for effective and accessible online course development. The chapter by Barbora Bazalová, Dana Zámečníková, Veronika Včelíková, and Pavla Pitnerová turns attention to students with diverse needs in the Czech Republic, presenting strategies for inclusive digital learning and present tools that enhance participation and equity. Milena Ivanuš Grmek, Monika Mithans, and Sabina Ograjšek examine the digital competences of future teachers, arguing for reforms in initial teacher education to better address technological integration. Danijela Ljubojević and Nikoleta Gutvajn contribute a comparative analysis of foreign language teachers' digital competencies in Serbian higher education institutions, using the DigCompEdu framework to benchmark preparedness.

Mojca Žefran and Silva Bratož focus on inquiry-based learning as a method for cultivating digital skills among university students, providing empirical evidence for learner-centered pedagogies. Stanko Pelc analyses faculty digital literacy and perceptions of technology integration at the University of Primorska, identifying tensions between pedagogical intention and technological proficiency. Martin Červený and Kemal Elyeli examine technology-enhanced teaching methods for nursing students, demonstrating their effectiveness in promoting both knowledge acquisition and skill development. Boris Ilić and colleagues address student engagement in distance learning, offering strategic insights into sustaining participation and motivation in virtual nursing education.

Manuel Lillo-Crespo's chapter addresses culturally congruent digital learning for health professions across Europe, advocating for inclusive practices that support transnational professional mobility. Mateja Lorber, Lucija Gosak, Gregor Štiglic, and Adrijana Svenšek present an interdisciplinary perspective on digital technology in healthcare education, illustrating how digital tools can simultaneously enhance student learning and patient care. In their second contribution, Mirko Prosen and Sabina Ličen investigate students' perceptions of e-learning in nursing education, identifying factors that shape satisfaction and learning efficacy. Igor Karnjuš, Mirko Prosen, and Sabina Ličen explore the use of simulation-based learning for developing cultural competencies in nursing, based on a systematic review of international literature. In a complementary chapter, Igor Karnjuš and colleagues analyse assessment tools for non-technical skills in healthcare simulations, offering a scoping review of evaluation methods for interdisciplinary team training. Betül Tosun and Ayla Yava examine the use of serious digital games in nursing education, demonstrating how game-based learning can foster clinical competence and learner autonomy. The monograph concludes with a compelling contribution by Juan M. Leyva, who proposes digital narrative photography as an innovative method for cultivating empathy in health sciences education, blending digital literacy with affective learning.

These contributions reflect a wide range of research, practice and critical reflection that addresses the complexity and potential of digital education. The monograph underscores the imperative of equity, engagement, and interdisciplinarity in the design of digital learning environments, offering valuable insights for educators, instructional designers, researchers, policymakers and students who want to understand digital transformation in higher education more deeply - not just as a set of tools or techniques, but as a complex, multidimensional phenomenon that requires theoretical sophistication and practical accountability.

We extend our sincere gratitude to all the authors and reviewers for their scientific rigour and collegial dedication, and the production team for their commitment to excellence.

Psychological Factors and Mechanisms of Digital Learning

Maša Černelič-Bizjak
University of Primorska, Slovenia
masa.cernelic@fvz.upr.si

Sabina Ličen
University of Primorska, Slovenia
sabina.licen@fvz.upr.si

The digital environment is different from natural and social environments. Technologies are evolving to support new methods of collaborative learning and interaction. A key challenge is to ensure that technology-enhanced education is effective and creates a supportive environment for students. This requires considering adaptive motivations, emotions, and psychological factors such as intrinsic motivation, cognitive load and self-regulation, all which influence student engagement and success in digital learning.

This chapter provides an overview of literature on psychological processes important in digital learning. Factors such as motivation, cognitive management, and self-regulation shape student performance in these environments. The psychology of digital learning explores the cognitive, emotional, and social dimensions of education in the digital age. Research aims to optimize these environments for better learning outcomes. Understanding these psychological elements is essential for educators to create more effective, engaging, and enjoyable digital learning experiences, though the field is still developing, and many aspects remain to be explored.

Keywords: digital learning, intrinsic motivation, cognitive load, self-regulation, technology-enhanced education

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Introduction

Digital technology presents new learning opportunities and is now a dominant mode of education (Wang et al., 2024). Emerging digital media foster learner autonomy but demand efficient regulation of the learning process for sustained academic progress. Understanding psychological factors, like cognitive load, motivation, and self-regulation, is vital for improving educational outcomes (Edisherashvili et al., 2022). As digital education evolves, supporting self-regulated learning (SRL) becomes crucial for academic success.

This chapter reviews studies to highlight how these interconnected psychological dimensions influence digital learning, aiming to optimize experiences and address challenges unique to online environments.

Self-Regulation and Metacognition

Students in digital environments must regulate their learning through time management, goal setting, and self-monitoring. Strong self-regulation skills are essential for managing time, setting goals, and tracking progress. Metacognitive strategies like planning, monitoring, evaluating, self-assessment, and reflection support learners in staying on track and improving performance (Pintrich, 2002; Schraw & Moshman, 1995). These skills are crucial for successful digital learning. While self-regulation and metacognition are closely related, they are distinct concepts in cognitive science and educational psychology, each playing a unique role in the learning process.

Self-Regulated Learning

Self-regulated learning (SRL) is a key competence of successful learning in digital learning environments, and it is a dynamic process characterized by the active participation of learners. including the cognitive, metacognitive, behavioral, motivational, and emotional/affective aspects of learning (Panadero, 2017). It is often referred to as the driving competence needed for transforming individuals into successful independent learners (Boekaerts, 1991). SRL requires learners' active participation, i.e., they need to activate cognitive and metacognitive learning strategies and to be aware of their prior knowledge and skills (Broadbent, 2017).

Previous studies in digital educational settings (Yilmaz et al., 2020; Bui et al., 2022) suggest that those who can effectively monitor and regulate their cognition, motivation and behavior are more likely to engage in deeper learning and achieve greater academic success than learners with weaker self-regulation skills (Carter et al., 2020). Self-regulated learners could plan their learning, set goals and acquire new knowledge independently (Theobald, 2021).

SRL has been widely investigated by different authors within last three decades to determine how behavioral, motivational, and cognitive components interact, and several models for SRL have been developed. For further reading, see Panadero (2017) overview of models of SRL. However, what the various existing models of SRL have in common is its cyclical process with several phases and areas that are partly overlapping. Panadero (2017) highlighted a three-phase structure identified by Puustinen and Pulkkinen (2001): *Preparation, Performance, and Appraisal*. While these phases may be labeled differently across models, they are consistently present. Based on meta-analytic evidence from existing SRL models, Panadero (2017) draws two key conclusions. First, SRL models offer a broad and cohesive framework that aids in teaching students to be more strategic and efficient learners. Second, the effectiveness of these models depends on the students' developmental stages or educational levels. Thus, researchers and educators must take these differences into account when utilizing SRL models and theories to enhance students' learning outcomes and self-regulation abilities.

However, findings from studies involving higher education students and workplace trainees (Sitzmann & Ely, 2011) indicate that the four strongest predictors – *goal setting, persistence, effort, and self-efficacy* – hold considerable motivational significance and are all encompassed within socio-cognitive theory. These findings are consistent with those of Richardson and colleagues (2012), who identified that (a) self-efficacy is the strongest predictor, (b) goal-setting strategies enhance effort regulation, and (c) comprehensive interventions tend to be more effective. Consequently, it appears that interventions targeting motivational and emotional aspects, such as self-efficacy and goal setting, tend to yield better outcomes for higher education students.

The article by Zeitlhofer et al. (2023) provides practical advice on enhancing learning performance in digital learning environments through the strategic use of prompts. One key recommendation is to *incorporate cognitive prompts* that encourage learners to focus on important information, identify relationships, and organize content, thus improving comprehension and retention of knowledge. The authors also suggest the use of *metacognitive prompts* to foster self-reflection, planning, and monitoring of the learning process, guiding learners in evaluating their understanding and adapting their strategies accordingly. It is important to *balance the frequency of prompts*; they should be provided at appropriate intervals to support learning without causing interruptions. Too frequent prompts can overwhelm learners, while too sparse prompts may not offer sufficient support. Additionally, prompts should be *customized based on individual learner needs*, optimizing their effectiveness by catering to learners at various stages of their learning journey. Lastly, the authors (Zeitlhofer et al., 2023) advise using *interactive digital tools* that allow for engagement with prompts. These tools can track progress and provide adaptive feedback, further enhancing the learning process in digital environments. In summary, the article emphasizes that cognitive and metacognitive prompts, when strategically implemented, can significantly improve learning outcomes in digital settings.

Metacognition

Metacognition encompasses the processes through which individuals assess their own understanding and adapt their learning strategies accordingly, improving problem-solving and decision-making. Metacognition is defined as 'thinking about thinking' or the ability to monitor and control one's cognitive processes (Dunlosky & Metcalfe, 2008) and comprises both the ability to be aware of one's cognitive processes (metacognitive knowledge) and to regulate them (metacognitive control) (Fleur et al., 2021). Metacognition plays an important role in learning and education (Pintrich, 2002). By fostering metacognitive skills, learners become more effective in planning, monitoring, and evaluating their cognitive activities, which enhances their overall academic performance.

In the field of educational sciences, there is extensive research on metacognitive training, but we lack a solid understanding of what methods are most effective and why. While some studies suggest that enhancing metacognitive skills improves academic performance (Dignath et al., 2008), other interventions show inconsistent results (Jacob & Parkinson, 2015; Kassai et al., 2019), and there remains limited understanding of their long-term impact or transfer effects. So, there is still a need to establish clear links between metacognition in the brain and its application in areas such as education. Furthermore, educational and cognitive neuroscientists explore metacognition in different contexts and using different methods. While cognitive neuroscientists often examine metacognition through behavioral tasks (such as Flanker tasks, Stroop task...), educational researchers tend to rely primarily on introspective, self-report questionnaires or interviews (Dinsmore et al., 2008). It remains uncertain to what degree these differing approaches to measuring metacognition align and represent the same underlying processes. Gaining a deeper understanding of the cognitive processes that underpin metacognition and their representation in the brain could offer valuable insights into these aspects. In recent years, there has been a lot of progress in brain research, studying the neural mechanisms of metacognition (Vaccaro & Fleming, 2018), and starting to orient itself towards training metacognitive abilities that would translate into real-life benefits, yet it is unclear at this point how these results may inform educational sciences or interventions.

In cognitive neuroscience, metacognition research follows two paths: one explores meta-knowledge, focusing on the neural basis of introspective judgments about one's own cognition (i.e., metacognitive judgements), and meta-control with experiments involving cognitive offloading (e.g., subjects can perform actions such as set reminders, making notes and delegating tasks) (Risko & Gilbert, 2016; Gilbert et al. 2020), while the other investigates executive functions (EF), also referred to as cognitive control (Fernandez-Duque et al., 2000), which is closely related to metacognition.

However, it is important for researchers and practitioners to know how to improve learning in digital environments. Braad and colleagues (2022) focus their research on the importance of metacognitive support in SRL and investigated a detached approach in which digital metacognitive support is provided in parallel to ongoing domain-specific training via a digital tool. The results suggest that students should be encouraged to assess and improve their metacognitive skills, increase their metacognitive knowledge and improve their metacognitive skills. Types of support include direct instruction on how to use metacognitive strategies effectively, metacognitive scaffolding (like using virtual characters to guide learners), and metacognitive prompts that remind students to self-monitor and regulate their learning process. The results also indicated that, while students with higher metacognition found a lack of relevance of using the tool, students with lower metacognition are less likely to make (structural) use of the available support. A key challenge for future research is thus to adapt metacognitive support to learner needs, and to provide metacognitive support to those who would benefit from it the most. Devers et al. (2018) emphasize using instructional support to improve SRL and metacognition. This support includes strategies such as direct teaching of metacognitive processes and providing environments that limit distractions. They point out that teacher expectations and feedback can significantly impact students' ability to self-regulate

Motivation

One of the key factors contributing to the success of digital learning is the student's motivation. Motivation to learn is a key psychological concept in education and one of the most important factors determining success in different learning environments, including digital ones, that drives students to engage in learning (Hartnett, 2016; Faridah et al., 2020; Berestova et al., 2022).

In digital learning environment, cognitive motivation, which involves motivation for conscious action, plays a crucial role (De Leeuw et al., 2019). In addition, in a digital environment, where learners experience more autonomy and flexibility, intrinsic motivators such as curiosity, personal achievement, and self-determination play a key role in their success (Hsu et al., 2019). Learners must often rely on intrinsic motivation because the absence of face-to-face interaction can reduce external motivators, such as direct praise from instructors or peer pressure. Some studies (e.g. Soffer & Nachmias, 2018) reinforce the idea that well-designed digital learning platforms, with rich interactive content, are key to engaging learners and fostering intrinsic motivation. Typically, digital learning is externally regulated, meaning that many students tend to complete assignments driven primarily by extrinsic motivation. Without adequate educator support that emphasizes the value of e-learning, there is a risk that students' motivation may decline into amotivation, as their online learning experiences may lack sufficient motivational regulation (Fryer & Bovee, 2016).

To increase learner motivation and engagement in both traditional and digital environments, Keller's ARCS model (Keller, 1987) is widely used in instructional design. From the perspective of digital learning (Keller, 2009), the 'A' in Keller's ARCS model stands for '*Attention*', which emphasizes the importance of creating an engaging and attractive online or technology-enhanced environment. This involves considering the design elements, interactivity, and presentation formats that capture and sustain learners' attention and curiosity. The visual appeal and interactive nature of digital platforms play a key role in drawing learners in and keeping them motivated throughout the learning process. The 'R' stands for '*Relevance*', which involves ensuring that the content is meaningful and applicable to learners' goals, needs, and interests. In digital learning, this means creating content that connects with learners' prior knowledge, future aspirations, or personal interests, and making it clear how the material will benefit them in real-world situations. By aligning content with the learners' objectives, digital platforms can maintain their engagement and motivation throughout the learning process. The 'C' stands for '*Confidence*', which refers to ensuring that learners feel capable of successfully completing the tasks or mastering the content. In digital learning, this involves designing activities and providing feedback that build learners' belief in their own abilities. When learners are gradually challenged in ways that match their skill level and receive positive reinforcement, they develop the confidence needed to persist and succeed in their learning journey. The 'S' stands for '*Satisfaction*', which refers to ensuring that learners feel a sense of accomplishment and reward after completing tasks or learning activities. In digital learning, this can be achieved through positive feedback, recognition of achievements, and offering opportunities for learners to apply what they've learned in meaningful ways. By ensuring learners feel satisfied with their progress and outcomes, digital platforms help sustain their motivation and encourage continued engagement with the material. In digital learning, the satisfaction that learners experience is crucial for sustaining motivation and engagement.

Recent studies emphasize that satisfaction in digital environments often comes from a combination of well-designed technological platforms, interactive elements, and emotional engagement (Li et al., 2023). For example, a study published in 2024 (Yin et al., 2024) revealed that learning satisfaction is not merely driven by a student's adoption of new learning technology, but also by a range of cognitive and emotional attributes that reflect the user's positive perception of and engagement within the system. In other words, students with a positive attitude toward technology are more likely to perceive the design intentions for fostering advanced thinking, actively communicate and collaborate with peers, and emotionally invest in the learning process. These affirmative experiences, in turn, result in higher satisfaction with the digital learning experience. In digital and e-learning environments, students' satisfaction significantly improves due to the perceived ease of access, intuitive navigation, interactivity, and user-friendly interface design, especially when compared to traditional education methods (De Leeuw et al., 2019). Overall, several factors can influence students' satisfaction with learning and, in turn, their motivation to achieve better outcomes. These factors include feedback, progress, and internal rewards. Students' perceptions of satisfaction may vary based on prior experiences, technological familiarity, and individual preferences (Faridah et al., 2020).

Various motivational theories, such as self-determination theory (SDT) (Ryan & Deci, 2020), expectancy-value theory (Wigfield & Eccles, 2000), achievement goal theory (Senko et al., 2011), and control-value theory (Pekrun et al., 2017), have been widely applied to understand factors that boost students' learning and engagement. These theories examine how environmental and psychological factors influence motivation and learning. While effective in traditional settings (Lazowski & Hulleman, 2016), there has been limited exploration of how these theories can be adapted to enhance online learning and engagement in technology-driven environments (Chiu, 2021; Hsu et al., 2019).

Despite the limited focus on adapting motivation theories for digital contexts, learner motivation remains a key factor for successful SRL, which is presented in the previous section. As a reference discussing the importance of learners' motivation in SRL within digital learning, Artino (2008) explores how motivation plays a critical role in digital environments, highlighting the interaction between motivational beliefs and the use of self-regulatory strategies in online learning contexts.

For conclusion, to foster motivation in digital learning, educators can implement strategies such as personalized learning pathways, gamification elements, and interactive content that actively engages students (Huang et al., 2020). Gamification elements, such as point systems, badges, and leaderboards, can increase student engagement by introducing a sense of achievement and competition. Providing timely and constructive feedback, along with opportunities for social interaction and collaboration, can enhance students' sense of autonomy and competence, reinforcing intrinsic motivation (Deci & Ryan, 2000). Integrating social components, such as collaborative learning, discussion forums, and virtual study groups, which promote a sense of belonging and social connection. This social presence can positively influence motivation and long-term engagement in digital learning. Timely and personalized feedback is also essential when students receive immediate, specific feedback tailored to their progress, they are more likely to stay motivated and persist in their learning efforts. Additionally, incorporating real-world applications and goal-setting techniques helps learners see the relevance of their studies, increasing their persistence and overall engagement in digital environments (Pintrich, 2003). By incorporating these strategies, digital learning environments can better support student motivation, ensuring sustained interest and improved learning outcomes.

Cognitive Load and Information Processing

Cognitive load and information processing are important psychological factors in digital learning. Given the rapid development of digital learning, it is important to advance the understanding of cognitive load theory (CLT) in line with this growing body of research (Skulmowski & Xu, 2022).

In cognitive psychology, cognitive load refers to the amount of working memory resources used. Cognitive load can be understood as the mental effort required to process and retain information, which is limited by the constraints of working memory. Effective instructional design aims to manage these cognitive demands to optimize learning and prevent cognitive overload, and CLT describes the different categories of load that can occupy their memory capacity (Sweller et al., 1998). CLT suggests that excessive information can overwhelm a learner's working memory, thereby reducing their ability to learn effectively. The central focus of CLT categorizes the demands on working memory into three types*:* intrinsic cognitive load (ICL), extraneous cognitive load (ECL), and germane cognitive load (GCL) (Sweller et al., 1998). Intrinsic cognitive load is the effort associated with understanding a specific topic, extraneous cognitive load relates to how information or tasks are presented, and germane cognitive load involves the effort put into creating a permanent store of knowledge (Sweller et al., 2019). However, over the years, the additive nature of these types of cognitive load has been examined and questioned. It is now believed that they influence each other in a more circular manner.

Recent research (Skulmowski & Xu, 2022; *Orru & Longo, 2019;* Januchta et al., 2022) emphasizes that cognitive load and information processing are crucial factors in digital learning environments. The latest studies expand on CLT by refining its model to better fit the complexities of digital learning settings, highlighting ICL, ECL, and GCL as key components to consider. ICL relates to the complexity of the learning material itself and varies depending on the learner's level of expertise. Recent studies suggest that while ICL cannot be modified through instructional design, it can be managed by gradually increasing complexity and matching content to the learner's prior knowledge (Skulmowski & Xu, 2022). In addition, ECL arises mainly from how information is presented, including poorly designed digital tools that may clutter the interface with irrelevant elements. Reducing extraneous load by streamlining design and focusing on essential information is critical to freeing up cognitive resources for deeper learning (Januchta et al., 2022). Moreover, GCL refers to the cognitive resources devoted to processing and integrating new knowledge into long-term memory. Recent work emphasizes that reducing extraneous load creates more cognitive capacity for germane processes, thereby fostering deeper learning (Skulmowski & Xu, 2022).

Overall, these findings stress the importance of optimizing the design of digital learning environments to balance cognitive load. Digital platforms often present learners with vast amounts of information, which can overwhelm their working memory if not managed effectively. Inappropriate instructional formats can increase extraneous cognitive load, making it harder for students to learn (Abeysekera et al., 2024). Simplifying interfaces, focusing on essential content, and supporting learners with tools that align with cognitive processing principles can significantly enhance information retention and learning outcomes. To further support teachers in optimizing digital learning environments, adaptive learning technologies that personalize content based on individual learners' progress and performance can be implemented. These technologies adjust the difficulty and pacing of learning tasks to match students' cognitive capacities, thereby reducing cognitive overload. Studies, such as by Dziuban et al. (2016), indicate that adaptive learning environments can align with students' cognitive capacities, enhancing learning efficiency.

Attention and Engagement

Attention plays a crucial role in processing information and retaining knowledge, and the ability to focus attention effectively is directly linked to better learning outcomes and memory retention (Chun et al., 2011). Numerous studies in cognitive psychology have shown that humans have a limited capacity for sustained attention, allowing them to focus on a specific task for only a finite period (Oberauer, 2019). This capacity is flexible and can change based on factors such as the task's complexity and individual aspects like interest, motivation, and experience.

However, the rapid proliferation of digital tools, including smartphones and social media, has introduced new difficulties in maintaining prolonged focus, making constant distraction more accessible than ever. Maintaining attention in digital learning environments is challenging due to potential distractions like social media, constant notifications, multitasking, and the flexible nature of online formats. According to research by the Coalition for Psychology in Schools and Education (2020), strategies such as limiting distractions, using interactive elements, and promoting active engagement can help improve learning retention. These approaches emphasize the importance of creating a focused and engaging online learning environment for students.

Research indicates that the digital environment introduces challenges for maintaining sustained focus due to the constant influx of stimuli, including messages, alerts, and digital interruptions. This phenomenon, known as '*continuous partial attention*', can lead to superficial understanding and decreased ability to concentrate (Kirjakovski, 2023). 'Continuous partial attention' describes the ongoing process of dividing and shifting focus between multiple tasks or stimuli without fully engaging in any of them. This practice often results in a shallow understanding of information and diminished concentration on any single task. As noted by Firth et al. (2019), we have moved from the 'information age' into an 'age of interruption.' This phenomenon, identified by Stone (2007), is a symptom of attentional overload, which occurs when environmental demands exceed an individual's available attentional resources. In the digital world, this overload is driven by a constant stream of stimuli, such as alerts, personalized notifications, social media updates, emails, texts, and news feeds, all vying for our attention. Moreover, frequent interruptions in digital settings, such as checking smartphones or engaging with social media, can overload attentional capacity, impacting cognitive performance and learning outcomes. Studies (Shanmugasundaram & Tamilarasu, 2023) show that excessive use of smartphones and multitasking are linked to poorer attentional control, making it difficult for learners to maintain focus on their tasks.

Engagement, Interactive Methods and Microlearning: Practical Approaches for Maintaining Attention in Digital Learning Environments

Engagement through interactive learning methods, such as quizzes, polls, and gamified elements, plays a crucial role in enhancing learning outcomes in digital environments. These methods help transform passive learning into an active process, as they require learners to actively participate, apply knowledge, and receive immediate feedback (Dichev & Dicheva, 2017). For instance, quizzes can serve as knowledge checkpoints, allowing students to assess their understanding and identify areas for improvement. Similarly, polls and interactive discussions encourage active reflection and help maintain focus by involving learners directly in the material. The use of gamification has been shown to increase not just short-term engagement but also long-term retention by making learning experiences more enjoyable and rewarding (Hamari et al., 2014). Gamified elements, like points, badges, and leaderboards, further boost motivation and engagement by incorporating elements of competition and reward. This approach taps into intrinsic motivators, encouraging learners to remain attentive and committed to the learning process.

Microlearning is another highly effective strategy for maintaining attention and enhancing retention in digital environments. By breaking content into smaller, focused lessons, microlearning minimizes cognitive overload, which can occur when learners are exposed to large amounts of information at once (Hug & Friesen, 2007). Short, targeted lessons align with the natural attention span of learners, making it easier for them to absorb and retain key concepts. This approach supports spaced repetition, a method proven to enhance long-term memory by revisiting information at intervals (Smolen et al., 2016).

To summarize, both interactive methods and microlearning provide practical approaches for maintaining attention in digital learning environments. By promoting active engagement and managing cognitive load, these strategies foster a more effective and sustainable learning process.

Conclusion

In conclusion, the reviewed studies emphasize that digital learning environments require effective support for self-regulation, motivation, and metacognition to enhance educational outcomes. Self-regulated learning (SRL) and metacognitive strategies are critical for managing the learning process, while motivation significantly impacts learners' engagement and success. Optimizing cognitive load through proper instructional design and balancing attention through interactive methods and microlearning can further enhance learning effectiveness. Overall, tailored interventions that consider individual learner needs are vital for supporting sustainable academic progress in digital settings.

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Psihološki dejavniki in mehanizmi digitalnega učenja

Digitalno okolje se razlikuje od naravnega in družbenega okolja. Tehnologije se razvijajo in podpirajo nove metode sodelovalnega učenja ter interakcij. Ključni izziv je zagotoviti, da bo izobraževanje, podprto s tehnologijo, učinkovito in bo ustvarjalo spodbudno okolje za učence. Pri tem je treba upoštevati motivacijo, čustva in psihološke dejavnike, kot so notranja motivacija, kognitivna obremenitev in samoregulacija, ki vplivajo na vključenost in uspešnost učencev pri digitalnem učenju.

To poglavje vsebuje pregled literature o psiholoških procesih, pomembnih za digitalno učenje. Dejavniki, kot so motivacija, upravljanje kognitivnih procesov in samoregulacija, oblikujejo uspešnost učencev v teh okoljih. Psihologija digitalnega učenja raziskuje kognitivne, čustvene in socialne razsežnosti izobraževanja v digitalni dobi. Cilj raziskav je optimizirati ta okolja za boljše učne rezultate. Razumevanje teh psiholoških elementov je ključnega pomena za izobraževalce, da ustvarijo učinkovitejše, zanimivejše in prijetnejše digitalne učne izkušnje, čeprav se področje še vedno razvija in je treba raziskati še veliko vidikov.

Ključne besede: digitalno učenje, intrinzična motivacija, kognitivna obremenitev, samoregulacija, tehnološko podprto izobraževanje

The Panorama of Digital Education in the XXI Century

Pedro Tadeu
Polytechnic University of Guarda, Portugal
ptadeu@ipg.pt

Carlos Brigas
Polytechnic University of Guarda, Portugal
brigas@ipg.pt

This chapter aims to analyse digital education in the twenty-first century, a complicated topic with tremendous advancements and challenges. We analyse digital education from different angles and like this we want to analyse his substantial significance in the modern education framework. This approach highlights several benefits, such as extensive educational opportunities, engaging and dynamic learning opportunities, and tailored training that meets each learner's needs. However, we also discuss the inherent challenges that the digital education brings to us nowadays, they include the availability and fairness, the technology limitations, and the absence of in-person social interaction. Another important aspect to analyse is the significant impact of the digital education on the pedagogical approaches and how the digital education could affect globalisation, specifically how it might help people engage across cultural boundaries and overcome specific constraints. To conclude, we also analyse new trends like gamification, virtual and augmented reality, and artificial intelligence to find possible future directions for digital education. The chapter ends by stating that to fully realise the potential of digital education and create an inclusive and successful learning environment for the future, these opportunities and challenges must be continuously explored.

Keywords: digital education, artificial intelligence, ict tools, challenges, opportunities

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Introduction

Goals

The chapter look to the perspectives and experiences of digital education in the education institutions. This is a very important topic since recent studies indicate that digital education can significantly influence students' learning experiences and outcomes (Nurmalisa et al., 2023; Gutiérrez-Ángel et al., 2022; Brown, 2020). The aim is to try to analyse the different perspectives from the education setting, which includes students and teachers, which is probably the most important group to listen to in times like this. So let's enter into a fruitful discussion in the following sections.

Background and History of Digital Education

Digital education, which is sometimes also known as e-learning, has become a crucial element of the modern educational organisation since it has changed how our knowledge is disseminated and acquired (Smith, 2018). The digital technologies and their subsequent integration into educational settings have significantly transformed the education as we have today, and these technologies have greatly expanded education's scope, facilitated personalised learning, and fostered global collaboration (Johnson & Adams, 2011).

The 1980s was the initial phase of integrating digital technologies into educational settings. This period saw the introduction of computers into the classrooms, which paved the way for using digital tools in the teaching and learning processes (Johnson & Adams, 2011). But even if most of the time the computers were there, actually they were not operating since the teachers' lack of formation. This period testifies to the change and transformation from traditional teaching methods to innovative ones with digital tools. This was the beginning of the role of digital technologies in the educational process with the integrating of computers into the educational setting. This has opened the way for a more interactive and engaging learning experience, marking the first step towards a digital revolution in education (Bates, 2015).

The rise of the Internet in the 1990s has transformed education by increasing the accessibility of educational resources and, at the same time, allowed the exchange of knowledge beyond geographical boundaries, something never imagined until then. This time marked the beginning of a modification from the traditional classroom-based education to a more flexible and accessible way of learning inside and outside our classrooms. The World Wide Web had opens the door to an incredible scale of possibilities by providing not only the door, but also the keys to a vast set of information that was previously isolated from the common public. Suddenly the world have access to online resources such as, e-books, educational websites, and digital libraries. We pass from traditional classroom-based education to a more flexible, innovative and accessible way of learning. This enable the learners to have access to educational content anytime, anywhere (Clark & Mayer, 2016). Of course, there is still difficulty in how these aspects reshape the school environment. Shifting from the traditional to an equilibrium of the digital age is a hard process that needs to be understood and continued work by all.

The turn of the millennium, entering the XXI century, saw the rise of virtual classrooms and Massive Open Online Courses (MOOCs). It was a time for great innovation and creation, and the so called virtual classrooms, allowed a real-time interaction within the classroom environment. Like this the education system could break geographical barriers, turning education more accessible to all. The MOOCs, on the other hand, were offering free, and high-quality, courses from a wide range of known universities worldwide. These types of platforms have democratised education by enabling anyone with a moderate internet connection to access courses from some of the world's best institutions (Bates, 2015). So, a proliferation of online courses and digital resources in Higher Education Institutions (HEI) reshaped the educational ecosystem. The start of digital education has seen a significant expansion in the online offerings of many of the world's largest universities. They quickly embrace this opportunity, offering various online courses and degree programs (Hollands & Tirthali, 2014). Institutions like Harvard, MIT, and Stanford have been leading this process of online education revolution, proposing courses and programs to students globally (Christensen et al., 2013).

Besides the universities, there were also new companies that start to providing online courses to the general public, they also have marked the digital education system. Companies like Coursera, Udacity, and Khan Academy have made high-quality educational content accessible to millions worldwide (Shah, 2020), and these, often called ed-tech startups, have stated a democratised access to education. These platforms offer a wide range of courses, from K-12 to higher education and professional development, most of the times they have partnerships with top universities to ensure the quality of what they are offering to the public (Sharma, 2024). The rise of these companies represents a significant shift in the education sector, with online learning becoming an increasingly mainstream option for a very large percentage of people (eSchool News Staff, 2020).

So, integrating digital technologies into education has revealed new opportunities, such as the fact that education can reach a wider audience, provide flexible learning options, and offer a diverse range of educational resources (Brown, 2020).

In one hand, the rise of digital education has taken numerous opportunities to the education panorama, but also had introduced new challenges. Issues related to digital literacy have become increasingly important, essentialy because not all learners possess the necessary skills to surf and learn from online platforms effectively (Van Deursen & Van Dijk, 2019). Other very important issue is the data privacy that has shaken the world (not only that time but even more nowadays). Since almost all the online learning platforms often collect a significant amount of personal data from the users, this start to raise questions about how this information is stored, used, and protected (Sullivan & Egelman, 2020).

Moreover, the gap between those with access to digital technologies and those without has also increased the turn to online learning, potentially worsening existing educational inequalities (Robinson et al., 2015). We know that not everyone has equal access to digital education, which makes digital education even more exclusive for some.

Despite all the significant changes made in digital education, there are still several issues that remain as major obstacles, another one is the internet connectivity. This is one of the major issues, since it is a fundamental requirement for digital education; yet, a significant portion of the global population still misses a good internet access. If we pay attention to the United Nations' International Telecommunication Union (ITU) (2020), in 2019 only 53.6% of the world population have Internet access, this study also says that in 2023 approximately 67% of the world's population was using the Internet, leaving around 2.6 billion people still offline. This is a huge gap, particularly in the developing countries, where internet penetration rates are very low. The lack of internet connectivity is due to many aspects, some of them are related to infrastructure problems, affordability, and the digital literacy also plays a key role. In many rural and remote areas, the necessary infrastructure for internet connectivity simply didn't exist, even if in some areas there exist infrastructure, the real cost of internet services that are provided can be very high for the common public. Even when the public have access to the Internet, there is still a lack of digital literacy skills that didn't allow these persons to use effectively the digital educational resources (Van Dijk, 2006). This digital gap has significant implications for education since it exacerbates existing educational inequalities, as, for instance, those without internet access cannot benefit from online educational resources. This type of problems has been particularly notice during the COVID-19 pandemic, when almost every educational institutions turned to the online process. Students that didn't have a reliable internet access were significantly in disadvantaged comparing to their colleagues. In this way we have open even more the educational breach (Reimers & Schleicher, 2020). So, dealing with the issue of internet connectivity is one of the crucial steps for the future of digital education. There should be made efforts to improve infrastructure, making internet services more affordable to the general public, enhancing also the digital literacy skills. Only then, we can start thinking on a fully acomplished digital education – in a world where high-quality education is accessible to all, regardless of location or socioeconomic status.

Nevertheless, this extraordinary evolution/revolution was achieved due to the many individuals and organisations that played important roles. Investigators like Seymour Papert have introduced innovative concepts that really form the basis of many modern educational technologies (Papert & Harel, 1991). Companies and organizations, like the Khan Academy, have made significant contributions by providing free, high-quality educational content online, thereby democratising access to education (Khan, 2012). These type of contributions have changed the digital education environment, carrying the world to innovation and expanding the way to learning. As we move forward, the technology rapid development continues, which redefine a new frontier on education, offering new possibilities for teaching and learning. However, to be a real opportunity, the existing disadvantages need to be considered in the equation. Education should be for everybody.

So, the digital education landscape continually evolves, becoming increasingly complex as new technologies and trends emerge daily. The rapid pace of technological advancement presents both opportunities and challenges in education.

The new technologies can transform the teaching and learning process, because they can make education more interactive, engaging, personalised and like this open the persons to new communication, collaboration, and creative expression possibilities. For example, advancements in artificial intelligence and machine learning enable the development of adaptive learning systems that can fit the individual needs of each student, while virtual and augmented reality technologies are creating new opportunities for immersive, experiential learning (Weller, 2021). On the other side, the speed that these technologies appear, can make it very difficult for educators and institutions to keep up. The integration into the classroom always requires a financial investment, which most of time mean, government support. Even when we have good conditions and proper tech, it is very important to spend a significant amount of time and efforts to learn how to use them effectively. Everybody know that the change can promote instability and uncertainty, this is something that usually happens also on the educators side when using the technology. It is possible that they may feel pressure to keep up constantly updated, for this reason, the knowledge triangle (professors, students, community) must stay connected on the technological change, carefully evaluating new technologies' potential benefits and challenges before adopting them to the classroom (Facer & Selwyn, 2021).

Another very important toll is the Virtual reality (VR) integration in education. It has gained significant attention, particularly in HEI, since VR can provide students with teaching aids closer to real life, rich and diverse personalised learning environments, and change traditional classrooms (Ding &

Li, 2022). The VR technology has been described as a learning aid for the 21st century, there are studies showing that students retain more information and can better apply what they learn after engaging in VR exercises (Rogers, 2019; Krokos et al., 2019). The use of VR with students has been analysed by some authors, these studies shown that they could have positive effects, mainly because they can affect students' behaviours and learning results (Ding & Li, 2022). But, it is also notice that most of the time students often miss guidance and training while using the VR equipment. This can have implications on the effectiveness of VR in education (Ding & Li, 2022). Other important aspect is that the equipments often used in HEI are mainly computers and headsets, which are not portable enough yet (Ding & Li, 2022). This highlights the need for more portable and user-friendly VR devices in education to enhance the learning experience for students. Something that started to be considered by the major companies since the latest breaks through and novelties.

Another emerging trend is using Artificial Intelligence (AI) in personalised learning. AI has the potential to revolutionise education by providing personalised learning experiences tailored to each student's unique needs and abilities. Still, this needs to be handled with caution.

These AI systems can lead to more effective learning outcomes by ensuring students are challenged at the appropriate level and receive the support they need to succeed (Weller, 2021). The AI systems can adjust learning according to the requirements of each student, providing a differentiated level of education and transforming the education sector with a smart content such as digitalised books, video lectures, and lecture notes (Hyder, 2022). This smart content makes access to education easy as it can be accessed remotely, expanding learning opportunities. Moreover, AI applications assist teachers in various tasks, allowing them to concentrate on tasks that require a personal touch. These applications use various techniques to collect and analyse accurate data to predict students' learning patterns and identify their educational needs (Hyder, 2022). Another important aspect is that AI can help students to plan each step of the learning process, such as pre-class preparation and searching for learning materials. It can provide personalised tutoring based on the preferences of the students and also facilitate the distance education (Al-Emran et al., 2022).

Nevertheless, and like always happens when breakthroughs exist, it is important to note that while AI provides many advantages in the education service, it also comes with ethical risks. This main aspect truly scared the common population and the education community. Within this risks, we include the potential for data security breaches, the risk of educational inequality due to the provision of discriminatory data by AI applications, and the potential for students to become dependent on fragmented digital information (Al-Emran et al., 2022). The ethical implications of AI in education must be carefully considered by all intervinentes.

Other important change in last year's education panorama was the COVID-19 pandemic, because it has also significantly impacted digital education in that moment and for the future. Suddenly, the pandemic has forced a shift by all of us to the remote learning. While doing this, it has accelerated the implementation of digital education. This change has presented several challenges and opportunities, since the educators, students, famillies, had been forced to adapt quickly to new types of teaching and learning. On the other side, it has also showned the potential of digital education to provide flexible, accessible learning opportunities, even in times of crisis (Hodges et al., 2020).

In spite of these obstacles and challenges, the digital education has tremendous potential. According to Brown (2020), when we use digital education reforms, and how we instruct and are instructed, makes the learning process more open, individualised, and collaborative. But, to properly capitalise on the promise of digital education, it is necessary to find possible solutions to the problems that we mention before, this way we ensure that it is inclusive and available to everyone.

If we take a look to the future, experts in this field of research, have made several predictions based on the current trends. According to Facer and Selwyn (2021), the integration of advanced technologies like the previous ones, VR and AI in education is expected to continue, and the change towards remote learning is likely to persist. This suggests that digital education will continue to play a significant role in the future of education. Fernández-Batanero et al. (2022) highlight, the significant role of online education during the COVID-19 pandemic, suggesting that online education is the future direction in HEI which means that institutions have to invest even more in online education platforms and improve faculty training plans. This shows the importance of the continued investment, that could ensure that the institutions are always prepared for the challenges, at the same time they need to continue providing high-quality and accessible education to all students.

Views on Digital Education

Perspectives from Educators

When we focus on the educator side, they usually view the digital education as a transformative force in teaching and learning, and they appreciate its flexibility, allowing students to learn at their own pace and on their schedule.

They also understand the great value of digital tools to provide immediate feedback, which can help the students to identify weak areas, allowing to focus their study. But, educators also express concerns and afraid about the digital divide and the potential for digital education to extend even more the educational inequalities. They are worry that students could be left behind because due to the poor access to technology (Selwyn, 2016).

In the context of HEI, the digital transformation is often understand as a double-edged blade. In one hand, it can enhance accessibility and inclusivity, reducing inequality by making rich content and innovative curricula available online (Alenezi et al., 2023), but, on the other side, educators express their concerns about the potential to create a division between 'elite' students (have access to high-quality face-to-face education) and the 'masses' who are relegated to distance learning (Rogozin et al., 2022, pp. 271–286).

Moreover, educators are aware of the challenges that come with digitalising education. They recognise that introducing digital technologies in the classroom requires a shift in traditional teaching paradigms and can place additional pressure on students (Alenezi et al., 2023). They also acknowledge that the effective implementation of digital education goes beyond merely equipping schools with the latest technology, this is not enough. It requires a comprehensive approach that considers teachers' attitudes, motivation, mastery of methodology, and other organisational factors (Szyszka et al., 2022, p. 3).

Despite these challenges, educators remain committed to using the potential of digital education. They consistently use the digital teaching aids and are willing to experiment with different forms of ICT in their teaching practice (Szyszka et al., 2022, p. 15). They also identify the importance of having support from the school management in facilitating the digital transformation of education (Szyszka et al., 2022, p. 15). An aspect directly connected to the leadership in institutions since the management needs to foster a culture of trust and openness to embrace the change. This can help alleviate the resistance to digital transformation and encourage teachers to experiment with different forms of ICT in their teaching practice.

While educators acknowledge the potential of digital education to revolutionise teaching and learning, they also recognise the challenges and complexities involved in its implementation. As such, they believe in a balanced and thoughtful approach to digital transformation that considers all students' diverse needs and circumstances.

Perspectives from Students

The majority of students have a positive attitude towards learning through digital means. They value its convenience and adaptability, particularly those who see their education with other commitments such as a job or family. They also point out the flexibility that this brings to their lifes, they can tailor their educational experience, giving them control, knowing when and how they acquire new knowledge. Despite this, students expressed concerns over the possibility of isolation and the absence of face-to-face interaction that may result from using digital education (Margaryan et al., 2015).

Further research indicates that students actively seek ways to improve their learning experience through digital means (Yu & Bryant, 2019). They appreciate the intersection of their personal, digital, and educational lives, which shapes their learning experience. Digital storytelling and narrative techniques have been found to engage student learning, replace assessments, create new knowledge, and support creative writing and teaching (Yu & Bryant, 2019) in the digital environment.

Today's learners are much more autonomous than ever, and the digital age offers them a wealth of information at a hand of distance. This autonomy is not just about having access to information but also about the ability to critically evaluate, interpret, and apply this type of information in several contexts. So, the digital environment has transformed the traditional learning landscape, enabling these students to take control of their learning pathways. They can now choose what, when, and how the learning could happen. While doing this, they create personal networks, collaborate with peers, and use ICT to access relevant information (Selwyn & Gašević, 2020; Tondeur et al., 2017). This action of integrating, for instance, social media platforms and other digital tools into the learning process has also brought different challenges, such as social isolation, pressure, and engagement (Teräs et al., 2020).

Despite these challenges, students have developed personal interpretations of their identity within the community. They have formed personal and professional connections through tutorials, lectures, peer-assisted groups, and various societal meetings and hope to keep these connections even after graduation (Kasa et al., 2021). So, the perspective is slightly different from the point of view of the teacher, who tends to find digital education as the key solution rather than another tool to promote knowledge.

Perspectives from Education Community

The educational community recognises digital education's potential but acknowledges its challenges. Still, it considers that implementation and ongoing support are required for digital education to be really effective. So, the community continues to explore this field, seeking to understand how best to use digital tools for learning and teaching and to address the challenges that arise (Teräs et al., 2020; Kivunja, 2014).

Despite all the normal inherent complexities, several initiatives aim to link the digital divide and enhance access and equity within the education system. We could present some interesting examples. For instance, the ERASMUS+ program, a European Union (EU) initiative, that support education, training, youth, and sport in Europe, it provides to over 4 million European Citizen the opportunity to study, train, gain experience, and be a volunteer abroad. Similarly, Horizon 2020, another EU research and innovation program, had nearly €80 billion of funding available during the last years (2014 to 2020) to ensure Europe produces world-class science, removes barriers to innovation, and makes it easier for the public and private sectors to work together in delivering innovation. We can also present more interesting projects:

– The 'One Laptop per Child' initiative – this project aimed to provide each student (developing countries) with a robust, low-cost, low-power, connected laptop. The goal was to create educational opportunities for the most disadvantaged children;
– The Khan Academy – A non-profit organisation that provides free online materials and resources to support personalised education for learners of all ages (depending on the internet connection);
– Google's 'Project Loon' – A project that aimed to provide internet access to rural and remote areas using high-altitude balloons placed in the stratosphere to provide a signal in non-signal areas. It was a very ambicious project;
– Microsoft's 'Airband Initiative' – This project had the goal to connect broadband to rural communities in the United States over the last years (another big investment);
– The 'Global Learning XPRIZE' – A competition that incentivised teams to develop open-source, scalable software solutions to allow children in developing countries to teach themselves basic reading, writing, and arithmetic.

These examples, among many others, are efforts to connect the digital divide and improve global access and equity in the educational system, from primary to HE.

Despite this, significant digital material access gaps still result in unequal learning possibilities. According to Kivunja (2014), the community recognises the requirement for more action to guarantee equitable access to digital resources for all learners. Educational researchers and the broader educational community also see digital education as a rich field for exploration. They are interested in understanding how digital tools can enhance learning and how they can be best integrated into teaching practices. They are also concerned with issues of access and equity and understanding how digital education impacts different groups of students. However, they caution that digital education is not a panacea and must be thoughtfully implemented to be effective (Selwyn, 2016). The year 2020, due to the pandemic, was a milestone in the history of digital technology in the education sector, allowing us to try to promote a sustainable education using ICT. The world was facing a pandemic crisis without precedents that forced, in a few days, a global transformation from traditional classroom teaching to online teaching, consequently forcing the use of Digital Education (Sousa et al., 2022). The same authors showed that the significant predictors of maintaining the online format were the characteristics of online classes, support from the school and professors, online classes vs. face-to-face classes, and gender. The probability of choosing to keep online classes increases exponentially with these factors (Sousa et al., 2022).

We could conclude that the educational community sees and comprehends the full potential of digital education but also acknowledges its challenges in an unbalanced world. On one corner are the top countries that can provide the ultimate solutions and tools, and unfortunately, on the other, the poor countries that strive to grow in every possible aspect – digital education is only one of them. Unfortunately, most of the time, this is not of the utmost importance for governments.

From Past to Emerging Trends – The AI

Several authors (Akour & Alenezi, 2022; Yang et al., 2022) studied the different stages that have occurred in the last years. It is important to take a close look at their findings. Starting with a timeline split:

Budding stage (2000–2006) – During this period, digital technology started to become a part of the lives of children from the moment they were born. The research of educational technology advances in HE began to be discussed and debated, with various laws, projects, and strategies offered. However, many digital divisions still exist, affecting the younger generation and their digital futures. Universities and teaching had to undergo significant shifts to prepare students for the technology-rich society they would be living in (Yang et al., 2022);

Slow Development Stage (2007–2017) – The growth of internet-based technologies altered the academic environment and helped colleges and universities transition to the digital environment. These technologies proved particularly helpful in improving communication between students and teachers in HE. However, the effectiveness of students' use of e-learning platforms was different, and students' opinions of the platforms utility and usability were related to their desire to use them successfully. Therefore, institutions were encouraged to support integrating e-learning platform functions into teaching-learning activities (Akour & Alenezi, 2022);

Rapid Development Stage (2018–2022) – This stage was marked by a significant shift due to the COVID-19 pandemic, which quickly and unexpectedly compelled institutions and the educational system to transform digitally. This transformation was brought about by changes in industry knowledge and competency standards, social changes taken by an increasingly digitalised world, new developments in didactics reflecting ongoing discussions in the field of didactics and learning theory, and new uses of digital technologies that were likely to result in the creation of new learning environments and methods of instruction. HEI had to train their staff (professors and non-professors) to meet the demands of educational institutions and digital transformation (Yang et al., 2022; Akour & Alenezi, 2022).

The evolution of technology has brought substantial changes across various sectors, with Education being a prime example. The nowadays trends indicate that the education system is progressively venturing into the 'new world' of AI (Brynjolfsson & McAfee, 2014). This 'new world' is an expansive terrain teeming with various tools and options constantly being discovered and developed at every second. The future of this landscape is intriguing, as it is impossible to predict the zenith of this technological slope (Bostrom, 2014). The continuous advancements in AI and machine learning technologies suggest that we are at the beginning of this journey, with much more to explore and understand (Russell & Norvig, 2016).

The potential of AI in education is deep and vast, from personalised learning experiences to efficient administrative tasks, and the possibilities are continually expanding (Luckin et al., 2016). As we move forward, it is crucial to ensure that these technologies are used responsibly and ethically, keeping the best interests of students at the forefront (Brynjolfsson & McAfee, 2014).

In this rapidly evolving landscape, the education community (students, educators, policymakers, and tech specialists) must work together to overcome the challenges and grasp the opportunities presented by AI in education. The goal should be to harness the power of AI to enhance learning outcomes and prepare students for a future where AI will be an integral part of their personal and professional lives (Blikstein, 2013).

One good solution may be integrating AI with existing digital tools, using this approach we can leverage the strengths of various technologies at the same time, creating a more comprehensive and effective educational experience (Zawacki-Richter et al., 2019). For instance, combining AI with Learning Management Systems (LMS) can provide personalised learning paths for students and adapt to their learning styles and pace (Klašnja-Milićević et al., 2020). This aligns with adaptive learning, where AI systems collect student learning behaviour data and plan the optimal learning path for students (Huang et al., 2021).

Also, integrating AI with digital assessment tools can facilitate more efficient and fair grading processes and release valuable time for educators to focus on instruction and student interaction (Liu et al., 2020). AI technologies such as image recognition, prediction systems, and computer vision can make teaching evaluations more diverse, scientific, and accurate (Huang et al., 2021).

Similarly, combining AI with collaborative tools can foster a more engaging and interactive learning environment, promoting critical thinking and problem-solving skills (Chen et al., 2021). The development of virtual reality (VR), augmented reality (AR), hearing, and sensing technologies with the help of AI can reform the teaching environment, creating virtual classrooms and laboratories that turn to the future (Huang et al., 2021). The combined process of AI with other digital tools can lead to an enriched learning experience, enhancing the teaching and learning processes in the digital age (Zawacki-Richter et al., 2019) for the triangle vertex of education: students, educators and parents. After all, AI will not take out the educator role but has the potential to enrich student learning and complement the teacher's work without dispensing with them (Reiss, 2021).

Ultimately, education is evolving regarding instructional methods and anticipation of the skills that must be taught, including previously unrecognised non-cognitive, technological, organisational, and programme administration characteristics. AI could assist educators in equipping young students, undergraduates, executives, or/and digital learners with the necessary skills to navigate and succeed in this 'new world' of AI and digital transformation.

As we navigate the 21st century, we are witnessing the emergence of new professions that were unimaginable just a few decades ago. These jobs, many of which have yet to be invented, are largely driven by technological advancements, particularly in AI, data science, and digital transformation (Bursali & Yilmaz, 2019; Dong et al., 2020). The evolving industries demand a workforce well-versed in technologies and adaptable to future innovations. Therefore, today's students must be well-prepared to face these challenges. They must have a robust foundation in STEM and skills such as critical thinking, creativity, and adaptability (Chang & Lu, 2019). Furthermore, they must be lifelong learners, something that the latest generations have done, always ready to continually update their knowledge and skills in response to the ever-changing technological landscape (Bergamin & Hirt, 2018). Educators, policymakers, and industry leaders must work together to ensure that our education systems are effectively preparing students for the jobs of the future, many of which remain unknown to us today (Reiss, 2021; Tuomi, 2018).

Opportunities and Challenges in Digital Education

Despite its huge potential, Digital Education also presents several challenges. One of the most important is the infrastructure that institutions have. The pandemic highlighted the difficulties that most have in supporting platform access when many students simultaneously need to connect.

On the other hand, while students are growing interested in exploring deeper Digital Education with all these new tools (AI is just one example), the unprecedented experience of the COVID-19 pandemic has highlighted a renewed appreciation for face-to-face teaching. The rapid change to remote learning during the pandemic revealed simultaneously the potential and the continuing challenges of online education. While technology facilitated continuity in education during school closures, many students faced issues related to a lack of access, motivation, and face-to-face interaction (Wang et al., 2020). Research indicates that most students miss the social aspects of face-to-face learning, which play a crucial role in their academic experience and overall well-being (Johnson et al., 2020). Furthermore, the effectiveness of online learning varies among students, with some benefiting from its flexibility while others struggle without the structure of a traditional classroom (Schwartzman, 2020).

So, we are witnessing a world of changes and evolution that is far from well established right now. Having this in mind, we present some ideas for the future of Digital Education in the form of opportunities and challenges congregated from several studies done in the last years:

Digital Divide – The digital divide is about access to technology and the ability to use it effectively. Gabriel et al. (2023) mention that teachers who are not confident using digital technologies in their work will avoid using them and instead engage in traditional activities with which they may have experienced previous success. This highlights the importance of providing access to technology and ensuring that teachers and students are confident and competent in using it. Male (2016) further emphasises that a transformation in the attitude and behaviour of teachers is required to maximise the possibilities and opportunities offered by digital technologies. Also, the education workforce tends to lag in terms of technological capability, suggesting that they are in the process of almost learning a new language;

Quality of Online Education – The effectiveness of digital technologies can vary, and students' opinions of the platforms' utility and usability are related to their desire to use them successfully. Gabriel et al. (2023) state that an effective education system should help students to deal with the rapid development of technologies and continuous access to vast amounts of new knowledge and information while fostering critical thinking, sensemaking, creativity and collaboration skills. The quality of online education is not just about the technology itself but also about how it is used to enhance learning and develop key skills. Male (2016) adds that the interactivity of digital devices with Internet access provides the opportunity to change how teachers work with their students and encourage networking, collaborative learning, and problem-solving situations;

Data Privacy and Security – Data privacy and security issues have become more prominent with the increased use of digital technologies in education. These issues can be particularly challenging in a digital learning environment where personal data is often stored and shared (Yang et al., 2022);

Changes in Teaching Practices and Institutional Policies – The shift to digital education requires significant changes in teaching practices and institutional policies. Gabriel et al. (2023) note that countries such as Portugal and Slovenia rely strongly on professional networks to promote peer learning, exchange good practices, upskill teachers' digital competency and boost their confidence. Professional development and peer learning are key strategies for teachers adapting to digital education. This sentiment is echoed by Male (2016), who argues that in order to make the most of the possibilities and opportunities afforded by digital technologies, educators need to undergo a metamorphosis in both their mindset and their behaviour;

Keeping Up with Technological Advancement – Keeping up with the rate of technological advancement is a significant challenge. Gabriel et al. (2023) state that the coming generation of citizens and emerging workforce must be capable and comfortable with a broad range of technologies to survive and thrive. They also mention the importance of continual professional development for teachers to integrate and update the technologies used in their classrooms, something very important in a life-long cycle. So ongoing learning and development are crucial for keeping up with technological advancements. Male (2016) addresses that digital technologies are a core feature of the current era, which presents the possibility for a shift from passive acquisition of someone else's ideas to active learning experiences that empower people to inquire, critique, create, collaborate, problem solve, and create understanding.

These challenges highlight the complexity of the digital education landscape and the need for thoughtful and strategic approaches to its implementation and ongoing development. Still, many situations and concerns exist in the Digital Education environment.

However, one certainty is that youngsters will need the most advanced and updated tools to face the challenges of the 21st century. These skills required for 21st-century jobs are often connected to soft skills, even though we may not know exactly what these new jobs will entail. These soft skills are increasingly important in a world where digital technologies are transforming the workplace and how we interact with information. Male (2016) notes that the online world has redesigned communication in and outside the workplace, and young people are now accustomed to accessing multiple open sources of information for solutions. As a result, more collaborative technologies have enabled the development of soft skills such as cooperation, collaboration, and problem-solving.

Furthermore, the shift from pedagogy/andragogy (teacher-centred), to a heutagogy approach (student-centred) – self-determined learning that focuses on the importance of knowing how to learn – recognises that discipline-based knowledge is inappropriate for preparing for living in modern communities and workplaces. This shift emphasises the development of a skill-based curriculum designed to deal with a rapidly changing world (Male, 2016). In the context of education, the same author suggests that the 'holy trinity' of the student vision for educational experience includes socially-based and collaborative learning, which are highly valued soft skills in the 21st-century workplace.

Therefore, it is crucial to focus on developing these soft skills in educational settings to prepare students for the demands of the 21st-century labour market.

Conclusion

Moving along the way, we can see that technological improvements are changing the education landscape forever. Integrating different tools in the educational context, for instance, AI, which is growing very fast, and others like VR or AR, can significantly alter the teaching and learning experiences for all the actors. These technologies can provide personalised learning experiences, foster immersive learning environments, and potentially transform how knowledge is transmitted and acquired.

However, the ethical implications of some, like the latest AI in education, such as data privacy and algorithmic bias, must be carefully considered and addressed. As we adopt these technologies, we must ensure they are used responsibly and ethically, considering the student's best interests and growth.

Another aspect is that the COVID-19 pandemic has highlighted the significance of digital education, accelerating the transition towards remote learning in some cases. This change has presented both obstacles and opportunities at the same time. On the one hand, it has brought issues such as the digital divide and the need for digital literacy, which must be addressed to guarantee equitable access to digital education. On the other hand, it has demonstrated the capability of digital education to provide flexible and adaptable learning experiences. Balance is what we need to achieve.

As described, educators', students' and stakeholders' perspectives offer valuable insights into the future of digital education. While educators recognise the transformative potential of digital education, they are also concerned about its potential to exacerbate educational inequalities in the school environment. Students have widely recognised digital education's convenience and adaptability. The flexibility to learn at their own pace and access educational content from anywhere at any time has been particularly beneficial during the COVID-19 pandemic. Despite these advantages, students have longed for the social interaction and in-person engagement that traditional classrooms offer. Understandably, the classroom is more than just a space for knowledge acquisition, it is a social environment where students learn from their peers and develop essential social and emotional skills for life. While digital education is crucial in today's world, it is equally important to find ways to incorporate opportunities for social interaction and in-person engagement, thereby creating a more holistic learning experience.

The future of Digital Education should be governed by a balanced strategy that capitalises on the potential of technological advancements while resolving the challenges they pose. It should provide equitable, engaging, and effective learning experiences that meet students' diverse requirements and preferences. This will require ongoing research, deliberative policymaking, and the active participation of all stakeholders in the educational community.

While advancing into the future of education, we are also revisiting and reinterpreting past educational practices. The future is not about completely new methods but a blend of new technologies and traditional pedagogical approaches. It is about integrating the digital with the physical, the new with the old, and balancing technological benefits with the essential human elements of learning.

In a nutshell, the future of digital education is a fusion of the past and the present, shaping a holistic approach to future learning.

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Panorama digitalnega izobraževanja v 21. stoletju

To poglavje obravnava digitalno izobraževanje v 21. stoletju, kompleksno in dinamično področje, ki se sooča s hitrim tehnološkim napredkom ter številnimi izzivi. Digitalno izobraževanje analiziramo z različnih vidikov, s čimer želimo poudariti njegov ključni pomen v sodobnem izobraževalnem ekosistemu. Med najpomembnejšimi prednostmi digitalnega izobraževanja so širše dostopne izobraževalne priložnosti, interaktivno in dinamično učno okolje ter

prilagojeni učni pristopi, ki ustrezajo individualnim potrebam učencev. Kljub tem prednostim pa digitalno izobraževanje prinaša tudi pomembne izzive, kot so vprašanja dostopnosti in pravičnosti, tehnološke omejitve ter zmanjšana neposredna socialna interakcija. Poseben poudarek namenjamo vplivu digitalnega izobraževanja na sodobne pedagoške prakse ter njegovi vlogi v procesu globalizacije, zlasti pri spodbujanju medkulturnega sodelovanja in premagovanju geografskih ter družbenih omejitev. Za zaključek analiziramo tudi nove trende, kot so igrifikacija, virtualna in obogatena resničnost ter umetna inteligenca, da bi našli možne prihodnje usmeritve za digitalno izobraževanje. Poglavje se zaključi s trditvijo, da je za popolno uresničitev potenciala digitalnega izobraževanja in ustvarjanje vključujočega ter uspešnega učnega okolja za prihodnost treba te priložnosti in izzive nenehno raziskovati.

Ključne besede: digitalno izobraževanje, umetna inteligenca, orodja IKT, izzivi, priložnosti

Innovative Teaching Methods in Higher Education: The Case of University of Primorska

Tina Štemberger
University of Primorska, Slovenia
tina.stemberger@upr.si

Andreja Klančar
University of Primorska, Slovenia
andreja.klancar@pef.upr.si

The paper addresses the use of innovative teaching methods in higher education, specifically at the University of Primorska (UP). In the last decades, the use of digital technologies in teaching has undoubtably changed both, teaching and learning process. However, not much research has focused on using innovative teaching methods in higher education settings, so the aims of the study were to (i) determine how frequently higher education professors use different teaching strategies and methods and tools, digital tools and generative AI tools, (ii) what kind of challenges they face in this context and (iii) which competences would they need to better implement innovative teaching methods into their teaching. Data was gathered with questionnaire which was administered in spring 2024. A total of 74 academic staff members of UP participated in the study. The results in general show that higher education professors frequently use as problem-based learning, team-based learning, and scenario-based learning, while gamification, design thinking, and cooperative learning are underutilized. They frequently use Google Drive and YouTube. The major barriers for using more innovative teaching strategies and methods are time constraints, limited access to resources and technology, and lack of pedagogical and digital skills, so they express the need for targeted training in digital tools, AI, and innovative teaching methods, as well as strategies for engaging students and managing large groups.

Keywords: higher education, innovative teaching methods, challenges, digital tools

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Introduction

Over the past two decades, Europe has focused on establishing a unified higher education area aimed at both the mutual recognition of qualifications and enhancing the quality and relevance of learning and teaching, exemplified by initiatives like the Bologna Process. However, despite efforts at both international and national levels, the shift from traditional teacher-centred education to a more flexible, student-centred approach has been slower than anticipated by policymakers (Navickienė et al., 2017, p. 8).

One of the four main goals of the EU's Education and Training 2020 (ET2020) strategy is fostering creativity, innovation, and entrepreneurship in higher education. The European Education Area aims to develop specialised programmes in advanced digital skills, focusing on emerging technologies like artificial intelligence and high-performance computing. Key priorities include inclusion, innovation, connectivity, digital and environmental readiness, and global competitiveness OECD

Despite many advantages of using digital technologies in a student-centered approach, several challenges persist. These challenges include time constraints, limited accessibility to educational technology, and lack of knowledge and motivation among teachers and students (Bond et al., 2020; Panakaje et al., 2024). Research shows that innovative teaching methods supported by digital technologies can significantly enhance student engagement and in higher education (Durrani et al., 2023).

The integration of digital technology in higher education positively influences teacher learning, pedagogical strategies, teacher performance, and student engagement, with institutional support playing a crucial role in these outcomes (Panakaje et al., 2024). The educational technology use in higher education primarily fostered behavioral engagement, followed by affective and cognitive engagement (Bond et al., 2020). The implementation of gamification and flipped classroom approaches through digital applications like CrossQuestion has also proven effective in enhancing student learning (Durrani et al., 2023).

The shift towards a student-centered approach in European higher education, supported by the use of digital technologies, represents an important step towards improving the quality of higher education (Bond et al., 2020; Panakaje et al., 2024). Despite the challenges, investing in the professional development of academic staff and adapting educational systems to the digital age is crucial for the successful implementation of this approach.

Theoretical Framework

As noted, innovation is a cornerstone of the European Education Area's objectives. Broadly defined, innovation involves creating or improving products or processes that differ significantly from previous versions and are either made available to users or adopted in practice (OECD, 2018). In education, organisations such as schools, universities, and training centres contribute to product innovation by introducing new or enhanced syllabi, textbooks, educational resources, pedagogies, or learning experiences, including e-learning and new qualifications (Vincent-Lancrin et al., 2019). They also engage in process innovation by transforming organisational practices, such as teacher collaboration, student grouping, and learning management. These transformations may involve partnerships, marketing strategies, communication methods, or other process changes, which can blur the distinction between products and processes in educational services (Vincent-Lancrin et al., 2019).

The Bologna Process, through its Rome Ministerial Communiqué (2020), has set a goal of adopting student-centred learning and teaching by 2030, thereby emphasising innovative teaching methods. However, innovation in teaching does not always equate to using the latest technologies. Instead, it involves the proactive application of novel strategies and methods tailored to classroom needs. Effective teaching relies on aligning methodologies with student needs and content relevance (Hashim et al., 2019). Innovation is understood as a process where new ideas are generated, applied, and refined to enhance outcomes. Zhang (2012) stressed the importance of reforming traditional models and building innovation-focused education systems. Ultimately, innovation may also involve adapting existing ideas to effectively meet the needs of a target audience (Hashim et al., 2019).

The Resolution on the National Higher Education Programme until 2030 emphases that student-centred teaching is a key component in achieving the strategic objectives. It emphasizes aligning education with future professions through the integration of professional, research, and artistic work into teaching practices. Key priorities include ensuring student well-being, fostering learning and teaching motivation, and strengthening the competencies of higher education staff to support active learning and critical thinking. This approach aims to prepare students for emerging challenges while ensuring excellence in teaching and research (Resolucija o nacionalnem programu visokega šolstva do 2030 (ReNPVŠ30), 2022).

The UP actively promotes the use of modern communication tools also by updating its information infrastructure through different projects. However, technology alone is insufficient; it is essential to empower users with the skills and knowledge for responsible and competent use, focusing on student-centered teaching strategies, to fully realize its potential, Since 2010, the UP Faculty of Education has been delivering programme PAI for higher education teachers and staff, focusing on student-centered teaching strategies. As part of the 'Internationalization in Higher Education' project (2016/2017), a module on teaching methods for integrating national and foreign students was introduced, recognized in the habilitation process. Additionally, Digital PAI program now provides training in digital competencies for the digital transition. From 2018 to 2020, the 'InoTez – Innovative Knowledge with Technology' project established technical and pedagogical support for digital technology in teaching, introducing the Open UP platform to foster student-centered learning. The 'INOVUP – Innovative Learning and Teaching in Higher Education' project (2018–2022) further improved teaching quality with flexible learning methods, pedagogical training, and open-access publications. Currently, the UP Faculty of Management (2021–2024) is enhancing blended learning through the project 'Improving the Quality of the Pedagogical Process by Incorporating Blended Learning into the Study Process', including the piloting of a hybrid course, 'Using Data for Proper Decision-Makin', integrating smart boards, cameras, microphones, and video conferencing systems. These initiatives collectively strengthen the University of Primorska commitment to modern, student-centered, and technology-enhanced higher education.

According to Rutar (2022) innovative teaching refers to any original method or approach to teaching that is intentionally developed, organized, and implemented (by the teacher alone or in collaboration with colleagues) to enhance, improve, or transform the educational process. The goal is to ensure academic success and promote the psychological well-being of students.

In this context, the roles of the teacher include:

- Facilitating and enabling insight into the development and role of knowledge in society;
- Facilitating and enabling understanding of the content and structure of a discipline or field;
- Facilitating and enabling the development of knowledge important to individuals within a learning community;
- Assessing prior knowledge and connecting it with new knowledge while reflecting on new insights;
- Providing feedback to students to support effective self-regulation in their studies;
- Encouraging active learning by incorporating all communication skills.

The educational process is often organized in a way that promotes collaborative and cooperative learning between students and teachers (e.g., inquiry-based learning or research) and/or collaboration with the surrounding environment. This may involve applying knowledge and adapting the structure and content of the educational process based on interaction with the broader community.

University of Primorska (UP) has been a member of the alliance Transform for Europe since 2023 and has therefore committed to implement innovative teaching methods in teaching. There are different definitions of the methods, however, on the level of alliance, mutual definitions have been adapted. Teaching strategies are understood as a collection of different methods the teacher uses to teach the subject material, which may vary from lesson to lesson. Meanwhile, teaching methods are considered to be a selection of methods (e.g. Jigsaw) used by the teacher to teach the subject material (Nedzinskaitė-Mačiūnienė & Jurgilė, 2024).

Active Teaching Strategies and Innovative Teaching Methods

Active Teaching Strategies

Below we present the definitions of the teaching methods agreed within Transform for Europe Alliance.

Team-based learning is defined as a structured form of small-group learning that emphasises student preparation out of class and application of knowledge in class. Students are organised strategically into diverse teams of 5–7 students that work together throughout the class (Burgess et al., 2020).

Flipped classroom is an organisational instructional content approach, which balances didactic and active learning modalities. Students review information-rich materials (e.g., lectures, reading, etc.) in advance and use class time for active application of concepts and creative engagement with the subject matter (Awidi & Paynter, 2019).

Gamification and game-based learning is an approach where instructional materials are designed like games to make learning fun and engaging for students (Dicheva et al., 2015).

Design thinking is a non-linear, iterative process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. It is most beneficial to tackle ill-defined or unknown problems and involves five phases: Empathise, Define, Ideate, Prototype and Test (Chon & Sim, 2019).

Problem-based learning is a student-centred approach in which students learn about a subject by working in groups to solve an open-ended problem. This problem is what drives the motivation and the learning (Schwartz et al., 2007).

Scenario-based learning is an immersive training environment where learners meet realistic work challenges and get realistic feedback as they progress since everything that happens reflects the learner's choices (Seren Smith et al., 2018).

Cooperative learning involves students working together in small groups on a structured activity. The members of the groups learn to work as a team to accomplish a specific goal, to solve a problem, to complete a project, or to develop a product. Teachers hold students accountable individually but also assess group work. Students are responsible not only for learning the material but also for ensuring that the other members of the group also learn the material (Slavin, 1980).

Innovative Teaching Methods

Also, the definitions of innovative teaching methods are presented as agreed within Transform 4 Europe Alliance.

Brainstorming aims to develop creative solutions to problems. It enables the students for generating new, useful ideas and promoting creative thinking (Jarwan, 2005).

Case studies are usually defined as a teaching method which requires students to actively participate in real or hypothetical problem situations, reflecting the kinds of experiences naturally encountered in the discipline under study (Ertmer & Russell, 1995).

Concept maps are a verbal or graphic presentation designed to assist the learner in developing a clear and useful mental representation of whatever is being studied (Lefrancois, 1997).

Cooperative learning can be defined as a set of teaching and learning strategies promoting student collaboration in small groups (two to five students) in order to optimise their own and each other's learning (Johnson & Johnson, 1999).

Debate is defined as the process of considering multiple viewpoints and arriving at a judgement, and its application ranges from an individual using debate to make a decision in his or her own mind to an individual or group using debate to convince others to agree with them (Freeley & Steinberg, 2005).

Games-based learning can be defined as learning that is facilitated by the use of a game. This can be at any academic level from preschool through to lifelong learning, from simple memorization and recall to high level learning outcomes such as evaluation or creativity. The use of the game can be intrinsic or supplemental, played face-to-face with physical objects or online, with a computer. Where the difficulty arises is in the exact definition of the term 'game,' because there is not a single accepted classification and definitions depend on the disciplinary background of those who create them (Whitton, 2012).

Group investigation is defined as a learning process involving four fundamental stages. This technique consists of the stages of determination of instructional goals, establishment of groups, implementation of the group investigation and evaluation of the group investigation. It is one of the techniques of the cooperative learning method (Baki, 2008).

Interactive lecturing implies active involvement and participation by the audience so that students are no longer passive in the learning process. Interactive lecturing also implies a different way of approaching the teacher's role (Snell, 2009).

I-Search is an approach to research that uses the power of student interests, builds a personal understanding of the research process, and encourages stronger student writing. The key element of this approach is that students select topics of personal interest. This model also stresses metacognitive thinking. Students are asked to keep a log of their action, thoughts, and feelings as they move through the process. In addition, students are asked to reflect on their previous research experiences to set the stage for an appreciation of the research process (Tallman & Joyce, 2006).

Jigsaw structure is meant to provide students with the chance to learn a material from their peers. A material is divided into sections and one section is for each student to take care of. The students who are responsible for the same section get together and form a new group of which the goal is for the students to master the section of the material and to enable them to teach the other members in their original learning group later (Aronson, 2006).

A learning contract is the final result of an ongoing process of negotiation between a teacher and a student with the purpose of developing a learning program that meets both the learning and the teaching agendas. Students negotiating their learning goals, the methods by which those goals will be met, the means by which the achievement of the goals can be assessed, and at what level (Brewer et al., 2007).

A learning diary is based on a written explication of one's own learning processes and outcomes. When this occurs over an extended period of time, it is called a 'learning diary'. Parameters, such as the extensiveness or the degree of structure of the protocol may considerably vary depending on the concrete instructional setting where the method is applied (Rambow & Nückles, 2002).

Peer learning is the acquisition of knowledge and skill through active helping and support among peers who are equals in standing or matched companions. Peer learning occurs among peers from similar social groupings, who are not professional teachers, helping each other to learn and in doing so, learning themselves (Topping & Ehly, 1998).

Problem-based learning is a teaching method in which complex real-world problems are used as the vehicle to promote student learning of concepts and principles as opposed to direct presentation of facts and concepts. In addition to course content, PBL can promote the development of critical thinking skills, problem-solving abilities, and communication skills. It can also provide opportunities for working in groups, finding and evaluating research materials, and life-long learning (Duch et al., 2001).

Project-based leaning is a student-driven (student-centred) approach to learning in which students are required to take part in a real project by developing a question or inquiry and under the supervision of teachers in order to create a project to share with the select audience (Challenge 2000 Multimedia Project, 1999).

Roleplaying is a teaching technique based on the pedagogical psychodrama, which requires the participants' dedication and interest to complete every stage, but also, teacher supervision to avoid participants' extreme reactions that could emerge as a result of the group problem-solving (Rojas et al., 2017).

Simulation and modelling refer to the representation of a small part of a real complex system through a model for understanding and discussing the complex phenomena that are part of the system. In an educational context, its use may aim to motivate the student to test hypotheses about reality, to represent systems through schemas, or to develop mental models, among others. In this context, a modelling activity is based on the use of a model that represents a phenomenon or system more simply and where certain aspects have been suppressed in order to make it easier to understand (Repenning et al., 1998).

Storytelling is the use of stories or narratives as a communication tool to value, share, and capitalize on the knowledge of individuals. Stories provide a powerful metaphor, framework, and set of practical processes for resolving issues, educated ourselves, and pursuing our goals. Storytelling can be a powerful element of communication process, being equally as textbooks and essays (Ohler, 2013).

In summary, innovative teaching methods are not necessarily the latest approaches but rather those that remain untried in addressing specific challenges, such as improving student engagement. Incorporating innovative teaching and learning strategies into higher education is a key responsibility of modern educators. Studies, including those by Freeman et al. (2014) and Deslauriers et al. (2019), highlight the potential of such methods to enhance the teaching process. Nonetheless, adopting innovative strategies can be difficult, as it may provoke student resistance, lead to setbacks, or fall short of intended goals. Despite these challenges, exploring new approaches can boost student engagement, motivation, and performance. Consequently, investing in the professional development of academic staff is essential. The European Commission's renewed EU agenda for higher education (2017) emphasizes that many higher education professors still require pedagogical training.

Aims of the Study

The aims of the present study were:

a) To find out how frequently higher education professors use different teaching strategies and methods and tools, digital tools and generative AI tools and whether there are differences in the frequency according to academic position, scientific field, teaching experience and the average number of students in one semester through the last two academic years and
b) To determine if and which are the concerns and obstacles, regarding using innovative different teaching strategies and methods and tools, digital tools and generative AI tools, perceived by higher education professors.
c) To determine which competences would higher education professors need to better implement innovative teaching methods into their teaching

Methodology

Method

Based on the aims of the research it was decided to use the quantitative approach.

Sample

A total of 74 academic staff members of UP participated in the study.

As it can be observed from Table 1, the majority of respondents (32,4 %) are assistants/lecturers, followed by associated professors (31.1 %), senior lecturer/Assistant Professors (25,8%) and professors (10.8 %). Regarding the scientific field, the majority (32,2 %) of respondents come from Social Sciences,

Table 1 Characteristics of Respondents

Characteristcs	f	f%	
Academic position	Assistant/lecturer	24	32,4
	Senior Lecturer/Assistant Professor	19	25,8
	Associated Professor	23	31.1
	Professor	8	10,8
Scientific field	Natural Sciences/life science (e.g. biology, chemistry, physics)	18	27,3
	Social Sciences (e.g. economics, psychology, sociology)	24	32,3
	Humanities (e.g. philosophy, cultures, languages)	8	12,2
	Formal sciences (e.g. mathematics, theoretical computer science)	9	13,6
	Technical sciences (e.g. engineering)	7	10,6
Teaching experience	Less than 10 years	28	37,8
	Between 11–20 years	28	37,8
	More than 21 years	18	24,3
Number (average) of students in one semester through the last two academic years	Less than 50	9	12,2
	Between 51–70	14	18,9
	Between 71–99	20	27,0
	More than 100	31	41,9
Dominated form of study	Blended	4	5,4
	Hybrid	4	5,4
	Face–to–face (on campus)	65	87,8

27,3 % from Natural Sciences, 13,6 % form Formal, 12,2 % humanities and 10,6 % from Technical Sciences. A total of 28 respondents (37,8 %) have less than 10 years of teaching experience, and the same share of respondents have between 11 and 20 years of teaching experience. 18 (24,3 %) of participants have more than 21 years of teaching experience. The vast majority of participants (41,9 %) usually teach more than 100 students per semester, followed by the ones who teach between 71–99 (27, 0 %) and between 51–70 (18,9 %). Only 12,2 % respondents report that they teach less than 50 students per semester. The majority of respondents (87, 8 %) mainly teach face-to-faced, while only 5,4 % percent report that they mainly use hybrid or blended mode.

Procedure

Data was gathered with the questionnaire that was developed within the alliance Transform4Europe. The questionnaire consists of:

a) a set of close-ended questions (academic position, scientific field, teaching experience, average number of students in in one semester through the last two academic years, dominated form of study),
b) a set of four points scale of frequency (always, often, sometimes, never) on teaching strategies and methods, on digital technologies, generative AI tools.
c) two open-ended questions on perceived concerns and obstacles to innovative teaching methods and on topics respondents would suggest to include in teacher training programmes

In this paper we only present the results of UP.

All UP academic staff was invited to complete the online questionnaire. The invitation with the link was first sent on 17 March 2024 and the reminder was sent on 4 April 2024.

Results

Active Teaching Strategies and Teaching Methods

According to Table 2 problem-based learning, team-based and scenario-based learning are the most widely used strategies among respondents, also design thinking is increasingly recognised and applied in the academic field. Chi-square test were carried out to test whether there are differences in the frequency of using active teaching strategies according to academic position, scientific field, teaching experience and the average number of students in one semester through the last two academic years. However, the results revealed no statistically significant differences.

As it can be observed from the table 3, respondents most often use discussion and teamwork. Discussions are always used by 45.9 % respondents and 35.1 % use them often. Debates are also often used: 20.3 % respondents use them always, and 37.8 % use them often. Teamwork is frequently used as well,

Table 2 The Application of Active Teaching Strategies

Active teaching strategy	Always		Often		Sometimes		Never	
	f	f%	f	f%	f	f%	f	f%
Team–based learning	8	10,8	26	35,1	31	41,9	9	12,2
Flipped classroom	3	4,1	9,0	12,2	42	56,8	20	27,0
Gamification and game–based learning	0	0,0	9,0	12,2	29	39,2	36	48,6
Design thinking	3	4,1	17	23,0	16	21,6	38	51,4
Problem–based learning	14	18,9	31	41,9	26	35,1	3	4,1
Scenario–based learning	3	4,1	23	31,1	24	32,4	24	32,4
Cooperative learning	3	4,1	12	16,2	27	36,5	32	43,2

Table 3 The Application of Teaching Methods

Teaching method	Always		Often		Sometimes		Never	
	f	f %	f	f %	f	f %	f	f %
Games	2	2,7	10	13,5	30	40,5	32	43,2
Study visits	0	0,0	14	18,9	33	44,9	27	36,5
Peer Learning	4	5,4	23	31,1	36	48,6	11	14,9
Simulation and modelling	3	4,1	23	31,1	29	39,2	3	4,1
Teamwork	12	16,2	36	48,6	23	31,1	19	25,7
Case study	6	8,1	31	41,9	29	39,2	8	10,8
Project	9	12,2	21	28,4	31	41,9	13	17,6
Role–playing	5	6,8	22	29,7	26	35,1	21	28,4
Brainstorming	12	16,2	22	29,7	31	41,9	9	12,2
Learning diaries	0	0,0	6	8,1	22	29,7	46	62,2
Experimentation	5	6,8	19	25,7	25	33,8	25	33,8
Discussions	34	45,9	26	35,1	12	16,2	2	2,7
Critical review method	3	4,1	15	20,3	42	56,8	14	18,9
Video review and discussion	3	4,1	15	20,3	42	56,8	14	18,9
Concept maps	3	4,1	6	8,1	25	33,8	40	54,1
Interactive strategies/lecture	6	8,1	19	25,7	25	33,8	24	32,4
Learning stations	4	5,4	7	9,5	25	33,8	38	51,4
Group investigations	5	6,8	19	25,7	30	40,5	20	27,0
Jigsaw	0	0,0	2	2,7	20	27,0	52	70,3
I–Search	1	1,4	3	4,1	25	33,8	45	60,8
Learning contracts	0	0,0	4	5,4	14	18,9	56	75,7
Peer–assisted learning	1	1,4	19	25,7	40	54,1	14	18,9
Learning centres	0	0,0	7	9,5	16	21,6	51	68,9
Storytelling	2	2,7	16	21,6	30	40,5	26	35,1

as 16.2 % of respondents use it always and 48.6 % use it often. They report to moderately use role-playing, case studies, and brainstorming show moderate adoption. The results show that 36.5 % use role-playing frequently (6.8 % always and 29.7 % often), case studies are used by the half of respondents and brainstorming is regularly used by nearly 46 % of respondents. Methods such as games, experimentation, and group investigation show the most different frequencies of use. Games are sometimes of never used by 83.7 % respondents, experimentation and group investigations are sometimes of never used by 67.5 % of respondents. However, some methods are really rarely used, these are: jigsaw, learning contracts, and I-Search are seldom used, possibly due to constraints in resources, time, or training. According to the results in Table 3, 62.2 % never use learning diaries, 70.3 % never use jigsaw, 75.7 % never use learning contracts, 60.8 % never use I-Search, and 68,9 % never use Learning Centres.

Chi-square test were carried out to test whether there are differences in the frequency of using active teaching strategies according to academic position, scientific field, teaching experience and the average number of students in one semester through the last two academic years. The results of chi-square tests only show statistically significant differences ($p = 0.028$) in frequency of using learning centres according to scientific field and in the frequency of using role-playing ($p = 0.002$) according to length of teaching experience and according to academic position ($p = 0.020$). Regarding the frequency of using learning centres, the analysis show they are most frequently used in natural and technical science. Related to role-playing, the results show that they are more often used by assistants and assistant professors compared to associate or full professors. Also, role play is most often used by professors with 10 or less years of work experience.

Digital Tools and AI Generated Tools

The EU Digital Education Action Plan (2021–2027) (European Commision, 2020) is a renewed European Union (EU) policy initiative that sets out a shared vision of high-quality, inclusive, and accessible digital education in Europe and aims to support the adaptation of Member States' education and training systems to the digital age. Following this Action Plan, we sought to collect data on digital learning technologies embedded in higher education teaching and learning.

The results in Table 4 show, that Google Drive and YouTube are the most frequently utilized tools across all categories. Interactive and gamified tools (e.g., Kahoot, Quizlet) have some engagement but could be better integrated to maximize educational benefits. Tools like Brainscape, Socrative, and Educaplay are underutilized, possibly due to lack of awareness, accessibility, or perceived usefulness.

Chi-square test were carried out to test whether there are differences in the frequency of using digital tools according to academic position, scientific field, teaching experience and the average number of students in one semester through the last two academic years. However, the results revealed no statistically significant differences.

As it can be observed from Table 5, ChatGPT is the most popular among AI tool in terms of adoption, with a sizable number of respondents using it at least 'sometimes' or more frequently. Mendeley shows relative utility among academic tools, likely due to its niche in citation management and research support. Visual AI tools like DALL-E 3 have some usage, but creative tools like Midjourney and music AI tools (Soundful, AIVA) are barely used. Adoption of

Table 4 The Application of Digital Tools

Digital tools	Always		Often		Sometimes		Never	
	f	f %	f	f %	f	f %	f	f %
Mentimeter	1	1,4	4	5,4	25	33,8	44	59,5
Socrative	0	0,0	0	0,0	3	4,1	71	59,9
Elever	0	0,0	0	0,0	5	6,8	69	93,2
Preguntados					1	1,4	73	86,6
Cerebriti					3	4,1	71	95,9
Kahoot	1	1,4	3	4,1	24	32,4	46	62,2
Brainscape					1	1,4	73	98,6
Educaplay					5	6,8	69	93,2
Quizlet			2	2,7	13	17,6	59	79,7
Google Drive	9	12,2	25	33,8	25	33,8	15	20,3
YouTube	9	12,2	26	35,1	26	35,1	13	17,6
Prezi	1	1,4	3	4,1	17	23,0	53	71,6

AI tools like Google Bard, SciSpace, and Otter.ai remains limited, possibly due to competition with similar tools or lack of awareness. Chi-square test were carried out to test whether there are differences in the frequency of application of AI tools according to academic position, scientific field, teaching experience and the average number of students in one semester through the last two academic years. However, the results revealed no statistically significant differences.

Perceived Concerns and Obstacles for Using Innovative Teaching Methods

Respondents were asked to list the obstacles to use innovative teaching methods in classrooms.

The main obstacle seems to be the time. It was listed 31 times. Respondents report that they have lack of time to learn about these methods and to use them in the classroom. The later mainly because to the pedagogical overload, to reduction of contact hours and because of big groups of students. Many (15) also point to the low accessibility to educational technology, poor classroom equipment and software available and lack of resources. Some respondents (12) also point out their lack of knowledge in the field and lack of motivation-on both sides-teachers and students. One of the obstacles on the list is also the lack of technical support and the belief that innovative methods are not applicable to each subject and that they are used just for fun, as they do not affect students' knowledge.

As one of the respondents summarised: 'One of the primary obstacles is resistance from faculty members or administrators who are accustomed to

Table 5 The Application of AI Tools

AI tools and resources	Always		Often		Sometimes		Never	
	f	f %	f	f %	f	f %	f	f %
ChatGPT	3	4,1	9	12,2	35	47,3	27	36,5
Bing AI			1	1,4	4	5,4	69	93,2
Google Bard					5	6,8	69	93,2
Copilot	1	1,4			5	6,8	68	91,9
DALL–E 3					9	12,2	65	87,8
Midjourney					1	1,4	73	98,6
ASReview Lab					1	1,4	73	98,6
ResearchRabbit					3	4,1	71	95,9
SciSpace			1	1,4	5	6,8	68	91,9
Invideo			1	1,4	3	4,1	70	94,6
AIVA					1	1,4	73	98,6
Soundful					1	1,4	73	98,6
Mendeley	1	1,4	5	6,8	15	20,3	53	71,6
Otter.ai	1	1,4	1	1,4	5	6,8	67	90,5

traditional teaching methods. Implementing innovative teaching methods often requires investment in training, technology, and infrastructure, which some institutions may struggle to allocate due to budget constraints. Faculty members may feel overwhelmed by their existing workload and find it challenging to invest time in learning and implementing new teaching methods effectively.'

However, it also needs to be stressed, that 12 respondents clearly stated they see no obstacles for implementing innovative teaching methods.

Higher Education Professors Training Needs Regarding Better Implement Innovative Teaching Methods into their Teaching

A total of 36 respondents stated they need courses in which they would gain the knowledge of using digital skills and digital tools used for teaching, with 11 of them specifically pointing to the use of AI in teaching. They also expressed the need to learn about digital and cyber security teaching methods, innovative didactics, introducing games into course teaching, using digital content in teaching, using digital technologies to adjust curriculum and how to adopt innovative method to subjects hey teach. Interestingly, teachers also suggested topic which are not directly connected to innovative teaching methods in sense of using digital tools, but are more generally related to pedagogy and didactics. These are: efficient student management, participatory teaching methods, methods that are appropriate to use to teach with new generations, how to manage exams when someone has big numbers of students, how to engage students, general teaching strategies, effective learning.

They also stated they need more trainings on innovative methods and strategies to save time or how to stretch day from 24 to 28 hours. Some (7 participants) stated they do not need additional courses and some (6) do not really know what they need. One stated that he/she prefers traditional ex-cathedra approach. Two respondents also point out that would need technical support to learn innovative teaching methods.

Conclusion

The study highlights that active teaching strategies such as problem-based learning, team-based learning, and scenario-based learning are the most frequently adopted among UP academic staff, while methods like gamification, design thinking, and cooperative learning remain underutilized due to time constraints, lack of resources, or limited training.

Regarding teaching methods, it was determined that discussion and teamwork are the most frequently used methods. Respondents moderately use role-playing, case studies and brainstorming. On the other hand, jigsaw, learning contracts and I-Search and used very rarely.

Digital tools such as Google Drive and YouTube are frequently used, whereas gamified tools and AI applications like ChatGPT show moderate adoption, reflecting potential for further integration. Major barriers include time constraints, limited access to resources and technology, and lack of pedagogical and digital skills, alongside resistance to change and perceptions that innovative methods are not universally applicable as significant challenges. Respondents emphasized the need for targeted training in digital tools, AI, and innovative teaching methods, as well as strategies for engaging students and managing large groups. These findings underscore the importance of institutional support and professional development to enhance the effective use of innovative teaching methods in higher education.

Specifically, they point to the need for systematic organisation and delivery of trainings for higher education professor, focusing on specific teaching strategies and methods, as well as on general pedagogical knowledge. In order to overcome prejudices and reservations about the use of digital technology for learning and teaching, trainings should also provide informed experience of the use of different teaching strategies and methods and digital tools. The university also needs to ensure access to the necessary equipment, as well as to provide professors with the possibilities with additional training, especially in terms of time and decreasing teaching load.

Limitations

The ability to make broader conclusions from this study is restricted because the participants were exclusively drawn from a single university in Slovenia, which, like all universities, has its unique setting and socio-cultural context. As a result, the findings cannot be directly applied to higher education professors in other contexts. Additionally, the study's sample size is limited to 74 participants, indicating that future research could focus on including a larger sample.

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Inovativne metode poučevanja v visokem šolstvu: primer Univerze na Primorskem

Prispevek obravnava uporabo inovativnih učnih metod v visokem šolstvu, s posebnim poudarkom na Univerzi na Primorskem (UP). V zadnjih desetletjih je uporaba digitalnih tehnologij pri poučevanju nedvomno spremenila tako učni kot učiteljski proces. Kljub temu raziskave le redko obravnavajo uporabo inovativnih učnih metod v visokošolskem okolju. Cilji raziskave so bili (i) ugotoviti, kako pogosto visokošolski učitelji in sodelavci uporabljajo različne učne strategije, metode, orodja, digitalna orodja in generativna orodja umetne inteligence, (ii) s kakšnimi izzivi se soočajo pri tem ter (iii) katere kompetence bi potrebovali za uspešnejše uvajanje inovativnih učnih metod v svoje poučevanje. Podatki so bili zbrani s pomočjo vprašalnika, na katerega se je odgovarjalo spomladi 2024. V raziskavi je sodelovalo skupno 74 visokošolskih učiteljev in sodelavcev UP. Rezultati kažejo, da visokošolski učitelji in sodelavci pogosto uporabljajo metode, kot so problemsko učenje, učenje na podlagi timskega dela in učenje na podlagi scenarijev, medtem ko so igrifikacija (angl. *gamification*), dizajnersko razmišljanje (angl. *design thinking*) in sodelovalno učenje premalo izkoriščeni pristopi. Med orodji se najpogosteje uporabljata Google Drive in YouTube. Glavne ovire za širšo uporabo inovativnih učnih strategij in metod so časovne omejitve, omejen dostop do virov in tehnologije ter pomanjkanje pedagoških in digitalnih spretnosti. Udeleženci izražajo potrebo po ciljno usmerjenih usposabljanjih za uporabo digitalnih orodij, umetne inteligence in inovativnih učnih metod ter strategij za aktivno vključevanje študentov in upravljanje večjih skupin.

Ključne besede: visokošolsko izobraževanje, inovativne učne metode, izzivi, digitalna orodja

AI in Higher Education: Analysis of Relevant Practices and Their Potential for Green Transition

Vesna Ferk Savec
University of Ljubljana, Slovenia
vesna.ferk@pef.uni-lj.si

Sanja Jedrinović
University of Ljubljana, Slovenia
sanja.jedrinovic@uni-lj.si

Artificial Intelligence (AI) has the potential to significantly impact the entire spectrum of sustainable development by targeting the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development. In the present study, we analysed reports from university teachers on 26 practises of AI implementation in pedagogical processes at nine faculties of the University of Ljubljana that responded to a call for participation in the Artificial Intelligence in Education project at the University of Ljubljana (2023–2024). We found that various AI tools were mainly used to facilitate the achievement of the sustainable development pillars Economy (SDG9, SDG12) and Society (SDG4) in different areas of KLASIUS-P educational activities, other SDGs were addressed to a lesser extent. Based on the results, we can conclude that the integration of AI into the pedagogical process has great potential but needs to be supported by regulatory insights and monitoring of AI-based technologies to enable sustainable development.

Keywords: sustainable development goals (SDGs), artificial intelligence in education (AIEd), higher education (HE)

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Introduction

The conceptualisation and operationalisation of sustainability as a global imperative has undergone a significant paradigm shift, catalysed by the formulation of the 17 Sustainable Development Goals (SDGs) and the associated 169 targets ratified by the United Nations in the 2030 Agenda for Sustainable Development (United Nations, 2015). This multi-layered framework has led to an unprecedented focus on the principles of sustainability across different disciplines and sectors. The SDGs represent a comprehensive, integrated approach to tackling complex global challenges and mark the transition from siloed interventions to a more holistic understanding of sustainable development (Bexell & Jönsson, 2017; Mensah, 2019). The adoption of the 2030 Agenda in conjunction with the Paris Climate Agreement represents a turning point in global sustainability governance, as this dual framework creates a comprehensive paradigm for both national implementation and international cooperation on sustainable development initiatives that require profound changes in governments, civil society, science and business (Bocken et al., 2016; Sachs et al., 2019, 2021). Its far-reaching impact can already be seen in its integration into national development plans, corporate sustainability strategies and research agendas in various disciplines (Rosa et al., 2019; Schroeder et al., 2019).

Vinuesa et al. (2020) argues that as artificial intelligence (AI) evolves and integrates into different aspects of society, the economy and governance, its potential to both accelerate and hinder progress towards the realisation of the SDGs becomes increasingly clear. To provide an overview of the general areas of positive and negative impacts of AI, they categorised the SDGs into three groups, corresponding to the three pillars of sustainable development, namely Society pilar (SDG 1-SDG 7, SDG 11, SDG 16), Economy pilar (SDG 8-SDG 10, SDG 12, SDG 17), and Environment pilar (SDG 13-SDG 15). The most positive impacts of AI were identified in Environmental pilar (93%), followed by Society pilar (82%) and Economy pilar (70%). In contrast, the most negative impacts were identified in Society pilar (38%), Economy (33%) and Environment (30%) (Vinuesa et al., 2020).

The usefulness of AI in many areas of sustainable development has sparked interest in exploring its role in higher education. Crompton and Burke's (2023) review of the literature on the use of AI tools in higher education points to the rapid increase in the implementation of AI in higher education, which has been used primarily at the undergraduate and graduate levels for the following purposes: (1) Assessment/Evaluation (e.g. automated assessment, test creation, feedback, review of students' online activities, evaluation of educational resources), (2) Predicting (e.g. academic performance, project topics, dropout, career decisions, innovation ability, etc.), (3) AI Assistant (e.g. virtual agents, chatbot assistance, general assistance), (4) Intelligent Tutoring System (adaptive instructional systems that incorporate the use of AI techniques and pedagogical methods) and (5) Managing Student Learning (e.g. learning analysis, identification of learning patterns, curriculum sequencing, instructional design, analysis of teaching effects, clustering of students' personal characteristics, etc.). Almost 50% of the studies were conducted in the fields of language learning, computer science, management and engineering, while only a few studies were reported in the fields of maths, education, medicine and music (Crompton & Burke, 2023).

As can be seen from the literature reviews on the integration of AI in education, the general role of AI in education has mostly been analysed in terms of supporting learners or teachers, and so far, few studies have aimed to bring together the role of AI in education and its potential to support the Sustainable Development Goals. One contribution to this discourse is the literature review conducted by AlGhamdi (2022), which sought to explore the role of AI in the educational context as a means to promote sustainable development. He suggests that the application of AI in education for sustainability goes beyond mere information resources and practical applications related to environmental, economic and social dimensions because it involves facilitating education, raising awareness and cultivating competences, trends and values that encourage individuals to adopt different viewpoints (AlGhamdi, 2022).

Metod

The successful implementation of sustainable development requires the meaningful integration of modern digital tools across different sectors and areas. The University of Ljubljana has tried to facilitate the integration of digital and green transition through several projects. One of them was the project Artificial intelligence in education at the University of Ljubljana (slo. Uporaba umetne inteligence v izobraževanju na Univerzi v Ljubljani). The project aimed to support the meaningful implementation of AI in the pedagogical process and to facilitate the exchange of best practises in different faculties of the University of Ljubljana. In this paper, we have adopted Vinuesa's definition of AI (Vinuesa et al., 2020, pp. 233) and consider AI to be any software technology with at least one of the following capabilities: perception (e.g. facial recognition), decision making (e.g. medical diagnosis systems), prediction (e.g. weather forecasting), automatic knowledge extraction and pattern recognition from data (e.g. detection of fake news circles in social media), interactive communication (e.g. social robots or chatbots) and logical reasoning (e.g. theory development from premises).

Based on the above-described context, our paper focuses in particular on the use of AI in pedagogical processes in higher education related to facilitating sustainable development through alignment with the 17 SDGs. Two main research questions guiding the research in this paper are:

RQ1: In which areas of educational activities according to the KLASIUS-P classification is AI used as part of the study programmes at the faculties of the University of Ljubljana?

RQ2: How is AI used in specific areas of educational activities according to the KLASIUS-P classification and which SDGs does it target?

At the beginning of 2023, all 26 faculties of the University of Ljubljana were invited to participate in the project *Artificial intelligence in education at the University of Ljubljana*. A total of 54 professors from 13 faculties accepted the invitation in April 2023.

During the project, the university professors were asked to submit their own practical examples of the use of AI in the pedagogical process. By the end of the project in November 2024, a total of 26 practises had been submitted by university teachers from 9 faculties (Faculty of Education, Faculty of Arts, Faculty of Natural Sciences and Engineering, Faculty of Architecture, Biotechnical Faculty, Faculty of Economics and Business, Faculty of Law, Veterinary Faculty, Faculty of Health Sciences).

In order to collect data on the implementation of AI, university professors were asked to document their practises in comprehensive reports. Each report contained detailed information about the use of AI in their courses, including the course name, faculty, programme of study, number of students enrolled, area of educational activity (KLASIUS-P), a description of how AI was integrated, details of the AI tools used, and an assessment of the positive and negative impact of AI on the course. The minimum length of the report was 2 pages and the maximum length was 15 pages.

The 26 collected examples of the use of AI in the pedagogical process were categorised according to the KLASIUS-P classification (Statistični urad Republike Slovenije, 2012). The results of the categorisation are shown in Table 1.

In order to obtain a coherent identification of the SDGs as described in the 2030 Agenda for Sustainable Development (2015) and a classification of the role of AI (Crompton & Burke, 2023) in the reported practices, two researchers separately analysed the 26 reports describing the implementation of AI in the pedagogical process. In this way, a total of 111 pages of reports were analysed independently. To avoid bias, the two researchers agreed on the final identification of the SDGs addressed and the classification of the role of AI implementation in the reports through discussion, reconstruction and agreement, which enabled a 95% inter-rater reliability of the analyzed items.

Results

The results section is organised according to the two research questions that guide this study. The first question provides contextual information about the research, the second one provides analysis on how AI is used in the peda-

Table 1 Total Number of Reported Cases of AI Implementation in Different Areas of Educational Activities (KLASIUS–P).

Areas of educational activities (KLASIUS–P)	Total number of reported practices
KLASIUS–P1: Education sciences and teacher training	4
KLASIUS–P2: Arts and humanities	8
KLASIUS–P3: Social sciences, business, law, and administration	5
KLASIUS–P4: Natural sciences, mathematics, and computer science	2
KLASIUS–P5: Engineering, manufacturing technologies, and construction	4
KLASIUS–P6: Agriculture, forestry, fisheries, and veterinary science	2
KLASIUS–P7: Health and social care	1
KLASIUS–P8: Services	0
Total	26

gogical process at the University of Ljubljana and how the use of AI in education and sustainable development influences each other.

RQ1 In which areas of educational activities according to the KLASIUS-P classification is AI used as part of the study programmes at the faculties of the University of Ljubljana?

The results of the analysis for the first research question show that AI tools are currently being used in various areas of educational activities.

The data presented in Figure 1 shows that AI is used most frequently in KLASIUS-P2 with 8 reported cases, indicating a growing interest in the use of AI tools for tasks such as language processing, content analysis and creative support. The potential of AI to improve both student engagement and educational resources in this traditionally qualitative area may be one reason for its prominent use.

Closely followed by KLASIUS-P3 with 5 reported cases. In these areas, AI is likely to be used to support data-driven research, improve decision-making processes and enable interactive learning experiences.

In the areas KLASIUS-P1 and KLASIUS-P5 there are 4 reported cases each for the use of AI. In the educational sciences, AI can be used to personalise learning, improve instructional methodologies, etc. In engineering, AI tools are suitable for core aspects of these fields, such as creating simulations, modelling and optimising problem-solving skills.

The results also show that KLASIUS-P4 and KLASIUS-P6 each have 2 reported cases of AI implementation. These areas often require complex data analyses and predictions modelling, which can be well supported by AI. However,

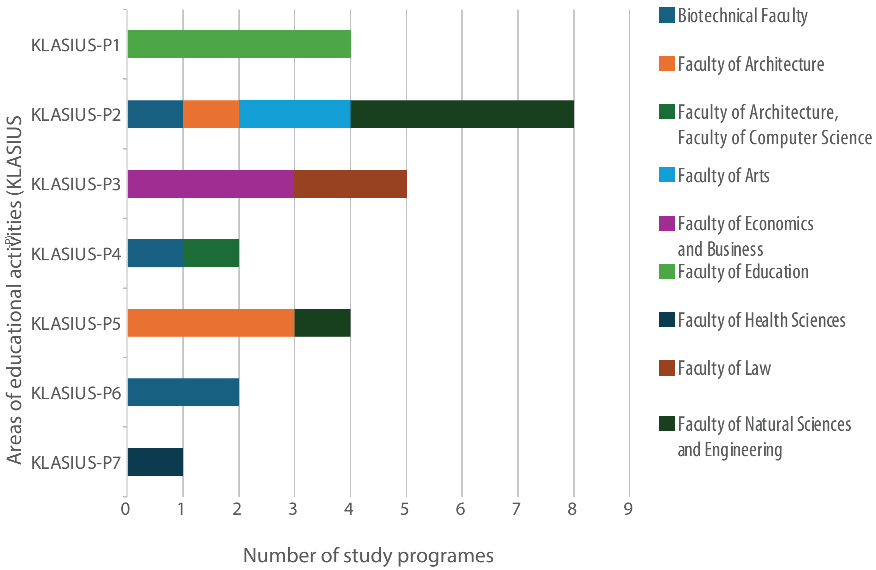

Figure 1 Number of Study Programmes in the Various Faculties of the University of Ljubljana According to the KLASIUS–P Classification.

the relatively low frequency indicates that AI in these areas is still at an early stage or is rather specialised.

Finally, KLASIUS-P7 reported only 1 case of AI use. The use of AI in health education holds great potential but may slow down due to regulatory concerns, ethical considerations and the need for validated results in sensitive environments with humans.

Further details in Table 2 point to the level of study of AI implementation in pedagogical process. More than two-thirds, namely 17 out of 26 reported practices, are integrated in the second study cycle, while 8 reported practices are from the first study cycle. However, it is important to note that the latter varies from faculty to faculty.

RQ2 How is AI used in specific areas of educational activities according to the KLASIUS-P classification and which SDGs does it target?

The analysis of 26 reported practices of AI implementation in the pedagogical process at the University of Ljubljana shows that 11 out of 17 SDGs were targeted. Figure 2 shows that most SDGs are associated with the pillars of Economy (SDGs 8-10, SDG 12, SDG 17) and Society (SDGs 3 - 4, SDG 11, SDG 16) and only rarely with the SDGs related to the Environment (SDG 13, SDG 15).

Table 2 An Overview of the Practices of AI Implementation in the Pedagogical Process as Reported by Professors in Project Artificial intelligence in Education at the University of Ljubljana.

Area of educational activity	Practice Number	Faculty of the University of Ljubljana	Study Level	Study Program
KLASIUS-P1	1	Faculty of Education	1st cycle	Two–subject teacher
	2	Faculty of Education	1st cycle	Two–subject teacher
	20	Faculty of Education	1st cycle	Erasmus (Two–subject teacher, Primary Education, Early Childhood Education, Special and Rehabilitation Pedagogy)
	21	Faculty of Education	1st cycle	Two–subject teacher
KLASIUS-P2	3	Faculty of Arts	2nd cycle	Translation
	4	Faculty of Arts	1st cycle	English studies
	5	Faculty of Natural Sciences and Engineering	2nd cycle	Graphic and interactive communications
	6	Faculty of Natural Sciences and Engineering	2nd cycle	Graphic and interactive communications
	7	Faculty of Natural Sciences and Engineering	2nd cycle	Graphic and interactive communications
	8	Faculty of Architecture	2nd cycle	Master's degree programme in Architecture
	9	Faculty of Natural Sciences and Engineering	2nd cycle	Graphic and Interactive Communications, Graphic and Media Technology
	10	Biotechnical Faculty	1st cycle	Landscape architecture
KLASIUS-P3	11	Faculty of Economics and Business	2nd cycle	Marketing
	12	Faculty of Economics and Business	2nd cycle	Supply chains and logistics
	13	Faculty of Law	1st cycle	Law
	18	Faculty of Law	2nd cycle	Law
	23	Faculty of Economics and Business	2nd cycle	Business Informatics
KLASIUS-P4	14	Faculty of Architecture	2nd cycle	Master's degree programme in Architecture
	24	Biotechnical Faculty	1st cycle	Biotechnology
KLASIUS-P5	15	Faculty of Architecture	2nd cycle	Master's degree programme in Architecture
	19	Faculty of Architecture	2nd cycle	Master's degree programme in Architecture
	25	Faculty of Architecture	2nd cycle	Master's degree programme in Architecture
	26	Faculty of Natural Sciences and Engineering	2nd cycle	Graphic and Interactive Communications, Graphic and Media Technology
KLASIUS-P6	16	Veterinary Faculty	1st cycle	Veterinary
	22	Biotechnical Faculty	2nd cycle	Animal science
KLASIUS-P7	17	Faculty of Health Sciences	2nd cycle	Radiological technology, Physiotherapy

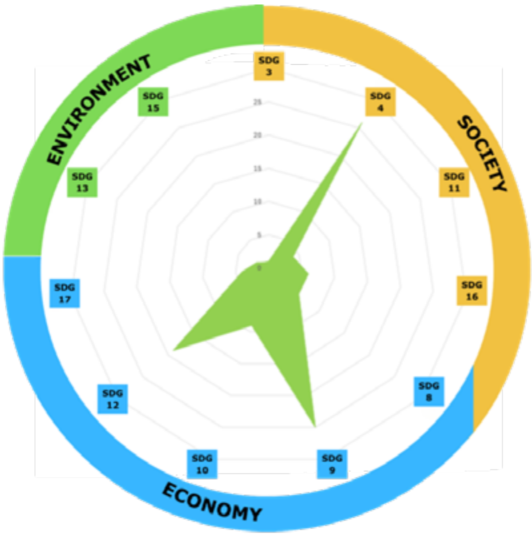

Figure 2 Mapping the Total Number of Targeted SDGs Through the Implementation of AIEd Tools in the Pedagogical Process.

The more detailed analysis following the categorisation of the SDGs using the KLASIUS-P classification indicates differences between the areas of educational activity (Table 3).

The further analysis of the reported practices according to their KLASIUS-P classification, the role of AI in the pedagogical process and the AI tools used is presented in Table 4.

Table 4 shows that in 24 reported practices, the implementation of AIEd tools targeted Society and Economy sustainable development pillars, while in a further two reported practices the Environment pillar was also addressed.

Table 4 shows that among the SDGs that fit into the *pillar Society* of sustainable development, SDG 4 (Quality education) is the most frequently targeted SDG and appears in all 26 reported practices. This shows that AI has great potential to improve the quality of education, provide personalised learning tools and act as an effective assistant for teachers and students. AI tools such as ChatGPT, Midjourney and intelligent tutoring systems are central to changing educational practice. SDG 11 (Sustainable Cities and Communities) and SDG 16 (Peace, Justice and Strong Institutions) are also often supported by the assistance of AI tools. The role of AI in these practices includes improving the quality of education for diverse communities and providing accessible information, which helps to reduce inequalities and promote peaceful, inclusive societies.

Table 3 Presentation of the Reported Practices According to the Targeted SDG Pillars and Areas of Educational Activities (KLASIUS–P).

SDG Pillar	Targeted SDGs	Number of reported practices targeting specific SDGs							
		Total	KLASIUS–P1	KLASIUS–P2	KLASIUS–P3	KLASIUS–P4	KLASIUS–P5	KLASIUS–P6	KLASIUS–P7
Society	SDG 1	0	0	0	0	0	0	0	0
Society	SDG 2	0	0	0	0	0	0	0	0
Society	SDG 3	1	0	0	0	0	0	0	1
Society	SDG 4	26	4	8	5	2	4	2	1
Society	SDG 5	0	0	0	0	0	0	0	0
Society	SDG 6	0	0	0	0	0	0	0	0
Society	SDG 7	0	0	0	0	0	0	0	0
Society	SDG 11	4	0	2	0	0	2	0	0
Society	SDG 16	6	1	2	3	0	0	0	0
	Sum	37	5	12	8	2	6	2	2
Economy	SDG 8	6	0	2	1	2	0	1	0
Economy	SDG 9	25	4	8	4	2	4	2	1
Economy	SDG 10	9	0	2	3	2	1	0	1
Economy	SDG 12	19	4	7	2	0	3	2	1
Economy	SDG 17	4	2	0	0	0	2	0	0
	Sum	63	10	19	10	6	10	5	3
Environment	SDG 13	2	0	1	0	0	1	0	0
Environment	SDG 14	0	0	0	0	0	0	0	0
Environment	SDG 15	1	0	0	0	0	0	1	0
	Sum	3	0	1	0	0	1	1	0
	Total	103	15	32	18	8	17	8	5

The sustainable development *pilar Economy* is the most supported, while SDG 9 (Industry, Innovation and Infrastructure) is the second most targeted goal, especially in areas such as engineering, social sciences and the arts. Tools such as Blender, Midjourney and Teachable Machine are frequently used to support creative activities and promote technological progress. Other SDGs in this pilar, such as SDG 12 (Responsible Consumption and Production) and SDG 10 (Reduced Inequalities), also have significant AI contributions, particularly in the social sciences, engineering and natural sciences. AI tools help to provide assessments, evaluations and innovative production, helping to reduce inequalities and ensure responsible production practices. SDG 8 (Decent Work and Economic Growth) benefits from the role of AI in managing education systems and enhancing skills. For example, AI assists

Table 4 Overview of the Role of AI in the Pedagogical Process in Different Areas of Educational Activities (KLASIUS–P) and its Contribution to the Development of the SDGs.

Area of educational activity	Practice Nº	Role of AI	Used AIEd tools	Targeted SDGs
KLASIUS–P1	1	AI Assistant	Science Activity Generator and ActivGenie	SDG 4 SDG 9 SDG 12 SDG 17
	2	Predicting	Teachable Machine	SDG 4 SDG 9 SDG 12
	20	AI Assistant Managing student learning	WiseCut, Photosonic, Lumen5 in Steve.AI, SongR.ai and Musicgen, D–ID AI Presenter and HeyGen AI, GravityWrite, Elicit, ElevenLabs	SDG 4 SDG 9 SDG 12 SDG 17
	21	AI Assistant	Elicit	SDG 4 SDG 9 SDG 12 SDG 16
KLASIUS–P2	3	AI Assistant	ChatGPT, GPT–4, Google Translate, DeepL	SDG 4 SDG 9 SDG 12 SDG 16
	4	Assessment and evaluation AI Assistant	ChatGPT	SDG 4 SDG 9 SDG 10 SDG 16
	5	AI Assistant	Midjourney	SDG 4 SDG 8 SDG 9 SDG 12
	6	Assessment and evaluation Predicting AI Assistant	expoze.io	SDG 4 SDG 9 SDG 12
	7	Assessment and evaluation AI Assistant	Virtual Caliper, Blender in CLO 3D	SDG 4 SDG 8 SDG 9 SDG 10 SDG 12
	8	Assessment and evaluation AI Assistant	DALL–E, Stable Difussion, and Midjourney	SDG 4 SDG 9 SDG 11 SDG 12
	9	AI Assistant	Blender, Nvidia	SDG 4 SDG 9 SDG 12

Continued on next page

Area of educational activity	Practice Nº	Role of AI	Used AIEd tools	Targeted SDGs
	10	AI Assistant	CHATGPT, Midjourney, DALL–E 2, Stable diffusion, Dream (Wombo)	SDG 4 SDG 9 SDG 11 SDG 12 SDG 13
KLASIUS–P3	11	Assessment and evaluation Predicting AI Assistant Intelligent tutoring system Managing student learning	Mimic Pro Digital Marketing Simternship	SDG 4 SDG 8 SDG 9 SDG 10 SDG 12
	12	Assessment and evaluation AI Assistant Intelligent tutoring system	ChatGPT	SDG 4 SDG 9 SDG 12
	13	Assessment and evaluation AI Assistant	ChatGPT, Grammarly, DeepL	SDG 4 SDG 10 SDG 16
	18	AI Assistant	ChatGPT	SDG 4 SDG 9 SDG 10 SDG 16
	23	Assessment and evaluation Predicting AI Assistant	ChatGPT	SDG 4 SDG 9 SDG 16
KLASIUS–P4	14	Assessment and evaluation AI Assistant Intelligent tutoring system	CodeQ	SDG 4 SDG 8 SDG 9 SDG 10
	24	Assessment and evaluation AI Assistant InstaText		SDG 4 SDG 8 SDG 9 SDG 10
KLASIUS–P5	15	AI Assistant	Midjourney and DALL·E	SDG 4 SDG 9 SDG 11 SDG 12
	19	AI Assistant	Midjourney	SDG 4 SDG 9 SDG 11 SDG 17
	25	AI Assistant	Midjourney and DALL·E	SDG 4 SDG 9 SDG 10 SDG 12

Continued on next page

Area of educational activity	Practice Nº	Role of AI	Used AIEd tools	Targeted SDGs
	26	AI Assistant	Chat GPT, Google bard, ChatSonic, Claude, Learnt.ai and similar, Dall E, NightCafe, Images.ai and similar.	SDG 4 SDG 9 SDG 12 SDG 13 SDG 17
KLASIUS–P6	16	Assessment and evaluation AI Assistant Intelligent tutoring system	Coursera	SDG 4 SDG 8 SDG 9 SDG 12
	22	Predicting	A dairy cattle breeding simulation program	SDG 4 SDG 9 SDG 12 SDG 15
KLASIUS–P7	17	AI Assistant	OpenCV, neural networks CNN (VGG16, VGG19, ALEXNET or similar), Tensorflow in Keras	SDG 3 SDG 4 SDG 9 SDG 10 SDG 12

in the provision of practical training simulations, such as the Mimic Pro Digital Marketing Simternship. SDG 17 (Partnerships for the Goals), although less common, involves AI fostering collaboration and knowledge sharing, particularly within the education community, to collectively achieve the SDGs (Table 4).

The sustainable development *pilar Environment* is least targeted by the AI implementations, whereby SDG 13 (Climate Action) and SDG 15 (Life on Land) are supported to a limited extent. SDG 13 is supported in cases where AI is used creatively and innovatively to raise awareness or mitigate the effects of climate change through visualisation tools such as Midjourney and DALL-E. SDG 15 was targeted only once, indicating a gap in the promotion of environmental sustainability through AI, particularly in areas such as biodiversity conservation and sustainable land use (Table 4).

The integration of artificial intelligence (AI) in diverse educational areas, as classified by KLASIUS-P, emphasizes the multi-layered role of AI tools and their contribution to achieving the SDGs, as shown in Table 4:

– In the area of *Education Sciences and Teacher Training* (KLASIUS-P1), AI functions primarily as an instructional aid through applications such as Science Activity Generator, ActivGenie and WiseCut. These tools facilitate the management of student learning, and the creation of educational content aimed primarily at SDG 4, SDG 9, SDG 12 and SDG 17, which are about quality education, innovation and sustainable development practices.

- In the field of *Arts and Humanities* (KLASIUS-P2), AI plays a central role in content creation and evaluation processes. Tools such as ChatGPT, Google Translate, DeepL and Midjourney are used to improve creative outcomes and assessment capabilities. Targeted SDGs in this context include SDG 4, SDG 8, SDG 9, SDG 10, SDG 11, SDG 12, SDG 13 and SDG 16, demonstrating that AI not only contributes to improving the quality of education, but also to reducing inequalities, fostering sustainable communities and ensuring responsible consumption and production.
- In the area of *Social Sciences, Business, Law, and Administration* (KLASIUS-P3), AI technologies such as ChatGPT, Grammarly and Mimic Pro Digital Marketing Simternship are used for assessment, learning management and skills development. The SDGs primarily addressed here include SDG 4, SDG 8, SDG 9, SDG 10, SDG 12 and SDG 16, emphasising the role of AI in promoting quality education, supporting inclusive economic growth and enhancing effective governance and institutional efficiency.
- For *Natural Sciences, Mathematics, and Computer Science* (KLASIUS-P4), AI tools such as CodeQ are used in both reported practices to improve the assessment and evaluation of teaching. These applications contribute to SDG 4, SDG 8, SDG 9 and SDG 10 by emphasising the importance of quality education, equitable work opportunities and the reduction of social inequalities through AI-driven education.
- In *Engineering, Manufacturing Technologies and Construction* (KLASIUS-P5), AI tools such as Midjourney and DALL-E are widely used for creative content creation and design processes. These activities are in line with SDG 4, SDG 9, SDG 10, SDG 11, SDG 12, SDG 13 and SDG 17 and reflect the commitment to quality education, sustainable infrastructure development and proactive climate action.
- In the field of *Agriculture, Forestry, Fisheries, and Veterinary Sciences* (KLASIUS-P6), AI is applied in educational simulations in both reported cases, including in dairy cattle breeding programmes targeting SDG 4, SDG 8, SDG 9, SDG 12 and SDG 15. These efforts emphasise the importance of AI in promoting quality education, sustainable agricultural practices and responsible resource management.
- In a reported practice from the area *Health and Social Care* (KLASIUS-P7), AI applications such as TensorFlow and OpenCV are used to support

health-related educational activities, addressing SDG 3, SDG 4, SDG 9, SDG 10 and SDG 12. This integration emphasises the improvement of health and well-being alongside quality educational outcomes through the use of AI-driven technologies.

– The *role of AI in higher education* outlined in Table 4 emphasises its transformative ability to promote the achievement of the SDGs:
– In the context of an *AI Assistant* (e.g. practice No 1, 3, 5, 9, 10, 13, 15, 17, 19, 26), tools such as ChatGPT, MidJourney and DALL-E enhance creative exploration (SDG 4) and promote innovation through personalised support and adaptive learning resources. These features enable inclusive education by tailoring learning experiences to learners' individual needs, fostering creativity and problem-solving skills.
– In the context of *predictive analytics* (e.g. practice No 2, 6, 11, 22, 23), tools such as Teachable Machine use data-driven insights to enable educators to recognise patterns and learning gaps to support quality education (SDG 4) and contribute to industrial innovation (SDG 9). Predictive AI technologies enable educators to proactively address students' needs and create an inclusive and equitable learning environment that enables sustainable educational progress.
– In terms of *assessment and evaluation* (e.g. practice No 4, 7, 8, 12, 13, 14, 16, 24), Intelligent Tutoring Systems and platforms such as Coursera improve inclusivity (SDG 10) by adapting content for diverse learner populations. They also empower educators with real-time feedback, promoting sustainable educational practices (SDG 12). These AI tools improve the effectiveness of assessments by facilitating personalized learning pathways that ultimately benefit both students and teachers.
– Tools such as MidJourney and Blender used in *managing student learning* (e.g. practice No 11, 20) expand the potential for creating immersive and engaging educational content, fostering creativity (SDG 8) and enhancing industry standards (SDG 9). AI-driven learning management tools enable collaborative content development and actively engage learners, enhancing the overall educational experience.
– Finally, the integration of AI into *learning tools* such as WiseCut and Photosonic (e.g. practice N° 20, 26) facilitates multidimensional collaboration (SDG 17) by streamlining content creation and enhancing global communication. These examples show how AI applications in education contribute to progress on multiple SDGs by fostering innovation, inclusivity and sustainability.

Conclusions

The results show that the integration of AI into the pedagogical process is very different in the various disciplines. We found that the reported practices on the implementation of AI in the pedagogical process at the University of Ljubljana cover all KLASIUS-P areas, except for the area of services (KLASIUS-P8), which differs from the results of other studies (e.g., Crompton & Burke, 2023), which indicate that educators integrate AI primarily in disciplines such as language learning, computer science, management and engineering, while relatively few cases are reported from the fields of mathematics, education, medicine and music.

The analysis emphasises the significant role of AI in supporting the SDGs, particularly those related to education and innovation, under the Society and Economy pillars. However, to achieve a holistic impact on sustainable development, more emphasis needs to be placed on the Environment pillar. Leveraging AI's potential to address environmental challenges would create a more balanced approach to sustainability and ensure that the benefits of AI are realised in all areas of society, the economy and the environment.

Our study analysed the reports describing the implementation of the AIEd tools. For a deeper understanding of how the SDGs were targeted, it would be useful to extend the study with interviews with university professors. In future studies, it would also be useful to examine the perspective of the targets related to specific SDGs, taking into account both the positive and negative impacts of AI on specific SDGs. It would also be reasonable to complement the study with additional examples of the use of AI in the pedagogical process at the University of Ljubljana or in the Slovenian higher education sector.

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Umetna inteligenca v visokem šolstvu: analiza ustreznih praks in njihovega potenciala za zeleni prehod

Umetna inteligenca (UI) lahko pomembno vpliva na celoten spekter trajnostnega razvoja, saj lahko naslavlja vseh 17 ciljev trajnostnega razvoja *Agende za trajnostni razvoj do leta 2030*. V pričujočem prispevku smo preučili poročila visokošolskih učiteljev o 26 primerih uporabe UI v pedagoškem procesu na de-

vetih članicah Univerze v Ljubljani, ki so se odzvale k sodelovanju v projektu Umetna inteligenca v izobraževanju na Univerzi v Ljubljani (2023–2024). Ugotovili smo, da so različna orodja UI v pedagoškem procesu uporabljena predvsem za doseganje ciljev stebrov trajnostnega razvoja Gospodarstvo (SDG9, SDG12) in Družba (SDG4) na različnih področjih izobraževalnih dejavnosti KLASIUS-P, ostali cilji trajnostnega razvoja pa so naslavljani v manjšem obsegu. Pričujoča raziskava je omejena in obravnava le prakse, o katerih se poroča v okviru projekta. Na podlagi ugotovitev lahko izpeljemo, da vključevanje UI v pedagoški proces ponuja številne možnosti, vendar mora biti njena uporaba podprta z ustreznimi regulativnimi razmisleki in nadzorom nad uporabo orodij UI z namenom omogočenja trajnostnega razvoja.
Ključne besede: cilji trajnostnega razvoja, umetna inteligenca v izobraževanju visokošolsko izobraževanje

Digital Standard for the Design of Inclusive and Effective Online Courses in Higher Education: An Integrative Literature Review

Sabina Ličen
University of Primorska, Slovenia
sabina.licen@fvz.upr.si

Mirko Prosen
University of Primorska, Slovenia
mirko.prosen@fvz.upr.si

This integrative literature review examines models and frameworks for digital education in higher education, synthesizing their key strengths and limitations. By analysing nine existing frameworks covering different aspects of digital education, including pedagogical approaches, technological solutions and assessment mechanisms, the study identifies gaps in the current literature. The findings show that while the individual models provide valuable insights, none of them independently offer a complete approach to the design, implementation and assessment of digital education. Therefore, this study proposes the development of an integrated digital standard that combines theoretical and practical perspectives to promote inclusive and effective online learning. Such a standard could increase the adaptability to students' needs, improve assessment mechanisms and increase the flexibility of digital learning environments. This study contributes to the development of sustainable and adaptable solutions for the future of digital education.

Keywords: innovative teaching methods, e-learning, sustainable education, effectiveness of online teaching, digital education

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Introduction

Digital education in higher education is evolving rapidly in response to global challenges such as climate change, digital transformation, and the increasing need for innovative teaching and learning strategies. To address these demands, universities play an important role in equipping students and educators with the necessary digital skills to navigate and contribute to a future shaped by technology (European Commission, 2022).

The European Union has identified digital transformation as a key priority, setting ambitious targets such as ensuring 80% of EU citizens have basic digital skills and developing 20 million digital experts by 2030 (European Education Area, 2021). Higher education institutions are integral to achieving these goals by implementing digital literacy initiatives, fostering innovation, and developing digital education strategies (Falloon, 2020). Despite advancements, disparities in digital skills persist across the EU, posing a significant challenge to achieving equitable and inclusive education (European Commission, 2022).

Digital education encompasses various teaching and learning modalities that leverage technology to enhance and transform traditional methods. The term has evolved over decades, with e-learning emerging as a prominent concept integrating distance, online, and mobile learning (Kennedy et al., 2011). Wheeler (2012) suggested using 'digital education' to encompass the holistic use of technology for instructional purposes, a definition supported by subsequent literature (Blankenship & Baker, 2019).

In Slovenia, for instance, the adoption of digital education has lagged behind other European nations. A 2017 study revealed that only 70% of Slovenian higher education institutions used learning management systems (LMS), compared to 91% in other EU countries (Bregar & Puhek, 2017). This disparity highlights the need for strategic investment in digital education infrastructure and policies. The integration of LMS platforms like Moodle has facilitated blended and online learning, but challenges remain in scaling these solutions to meet broader institutional needs (Ličen, 2013; Radovan et al., 2018).

The COVID-19 pandemic has emphasised the critical importance of digital education, enabling educational institutions to swiftly adapt to remote learning. However, it has also exposed significant gaps in teacher and student readiness for this type of education (Yeo et al., 2021). While digital education offers numerous opportunities, its effective implementation requires addressing both its benefits and challenges.

On the positive side, digital education offers flexibility, accessibility and cost-effectiveness while promoting personalised and interactive learning environments (Agariya & Singh, 2012; Ali, 2016). Despite these benefits, it also brings challenges, such as reduced interpersonal interaction, more preparation time for teachers and the need for greater self-discipline from learners (Koch, 2014; Lawn et al., 2017). In addition, technical barriers, including inadequate equipment and unreliable internet connections, widen existing inequalities in access to digital education (Rouleau et al., 2017).

To address these challenges, the European Education Area has introduced the Digital Education Action Plan (2021–2027), which aims to improve the quality of teaching through the integration of digital technologies and to promote the digitalisation of educational practise (European Education Area, 2021). The plan prioritizes the development of digitally competent teachers and the creation of secure, user-friendly platforms that meet ethical standards. In addition, it emphasises the design of inclusive courses that promote equality, equity and diversity and ensure accessibility for remote learners, individuals with disabilities and those with limited resources (Czerkawski & Lyman, 2016).

Instructional design plays a key role in creating effective digital learning programmes. Through systematic analysis, planning and implementation of instructional strategies, instructional design ensures that learning processes are engaging, accessible and aligned with defined outcomes (Nagpal & Kumar, 2020). Approaches such as learner-driven instructional models and frameworks that promote active engagement are particularly effective in improving student engagement and achievement (Leeds et al., 2013). These models also consider the cultural and political context of the regions in which the education is delivered, thus ensuring relevance and sustainability.

This integrative literature review examines existing models and frameworks for online learning in higher education. Its primary goal is to analyse their strengths and limitations, synthesizing insights to propose a digital standard for designing, implementing, and evaluating digital education. The focus is on fostering inclusivity and ensuring course effectiveness. This study addresses the research question: *What existing models and frameworks for digital education in higher education are identified in the literature, what are their strengths and weaknesses, and how can their synthesis contribute to the development of an innovative digital standard?*

Methods

This integrative literature review employed a rigorous methodology informed by the framework proposed by Whittemore and Knafl (2005), which accommodates diverse research designs, including qualitative, quantitative, and mixed-method studies. The review process was divided into three key stages: (1) conducting a systematic search of the literature; (2) performing an evaluation and thematic analysis of the data, involving data reduction, organization for clarity, and deriving validated conclusions; and (3) synthesizing and presenting the findings in a structured and coherent format.

To ensure transparency and robustness, the review adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021). These guidelines provided a systematic approach to selecting and excluding studies, employing a four-phase flowchart to manage the review process. Additionally, the PRISMA checklist, comprising 27 essential criteria, guided the thorough reporting of key sections, including the title, abstract, introduction, methods, results, discussion, and acknowledgments.

Eligibility Criteria

To ensure a thorough analysis, eligibility criteria for this integrative review were established. Inclusion criteria required studies to be published as full-text, peer-reviewed articles in English between 2014 and 2024. The review included studies focusing on models, frameworks, or practices that inform the development, implementation, or evaluation of digital education in higher education, with an emphasis on fostering inclusivity and effectiveness.

Studies were excluded if they did not relate specifically to higher education, lacked a focus on digital education and were published prior to the year 2014. Additionally, non-peer-reviewed materials such as conference abstracts, editorials, letters, and commentaries were excluded.

Search Strategy

An integrative literature search was conducted in several electronic databases, including PubMed, Medline, CINAHL (Cumulative Index to Nursing and Allied Health Literature) and ScienceDirect. The search focussed on identifying studies examining models and frameworks for online learning in higher education. A combination of keywords and Boolean operators were used to refine the search and identify relevant studies. The search terms included: *((‘online learning’[Title/Abstract] OR ‘e-learning’[Title/Abstract] OR ‘digital education’[Title/Abstract]) AND (‘higher education’[Title/Abstract] OR ‘university’[Title/Abstract]) AND (‘framework’[Title/Abstract] OR ‘model’[Title/Abstract]) AND (‘effectiveness’[Title/Abstract] OR ‘evaluation’[Title/Abstract])) AND ((y_10[Filter]) AND (fft[Filter]) AND (english[Filter]))*.

Two researchers independently reviewed the titles and abstracts of all retrieved articles to assess their relevance. Studies that did not fulfil the inclusion criteria were excluded. After this initial review, a full-text screening was performed to further assess the eligibility of the remaining studies.

The search and selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure a structured and transparent approach to identifying relevant literature (Figure 1).

The selection of studies began with a systematic search of several databases. A total of 329 records were identified, including 126 from PubMed, 43 from Medline and CINAHL and 160 from ScienceDirect. After removing 72 duplicate records, 257 studies remained for title and abstract screening.

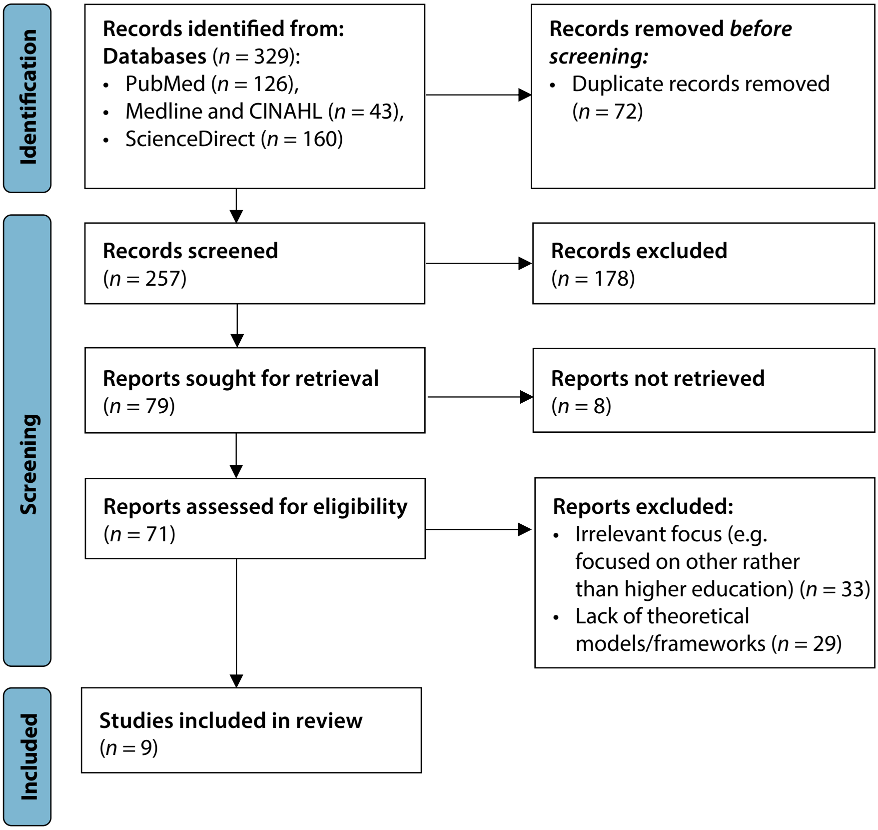

Figure.1 Literature Search Strategy Included in the Integrative Review

During the screening phase, 178 records were excluded because they did not fulfil the predefined inclusion criteria. The remaining 79 articles were used for the full-text search. However, 8 reports could not be retrieved and were excluded from further evaluation.

A total of 71 full-text articles were screened for eligibility. Of these, 33 studies were excluded due to an irrelevant focus (e.g. studies dealing with educational levels other than higher education), while 29 studies were excluded due to the lack of a theoretical model or framework. Following this rigorous selection process, 9 studies met all eligibility criteria and were included in the final analysis.

Quality Appraisal

To assess the methodological quality of the included studies, we applied the Critical Appraisal Skills Programme (Critical Appraisal Skills Programme, n.d.).

CASP provides a structured approach to determining the rigour, credibility and relevance of research findings.

The nine studies selected for synthesis underwent a systematic appraisal process. Each study was independently reviewed by the authors using the CASP checklist appropriate to their study design. This double-blind assessment was intended to minimise individual bias and ensure a thorough evaluation of study quality. Any discrepancies in the assessments were discussed at length, with final decisions made on the basis of consensus based on the evidence presented in each study. Following this critical appraisal, all nine studies met the quality criteria and were deemed suitable for inclusion in the study.

Data Extraction and Synthesis

A synthesis process was used to systematically analyse the models and frameworks identified in the selected studies. To ensure clarity and methodological consistency, the studies were first categorised according to their primary focus, i.e. whether they examined conceptual frameworks, implementation models or evaluation strategies for online learning in higher education.
For data extraction, each study was reviewed independently, using a customised data extraction form designed to capture key elements, including framework type, educational content and key findings. A narrative synthesis was conducted to integrate the findings of the different study types and enable a comparative analysis of the strengths and limitations of the existing models. This approach not only provided insights into the effectiveness and applicability of the different frameworks but also helped to identify common themes and emerging trends in the field of digital education.

Results

This review includes nine studies that present different models and frameworks for online learning in higher education. These studies include evaluation models (Campbell et al., 2019), frameworks for technology-enhanced learning (Choi-Lundberg et al., 2023), and pedagogical and theoretical constructs (Guàrdia et al., 2021; Kim & Gurvitch, 2020; Smith et al., 2017). They also examine quality measurement (Manian & Pius, 2023), integrative assessment (Marciniak, 2018), adaptive learning systems (Wang et al., 2015) and peer feedback models (Kerman et al., 2024). The selected studies provide insights into student engagement, instructional strategies, institutional assessment, quality assurance and technological integration in digital education (Table 1).

Table 1 Characteristics of Included Studies

Authors, Year	Framework type	Educational content	Key findings
Kerman et al., (2024)	Conceptual framework for online peer feedback	Higher education	Examines the key factors for online peer feedback, including student characteristics, learning environments and feedback processes, and proposes a guiding framework.
Choi-Lundberg et al. (2023)	Systematic review framework	Digital innovations in higher education	Identifies eight categories of digital technologies and emphasises the need for better evaluation and reporting standards.
Manian & Pius, (2023)	Quality measurement framework (DIGIQUAL)	Online higher education, focus on management courses	DIGIQUAL overcomes the limitations of existing models and provides a robust tool to assess the quality of online teaching, student satisfaction and engagement.
Guàrdia et al., (2021)	Transformative framework (Intelligent, Distributed, Engaging, Agile, Situated – IDEAS)	Higher education	Defines key trends in technology, pedagogy and organisation and provides a framework for next generation pedagogy.
Kim & Gurvitch, (2020)	Theoretical framework (Community of Inquiry)	Online education in higher education, focus on Kinesiology	Systematic review of 23 studies to identify effective online teaching strategies and student learning outcome variables.
Campbell et al. (2019)	Evaluation framework (Kirkpatrick's four–level model)	Online cancer education for nurses and allied health professionals	Finds online cancer education appealing but points to limited validated evaluations and assessments of clinical impact.
Marciniak (2018)	Integrative assessment model	Online higher education programmes	Develops a validated model that integrates programme quality assessment and continuous evaluation using 14 dimensions and 81 indicators.
Smith et al. (2017)	Theoretical framework (Community of Practice)	Online/blended learning in higher education and professional development	Reviews the application of Wenger's Communities of Practise framework and identifies key trends and research directions in the field of social learning
Wang et al. (2015)	Complex adaptive systems framework	Blended learning in higher education	Uses a systemic approach to blended learning and identifies research gaps and opportunities through a review of 87 empirical studies.

Table 2 Framework Synthesis

Framework component	Strength rating	Limitations rating	Integration potential
Online peer feedback framework (Kerman et al., 2024)	Medium – Focused on a specific aspect of online learning	Low – Limited to peer feedback	Medium – Can inform collaborative learning components
Digital technology categories (Choi-Lundberg et al., 2023)	Medium – Comprehensive overview of the technologies	Low – Limited evidence of impact	Medium – Provides a technological context for other frameworks
DIGIQUAL framework (Manian & Pius, 2023)	High – Focused on the perception of students	Medium – Limited to one institution	High – Can contribute to quality measurement in an integrated model
IDEAS framework (Guàrdia et al., 2021)	High – Comprehensive transformational approach	Medium – Limited empirical testing	High – Provides overarching principles for integration
Community of Inquiry (Kim & Gurvitch, 2020)	High – Well established in the literature on online learning	Medium – Potential for more sophisticated applications	High – Can provide theoretical basis for integrated model
Kirkpatrick's four–level model (Campbell et al., 2019)	High – Established evaluation framework	Medium – Weak evidence of effectiveness in the online context	High – Can be integrated with other quality measures
Integrative assessment model (Marciniak, 2018)	High – Comprehensive with expert validation	Medium – Complex with 81 indicators	Medium – Can provide detailed evaluation criteria
Community of Practice (Smith et al., 2017)	Medium – Proven theory	Medium – Unused in the online context	Medium – Can consider aspects of social learning
Complex adaptive systems framework (Wang et al., 2015)	High – Novel systems approach	Medium – Limited empirical testing	High – Can provide an overarching systems perspective

In order to effectively design, implement and evaluate digital education in higher education, various models and frameworks have been proposed in the literature. These frameworks address different aspects of digital education, including pedagogy, technology, assessment, and learner engagement. Table 2 provides a summary of the main frameworks identified in the literature and analyses their strengths, limitations and potential for integration (Table 2).

The analysis of nine key frameworks and/or models for digital education in higher education highlights their different contributions to the design, implementation and evaluation of digital learning environments. Each framework offers valuable insights into specific aspects of digital education, but none fully addresses all the essential components required for an integrated digital standard. The synthesis of these frameworks could allow the development of a holistic and scalable approach that ensures effective and inclusive online learning experiences.

Pedagogical and Theoretical Foundations

The Community of Inquiry (Kim & Gurvitch, 2020) and Community of Practise (Smith et al., 2017) frameworks emphasise the importance of collaborative learning and social integration in digital education. These models provide an established theoretical basis for structuring online interactions and fostering deep, collaborative and community-orientated learning. However, their use in digital learning is still underutilised, particularly in large-scale online courses.

Assessment and Quality Assurance

Kirkpatrick's four-stage model (Campbell et al., 2019) and the DIGIQUAL framework (Manian & Pius, 2023) both focus on evaluating the effectiveness and quality of online learning experiences. Kirkpatrick's model provides a structured approach to assessing learning outcomes, yet its applicability in digital learning environments is weakly evidenced. DIGIQUAL, on the other hand, prioritizes student perceptions and the measurement of quality, but is limited by its development in a specific institutional context.

Technology and Digital Integration

The Digital Technology Categories framework (Choi-Lundberg et al., 2023) provides a structured classification of digital tools used in digital education and helps educators and instructional designers navigate the diverse landscape of educational technologies. Although this framework provides a thorough overview, it does not examine in depth the pedagogical effectiveness or long-term impact of these technologies on learning outcomes, leaving a gap in empirical validation.

The Complex Adaptive Systems (CAS) framework (Wang et al., 2015) conceptualises online learning environments as dynamic, interconnected systems in which multiple components, such as learners, teachers, content and technology, continuously interact and adapt. This systems-based approach recognises the complexity of digital education and the need for flexible, responsive design strategies. While the CAS framework is theoretically sound, it has limited empirical testing, so there are gaps in understanding its practical applicability and effectiveness in real educational contexts.

Assessment and Feedback Mechanisms

Effective assessment and feedback are critical components of online learning that ensure students receive meaningful evaluations that support their academic growth (Jensen et al., 2021). The Integrative Assessment Model (Marciniak, 2018) and the Online Peer Feedback Framework (Kerman et al., 2024) offer complementary approaches to assessment, each with their strengths and limitations.

Marciniak's Integrative Assessment Model (2018) provides a structured assessment system that integrates multiple dimensions of student performance. With its 81 indicators, it ensures a detailed and multidimensional assessment covering aspects such as learning outcomes, engagement and skills development. Nevertheless, the complexity of this model could poses a challenge for practical implementation as it requires significant resources, time and expertise to apply it effectively in different educational institutions.

In contrast, the Online Peer Feedback Framework promotes student engagement, self-regulation and collaborative learning by involving learners in the assessment process. This model fosters student ownership and encourages deeper critical thinking through the exchange of constructive feedback. In addition, variations in the quality of student feedback and potential biases in peer assessments could be raising concerns about consistency and reliability (Double et al., 2020).

Discussion

The integration of different models and frameworks for digital education reveals distinct but complementary perspectives on digital learning. Existing frameworks offer valuable insights into pedagogy, technology, and assessment, yet their isolated application limits their ability to address the evolving complexity of digital education. Synthesising these frameworks provides an appropriate foundation for designing inclusive, effective and scalable online learning environments.

A key strength of the existing models lies in their targeted focus on key aspects of digital education. Frameworks based on social learning theories emphasise the importance of interaction, collaboration and engagement in digital learning environments (Kim & Gurvitch, 2020; Smith et al., 2017). These models suggest that fostering meaningful peer interaction and learner autonomy improves student motivation and cognitive development. The role of structured peer feedback in the development of higher order thinking skills is particularly well documented (Kerman et al., 2024), reinforcing the value of collaborative assessment as a learning tool.

Assessment-orientated models provide structured approaches to evaluate the quality and effectiveness of digital education (Campbell et al., 2019; Manian & Pius, 2023). They ensure that online courses achieve defined learning objectives and improve student performance. Their empirical validation in fully digital learning environments, however, remains limited, raising concerns about their applicability to contemporary, technology-enhanced pedagogies. Furthermore, some models prioritise institutional assessment measures over student-cantered assessment, overlooking formative learning processes that contribute to long-term knowledge retention (Morris et al., 2021).

Technological frameworks broaden the scope of digital learning by addressing the scalability and adaptability of digital education (Choi-Lundberg et al., 2023; Wang et al., 2015). They offer critical perspectives on how digital tools support learning, increase interactivity and improve accessibility. While these models recognise the dynamic nature of educational technology, they often focus on the logistics of implementation rather than pedagogical coherence (Chugh et al., 2023).

Assessment-centred models offer structured approaches to feedback and performance evaluation (Marciniak, 2018; Kerman et al., 2024). Peer-assessment models promote reflective learning and active student engagement, while integrative assessment models enable course evaluation. Their complexity can hinder practical implementation, as extensive indicators and metrics require significant institutional resources (Fleckney et al., 2025). Furthermore, these models often assume a uniform level of digital literacy among students, overlooking the diverse backgrounds and technological capabilities that exist across the higher education settings (Ortega-Ruipérez & Correa-Gorospe, 2024).

The synthesis of these models show the need for an integrated approach that combines pedagogical principles, technological innovation and systematic evaluation. While each of these models provides valuable insights, their limitations point out the need for a digital standard that aligns instructional design with learner needs, assessment strategies and scalable technological solutions.

The development of an innovative digital standard for digital education could combine a balanced approach that incorporates both theoretical and practical insights. The Community of Inquiry and Community of Practice frameworks provide theoretical foundations for collaborative and interactive learning and emphasise social and cognitive engagement. Kirkpatrick's model (Campbell et al., 2019) and DIGIQUAL (Manian & Pius, 2023) provide quality assurance mechanisms that ensure measurable learning outcomes and student satisfaction. Technology-orientated models such as the Digital Technology Categories framework (Choi-Lundberg et al., 2023) and the Complex Adaptive Systems framework (Wang et al., 2015) enable scalability and adaptability, ensuring that digital learning environments remain flexible and responsive to technological advances. In addition, assessment-orientated frameworks such as the Integrative Assessment Model (Marciniak, 2018) and the Online Peer Feedback Framework (Kerman et al., 2024) ensure that assessment mechanisms effectively support both summative and formative assessment.

Future research should focus on the empirical validation of these frameworks in different institutional settings to assess their impact on learning outcomes. In addition, it is important to explore the potential of new technologies such as artificial intelligence (Akgun & Greenhow, 2022) and virtual reality (Almasri, 2024) within the proposed integrated model to improve the effectiveness and accessibility of digital education.

Study Limitations

Despite the integrated approach taken in this study, several limitations must be acknowledged. First, the synthesis of existing frameworks is based on the published literature, which may lead to publication bias. Studies with inconclusive or negative results regarding the effectiveness of specific online learning models may be underrepresented, leading to an overemphasis on positive results and well-established frameworks. In addition, most of the concepts studied originate from Western educational settings, which may limit the generalisability of the results to other cultural and institutional contexts, especially in regions with different technological infrastructures and pedagogical traditions.

Secondly, although the study integrates several models to propose an innovative digital standard, the empirical validation of this integration remains a challenge. The study primarily conducts a theoretical synthesis, which means that a practical implementation and field test are necessary to assess the feasibility and effectiveness of the proposed framework. Future research should investigate longitudinal studies or experimental applications of the synthesised model in different higher education settings to assess its impact on student engagement, learning outcomes and quality of teaching.

Finally, the study summarises frameworks that focus on structured design and evaluation criteria. The dynamic nature of digital education, including rapid advances in artificial intelligence, adaptive learning technologies and student-led learning models, suggests that a static framework can quickly become outdated. Therefore, the proposed digital standard should be seen as an adaptive guide rather than a rigid framework that needs to be constantly updated and validated through new research and technological developments.

Conclusion

This study shows how important it is to develop a new and contemporary standard for digital education. Through the interplay of pedagogical, technological and assessment approaches, we can create a more flexible and inclusive framework that not only improves the learning experience but also enhances institutional effectiveness. Digital education should be viewed as a living and evolving system that adapts to technological advances and the ever-changing needs of learners. Future research will need to focus on empirical research to test and refine the standard and ensure its relevance in different educational contexts. As digital learning continues to evolve, continuous innovation and adaptation to new trends are key to maintaining its impact and accessibility. This holistic approach provides a solid foundation for improving the quality, inclusivity and long-term sustainability of digital education in higher education.

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Digitalni standard za oblikovanje vključujočih in učinkovitih spletnih tečajev v visokem šolstvu: integrativni pregled literature

Na podlagi integrativnega pregleda literature smo obravnavali modele in ogrodja za digitalno izobraževanje v visokem šolstvu ter sintetizirali njihove ključne prednosti in omejitve. V pregled smo vključili devet člankov, ki zajemajo različne vidike digitalnega izobraževanja, od pedagoških pristopov in tehnoloških rešitev do mehanizmov ocenjevanja. Na podlagi analize smo opozorili tudi na vrzeli, ki obstajajo v obstoječi literaturi. Rezultati kažejo, da posamezni modeli in okviri kljub pomembnim vpogledom samostojno ne zagotavljajo celostnega pristopa k oblikovanju, izvajanju in vrednotenju digitalnega izobraževanja. Zato na podlagi rezultatov predlagamo razvoj digitalnega standarda, ki bi združeval teoretične in praktične vidike ter spodbujal vključujoče in učinkovito digitalno izobraževanje. Takšen standard bi omogočil boljšo prilagoditev učnih vsebin potrebam študentov, izboljšal mehanizme ocenjevanja in povečal prilagodljivost digitalnih učnih okolij ter na ta način prispeval k oblikovanju trajnostnih in prilagodljivih rešitev za prihodnost digitalnega izobraževanja.

Ključne besede: inovativne metode poučevanja, e-izobraževanje, trajnostno izobraževanje, učinkovitost spletnega poučevanja, digitalno izobraževanje

Effective Teaching and Learning in Digital Education for Czech Students with Diverse Needs

Barbora Bazalová
Masaryk University,
Czech Republic
bazalova@ped.muni.cz

Dana Zámečníková
Masaryk University,
Czech Republic
zamecnikova@ped.muni.cz

Veronika Včelíková
Masaryk University,
Czech Republic
vcelikova@ped.muni.cz

Pavla Pitnerová
Masaryk University,
Czech Republic
pitnerova@ped.muni.cz

The authors describe different aspects of using information and communication technologies to promote effective teaching and learning for students with diverse needs in inclusive schools. The review of current research in each described area follows the theoretical concepts, as well as the description of hardware, software and other special aids that can be used at schools. A wide range of digital tools, suitable for children with special educational needs and thus diverse needs in education, can – and should – be used in education to reach each student's potential and, therefore, enable a maximum degree of inclusion. Technologies also play an essential role in communication. However, the benefits of technology are not limited. Still, they can also be used as a tool for social inclusion and the development of relationships at school since social comfort is one of the critical aspects of school success.

Keywords: information and communication technologies, special educational needs, inclusive education, digital education, students with diverse needs

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Introduction to Digital Education for Diverse Needs

Modern society is often referred to as an information society (Schement, 2018; Webster, 2014). In this context, we can talk about the so-called digital divide, which threatens people without access to modern technologies. The World Health Organization and UNICEF Global Report on assistive technology (2021, 2022, 2024) highlights the urgent need for improving access to assistive products, with an estimated 2.5 billion people requiring at least one assistive product.

According to the mentioned documents, assistive technology enables and promotes inclusion and participation, especially for persons with disability, ageing populations, and people with non-communicable diseases. The primary purpose of assistive products is to maintain or improve an individual's functioning and independence, thereby promoting their well-being. They enable people to live healthy, productive, independent, and dignified lives, as well as to participate in education, the labour market, and civic life (comp. UNESCO, 2023).

Education is evolving, just as society is evolving. The development of society is thus undeniably reflected in approaches to teaching. In recent years, we have increasingly encountered technology and its use in education, including special or inclusive education.

As recognised in the Incheon Declaration (UNESCO, 2023), the achievement of the fourth Sustainable Development Goal (SDG 4) is dependent on opportunities and challenges posed by technology. Technology appears in six out of the ten targets. Technology affects education through five distinct channels: input means of delivery, skill, tool for planning, and providing a social and cultural context.

For children with special and diverse educational needs, we encounter a wide range of support that aims to compensate for deficits and offer competencies, thus enabling a maximum degree of inclusion in all areas of school life. Technologies have an essential role in this process. They are used both in learning processes and in communication. However, the benefits of technology are not limited to these areas. Still, they can also be used as a tool for social inclusion and the development of relationships at school since social comfort is one of the critical aspects of school success. The premise that ICT improves the quality of life, reduces social exclusion and enhances participation is also recognised internationally. In 2011, the European Agency for Special Needs and Inclusive Education launched the ICT4I project (Information and Communication Technology for Inclusion), which focused on the use of ICT as a means of promoting inclusion in education. Many countries were involved. Among the outcomes were the findings that ICT has the potential to enhance respect for diversity and enable all pupils to have equal opportunities to learn (Watkinson, 2013).

Flair (2023) writes that electronic and digital tools are seen as a means to enhance learning and provide a rewarding experience for all students. Educational program administration is also benefiting from the growth of technology, allowing for more successful tracking and analysis of student progress. It provides for finer tuning of learning objectives and corresponding learning units. Although many people welcome these benefits, critics say that the overuse of electronic devices in classrooms can disrupt the educational experience for some students because it is too impersonal and lacks a sufficient social component.

Information and Communication Technologies (ICT) and Assistive Technologies (AT)

Information and communication technologies (ICT) and assistive technologies (AT) are partially interlinked. AT is designed for people with disabilities to overcome barriers caused by disability. ICTs are digital technologies that are initially used for information handling (searching, sorting, storing) and, once individual computers are connected, also for communication and information sharing, regardless of the user's health condition.

The use of ICT or assistive technologies is associated with the development of competence not only of students but also of teachers, parents, and counsellors. Interdisciplinary cooperation is thus essential in this area. Teachers can easily share student progress with parents. For example, they can create graphs on a laptop showing a particular student's successes and challenges.

The basic definitions of AT come from US legislation and the WHO. The Technology-Related Assistance Act (1988) and the Assistive Technology Act (1998) provide a standard definition of assistive technology as 'any item, piece of equipment, or product, whether acquired commercially, modified, or customised, that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities.' Similarly, WHO (Cook & Polgar, 2014) defines AT as any product, tool, device or technology adapted or specifically designed to improve the functioning of a person with a disability. The ISO 9999 classification of technical aids (2011, revised by 2022), together with the ICF (World Health Organization, 2007; Edyburn, 2004), defines AT as 'any product, apparatus, device or technical system used by a person with a disability, specially made or commonly available, that prevents, compensates for, monitors, mitigates or neutralises a disability or improve the functional capabilities of a child with a disability'. It is recognised that an assistive device can be any product or technology, including systems and services (World Health Organization, 2024). Assistive technology enhances independence and well-being, is a human right, and should be accessible to all (World Health Organization, 2022).

There are many studies describing AT. Functioning in everyday life and developing reading and functional literacy by providing access to printed materials and books in a variety of accessible formats, speech-to-text technologies, talking watches, support systems for the deaf or hard of hearing,

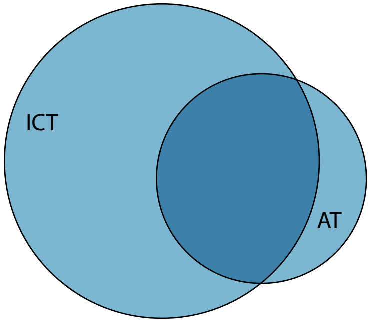

Figure 1 The Use of ICT and Digital Assistive Technologies in Education

Braille or other information accessibility for children with visual impairments describes Hunt (2021). Promoting productivity and school achievement and motivation to continue working discuss Parette & Peterson-Karlan (2007) or Svensson et al. (2019).

In the Czech Republic, computers began to appear in schools gradually and slowly in the 1980s. The first systemic integration of computers into education came in 2001 under the name 'Internet for Schools'.

Digital Education in Inclusion

The application of ICT in inclusive education widens the role of special education teachers. Červenka et al. (2023) define special education teachers as mediators with many roles.

The technology used in schools to educate students with diverse needs brings certain benefits; for example, it reduces the risk of social exclusion. Assistive, information, and communication technologies can facilitate or enable these students to access specific sources of information that would otherwise be difficult or unavailable to them. Digital technologies also allow or facilitate communication. The use of a combination of hardware + software + the Internet can provide students with diverse needs (physical, communicative, perception, psychical, etc.) with a connection with the outside world that would otherwise be limited or downright impossible.

Students with disabilities have difficulty participating in the classroom because of limitations (disabilities) that result from the nature of their disability (physical limitations, visual or hearing impairments, intellectual disabilities or cognitive impairments, impaired communication skills, autism spectrum disorders, etc.). These limitations can be alleviated (even if only partially) by the use of the necessary compensatory aids, the appropriate use of modern

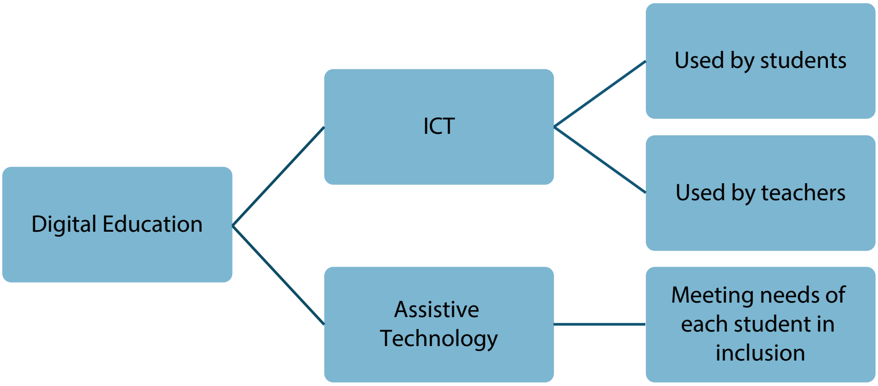

Figure 2 Connection Between ICT and AT used in Inclusive Education Leading to Meeting Diverse Needs

technology and the inclusion of didactic aids in teaching or re-education. A well-thought-out combination of assistive, information, communication and digital technologies can then reduce the risk of social exclusion, enable or facilitate the education of pupils with special educational needs and support people in their independence and dependence on the help of others (Pitnerová, 2013, 2016; Cizlerová, 2020).

The use of information and communication technologies in the educational process helps to reduce digital divides in favour of equality of educational opportunities. It is one of the means of supporting the individual learning needs of all pupils in inclusive education. For this reason, it is a powerful tool to promote differentiation and individualisation of the educational process in a heterogeneous classroom and to support the success of each student.

Currently, the education of pupils with special educational needs is provided through support measures such as (Education Act, 2004, and Ministerial Decree, 2016, as amended, Catalogues of Support Measures):

- special methods and forms of work (special education subjects),
- teaching assistants, sign language interpreters, and a second teacher in the classroom,
- special teaching material (audiobooks, AAC aids, aids for information acquisition and retention and aids for the development of manual skills),
- compensation aids (classroom equipment and to facilitate self-care),
- counselling services providing support and assessment,
- cooperation with families of students,
- reduced number of students in the class.

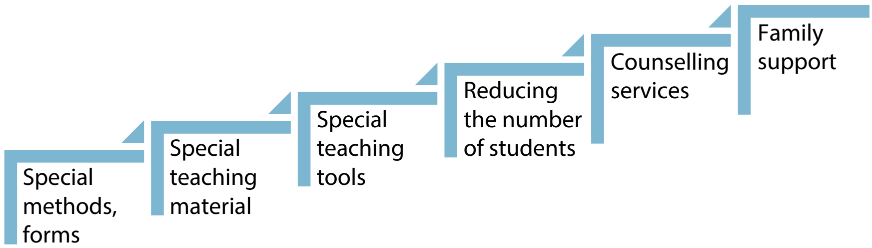

Figure 3 Support Measures of Students with Diverse Needs

Models and 3D Aids (printing)

In recent years, there has been increasing usage of 3D printing. It is a field with great potential for the future. 3D printing is often used in classrooms to support the complexity of approaches, for example, to facilitate reading and writing practice and to strengthen visualisation. This process makes it possible to more intensively connect the acquired knowledge and information with the use of sensory processing and thus increase the effectiveness of learning. 3D printing brought development in the availability of aids for people with disabilities.

The use of models and 3D aids as one of the support measures is appropriate for pupils with special educational needs, such as support for cognitive functions (necessary in the education of pupils with disorders of intellectual development and visual impairments or combined disabilities or support for spoken language comprehension (for pupils with a hearing impairment, a different first language, developmental dysphasia, phonation disorder or any of the autistic spectrum disorders), supporting motivation and sustaining attention (for pupils with learning, attention and behavioural difficulties, and those mentioned above).

Printing on 3D printers is used in the everyday life of children/people with disabilities. Various models of compensatory aids and other 'lifehacks' can be found on the web. While 76 % of the creators surveyed from the open-source community Thingiverse have no health disadvantage (and less than 1 % have undergone training or a course in creating compensatory aids), the motivation of some of them was to make everyday life easier for a family member or close friend. The use of modelling one's designs on a 3D printer has proven to be effective because the models can not only be cheaper and more accessible to the target group but also tailored to the needs of people with disabilities. These 'useful' products, created as 'do-it-yourself assistive technology', are labelled as *Accidentaly assistive technologies* and include, for example, holders such as tactile game dice, prostheses and the like (Buehler et al., 2015).

In the Czech Republic, we encounter 3D printers in schools, although not everywhere. Lepka (in Dosedla et al., 2023) found out in his research that 69 % out of 234 respondents (primarily primary school teachers) had already had some experience with 3D printing. In the Czech Republic, there are companies (Y Soft and Prusa Research) that support various projects to develop the use of 3D printing in primary and secondary schools. As part of its activities, it offers 3D printers to schools for borrowing and websites with finished models or teaching lessons. Some of the lessons, designed by experts from Masaryk University, Czech Republic and Y Soft (e.g. lessons Under the Microscope), support differentiation in heterogeneous classrooms and lead to individualisation of teaching, thus offering different levels of difficulty to students. They can choose the difficulty of the project they will create according to their interests and abilities (Masaryk University, n.d.).

Examples of Technology Use in Communication Development

Students with developmental speech or language disorders often require support for their communication skills in the educational process. They frequently benefit from programmes designed to support students with developmental learning disorders, given that these difficulties are often comorbid with language disorders or have their origins in them. The consequences of language disorders, particularly those affecting speech comprehension due to inadequate speech signal processing, can result in a range of misunderstandings and occasionally unintended outcomes within the educational context. Furthermore, educators' insufficient understanding of language difficulties that arise during the learning process, lack of effective motivational strategies, and inappropriate use of ICT in the classroom can impede progress and hinder the potential for an optimal and successful inclusive teaching and learning process. Furthermore, educators' inadequate understanding of language difficulties that emerge during learning, lack of effective motivation strategies, and insufficient use of ICT in the classroom can have a detrimental impact on the learning process, as these factors have been identified as essential for an optimal and successful inclusive teaching and learning process. It can be reasonably argued that the effective utilisation of ICT or digital technologies during classes can be highly beneficial (Hunt, 2021; Cincotti et al., 2008; Buchholz et al., 2020).

We gathered the most utilised digital devices in the Czech inclusive education. The findings are based on a quantitative survey of 115 respondents, namely teachers of the first grade of elementary school. Despite the gradual improvement in awareness and use of digital technologies, interactive whiteboards remain the most frequently used in the Czech environment. The data indicates that the most commonly used device is the interactive whiteboard, with 55 % of respondents indicating its use. Mobile phones are used by 18 % of respondents, tablets by 15 % of respondents, notebooks/PCs by 6 % of respondents, and iPads by 6 % of respondents. These results underscore the preeminence of interactive whiteboards in the Czech educational environment (Straková, 2021). This finding is substantiated by the research of Beránková (2024). Kindermann (2017) in his study adds additional information that reflects positive feedback from the use of digital technology in the form of an interactive whiteboard in the classroom from the perspective of the students themselves.

The information presented in the following section is based on the current state of educational practice and reflects the needs of the field. In order to succeed at an inclusive school for students with a developmental language disorder, they require comprehension support and simplification of instructions (verbal or written). Such an approach is often essential and plays a crucial role in effective inclusive education. The current market offers a variety of computer programs or applications intended for creating alternative and augmentative communication (AAC). These programs and applications are particularly beneficial in inclusive educational environments, such as those found in Czech schools. They facilitate communication and enhance comprehension.

The figure illustrates a selection of representative programs and applications, including Symwriter, InPrint with Widgit Software, and Boardmaker with Picture Communication Symbols. Moreover, there are a number of widely used applications, including Go Talk Now, MetaTalk, Grid for iPad, Grid Player, and the Czech school-specific applications 'Včelka' (The Bee) and Altík. However, as illustrated by the findings of Straková (2021), the most frequently utilised application in the Czech inclusive educational environment for supporting communication, interaction, reading, and writing literacy is the 'Včelka' application, which is used significantly more frequently than other applications. By the end of 2021, over 500 primary schools in the Czech Republic had adopted this digital tool to assist more than 400,000 students (Jiřičková, 2021). In contrast, applications such as Grid for iPad, MetaTalk, and Go Talk Now can be employed more effectively as a means of communication for the daily individual needs of a particular student, not only within the educational context (Castaneda et al., 2023).

In order to facilitate communication and comprehension, it may be beneficial to utilise software or applications that assist in modifying or reordering words within sentences, a process known as AAC. This approach can significantly contribute to the development of coherent syntax. Such software

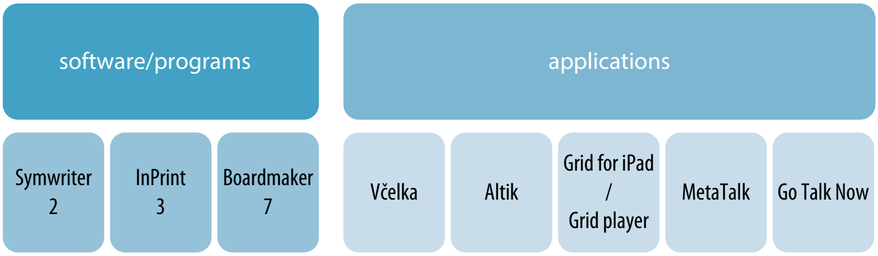

Figure 4 Software and Apps Used in the Czech Inclusive Environment

could also prove beneficial in facilitating comprehension of verbal instructions. It allows the creation of an individual core vocabulary, the highlighting of essential keywords, and the construction of communication logs or books, among other possibilities. It is of great importance to promote good comprehension and to facilitate the creation of syntax throughout the entire educational process in an inclusive school environment.

Furthermore, the utilisation of these software applications offers the additional benefit of facilitating the expression of a diverse range of emotions and feelings. The already mentioned software programs have been designed with a variety of specialised subcategories, which can be used to express a multitude of emotions and feelings and present a significant advantage during the educational process, as they enable the prevention of overload and the avoidance of psychosomatic problems or their deepening. For students who experience considerable difficulties in acquiring their native language and in expressing themselves, this support for communication can be invaluable. Šarounová (2022) maintains that the core vocabulary should comprise approximately 200–300 words and should be augmented with a thematic vocabulary that relates specifically to specific domains. Dodd (2017) argues that the selection of vocabulary for communication and its organisation should be undertaken with careful consideration. A similar approach should be applied to the choice of appropriate software. In general, the use of applications to support teaching in the Czech inclusive environment is currently reasonably sufficient, as evidenced by the survey results by Straková (2021) and Kindermann (2017).

Conversely, the utilisation of digital tools to facilitate the acquisition of language competencies and reading and writing proficiency is not yet pervasive across all educational institutions. Nevertheless, the outcomes depicted below appear to be notable. Potential explanations for the underutilisation of such technologies can be attributed to a lack of awareness and information regarding the availability of these resources for children with special needs.

The necessity of appropriate support for understanding instructions and assigning activities or tasks to students with developmental language disorders during classes is currently a topic of high debate within the Czech counselling and educational system. The necessity for support of students with developmental language disorder is currently most evident in counselling practice in an inclusive environment, reflecting the actual and real needs of this group of students. As evidenced by practice, the utilisation of programs that facilitate communication modelling is essential for language acquisition and also provides a practical approach to supporting comprehension in the educational process (Castaneda et al., 2023). The programs, as mentioned earlier, enable the creation of individual communication books, core vocabulary lists, and new terminology, and they can assist in orientation regarding assignments through the provision of a dictionary of complicated terms. They facilitate the successful comprehension of meaning and content, which is beneficial in an educational context.

Insufficient processing of the speech signal and a weak phonological loop (insufficient auditory verbal memory) result in significant difficulties during the teaching process, particularly regarding understanding or recalling instructions. The Czech educational system frequently places substantial demands on auditory processing, which can cause problems for students with language development deficits. Providing printed or digital instruction or learning texts with underlined or highlighted keywords can facilitate access to information for these students. ICT-based learning tools and software applications for teacher education, such as 'Včelka' and SymWriter, can be used to enhance learning. Alternatively, a regular computer and text editor can be employed.

What, then, are the principal criteria for the selection of one of the listed software and applications? The choice of an appropriate software program in a Czech inclusive environment is based on several fundamental considerations. Primarily, the software should reflect the individual requirements of the student. Secondly, the program should be designed to suit the specific requirements of the environment, allowing for the broadest possible use. In conclusion, as Koudelková (2023) indicates in her research, the decision should be a collective one, with input from all relevant parties. The decision to select an appropriate programme or software for the required system – the AAC system – requires a comprehensive assessment of the individual's current abilities, strengths and needs. It is of the most significant importance to avoid imposing any limitations on its potential (American Speech-Language-Hearing Association, n.d.). In their study, the authors Foster Skalová et

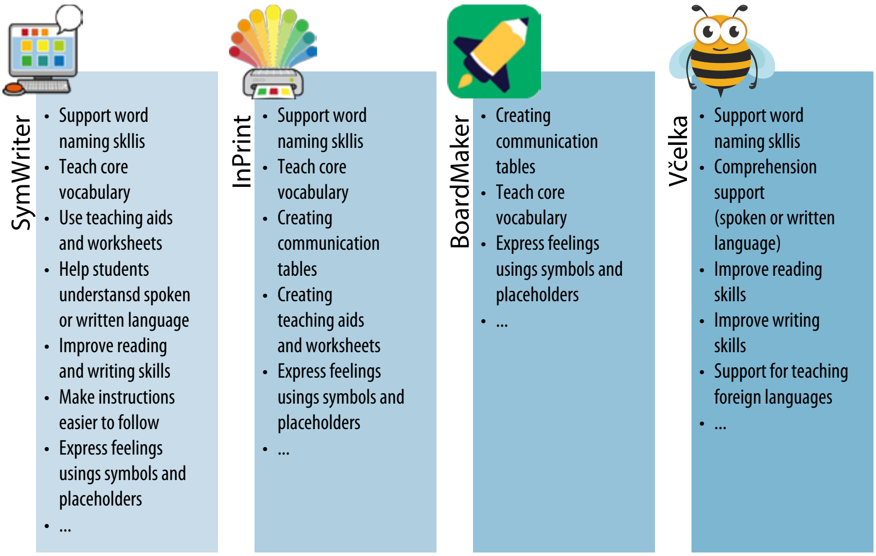

Figure 5 Purposes of Utilising Concrete Software and Applications in Inclusive Czech Environments

al. (2021) identify the principle of everyday communication modelling as the most significant approach to supporting communication while also identifying it as the most challenging. Observation is always beneficial. In an educational setting, modelling is demonstrated through the act of accompanying spoken keywords with the relevant symbol or supplementing them with a sign (Šarounová, 2022).

The following section outlines the specific purpose of utilising the mentioned software, derived from the experience and educational practice of special pedagogues and those working in inclusive schools. SymWriter is a valuable tool for individuals who have difficulty with written text, whether in the act of reading or writing. The software is beneficial for educators and learners alike, offering a feature that automatically inserts symbols above the typed word as it is entered. For educators, the software is a helpful tool for the creation of diverse instructional materials, including visual aids, didactic games for reading literacy development, step-by-step instructions or definitions, songs, stories, and style exercises with the support of symbols. In comparison with InPrint, it is more suitable for the composition of longer texts and is equipped with voice output functionality. The most used software for the creation and printing of communication boards is Boardmaker, which also permits the editing of symbols and the insertion of user-generated images (Petit HW-SW, n.d.; Pachner, n.d.). InPrint 3 is an alternative to

Boardmaker that offers the advantage of being fully translated into Czech. The software provides a range of options for the creation of diverse visual aids, games, tasks and modes of the day, as well as daily routines. The Grid 3 software is more frequently preferred for individualised use, as it allows the user to communicate using voice output and to control a computer or a smart home. The software offers users the ability to customise various aspects of its functionality, including text, colours, display size, and overall control. There are a variety of input methods, such as a switch, mouse, touch, pointer, or glance (Petit HW-SW, n.d.). In consideration of the American Speech-Language-Hearing Association (n.d.) findings indicating that the AAK systems currently in use may not be optimal in the future, it can be posited that the most prevalent software, applications, or programs at present may not retain their dominance soon.

Examples of Technology Use for Specific Sensory Needs

Special software and hardware make the text accessible. There is the possibility of enlarging details, enlarging and choosing a font, modifying colours or colour contrast, or tactile or voice output. There are screen readers and speech synthesisers, as well as braille tactile lines. The voice output enables auditory feedback, and the tactile line is suitable for displaying the grammatical side of the text.

The development of assistive devices for deaf and hard-of-hearing individuals has brought about both new tools and improvements to existing ones, whether they are corrective aids, compensatory aids, or educational-didactic aids. Technological advancements have also facilitated the creation of programs and applications that simplify communication for people with hearing impairments. Nowadays, it is possible to use video calls on phones for real-time communication. Over time, technologies like fax machines and teletypewriters have been replaced by more modern and faster methods of communication – thanks to computers, smartphones, and the Internet (Pitnerová, 2013; Pecháčková, 2017). The development of digital technologies has thus enhanced and expanded the possibilities for both intra-cultural and intercultural communication for individuals with hearing impairments.

Students with hearing impairments use hearing aids, such as radio transmissions of sound: FM systems or cochlear implants. Other devices serve for induction listening of sound (induction loops and wired and wireless amplifiers. Signalising devices can also help during school time (alarm clocks, timers, tools detecting and signalising sound). Software applications cover automatic computer speech recognition (technology that allows a computer to respond to information communicated by voice and convert it into text) and programs that help with speech development by visual feedback on how the user uses loud speech pronunciation. These special programs are Mentio or Brepta and are an integral part of speech therapy for children with congenital or early-acquired hearing impairments. There are also internet applications (videos on YouTube, WEBlik internet broadcasting for people who are deaf or hard of hearing) (Pitnerová, 2013).

The most used aids among the 24 deaf individuals surveyed in Gruberová's research (2021) were light and vibration signalling devices (34 %) (such as alarm signals, mobile phone notifications, or smartwatch vibrations). Right after signalling devices, mobile phones and mobile applications were the second most used (28 %). Cochlear implants were used by 13 % of respondents, hearing aids by 11 %, induction loops by 6 %, Teletext and TV subtitles by 4 %, and an assistance signal dog by 2 %. The most frequently used means of communication with hearing individuals were chat applications like Messenger and WhatsApp, which were used by 42 % of respondents. Facebook, Skype, and SMS messages were mentioned by 27% of respondents, the DEAFCOM application by 13 %, and the Tichá linka app from Tichý svět or Live Transcribe, as well as email by 5 % of respondents.

We will now introduce the basic AT used by people with severe *visual impairments*. Digital technologies improve and facilitate the lives of people with severe visual impairments when they do not have access to texts in digital form (Bernard, 2019). Paseka (2015) highlights information and communication technologies designed specifically for blind and visually impaired individuals, including specialised auxiliary devices for computing technology and tailored software. Additionally, it covers mobility assistance devices, which are various tools that help with orientation and movement. The document also mentions optical aids, such as special glasses and other optical tools that enhance. Finally, it discusses leisure and sports aids. Paseka's research (2015) showed frequently used tools by informants with visual impairments – Digital Reading Devices (a device with voice or tactile output), Digital magnifying glass/electronic magnifiers (often in the form of a personal computer or laptop), Braille E-reader, Braille printer, Screen Reader, Voice synthesiser (a device converting text to speech) and Electronic Communication Aids (a mobile phone or tablet with a screen reader and voice output).

Examples of Technology Use for Specific Physical Needs

People with physical disabilities often require lifetime support and experience challenges to maintain or (re)define their level of independence. Having a physical disability no longer means that things cannot be done. Thanks to technology, we can find new ways to accomplish our goals. Assistive technology can be used in two ways: to help do things that people without disabilities can do without technology and to improve access to everyday technology that is not designed for people with disabilities. In both cases, the focus is on matching individuals with the tools best suited to fill their needs (Anston, 2018). Some devices can be easily purchased and make a significant difference in everyday living or be a great starting point when reducing barriers (Awde et al., 2022). Computers, laptops, and mobile devices are a must today. Students can use symbols, written forms of spoken speech, or portable communicators with voice output and single or multiple messages. Other multifunctional assistants are computers with special programs and drivers, enabling cooperation with individually adapted buttons, sensors, keyboards, trackballs, joysticks, alternative mice and other control tools. Modified control devices facilitate access (instead of keyboard and mouse) and ensure more accurate and legible typing.

Cranmer (2021) investigates learning with digital technologies within the context of inclusive education. Assistive living technologies (ALT) are promising to increase independent living and execution of activities of daily living (ADL). Nine studies were included, of which seven qualitative, one quantitative, and one mixed method. Quality was generally high. ALT enabled participants to execute ADL. We found six themes for the impact of ALT on perceived independence: feeling enabled, choice and control, feeling secure, time alone, feeling less needy, and participation (Van Dam et al., 2024).

The research, as mentioned earlier, is supported by an investigation published by Moen & Østensjø (2024), who included in their study the 130 children with cerebral palsy and their families used a median of 2.5 assistive devices (range 0–12) to support positioning, mobility, self-care and training, stimulation and play. Devices had one or two primary purposes and were used both at home and in kindergarten/school. The usage rate varied from less than twice a week to several times a day. Most parents reported significant benefits for caregiving and/or the child's functioning. Total use increased in accordance with the level of the child's gross motor limitations and was associated with restrictions imposed by housing concerns. The findings show that the frequent use of a wide range of devices had many benefits. It demonstrates that early provision of assistive devices can be an effective function-enhancing strategy in young children with cerebral palsy. However, the findings also indicate that factors other than the child's motor abilities must be considered when integrating the use of devices into the child's daily routines and activities.

Support of mobility and motor skills and improvement of communication, using of residual motor skills for self-sufficiency – e.g. household management describes Cincotti et al. (2008). Increasing self-concept, independence and task performance are discussed in Chiang & Jacobs (2009).

Another area of use of assistive ethnology is in the field of education. The research conducted among 250 teachers showed that assistive technologies are used daily by more than 50 % of teachers, while for teachers working with pupils with special needs, this percentage is 70 %. On the other hand, the research also pointed out that it is not always necessary to use specially adapted software. Still, almost 50 % of pupils with special needs also use regular educational applications. The research also showed that educators use the full range of available applications (Cizlarová, 2020), and Cranmer (2021) came up with a similar result in his analysis of the research, where it is confirmed that individuals (pupils) with special needs are more likely to use technology themselves.

Further research by Dzivá (2023) suggests that in the education and development of pupils with disabilities, all areas of development need to be in balance and the approach needs to match this. Thus, we cannot just focus on technology in support but also on a holistic approach. In recent years, we have also increasingly seen the possibility of using AT, a topic that Pancholi et al. (2024) addressed in their investigation: assistive technologies (AT) enable people with disabilities to perform activities of daily living more independently, have greater access to community and healthcare services, and be more productive performing educational and/or employment tasks. Integrating artificial intelligence (AI) with various agents, including electronics, robotics, and software, has revolutionised AT, resulting in groundbreaking technologies such as mind-controlled exoskeletons, bionic limbs, intelligent wheelchairs, and smart home assistants.

As can be seen from the above, technology is making life much more accessible for people with disabilities and is affecting areas of everyday life and education. The further development and application of technology to this target group will continue to happen, and feedback from disabled people themselves reflecting their needs will also be necessary.

Examples of Technology Use for Developmental Learning Disorders and ADHD

Dictaphones, scanners, and copiers can be used to record or present indicators and buzzers during re-education, calculators to speed up numerical operations, and educational software to explain new material and verify already acquired knowledge. There is software for making printed text accessible in alternative formats – audio format, SAT format (synchronised audio and text = the application reads the source text with a synthetic voice and at the same time highlights the read text on the screen so that the disadvantaged reader can connect the spoken and written form of the word). Multimedia CD-ROMs with their sounds, graphics and animations can attract the pupil's attention, and interactive whiteboards allow the teacher to use materials and activities to diversify the teaching. The use of educational programs helps to remove some barriers, such as dislike of writing and supports creative work. Using tutorial software has the advantage that the program is consistent. As part of the intervention for people with ADHD, we increasingly encounter the EEG Biofeedback method. This method is used to strengthen the desired activation of the nervous system, primarily for training attention and concentration, as well as self-control. It assumes that the brain learns to use its abilities and capacity better, more efficiently, and with less energy expenditure through play. Biological feedback monitors brain activities based on cortical action potentials. Based on the use of a particular computer program enables the regulation of the frequencies of the electrical activity of brain waves. The program converts the sensed brain activity (EEG) into individual elements of the computer game and then issues feedback information about the effectiveness of the training. Training materials for memory, reading, writing, organisation practice, mathematical problem solving can be found in Lee & Templeton (2008). Text-to-speech or speech-to-text applications to simplify reading and writing are offered by many authors, such as Svensson et al. (2019), Balharová et al. (2021), Bäck et al. (2023) or Nordström et al. (2018).

Conclusion and Challenge for the Future

Multidisciplinary teams working with people with diverse needs are trying to promote independence through assistive technologies. It is always necessary to have sufficient information about the person and his needs before choosing assistive technologies and aids. The use of AT should be implemented and controlled by a specialist working with the student. The expert also works on developing strategies to overcome the barriers that reading and writing disabilities bring (Paseka, 2015; Bäck et al., 2023).

Bennett et al. (2018) suggest reducing the dependence of people with disabilities on the support of others by using assistive technologies. The authors define interdependence that can extend a diversity of ways to avoid dependence.

Some people see AT as an obstacle that slows them down – it distinguishes them from the majority and automatically puts them in the group of 'disadvantaged'. They cannot cope with it and have trouble integrating AT into their lives (Bennett et al., 2018; cf. Desmond et al., 2018). On the other hand, some people accept their aid as help, and thanks to it, they can move forward. They expand the possibilities of interaction between all members of society and can also help to support and protect the complete maintenance of fundamental human rights and freedoms (Desmond et al., 2018).

We described different aspects of using information and communication technologies to promote effective teaching and learning for students with diverse needs in inclusive schools in eight subchapters. Each focused on a specific disorder. The review of current research in the described area followed the theoretical concepts. We described hardware, software and other special aids which are used in Czech inclusive schools. Our goal was to show that a wide range of digital tools is suitable for students with special educational needs and, thus, diverse needs that can be incorporated into education. These aids help to reach each student's potential. They, therefore, enable a maximum degree of inclusion. Technologies play an essential role in communication, and they can be used as a tool for social inclusion and the development of relationships at school since social comfort is one of the critical aspects of school success, as we stated in the Abstract.

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Učinkovito poučevanje in učenje v digitalnem izobraževanju za češke učence z različnimi potrebami

Avtorji v prispevku obravnavajo različne vidike uporabe informacijsko-komunikacijskih tehnologij za spodbujanje učinkovitega poučevanja in učenja učencev z raznolikimi potrebami v inkluzivnih šolah. Pregled obstoječih raziskav na posameznih obravnavanih področjih sledi teoretičnim konceptom ter vključuje opis strojne in programske opreme ter drugih specializiranih pripomočkov, ki jih je mogoče uporabljati v šolskem okolju. Širok nabor digitalnih orodij, ki so primerna za učence s posebnimi potrebami in posledično naslavljajo raznolike izobraževalne potrebe vseh učencev, se lahko – in bi se moral – uporablja(ti) v splošnem izobraževanju, da bi vsakemu učencu omogočili uresničitev njegovega potenciala, in s tem najvišjo stopnjo vključenosti. Tehnologije imajo ključno vlogo tudi pri komunikaciji. Njihove koristi pa niso omejene zgolj na učne procese, temveč lahko služijo tudi kot orodje za spodbujanje socialne vključenosti in razvoj medosebnih odnosov v šolskem okolju, saj je socialna varnost eden izmed ključnih dejavnikov šolskega uspeha.

Ključne besede: informacijsko-komunikacijske tehnologije, posebne izobraževalne potrebe, inkluzivno izobraževanje, digitalno izobraževanje, učenci z raznolikimi potrebami

Digital Competencies of Future Teachers

Milena Ivanuš Grmek
University of Maribor, Slovenia
milena.grmek@um.si

Sabina Ograjšek
University of Maribor, Slovenia
sabina.ograjsek@um.si

Monika Mithans
University of Maribor, Slovenia
monika.mithans1@um.si

The present article deals with the importance of digital competencies of future teachers, highlighting the role of ICT in education. The research was conducted on a convenience sample of 328 students of the Faculty of Education, University of Maribor, in the academic year 2023/2024. The data was obtained through an online questionnaire. The results show that students feel most confident performing basic digital tasks such as searching for information on social media and using digital calendars. However, they feel less confident performing advanced tasks such as web design and using licences. Overall, students of elementary education feel more competent than students of preschool education. The findings of the research highlight the necessity of enhancing digital literacy by providing further education and training for future teachers across all levels and disciplines. Only through such initiatives can the full potential of contemporary technology in education be achieved.

Keywords: digital competencies, ICT in education, teacher training, higher education

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Introduction

The objective of educational institutions is to equip children for a life of independence and responsibility. They should impart the knowledge, skills, competencies, and values necessary for students to grow holistically as individuals and to engage actively in the development of society (Globokar, 2021). Digital technology is increasingly influencing many aspects of our lives and changing the way we communicate, learn and work. Consequently, one of the basic requirements of education is to prepare students for active participation in an information society (Hakkarainen et al., 2000). The research available informs us that there is a relationship between teachers' digital competence and their use of information and communication technology (ICT) in practice (European Commission, 2013). For this reason, it is essential that (future) teachers are competent users of ICT, plan their professional development and actively improve their skills in this area during their studies. In addition, teacher education programmes should focus on developing the skills needed to work successfully in a digital society (Orazbayeva et al., 2024), as appropriate competencies are crucial for the effective introduction of new technologies in education (Hakkarainen et al., 2000).

Digital Competence

Due to the rapid advancement of ICT, individuals need to acquire more sophisticated digital skills that enable reliable and critical use of technology on a daily basis (Juvan et al., 2016). UNESCO (Law et al., 2018, p. 6) defines digital literacy as follows:

Digital literacy is the ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital technologies for employment, decent jobs and entrepreneurship. It includes competencies that are variously referred to as computer literacy, ICT literacy, information literacy and media literacy.

This competence is crucial for the acquisition of other skills and active participation in society (Ferrari et al., 2014; Kiryakova, 2023), as it includes understanding media, critically evaluating information, and communicating using digital tools (Brečko, 2015). As it facilitates functioning in a variety of contexts, personal development, and independence, it plays an important role in work, learning, and social interaction (Javrh et al., 2018). Moreover, it helps individuals understand how digital media affects their behaviour (Tomczyk & Potyrała, 2021).

Digital Literacy in Education

In order to engage effectively and successfully within society, individuals must be digitally literate, which introduces new challenges for the education of young people. Teachers need new knowledge, skills and relevant digital competencies to effectively implement and integrate digital tools into the learning process (Kiryakova, 2023). In comparison to digital literacy in other professions, digital competence for teachers is characterized by its complexity, as it also demands pedagogical skills that enable the effective integration of technology in educational settings with children and young individuals (European Commission, 2013).

The rapid development of digital technologies, therefore, raises questions about the digital training of future teachers. Educational curricula typically incorporate ICT courses to equip students with basic skills and the confidence required to effectively utilise digital tools (Falloon, 2020). Nevertheless, this raises the question of whether these courses are sufficient for cultivating the necessary competencies. Future teachers should integrate digital technologies into their pedagogical approaches to accomplish learning objectives and assist students in cultivating necessary digital competencies. These competencies can only be developed through targeted educational activities (Kiryakova, 2023).

Research indicates that teachers often perceive themselves as lacking adequate skills in digital literacy (Garzón-Artacho et al., 2021; Hall et al., 2014). This situation is concerning, especially considering that Juvan et al. (2016, p. 30) emphasize the importance of teachers as influential role models. The extent of teachers' knowledge of and attitudes towards technology significantly influence how students develop their ICT skills and digital competencies. Given that the development of digital competencies is closely associated with how (future) teachers perceive these competencies (Sartor Harada et al., 2022), we focused our research on exploring this issue.

Methodology

Sample

The research was conducted on a convenience sample of 356 students enrolled in elementary education or preschool education study programmes

Table 1 *Structure of the Sample of Students*

		N	%
Gender	Male	31	8.7
	Female	324	91.0
	Other	1	0.3
	Prefer not to disclose	0	0.0
Age	$M = 21.49$, $SD = 1.81$, $MIN = 19.00$, $MAX = 27.00$		
Study programme	Preschool education	129	36.2
	Elementary education	227	63.8
Degree and year of study	1st degree	302	84.8
	1st year	79	22.2
	2nd year	93	26.1
	3rd year	82	23.0
	4th year	48	13.5
	2nd degree	54	15.2
	1st year	54	15.2
Average grade for the winter semester of the academic year 2023/2024	$M = 8.55$, $SD = 0.82$, $MIN = 5.00$, $MAX = 10.00$		
	Total	356	100.0

at the Faculty of Education, University of Maribor, during the academic year 2023/2024. A more detailed description of the sample is presented in Table 1 below.

In our research, we included students from elementary education (63.8%) and preschool education (36.2%). Further examination reveals that the research included students from first-degree (84.8%) and second-degree (15.2%) programmes. A detailed analysis of the student composition by year of study shows that students from all years participated in the research. It appears that the students participating in the study are, on average, successful in their academic endeavours, as their average grade is 8.55. The average age of the students is 21.49 years, reflecting a relatively young population of participants. Among the participants, the majority were female (91.0%).

Instrument

For research purposes, we developed a questionnaire that included closed-ended and open-ended questions. The questionnaire was divided into several sections, which include the following: a) demographics, b) academic performance, c) participation in training and projects related to digital literacy, d) use of digital technology, and f) digital competence. The most relevant sections for this paper include the demographic questions and those sections that are related to digital competence. The section on digital competencies was based on the Student Digital Competence Scale (SDiCoS) questionnaire, developed by Tzafilkou et al. (2022). It consists of the following six areas: a) search, find, access (five items), b) develop, apply, modify (six items), c) communicate, collaborate, share (three items), d) store, manage, delete (five items), e) evaluate (six items), and f) protect (three items). Students provided their responses on a Likert scale ranging from 1 – strongly disagree to 5 – strongly agree. The section assessing digital competencies demonstrated high overall reliability, with a Cronbach's alpha (α) higher than 0.9. The internal consistency for specific content areas was 0.7 or higher, indicating that the questionnaire is suitable for further data analysis.

Research Design

To obtain data, we created an online questionnaire at the beginning of May 2024. Personal invitations were extended to the students to participate in the research, allowing them to access the questionnaire via a QR code. The questionnaires were completed in the classroom and typically took between five to ten minutes to complete. The procedures followed ethical guidelines, ensuring anonymity and voluntary participation. Participants were also given the option to withdraw from the study at any time without facing any consequences. The data were collected until the beginning of June 2024.

Data analysis was performed using IBM SPSS 29.0. The data processing involved both descriptive and inferential statistics. Before the analysis, a check for missing values was undertaken. Since the students completed the questionnaire in the classroom, there were a few missing values. However, most students stopped giving answers to questions in the demographics section, so we excluded nine cases from the study.

Since our objective was to compare the level of digital competence between students in preschool education and those in elementary education, we segmented the database. We conducted separate analyses of outliers and normal distribution for each group. Outliers were identified within each group by standardising the scores and checking the standardised scores for absolute values higher than 3.29. After further analysis, we determined that these outliers are not due to errors but accurately reflect the variability within the data. The univariate normal distribution of the items was assessed using the Kolmogorov-Smirnov test, as well as by analysing skewness and kurtosis coefficients. The Kolmogorov-Smirnov test revealed deviations from the normal distribution in all items ($p < 0.05$). The skewness coefficient for preschool education students ranged from −0.86 to 0.40, and for primary education students from −0.75 to 0.30. The kurtosis coefficient for preschool education students ranged from −0.71 to 1.26, and for primary education students, from −0.94 to 0.80. This also indicates a deviation from the normal distribution.

Given the deviations from normality and the presence of outliers, we used the Mann-Whitney test for subsequent analysis to compare the level of digital competencies, measured on an ordinal scale, between students enrolled in elementary education and preschool education.

At the level of descriptive statistics, the mean (M), standard deviation (SD), minimum (MIN) and maximum (MAX) values were used, as well as coefficients of skewness and kurtosis.

Results

The results are presented in six thematic sections.

Search, Find, Access

The responses reflect students' self-assessed abilities in searching, finding, and accessing information and content with the use of digital tools. Students feel most confident in their ability to search and find groups on specific topics on social media. The ability to consume content on various smart devices

Table 2 Students' Self-Assessments of their Abilities in Searching, Finding, and Accessing Information and Content Using Digital Tools

I can …	N	M	SD	MIN	MAX	U	p
… search and find groups on a specific topic (e.g., hobby, profession, artist, science, historical event, travel destination) on various social media.	356	4.22	0.69	2.00	5.00	12213.50	0.005
… watch (read, listen, view) content in various formats on various smart devices.	356	4.18	0.60	3.00	5.00	13648.50	0.242
… search and find a specific person on various social networks using various techniques and filters (e.g., various formats of name, photo, email address, school, company, etc.).	356	4.06	0.71	2.00	5.00	12839.50	0.038
… navigate in the real–world using the advanced features of a navigator.	356	4.06	0.72	2.00	5.00	12917.00	0.048
… search and find a specific object or similar objects using various search engines (e.g., Google, Yahoo, Bing) and databases, using appropriate keywords and advanced criteria and filters.	356	3.93	0.78	2.00	5.00	14284.00	0.683

also receives a high rating. Searching for specific people on social networks and navigating in the real world using advanced navigation features are rated equally. While still highly rated, the ability to search and find specific objects or similar objects using various search engines and databases shows the lowest average among the assessed abilities. This may indicate that students find this task slightly more challenging than the others, possibly due to the complexity of effectively using advanced search criteria and filters.

In the section, 'Search, Find, and Access,' we also compared the abilities of elementary and preschool education students. The Mann-Whitney test revealed significant differences in three abilities between the two groups. Elementary education students generally ranked higher in finding people on social media, finding groups on social media, and real-life navigation. However, no significant differences were found regarding their general internet search abilities and ability to view content in various formats on smart devices.

Develop, Apply, Modify

The responses reveal students' self-assessed abilities in developing, applying, and modifying digital content and tools. Converting content from one format to another is the area where students are most confident. Creating events and setting notifications using digital calendars also ranks highly. Creating documents with advanced features such as text, diagrams, tables, and

Table 3 *Students' Self–Assessments of Their Abilities in Developing, Applying, and Modifying Digital Content and Tools*

I can …	N	M	SD	MIN	MAX	U	p
… convert content from one format to another format.	356	4.05	0.74	2.00	5.00	12856.50	0.039
… create an event and set notifications using a digital calendar (e.g., Google Calendar, Apple Calendar, Microsoft Outlook Calendar).	356	3.99	0.81	2.00	5.00	14535.00	0.904
… create a document with text, diagrams, tables, reports, and advanced formatting.	356	3.96	0.73	2.00	5.00	13554.50	0.212
… apply statistical techniques using appropriate software (e.g., SPSS, R, MS Excel, Google Sheets) to make forecasting or predictions.	356	3.33	0.86	1.00	5.00	13474.50	0.295
… creatively design and/or develop a website using various digital tools (e.g., Wix, WordPress).	356	2.75	1.22	1.00	5.00	12628.00	0.028
… apply Creative Commons licenses to content or software that I have created.	356	2.63	1.06	1.00	5.00	13693.00	0.295

reports follows closely. Applying statistical techniques with the use of appropriate software shows moderate confidence among students. The ability to creatively design and/or develop websites using tools such as Wix or WordPress has a lower average. This indicates that students feel less confident in web design and development, which could be due to the specialised skills required for such tasks. Applying Creative Commons licenses to content or software created by students has the lowest average. This suggests that students are not as familiar with or confident in the legal and procedural aspects of applying licenses to their work, which additionally highlights an area in need of further education or training.

The Mann-Whitney test showed significant differences in two abilities between elementary and preschool education students. Elementary education students generally ranked higher in website design and development and converting content formats. However, no significant differences were found in their abilities to use digital calendars, create documents with advanced formatting, add Creative Commons licenses, or use statistical techniques for predictions.

Communicate, Collaborate, Share

The responses offer insights into students' self-assessed communication, collaboration, and sharing abilities using digital tools. Students feel most confident collaborating with others using various smart devices, platforms, and

Table 4 *Students' Self-Assessments of Their Abilities in Communicating, Collaborating, and Sharing Using Digital Tools*

I can …	N	M	SD	MIN	MAX	U	p
… collaborate with people using various smart devices, platforms, and digital tools.	356	4.10	0.69	2.00	5.00	12311.50	0.007
… teach an e-course or an e-seminar, give a lecture or make a presentation using various digital tools.	356	3.82	0.81	2.00	5.00	11893.50	0.002
… upload and share software or app that I have developed on various social media.	356	3.74	0.90	1.00	5.00	12697.50	0.028

digital tools. Teaching an e-course or e-seminar, giving lectures, or making presentations using digital tools has a slightly lower average rating. The ability to upload and share software or apps they have developed on various social media platforms has the lowest average rating. This suggests that students feel least confident in this area, possibly due to the technical skills involved in software development and the specific knowledge needed to share such content effectively on social media.

We further compared the abilities to collaborate and share digital content between elementary and preschool education students. The Mann-Whitney test revealed significant differences in all three abilities between the two groups. Elementary education students generally ranked higher in all three abilities.

Store, Manage, Delete

The responses in this section provide insights into students' self-assessed abilities in storing, managing, and deleting digital content. Students feel most confident in copying and saving screenshots from various smart devices. The ability to delete connections or friends on social networks also ranks highly. Students are also confident in their ability to manage downloaded content efficiently. Additionally, students feel confident in organising files on their computers into a hierarchical folder structure. Taking photos or videos and saving them in various formats using smart devices and digital tools has the lowest average rating among the listed tasks. Although still high, this suggests that while students are proficient in this area, it is perceived as slightly more challenging than the other tasks.

We further compared the abilities to store, manage, and delete digital content between elementary and preschool education students. The Mann-Whitney test revealed significant differences in two abilities between the two groups. Elementary education students demonstrated greater pro-

Table 5 *Students' Self-Assessments of Their Abilities in Storing, Managing, and Deleting Digital Content*

I can …	N	M	SD	MIN	MAX	U	p
… copy and save the screenshot from various smart devices.	356	4.34	0.61	3.00	5.00	13493.50	0.182
… delete some of my connections/ friends in various social networks.	356	4.29	0.70	2.00	5.00	14545.00	0.912
… download content and save it directly to the relevant folder.	356	4.16	0.67	2.00	5.00	13155.00	0.084
… organize the files on my computer into a hierarchical folder structure.	356	4.11	0.81	2.00	5.00	11816.00	0.001
… take a photo or a video and save it in various formats (mp4, wmv, avi, qt, gif, jpg, etc.) using various smart devices and digital recording tools.	356	4.08	0.76	2.00	5.00	12378.00	0.010

ficiency in recording and saving photos or videos in various formats, as well as in organising files into a hierarchical system of folders on their computers. However, no significant differences were observed in their abilities to transfer and save content directly to specific folders, take and save screenshots on various smart devices, or remove friends/connections on social media.

Evaluate

The responses in this section reveal students' self-assessed abilities in evaluating digital content and devices. Students feel most confident in evaluating whether an email is spam, adware, phishing, or fraud. Evaluating whether information is a hoax, fake, scam, or fraud also ranks highly, indicating that students are quite confident in their ability to discern the credibility of online information. Critiquing objects or smart devices on relevant social media platforms and evaluating objects and smart devices using appropriate quality criteria have the same average rating. Evaluating whether a website is secure and trusted is another area where students feel confident, although slightly less so than in identifying email fraud or evaluating information credibility. Identifying online content's intellectual property rights (IPRs) has the lowest average rating among the tasks listed. Although still moderately confident, students perceive this task as more challenging than others, possibly due to the complexity and specialised knowledge required to understand and identify IPRs.

The Mann-Whitney test revealed significant differences in three abilities between elementary and preschool education students. Elementary education students generally ranked higher in their ability to judge whether an email

Table 6 *Students' Self–Assessments of Their Abilities in Evaluating Digital Content and Devices*

I can …	N	M	SD	MIN	MAX	U	p
… evaluate whether an email is spam, adware, phishing, or fraud.	356	4.14	0.71	2.00	5.00	12208.50	0.005
… evaluate whether some information is hoax, fake, scam, or fraud.	356	3.91	0.73	2.00	5.00	12912.50	0.047
… evaluate an object and/or a smart device using appropriate quality criteria (e.g., authenticity, utility, easy to use, appearance, functionality, enjoyment).	356	3.84	0.77	2.00	5.00	13011.50	0.063
… critique an object and/or a smart device on relevant social media (e.g., TripAdvisor, YouTube, Amazon).	356	3.84	0.74	2.00	5.00	13293.50	0.121
… evaluate whether a website is secure and trusted.	356	3.81	0.74	2.00	5.00	13637.00	0.247
… identify the intellectual property rights (IPRs) of content that I have found on Internet.	356	3.59	0.83	1.00	5.00	12666.00	0.026

is spam, adware, phishing, or fraud, recognize intellectual property rights of online content, and determine if a piece of information is fake or fraudulent. However, no significant differences were found in their abilities to assess the quality of a product or smart device, critically review items on social media platforms, or evaluate the safety and trustworthiness of websites.

Protect

The responses provide insights into students' self-assessed abilities in protecting their digital identities and devices. Students feel most confident in regularly changing passwords and settings on their smart devices and internet accounts. The ability to protect various smart devices and e-accounts using different passwords and frequently changing them also ranks highly. Students show moderate confidence in their ability to protect themselves and others against identity theft, harassment, bullying, or slander, which has the lowest average rating among the tasks listed. While they feel capable in this area, the lower rating indicates that students perceive this task as more complex and challenging than managing passwords and device settings.

The Mann-Whitney test revealed significant differences in one ability, as elementary education students ranked higher in their ability to protect themselves and others from identity theft, harassment, bullying, or defamation. However, no significant differences were found between elementary and preschool education students in their abilities to regularly change passwords and settings on their smart devices and internet accounts, or to protect var-

Table 7 *Students' Self–Assessments of Their Abilities in Protecting Their Digital Identities and Devices*

I can …	N	M	SD	MIN	MAX	U	p
… regularly change my passwords and settings of my smart devices and Internet accounts.	356	3.77	0.91	1.00	5.00	14594.50	0.958
… protect various smart devices and e–accounts using different passwords and frequently changing them.	356	3.72	0.91	1.00	5.00	13842.50	0.373
… protect myself and others against identity theft, harassment, bulling, or slander.	356	3.59	0.83	1.00	5.00	12162.50	0.005

ious smart devices and e-accounts with different and frequently changed passwords.

Discussion

Teachers with greater confidence in their digital skills are more motivated to pursue further education and integrate ICT into their teaching practice. Their use of ICT is strongly related to the assessment of their own digital competencies and judgements about the appropriateness of ICT use, making professional development in this area crucial (European Commission, 2013). In order to cultivate independence and confidence among future teachers, they should acquire new skills while they are still engaged in their studies.

Our study shows that students feel most confident in their abilities to search and find groups on social networks, view content on various smart devices, convert content from one format to another, use digital calendars, and collaborate with people with the use of ICT. They also feel confident in their abilities to copy and save screenshots on various smart devices, delete connections on social networks, identify false information and fraud, and protect their devices.

In contrast, students feel less confident in their abilities to find specific objects with the use of advanced search criteria, to design or develop a website and to apply licences to the content they have created. Additionally, they lack confidence in sharing software and applications on social media, taking and saving pictures and videos in various formats, and identifying the intellectual property rights of content they find online. Such uncertainty might be the result of the complexity of these tasks and the lack of technical skills.

One of the fundamental tasks associated with digital literacy is training teachers to fully utilize digital technologies to enhance and improve teaching (Redecker, 2017). Considering the highlighted weaknesses related to the use of ICT among future teachers, there is no doubt that additional training and education in these areas is necessary, as this will allow them to fully exploit the benefits of modern technology in education.

Furthermore, we find that elementary education students assess themselves as more competent than preschool education students. It is clear from this finding that the quality of education for future preschool teachers needs to be improved, especially because Kontkane et al. (2023) also observe that children are not sufficiently engaged during the preschool years in their acquisition of digital competencies. This fact further emphasises the need to integrate more digital literacy content into preschool education curricula, which is vital for the development of children's digital skills from an early age, as teachers play a crucial role in the successful development of these competencies, as Juvan et al. (2016) confirm.

Teacher education programmes around the world continue to face the challenges of providing future teachers with the necessary skills to effectively integrate digital technologies into their future teaching practice (Instefjord, 2015). Hence, it is imperative that education programmes for future teachers are continuously updated and adapted to current technological trends to prepare them for the challenges of the digital age.

Conclusion

To conclude, the development of digital competencies is critical for ensuring quality in educational endeavours, as only teachers with adequate digital skills are capable of providing effective and high-quality teaching (Trujillo-Torres et al., 2020).

The value of our research lies in identifying digital literacy among future teachers and raising awareness of its importance. The research also bears some limitations, namely that the findings cannot be generalised, as only students of the Faculty of Education at the University of Maribor were included in the study. It should also be borne in mind that the findings are based on the subjective assessments of future teachers, thus not necessarily reflecting the reality of the situation.

In the future, the focus on developing digital competencies should continue through effective strategies that aid individuals in taking advantage of the benefits of digital technology. ICT training should become a mandatory component of all initial teacher education programmes (European Commission, 2013) to ensure that future teachers are adequately prepared to teach and prepare students for life in the digital age.

Acknowledgements

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Digitalne kompetence bodočih učiteljev

Članek obravnava pomen digitalnih kompetenc bodočih učiteljev, pri čemer poudarja vlogo informacijsko-komunikacijske tehnologije (IKT) v vzgojno-izobraževalnem procesu. Raziskava je bila izvedena na priložnostnem vzorcu 328 študentov Pedagoške fakultete Univerze v Mariboru v študijskem letu 2023/2024. Podatki so bili zbrani s spletnim vprašalnikom. Rezultati raziskave so pokazali, da se študenti najsamozavestnejše počutijo pri osnovnih digitalnih nalogah, kot sta iskanje informacij na družbenih omrežjih in uporaba digitalnih koledarjev. Kljub temu pa so manj samozavestni pri naprednih nalogah, kot sta spletno oblikovanje in uporaba licenc. Ugotavljamo, da se študentje razrednega pouka v primerjavi s študenti predšolske vzgoje počutijo kompetentnejše.

Rezultati raziskave poudarjajo, da so za izboljšanje digitalne pismenosti nujno potrebna dodatna izobraževanja in usposabljanja bodočih učiteljev na vseh stopnjah ter smereh izobraževanja, saj se lahko le tako izkoristijo prednosti sodobne tehnologije v izobraževalnem procesu.

Ključne besede: digitalne kompetence, IKT v izobraževanju, izobraževanje učiteljev, visoko šolstvo

The Digital Competence of Foreign Language Teachers at HEI in Serbia: A Study Based on the European Framework DigCompEdu

Danijela Ljubojević
Institute for Educational Research, Serbia
danijela.ljubojevic@ipi.ac.rs

Nikoleta Gutvajn
Institute for Educational Research, Serbia
gutvajnnikoleta@gmail.com

In recent years, considerable literature has grown up around the theme of digital education at higher education institutions. The issue has grown in importance in light of Covid-19 pandemic, which made teachers face rapidly changing demands. However, the question remains what this abrupt change has brought when it comes to the development of digital competences of teachers. This study therefore set out to determine the level of digital competence of foreign language teachers working at HEI in Serbia, as well as to (self-) assess their strengths and identify areas of improvement. In order to carry out this study, a questionnaire of 33 questions was implemented based on the DigCompEdu framework. The European Framework for the Digital Competence of Educators (DigCompEdu) lists 22 competences organised in six areas: Professional engagement, Digital resources, Teaching and learning, Assessment, Empowering learners, Facilitating Learners' Digital Competence. The findings of this study show that the actual level of digital competences of teachers is A2+/B1. They also outline concrete and feasible national, institutional and interinstitutional policy recommendations to enhance the development of digital competences in higher education.

Keywords: foreign language teachers, digital competences, DigCompEdu

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Introduction

Recent rapid digitalization in education, specifically accelerated by COVID-19 pandemic, has placed new demands on educators to adapt their teaching methodologies. Foreign language teachers, in particular, face complex challenges in this digital transition, as they must effectively integrate technology to enhance language teaching and learning. For them, digital competence goes beyond using basic digital tools – it involves the ability to create engaging, multimodal learning experiences that facilitate language learning, development and acquisition. Digital platforms offer opportunities for immersive language practice, from virtual classrooms to interactive resources that simulate real-world linguistic contexts. Research has shown that teachers with more experience in using educational platforms and who frequently incorporated teamwork into their online teaching fostered digital skills of students more effectively (Kadijevich et al., 2023). Moreover, using social learning environments supports problem-based and project-based learning, encouraging more active engagement and communication between students and teachers (Raspopovic Milic et al., 2017).

However, the extent to which teachers in Serbia have developed digital competences to sucessfully integrate these advanced digital tools and strategies into their foreign language teaching remains an open question. This study focuses on the digital competence of foreign language teachers working at higher education institutions (HEIs) in Serbia, as recommended by the European Framework for the Digital Competence of Educators (DigCompEdu) (Redecker, 2017). This framework provides a structured approach to evaluating and enhancing the digital skills necessary for effective teaching in a digitally integrated educational environment. This study aims to identify the current levels of digital competence among these educators, highlight their strengths, and pinpoint areas for improvement. Previous research has highlighted the necessity of improving ESP teachers' digital competences in HEIs, emphasizing the role of professional development programs tailored to the unique challenges of digital language instruction (Ljubojević, 2025). To this end, the following research questions will be addressed:

1. What is the current level of digital competence among foreign language teachers at higher education institutions in Serbia, as assessed against the DigCompEdu framework?
2. Which specific areas of digital competence (e.g., Professional Engagement, Digital Resources, Teaching and Learning, etc.) are perceived as their strengths?
3. What are the perceived areas of improvement in digital competence among foreign language teachers in Serbia, according to the DigCompEdu framework?

The findings from this study will not only contribute to the academic discourse on digital competence but also provide practical recommendations for policymakers and educational institutions in Serbia. This will ensure that foreign language teachers are well-equipped to navigate the complexities of digital teaching and learning, ultimately benefiting students and the broader educational community. Furthermore, the insights gained will serve as a foundation for a potential project aimed at developing educators' competences, shifting the balance from traditional teaching methods towards a more comprehensive, technology-enabled repertoire of practices.

Literature Review

DigCompEdu was developed by the European Commission and describes 22 competences organized into six key areas: Professional Engagement, Digital Resources, Teaching and Learning, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence (Redecker, 2017). These competences are intended to help educators integrate digital technologies into their teaching practices effectively, thus enhancing both their professional development and the learning outcomes of their students. By providing a structured framework to evaluating and developing digital skills, DigCompEdu serves as a valuable instrument in research designed for assessing the digital competence levels of educators, identifying both areas of strength and opportunities for further professional growth. It is often used as a self-assessment tool by educators to evaluate their own digital competences and identify areas for improvement. Based on it, SELFIE for Teachers was developed in 2021 as an online self-reflective tool to help teachers to review and gain feedback on how they are currently using digital tools and technologies. It was also a statring point for the first digital framework for primary and secondary school teachers in Serbia *Digital Competences Framework – Teachers for the Digital Age* published in 2019.

There have been several projects trying to determine the level of digital competences based on the DigCompEdu. *Digital Competence in Higher Education: A European Perspective* highlights the importance of developing professional engagement, digital resource management, assessment techniques, and empowering learners with digital tools. It also emphasizes the role of personalized and inclusive online education, cybersecurity awareness, and self-regulated learning as essential components of fostering digital competence. The findings aim to contribute to shaping a digitally competent educational workforce capable of supporting a high-quality, inclusive digital education ecosystem (Pérez-Valls & Bernal Bravo, 2023).

In the same vein, Rubio-Gragera et al. (2023) conducted research with the aim to evaluate the digital competence of teachers in Official Language Schools in Spain, using the DigCompEdu framework to assess teachers' digital skills. It was found that the teachers have low overall digital competence, and they self-assessed themselves at an average digital competence level, with the lowest scores in facilitating learners' digital competence and cybersecurity awareness (Rubio-Gragera et al., 2023).

In the context of this study, DigCompEdu is used as a foundational framework as well for designing the research instrument, allowing for a systematic analysis of the digital competences of foreign language teachers in higher education institutions in Serbia. Moreover, it is particularly focused on supporting individual teachers in their professional development related to digital competence. DigCompEdu provides a progression model to help educators assess and develop their digital competence, thus making it a choice for the instrument in this study.

Methodology

Design of the Study

This study employs a descriptive survey design aimed at determining the level of digital competences of foreign language teachers at HEIs in Serbia. The design was chosen because it allows for the collection of data on participants' self-assessed competences, providing a comprehensive view of their current digital proficiency. The study is non-experimental and cross-sectional, as the data is collected at a single point in time without manipulation of variables.

The questionnaire, based on the DigCompEdu framework, comprises 33 questions. It was designed to cover six key areas of digital competence as outlined in the DigCompEdu framework.

The target population for this study consists of foreign language teachers working at universities across Serbia. Data collection is carried out through an online survey, distributed via emails to university heads and language societies, who forward the questionnaire to the relevant teachers. The questionnaire responses are anonymized to ensure privacy and unbiased data collection.

The results are analysed using descriptive statistics to determine the overall level of digital competence, as well as to identify any significant trends or gaps in the digital skillset of the educators.

The main method used for data collection in the study included a very comprehensive and detailed online survey, which was distributed to teachers. The questionnaire included sets of questions regarding teachers' awareness of digital competences, their institutions' support, professional development in this field, pedagogical aspects of using digital competences in the classroom, student digital competence and digital-based assessment practices.

Participants

The analysis was conducted at the national level, with data collected from 54 participants through an online questionnaire. The target population for this study consists of foreign language teachers working at HEIs in Serbia. Although the sample includes teachers from multiple state universities, it does not encompass educators from private institutions, colleges, or non-university language programs.

Based on the unpublished study carried out by Jovanović et al. (2024), the total number of foreign language teachers working at HEIs in Serbia is 69 for English, 7 for Italian, 10 for German, 8 for Russian, 12 for French, and 2 for Spanish, making a total of 108 foreign language teachers across various HEIs.[1]

As shown in Diagram 1, out of the 54 participants who completed the questionnaire, 46 were female (85.18%) and 8 (14.82%) were male. When it comes to the educational level, educational attainment varied from BA to Ph.D., with 4 participants holding a bachelor's degree (until 2006), 1 holding a bachelor's degree (after 2006), 5 having a magister degree, 7 with a master's degree, and 37 possessing a doctoral degree. Teaching experience was categorized into several ranges: 6 participants (11%) had 0–5 years of experience, 3 participants (6%) had 6–10 years, 15 participants (28%) had 11–20 years, 24 participants (44%) had 21–30 years, and 6 participants (11%) had more than 30 years, reflecting a diverse spectrum of experience levels among the educators. The majority of respondents teach English, with 34 teachers (63%) specialized in this language. Other languages represented include Italian (5 participants, 9%), Spanish (4 participants, 7%), German (3 participants, 6%), French (2 participants, 4%), Russian (2 participants, 4%), Serbian (1 participants, 2%), Slovene (1 participant, 2%), Greek (1 participant, 2%), and Norwegian (1 participant, 2%).

The respondents occupy a wide range of academic positions, with the majority serving as Assistant professors (29.63% (16)), followed by Foreign language teachers (16.67% (9)), Associate professors (20.37% (11)), and Readers (12.96% (7)). A smaller proportion holds the position of Junior teaching assistant (3.70% (2)), Teaching assistant (3.70% (2)), Teaching assistant with PhD (1.85% (1)), and Senior lecturer (1.85% (1)). The smallest group consists of Full professors (0.28% (1)).

[1] The questionnaire in the study by Jovanović et al. (2024) was completed in all nine university centers of Serbia, and responses were received from 56 faculties, representing 62.6% of all state. This means that total number of foreign language teachers working at HEI is higher than 108 but approximatelly no more than 173. The sample of 54 foreign language teachers represents approximately 31.2% of the estimated total population (173 teachers) working at HEIs in Serbia. This indicates that this study captures nearly one-third of the total foreign language teaching faculty, which is a moderate representation for generalizing findings.

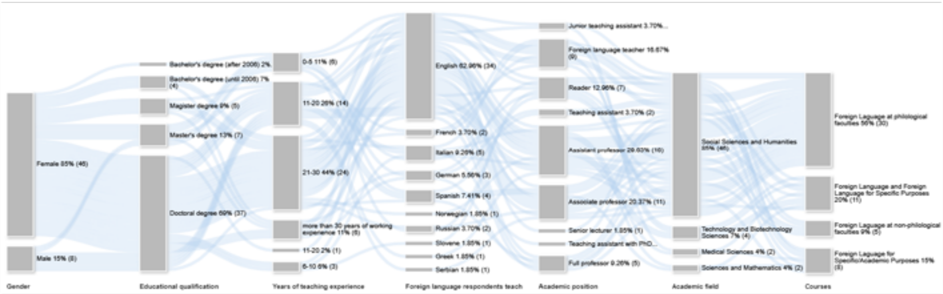

Figure 1 Distribution of Gender, Educational Qualification, Teaching Experience, Foreign Language Taught, Academic Position, Academic Field, and Courses Taught

The majority of respondents, 85% (46), are in the Social Sciences and Humanities field, followed by Technology and Biotechnology Sciences (7% (4)), Medical Sciences (4% (2)), and Sciences and Mathematics (4% (2)).

Regarding courses taught, most respondents teach Foreign Language at Philological Faculties (56% (30)), while 20% (11) teach Foreign Language for Specific/Academic Purposes. Other significant areas include Foreign Language at Non-Philological Faculties (9% (5)) and Foreign Language and Foreign Language for Specific Purposes (20% (11)).

Instrument

For the purpose of this study, the DigCompEdu check-in questionnaire was used as an instrument for data collection (Redecker, 2017). The instrument consists of 33 questions, nine of which refer to the sociodemographic background of respondents: gender, educational qualification, years of teaching experience, foreign language respondents teach, academic position, type of institution, academic field, courses, level of studies Two questions reffered to the level of digital competences (as perceived by the teachers prior to and after completing the questionnaire). The remaining twenty-two questions fall within the six distinct competency areas outlined by DigCompEdu, which constitute the central focus of our research. The competences are explained at six different levels of proficiency (A1, A2, B1, B2, C1, C2). The proficiency levels are categorized as A (Beginners level), B (Intermediate level), and C (Advanced level). Each category is further divided into specific levels:

- A (Beginners level) includes A0, A1, and A2.
- B (Intermediate level) includes B1 and B2.
- C (Advanced level) includes C1 and C2.

Table 1 Areas, Items and Indicators for Assessing Digital Competence of Educators Based on DigCompEdu (Redecker, 2017)

Area	Item	Indicator
Professional engagement	Digital channels	I systematically use different digital channels to enhance communication with students, parents and colleagues.
	Collaboration with colleagues	I use digital technologies to work together with colleagues inside and outside my educational organisation.
	Development of digital teaching skills	I actively develop my digital teaching skills.
	Online training	I participate in online training opportunities.
Digital resources	Search strategies	I use different internet sites and search strategies to find and select a range of different digital resources.
	Modification of existing digital resources	I create my own digital resources and modify existing ones to adapt them to my needs.
	Sensitive data	I effectively protect sensitive content, e.g. exams, students' grades, personal data.
Digital teaching and learning	Value creation	I carefully assess how, when and why to use digital technologies in the classroom with my students, to ensure that they add value.
	Monitoring interactions	I monitor the activities and interactions of my students in the online collaborative environments we use.
	Digital technologies in groupwork	When my students work in groups, they use digital technologies to acquire and reflect knowledge.
	Documentation and planning	I use digital technologies to enable my students to plan, document and monitor their own learning process.
Assessment and feedback	Tracking of student progress	I use digital assessment tools to monitor student progress.
	Analysing data	I analyse all available data to effectively identify students in need of additional support.
	Feedback	I use digital technologies to provide feedback to students.
Empowering learners	Addressing digital problems	When creating digital tasks for students, I consider and address possible practical or technical difficulties.
	Personalised learning opportunities	I use digital technologies to offer students personalised learning options.
	Active participation	I use digital technologies to actively engage students in class or online.
Facilitating learners' digital competence	Assessment of reliable information	I teach students how to assess the reliability of information.
	Communication and collaboration	I set assignments that require students to use digital media to communicate and collaborate with each other or with an external audience.
	Creation of digital content	I set assignments that require students to create digital content.
	Safe and responsible behaviour	I teach students to use digital technology safely and responsibly.
	Problem solving	I encourage students to use digital technologies creatively to solve concrete problems.

These levels reflect the progression of respondents' engagement and proficiency in various digital skills, with A0 being the most basic, and C2 representing the highest level of digital competence. These areas are the following: professional engagement, digital resources, digital teaching and learning, assessment and feedback, empowering learners, and facilitating learners' digital competence.

Procedure, Data Collection and Data Analysis

The data collection for this study utilized snowball sampling (referral sampling), i.e. the survey was initially sent to heads of universities and language societies, who then forwarded it to language teachers. The instrument was disseminated via email between June and September 2024, first through the heads of faculties at each of the nine universities involved and then by contacting the language departments of each institution. Additionally, the Society for Foreign Languages and Literatures in Serbia was contacted to distribute the questionnaire. All responses remained anonymous.

To collect the values of the variables used in this study, an online survey was conducted. It made use of a questionnaire available via Google Forms. Items (indicators) used to measure the level of digital competences are listed in Table 1.

Data analysis was caried out in Microsoft Excel.

Results

This section presents the findings of the study, based on the participants' responses to the questionnaire regarding their level of digital competences. The results are divided into key areas of digital competences, that is, professional engagement, digital resources, digital teaching and learning, assessment and feedback, empowering learners, and facilitating learners' digital competence.

Professional Engagement

Chart 1 shows respondents' levels of professional engagement across four key areas based on their proficiency levels. The areas which are measured are: the use of digital channels for communication, collaboration with colleagues using digital technologies, developing digital teaching skills, and participation in online training opportunities.

The proficiency level for using digital channels to communicate (such as with students, parents, or colleagues) is at the B2 level, which represents an intermediate level of proficiency. In terms of collaboration with colleagues, the respondents are at a B1 level. For the development of digital teaching skills, respondents are also at a B1 level, suggesting they are actively working on improving their skills but remain in the intermediate range. In the same line,

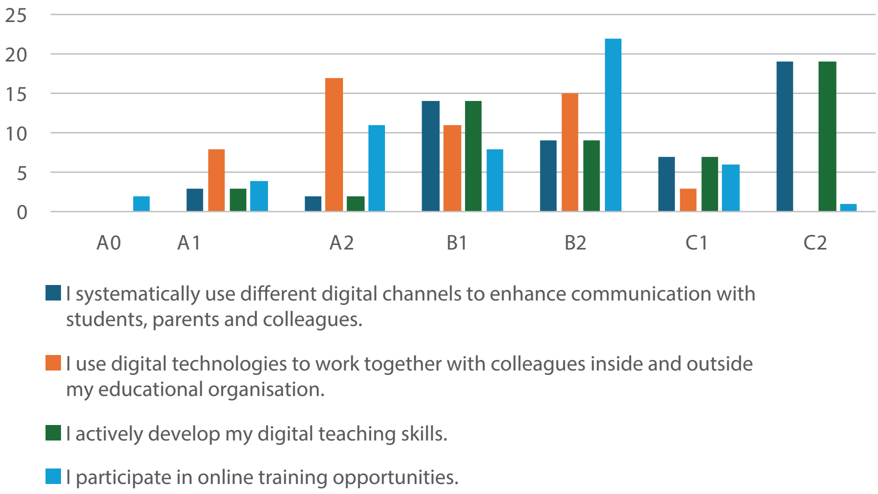

Chart 1 Professional Engagement

regarding online training, the proficiency level is also at B1, which shows that respondents are moderately engaged in participating in professional development through digital training opportunities but may not yet be making full use of advanced online learning platforms.

Overall, the respondents show intermediate proficiency (B1) in most areas of digital engagement, indicating that they are generally comfortable with digital technologies but still have room to advance to higher proficiency levels.

Digital Resources

Chart 2 illustrates respondents' levels of using digital resourses across three key areas based on their proficiency levels, ranging from A0 (beginner) to C2 (advanced). The measured areas include search strategies, modification of existing digital resources and sensitive data.

Based on the results shown in Chart2, in general the respondents are at a B2 level, i.e. at an intermediate level of proficiency concerning using digital tools and techniques to find and select a range of digital resources. Similarly, in the area of creating and modifying digital resources, the respondents are at a B1 level, suggesting they possess intermediate proficiency. However, when it comes to protecting sensitive content such as student grades, exams, and personal data, the respondents are at an A2 level, reflecting a basic level of proficiency. Overall, while the respondents demonstrate strong intermediate skills in search strategies and resource modification, there is a noticeable gap

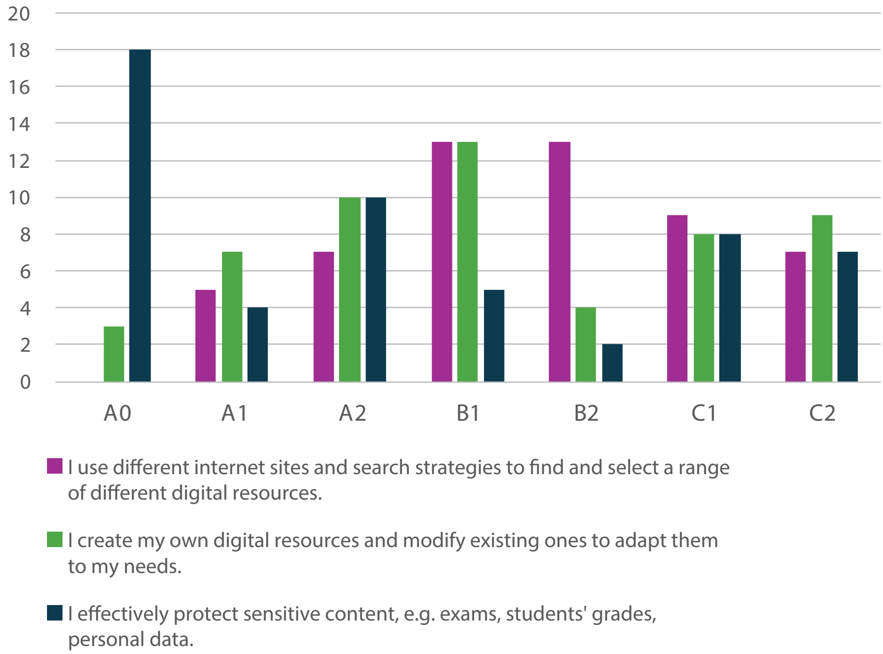

Chart 2 Digital resources

in their ability to effectively protect sensitive data, indicating the need for focused efforts to improve data security practices.

Digital Teaching and Learning

Chart 3 illustrates respondents' engagement with Digital Teaching and Learning across four key areas: Value creation, Monitoring interactions, Digital technologies in groupwork, and Documentation and planning.

In the first three areas – assessing the use of digital technologies in the classroom, monitoring student interactions in online environments, and using digital technologies in group work – respondents consistently demonstrate a B1 level of proficiency. In the fourth area – using digital technologies to enable students to plan, document, and monitor their learning processes – respondents are at an A2 level, which suggests a basic level of proficiency. Overall, the B1 level reflects the general proficiency of respondents in digital teaching and learning, indicating a solid foundational understanding and ability to incorporate digital technologies in classroom settings, though certain areas, such as supporting students in documenting their learning, may need further improvement.

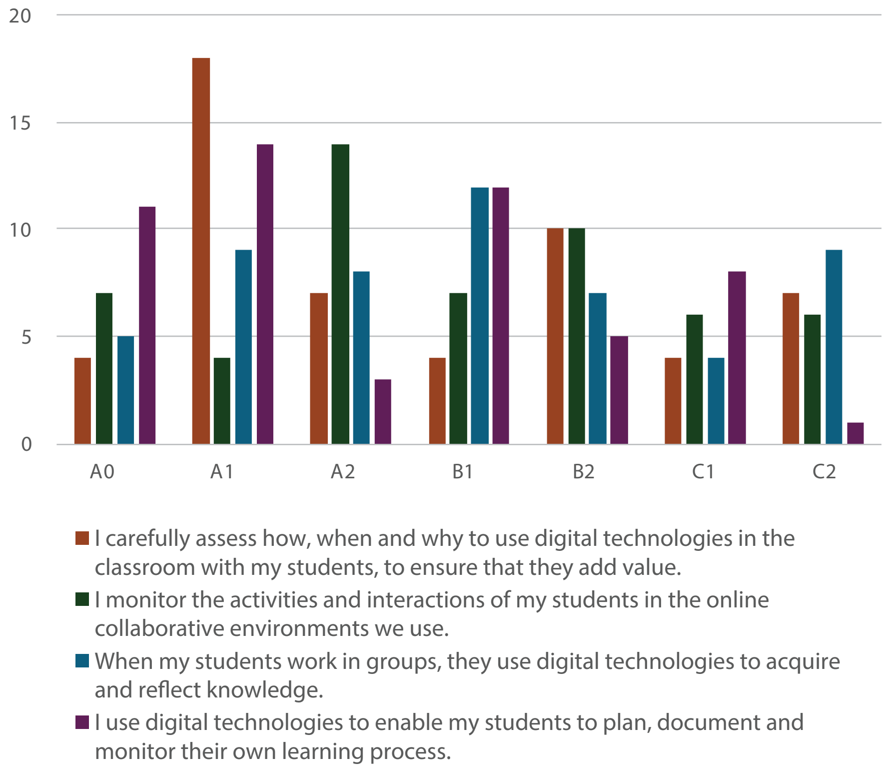

Chart 3 Digital teaching and learning

Assessment and Feedback

Chart 4 illustrates respondents' engagement with Assessment and Feedback across three key areas: Tracking of student progress, Analysing data, and Feedback.

The proficiency level for tracking student progress is rated as A2, indicating a basic to intermediate level of proficiency. When it comes to analysing data, respondents are at a B1 proficiency level, reflecting an intermediate ability to effectively analyze available data to identify students who may require further assistance. Similarly, proficiency in providing feedback using digital technologies is also rated at B1, indicating respondents have a moderate level of skill in using digital tools to offer feedback to students, which is consistent with the need for further professional development. Overall, the B1 level across the majority of areas suggests that respondents are at an intermediate proficiency level in their engagement with digital tools for assessment and feedback.

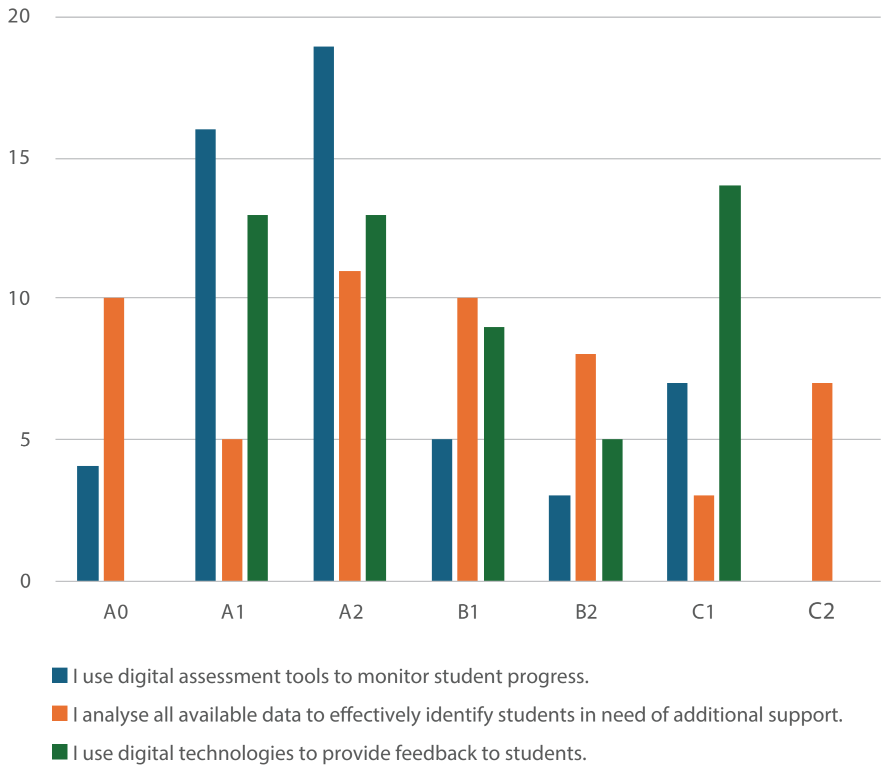

Chart 4 Assessment and Feedback

Empowering Learners

Student empowerment reflects respondents' proficiency in using digital tools to support student engagement and personalized learning, divided into three key activities: addressing digital problems, personalised learning opportunities and active participation.

When it comes to addressing digital problems, the majority of respondents are at the B1 level of proficiency. In terms of providing personalized learning opportunities, most respondents are at the A2 level of proficiency. Regarding facilitating active participation, the majority of respondents are also at the B1 level of proficiency. This indicates that respondents have intermediate proficiency in handling digital problems and engaging students, while their skills in offering personalized learning options are more basic to intermediate. Overall, B1 is the most prevalent level for empowering students, reflecting a moderate proficiency in using digital tools, with some areas like personalized learning requiring further development.

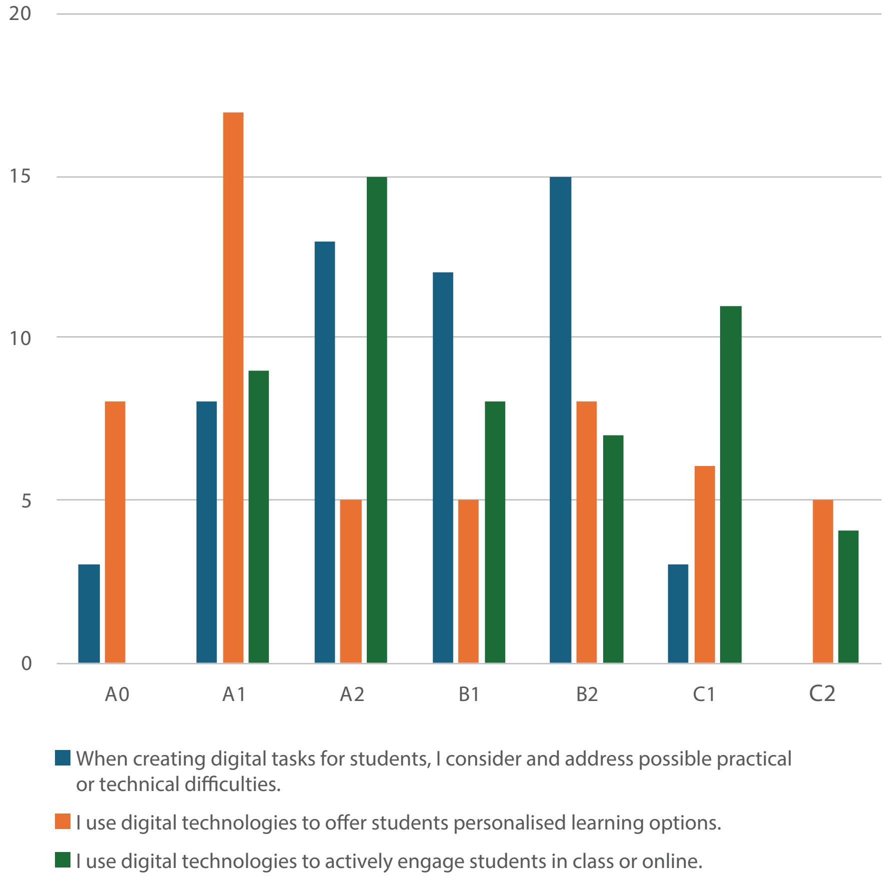

Chart 5 Student Empowerment

Facilitating Learners' Digital Competence

Chart 6 illustrates respondents' engagement across five key areas related to enhancing learners' digital skills. The measured areas include: assessment of reliable information, communication and collaboration, creation of digital content, safe and responsible behaviour and problem solving.

In terms of assessing the reliability of information, the majority of respondents are at the B1 level of proficiency. Regarding communication and collaboration, creation of digital content, safe and responsible behavior, and problem solving, the dominant proficiency level is A2. This suggests that respondents have intermediate proficiency in assessing information, while they demonstrate basic to intermediate proficiency across the other key areas of digital competence.

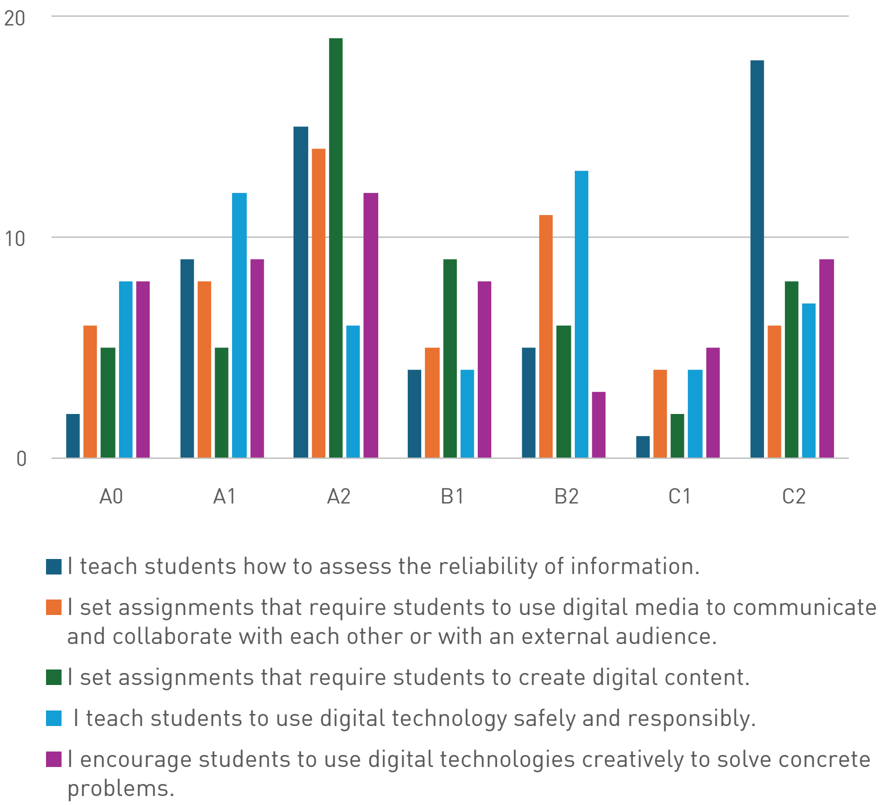

Chart 6 Facilitating Learners' Digital Competence

Level of Digital Competences of Foreign Language Teachers

Two of the questions in the survey asked foreign language teachers to self-assess their level of digital competence, both before and after completing the survey. Initially, the overall self-assessed level was B2, with an average score of 4.05. However, after answering questions related to DigiComEdu Framework, the average score dropped slightly to 3.79, but still remained at the B2 level. Despite this self-assessment, the actual level of digital competences of teachers, as reflected in their responses, was found to be at the A2/B1 level, with an average score of 2.68 out of 6 (Table 2). For a correct interpretation of these data, it is important to consider that the response interval ranges from 0 to 6, which means a total of seven response options, 0 being the value given to the lowest level (A0) and 6 to the most advanced (C2).

This discrepancy highlights the difference between perceived and actual level of digital competences among the teachers.

Table 2 Actual Level of Digital Competences of Teachers

Area	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5
Professional engagement	Digital channels	Collaboration with colleagues	Development of digital teaching skills	Online training	
	B2	B1	B1	B1	
Digital resources	Search strategies	Modification of existing digital resources	Sensitive data		
	B2	B1	A2		
Digital teaching and learning	Value creation	Monitoring interactions	Digital technologies in groupwork	Documentation and planning	
	B1	B1	B1	A2	
Assessment and feedback	Tracking of student progress	Analysing data	Feedback		
	A2	B1	B1		
Empowering learners	Addressing digital problems	Personalised learning opportunities	Active participation		
	B1	A2	B1		
Facilitating learners' digital competence	Assessment of reliable information	Communication and collaboration	Creation of digital content	Safe and responsible behaviour	Problem solving
	B1	A2	A2	A2	A2

Discussion

The results of this study point to the current state of digital competences among foreign language teachers working at higher education institutions is Serbia, demonstrating a general proficiency at the A2+/B1 level, with some areas revealing more significant issues that need addressing. This section discusses the key findings in relation to each area of digital competence and explores their implications for foreign language teaching and teacher development.

Professional Engagement

The findings suggest that foreign language teachers possess intermediate digital proficiency (B1) in professional engagement, specifically in communication, collaboration, and participation in online training. When it comes to using different digital channels for professional communication, the responses reflected an upper-intermediate level of competences. These findings allign with the ones of Rubio-Gragera et al. (2023). While this reflects a solid foundational understanding, it also indicates potential barriers to fully engaging with more advanced professional development opportunities. Teachers appear moderately comfortable with using digital tools to interact with colleagues and parents, but their level of engagement in online training platforms remains at a similar level, suggesting that they may not be maximizing the benefits of available digital resources (for example, online courses, MOOCs, webinars or virtual conferences). Increased focus on integrating advanced digital teacher training programs could help bridge the gap between intermediate and advanced proficiency in professional engagement. Furthermore, online platforms and digital resources can provide continuous professional development opportunities that foster skills and reduce feelings of inadequacy contributing to teachers mental health and well-being (Gutvajn & Ljubojević, 2024). Overall, this area is also identified as one of the two key areas where foreign language teachers at higher education institutions in Serbia demonstrate the greatest strength.Digital Resources

In terms of digital resource use, the study shows that teachers are generally at a B2 level for search strategies and at B1 for creating and modifying digital content to suit their own needs. However, their ability to protect sensitive data lags behind, with an average proficiency at the A2 level. A This gap in digital safety is concerning, particularly given the growing importance of data protection in education. Inadequate proficiency in this area could expose both teachers and students to risks related to privacy and cybersecurity. These findings suggest a need for targeted professional development focused on data protection, aligning with recent policy recommendations such as the EU's General Data Protection Regulation (GDPR), which emphasizes the importance of data safety in educational settings Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, 2016. This area is also identified as one of the two key areas where foreign language teachers at higher education institutions in Serbia demonstrate the greatest strength.

Digital Teaching and Learning

The respondents demonstrated B1-level proficiency across most areas of digital teaching and learning, including value creation, monitoring student interactions, and the use of digital tools in group work. Nevertheless, the A2-level proficiency in documenting and planning student learning processes indicates that teachers may struggle to incorporate digital tools into more structured, reflective student practices (for example, self-assessments, digital portfolios for documentation and presentation, online journals/blogs for reflections, etc.). Effective documentation and planning are critical in personalized learning environments, especially when using technology to track and monitor individual student progress. Teachers often neglect using digital tools for reflective practices, opting instead for more traditional methods. Professional development and teachers training should focus on integrating digital documentation tools into routine teaching to enhance personalized and adaptive learning (Taylor et al., 2021).

Assessment and Feedback

Teachers showed a B1 level of proficiency in analyzing student data and providing digital feedback, but only A2-level proficiency in tracking student progress. This discrepancy suggests that while teachers can analyze data effectively, they may not be using digital tools to their full potential for ongoing student assessment. These results highlight an opportunity to improve teachers' use of formative assessment tools, such as learning management systems and analytics platforms, to provide continuous feedback. Research has shown that carefully designed e-assessment feedback can significantly improve student outcomes when used effectively (Kadijevich et al., 2022). Therefore, teacher training should prioritize the adoption of these tools to enhance both real-time feedback and long-term student monitoring.

Empowering Learners

In the area of student empowerment, teachers showed B1-level proficiency in addressing digital problems and facilitating active student participation, while their proficiency in offering personalized learning options was at the A2 level. This finding suggests that teachers are more confident in engaging students in digital activities than in customizing learning experiences to individual needs (for example, to set different digital tasks for students to address individual learning needs, šreferences and interests). Addressing this gap is essential for creating more inclusive, learner-centered environments, especially in foreign language teaching, where individual student needs can vary widely.

Facilitating Learners' Digital Competence

The results in this area indicate that teachers are at an intermediate level (B1) in helping students assess the reliability of information, but they demonstrate lower A2-level proficiency in fostering digital collaboration, content creation, safe behavior, and problem-solving. These findings suggest that while teachers can guide students in critical evaluation of online information, they may be less skilled in facilitating other key digital competencies that require not only using digital media to communicate and collaborate but also creating digital content and solving concrete problems creatively. As digital competence becomes increasingly essential for students in the 21st century, teacher training programs should incorporate comprehensive strategies for building these skills (Kadijevich et al., 2023). Another noticeable weakness is reflected in the responses regarding safe and responsible use of digital technology, amounting poorly to A2 level. This gap could impede students' ability to fully engage with digital tools in a safe and responsible manner, detecting and evaluating online malpractices and routes to report if they feel personally offended or attacked.

Self-Assessed vs. Actual Competence

Interestingly, teachers initially self-assessed their digital competence at the upper-intermediate level (B2). However, after completing the questionnaire, their self-assessment mark dropped slightly to 3.79, but still remained at the B2 level. The actual competence, as reflected by their responses, was found to be at the A2/B1 level, indicating a significant gap between perceived and actual proficiency. Again, this is completely in line with the study by Rubio-Gragera et al. (2023) which reports that teachers tend *to overestimate their digital competence*. The results suggest that teachers may require more structured reflection and feedback on their digital skills to align their perceptions with reality, which could be achieved through more targeted, diagnostic assessments in teacher training programs.

Several limitations must be acknowledged. Firstly, the relatively small sample size (54 respondents) may limit the generalizability of the findings to the entire population of foreign language teachers in Serbian higher education. Secondly, since data were collected via an online questionnaire, response bias may be present, as participation was voluntary and those with higher digital competence may have been more inclined to respond. Furthermore, the study focuses solely on state universities, meaning the results may not fully reflect the experiences of teachers in private higher education institutions. Finally, self-reported data may introduce subjective biases, as respondents' perceptions of their digital competence might not always align with objective assessments. Although the dataset includes responses from multiple institutions, future research could expand the sample to include teachers from private universities and other educational sectors to provide a more comprehensive picture.Implications for practice and future research

The findings of this study have several implications for foreign language teaching and teacher development. Firstly, there is a clear need for targeted professional development to improve teachers' proficiency in critical areas such as data protection, digital documentation and planning, tracking of student progress, personalized learning, safe and responsible behaviour, student communication and collaboration and student creation of digital content. Teacher education programs should prioritize these areas to ensure that teachers can effectively use digital tools to enhance both teaching and learning. Additionally, future research should explore the reasons behind the gap between self-assessed and actual digital competence, and investigate strategies to better align teachers' perceptions with their true competence levels.

These recommendations are entirely consistent with those stated in a recent report on digital competences programmes in Serbia:

> Support the implementation of seminars and workshops aimed at enhancing the digital competencies of teaching staff at faculties of social sciences, humanities, and arts, in accordance with their research needs and their ability to integrate these competencies into their syllabi, especially in areas that are underrepresented, even among general population courses, such as datafication, artificial intelligence, and similar. [Matović, 2021, p. 49]

Finally, this study highlights the need for ongoing digital competence assessments to track teachers' progress over time and ensure that they continue to develop the skills needed to thrive in a rapidly changing educational landscape.

Conclusion

The findings of this study highlight the (pre-)intermediate level of digital competences among foreign language teachers at higher education institutions in Serbia, with significant areas for improvement. While teachers demonstrate proficiency in using digital channels for communication and collaboration, plus general engagement with digital resources, gaps persist in areas such as data protection, enabling students to plan, document and monitor their own learning process, personalized learning, and facilitating learners' digital competence. The areas which require more attention to be paid to are Empowering learners and Facilitating learners' digital competences. The results highlight a discrepancy between teachers' self-assessment of their digital skills and their actual proficiency, emphasizing the need for targeted, *reflective* professional development.

As digital technologies continue to transform education, especially in foreign language teaching, it is crucial that educators receive ongoing training to bridge these gaps. The study suggests that institutional policies should focus on offering structured opportunities for teachers to improve in critical areas such as cybersecurity, personalized learning, and student engagement through digital platforms. Future research should further explore the impact of these interventions on enhancing digital competence, ensuring that foreign language teachers are well-prepared to meet the demands of modern, digitally integrated classrooms.

In light of these findings, it is clear that building comprehensive digital competencies among educators is key to fostering innovative, effective, and secure learning environments. These insights contribute not only to the academic discussion but also to the broader goal of strengthening digital competence in higher education across Serbia.

Ethics Statement

The participants were informed that the survey would examine their level of digital competences, and that to support this examination, they were invited to fill in the questionnaire, with a note that the results of this anonymous survey would only be presented at group level. Before they started to give answers, they indicated (using an obligatory field) that they agreed to participate in the survey. The study has received ethical approval from the Ethics Committee of the Institute for Educational Research (No: 715; approval date: 12 December 2023).

Data Availability Statement

The dataset that supports the findings of this study is available on request from the corresponding author.

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Digitalna kompetenca učiteljev tujih jezikov na visokošolskih zavodih v Srbiji: raziskava, ki temelji na evropskem okviru DigCompEdu

V zadnjih letih je nastala obsežna literatura na temo digitalnega izobraževanja v visokošolskih ustanovah. Ta tematika je pridobila na pomenu zaradi pandemije covida-19, ki je učitelje postavila pred izziv hitrega prilagajanja novim zahtevam. Kljub številnim spremembam ostaja odprto vprašanje, kakšen vpliv je imela ta nenadna sprememba na razvoj digitalnih kompetenc učiteljev. Raziskava je bila zato usmerjena v ugotavljanje ravni digitalnih kompetenc učiteljev tujih jezikov, ki poučujejo na visokošolskih zavodih v Srbiji. Poleg tega je raziskava vključevala njihovo (samo)oceno prednosti in identifikacijo področij izboljšav. Za izvedbo raziskave je bil zasnovan vprašalnik, ki temelji na okvirih digitalnih kompetenc DigCompEdu in OpenEdu ter vključuje 25 vprašanj. Evropski okvir digitalnih kompetenc učiteljev (DigCompEdu) podrobno opisuje 22 kompetenc, razdeljenih v šest ključnih področij: strokovno udejstvovanje, digitalni viri, poučevanje in učenje, ocenjevanje, opolnomočenje učencev ter spodbujanje razvoja digitalnih kompetenc učencev. Rezultati raziskave kažejo, da je raven digitalnih kompetenc učiteljev tujih jezikov na ravni A2+/B1. Ugotovitve vključujejo konkretna in izvedljiva priporočila na nacionalni, institucionalni ter medinstitucionalni ravni za izboljšanje razvoja digitalnih kompetenc v visokem šolstvu.

Ključne besede: učitelji tujih jezikov, digitalne kompetence, DigCompEdu

Using Inquiry-Based Learning for Developing University Students' Digital Skills

Mojca Žefran
University of Primorska, Slovenia
mojca.zefran@pef.upr.si

Silva Bratož
University of Primorska, Slovenia
silva.bratoz@upr.si

In recent years, the development of digital skills has been encouraged at all levels of education. For this purpose, innovative pedagogies and approaches aimed at fostering learners' active participation, critical skills, and autonomy have been proposed. In this paper, we focus on the benefits of using the inquiry-based approach (IBL) for developing education students' digital skills. A design-based study was conducted with a group of students ($n = 38$) in the primary education study programme with a view to identifying students' attitudes towards IBL as well as their experiences and challenges encountered in the process. The design-based scenario followed the 5E inquiry-based instructional model (engagement, exploration, explanation, elaboration, and evaluation). Data for this study was gathered through an online survey, a focus group discussion, and through an in-depth analysis of the IBL scenario. The results indicate that students hold positive attitudes towards IBL. The most significant challenge identified was the application of critical thinking skills to locate and evaluate relevant research sources.

Keywords: digital skills, inquiry-based learning, pre-service primary school teachers, critical thinking

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Introduction

In the rapidly evolving society of the 21st century, skills such as cooperation, communication, ICT literacy, and social or cultural competencies are increasingly recognized as essential for success. These competencies, along with creativity, critical thinking, and problem-solving abilities, form the foundation of what are commonly referred to as '21st-century skills.' (Geisinger, 2016). As the world becomes more interconnected and reliant on technology, the importance of developing digital skills – particularly the ability to navigate and utilize digital tools effectively – has become critical. Digital literacy is thus no longer seen as optional but rather a fundamental skill set that supports both personal and professional development (Chu et al., 2017).

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In response to these educational demands, innovative pedagogical approaches have been explored to enhance digital literacy in a meaningful and sustainable way. Inquiry-based learning (IBL), which emphasizes student-driven exploration, active problem-solving, and hands-on engagement with learning materials, has long been recognized as an effective strategy in science education (Bybee et al., 2006). Recently, however, it has gained increasing attention across various disciplines, including digital literacy, due to its potential to cultivate deeper understanding and foster independent learning. By encouraging students to formulate questions, investigate problems, and seek solutions through exploration, IBL not only facilitates the acquisition of technical skills but also enhances cognitive abilities such as critical thinking, creativity, and the capacity to evaluate digital resources. Through this approach, students learn to engage with technology in a reflective and purposeful way, developing competencies that go beyond mere tool proficiency to include ethical considerations, digital communication strategies, and responsible information management.

Given the growing importance of digital literacy and the potential of IBL in fostering meaningful learning experiences, this paper explores the intersection of these educational priorities. Specifically, it examines students' perspectives on the effectiveness of an IBL approach in developing their digital skills. A design-based research framework was adopted to implement and evaluate a structured IBL scenario tailored to pre-service primary school teachers. By analyzing students' attitudes, experiences, and the challenges they encountered, this study aims to provide insights into the role of inquiry-based methods in fostering digital competencies and promoting deeper engagement with digital technologies in educational contexts.

Theoretical Framework

Inquiry-based learning is a pedagogical approach that emphasizes the active engagement of the learners in the learning process thus shifting the focus from traditional teacher-led instruction to a more student-centred model (Pedaste et al., 2015). According to Keselman (2003), IBL encourages students to gather knowledge by following all the stages of scientific research, such as formulating research questions or hypotheses, conducting research and deriving conclusions based on their findings. A significant contribution to understanding IBL was made by Dewey through his advocacy for experiential learning, reflective thinking, and student-centred education (Dimova & Kamarska, 2015). His ideas laid the foundation for IBL by emphasizing active engagement, problem-solving, and learning through experience.

In an IBL task, learners play the role of active researchers, they solve problems, try to find answers to research questions, etc., while the teacher 's role is that of facilitator (Ivanuš Grmek et al., 2009). Another important feature of the IBL approach is that the focus is on the research process itself and not, or to a lesser extent, on the final result or product. In the process, learners also develop different social skills as they all strive towards a common goal. In this way, IBL contributes to knowledge that is more functional or applicable (Rems Arzenšek, 2006) and develops academic thinking skills (e.g. predicting, observing, comparing, analysing, inferring, etc.), intellectual abilities, resourcefulness, critical thinking, problem-solving skills, etc. (Petek, 2012).

IBL is grounded in several educational theories and principles that emphasize active, student-centred learning. The primary theoretical foundation of IBL is the constructivist theory which posits that learners actively construct their own understanding and knowledge of the world through experiences and reflection (Hyslop-Margison & Strobel, 2007). Rather than passively receiving information, students in IBL environments engage with content by exploring, questioning, and problem-solving, thus constructing their own understanding based on previous knowledge and new discoveries. While IBL promotes independence in learning, it often relies on scaffolding, i.e. support or guidance to students as they engage in inquiry, gradually removing that support as they gain confidence and skills. According to Aparicio-Ting et al. (2019, p. 1): 'Effective IBL curricula must provide students with the foundational knowledge, resources and skills required, and, as needed, at each point during the inquiry cycle.' The constructivist learning theory acted as a source for the development of several student-centred approaches which were commonly described as opposed to traditional instruction methods based on the teacher transferring knowledge to passive students (Baeten et al., 2010). Another theoretical framework which is closely linked to IBL is experiential learning (Dewey, 2007; Seaman et al., 2017) according to which students learn best by doing and reflecting on their experiences. In IBL, students actively participate in the learning process by engaging in investigations, experiments, or projects that mimic real-world scenarios.

We can speak of several inquiry-based approaches, which actively engage learners in the process of exploration, questioning, and problem-solving. Project-based learning (Thomas & Mergendoller, 2000; Thomas et al., 1999) involves students working on extended projects aimed at creating presentations or products, which promotes collaboration and critical thinking. Problem-based learning (Barrows, 1996) focuses on solving complex, authentic problems without prior preparation, thus fostering deep understanding, critical thinking and problem-solving skills. Design-based learning (Hmelo et al., 2000) integrates design and engineering practices to design and create prototypes, which encourages creativity and practical application of knowledge in real-world contexts. Challenge-based learning (Johnson & Adams, 2011) centres around addressing real-life challenges, promoting interdisciplinary learning and practical application. These approaches share a common foundation in inquiry, supporting active learning and the development of critical thinking skills.

IBL has been articulated through various models, each proposing distinct but overlapping phases in the learning process. Pedaste et al. (2015) outline a five-phase model, comprising orientation, conceptualization, investigation, conclusion, and discussion, which emphasizes the cyclical and iterative nature of inquiry. Banerjee (2010) identifies a sequence beginning with investigating scientifically oriented questions, followed by prioritizing evidence, formulating explanations, connecting them to scientific knowledge, and finally communicating and justifying the results. Bell et al. (2010) propose a more detailed process, including phases like orientation, hypothesis generation, planning, investigation, analysis, model, conclusion, communication, and prediction which emphasize both the investigative and communicative aspects of learning. Bevevino et al. (1999) take a more simplified approach with exploration, presentation of new content, and application. Similarly, other models (Conole et al., 2010; Çorlu & Çorlu, 2012; Etkina et al., 2010; Steinke & Fitch, 2011) also emphasize cyclical inquiry processes, involving phases such as questioning, investigating, collecting evidence, developing explanations, and engaging in reflective or argumentative practices to deepen understanding and foster critical thinking.

Another framework designed to promote active, inquiry-based learning and deepen students' understanding through a structured process of exploration and reflection is the 'BSCS 5E Instructional Model'. The model, developed by the Biological Sciences Curriculum Study is widely used in science education but is also applicable to various other disciplines.[1] The essence of the 5E model lies in its five phases, which are intended to guide students through the process of learning by engaging them with concepts, exploring them through investigation, and developing deeper understanding through application and reflection. Each phase builds on the previous one, helping to scaffold learning effectively. The five phases of the BSCS 5E Instructional

[1] https://bscs.org/reports/the-bscs-5e-instructional-model-origins-and-effectiveness/.

Model are Engagement, Exploration, Explanation, Elaboration, and Evaluation (Bybee et al., 2006).

The main purpose of the *engagement* phase is to capture students' interest and stimulate their curiosity. The teacher introduces a topic, often through a thought-provoking question, demonstration, or scenario that connects to students' prior knowledge. This phase aims to elicit students' preconceptions and encourage them to ask questions or express predictions about the concept they will explore. In the *exploration* phase, students actively investigate the concept or problem through hands-on activities or experimentation. This is where inquiry-based learning occurs, as students experiment, collect data, and build a foundation of understanding based on their observations. The teacher acts as a facilitator, guiding students as they explore but allowing them to investigate freely and make discoveries on their own. The *explanation* stage involves direct instruction and reflection, where students articulate their findings and teachers introduce formal concepts and terminology. This phase allows students to clarify their understanding by connecting their exploratory experiences to scientific principles or subject-specific content. Students may present their results, discuss their findings, and begin to understand how the concepts fit into a broader framework of knowledge. During the *elaboration* stage, students extend and deepen their understanding by applying their newly learned concepts to new situations or more complex problems. This helps solidify their knowledge and reinforces the relevance of the material. Teachers may present additional scenarios, problems, or challenges that require students to apply their learning in different or more advanced contexts. The last stage, *evaluation*, focuses on assessing students' understanding and learning progress. Both teachers and students engage in reflection on what has been learnt, and teachers use assessments – formal or informal – to gauge comprehension. Students may also self-assess their learning or demonstrate their understanding through projects, presentations, or discussions (Bybee et al., 2006).

The 5E model allows students to construct their understanding by making connections between their prior knowledge and new experiences. By guiding learners through a systematic process of inquiry, the 5E model not only helps build deep, conceptual understanding but also fosters critical thinking, problem-solving, and the ability to apply knowledge in various contexts.

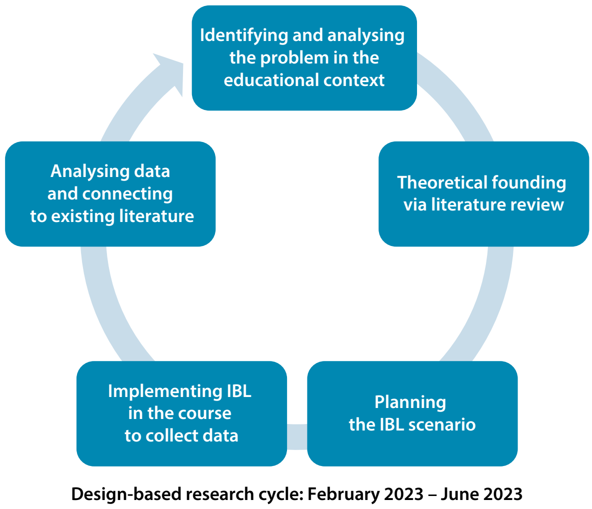


Figure 1 Overview of Activities in the Design–Based Research Cycle

Methodology

This study was guided by the following research questions:

1. How effective is the IBL approach in developing students' digital skills?
2. What are students' attitudes towards and perceptions of IBL?
3. What challenges do students perceive in developing digital skills through IBL?

Research Design

To investigate the effectiveness of using the IBL approach for developing pre-service teachers' digital skills we employed a design-based research (DBR) approach. As outlined by Wang and Hannafin (2005), DBR is a flexible, iterative methodology that aims to improve educational practices through ongoing cycles of analysis, design, implementation, and refinement in real-world settings, with collaboration between researchers and practitioners. The present study represents one DBR cycle conducted over one semester (Figure 1) focused on the implementation and evaluation of an IBL scenario aimed at enhancing students' digital competencies.

IBL Scenario and Data Collection

The IBL scenario was designed on the basis of the 5E instructional model (Bybee et al., 2006). The scenario served as a framework for developing students' digital skills through a series of structured, inquiry-driven activities. Data col-

Table 1 Steps in the Scenario

Step	Description
Step 1 (Engagement)	Group work and research question formulation: classroom discussion in which students were encouraged to reflect on their digital competences and ways of improving their learning experiences using digital technology. Students worked in groups to formulate a research question which would address an improvement in their studies by employing digital technology.
Step 2 (Exploration)	Exploration of relevant resources: students engaged in exploring the available resources (digital tools and apps) and examined their relevance for their research focus. The teacher played the role of facilitator, answering their questions and guiding them through the data collection process.
Step 3 (Explanation)	Reflection and presentation of observations: the instructor led the students through the process of finding and reviewing relevant literature and sources aimed at evaluating the suitability of the selected digital tools. Students presented their findings and observations to the instructor and other groups.
Step 4 (Elaboration)	Peer–to–peer workshop design: students were given the task to use the evidence and information collected through their research to design and carry out workshops for their peers and thus apply their learning in a different context.
Step 5 (Evaluation)	Workshop evaluation: students first engaged in self– and peer–assessment based on jointly designed evaluation criteria. This was followed by a final evaluation discussion with their instructor.

lection took place at the conclusion of the scenario through an online questionnaire and a focus group discussion, complemented by an in-depth analysis of the scenario implementation.

The IBL scenario was implemented in the study course English for Education Studies at the Faculty of Education, University of Primorska. Its primary aim was to enhance students' digital skills in educational contexts, encouraging them to design and lead peer workshops on the use of various digital tools and applications. The scenario followed five distinct steps, corresponding to the phases of the 5E instructional model (Table 1):

Upon completing the scenario, students participated in an online questionnaire and a focus group discussion, where they shared their experiences, attitudes, and perceived challenges related to the IBL approach.

Context and Participants

The study is related to the project *Green, Digital and Inclusive University of Primorska* whose main objective is to enhance university teachers' and students' digital skills. The needs analysis conducted within the project revealed an increased need to develop both teachers' and students' digital skills. This led to a search for new and innovative approaches which would not only actively engage students in developing their digital skills but also give them the opportunity to reflect upon and critically appraise the use of different digital sources.

The participxants in the study were first-year students enrolled in the Primary Education study program ($N = 38$). After the course, the students voluntarily completed an online questionnaire, and 10 participated in a focus group discussion (June 2023), providing qualitative insights into their experiences with IBL and the challenges they faced.

Data Analysis

The analysis was conducted in two stages. First, we systematically evaluated the IBL scenario using the 5E ILPv2 scoring instrument (Goldston et al., 2013), which assesses each phase of the IBL process across 21 items (4 items for Engagement, 4 items for Exploration, 6 items for Explanation, 3 items for Elaboration and 4 items for Evaluation). The scoring system ranged from 0 to 4 points (0 = 'unacceptable', 1 = 'poor', 2 = 'average', 3 = 'good', and 4 = 'excellent'). This allowed us to identify strengths and areas for improvement across the phases of the IBL scenario.

Second, data from the online questionnaire and the focus group discussion were analysed to explore students' attitudes toward IBL, their experiences with digital skill development, and the challenges they encountered. This qualitative data provided deeper insights into the students' perceptions and highlighted areas for refining the IBL approach to better meet their needs. The results of the study are presented in the following section.

Results

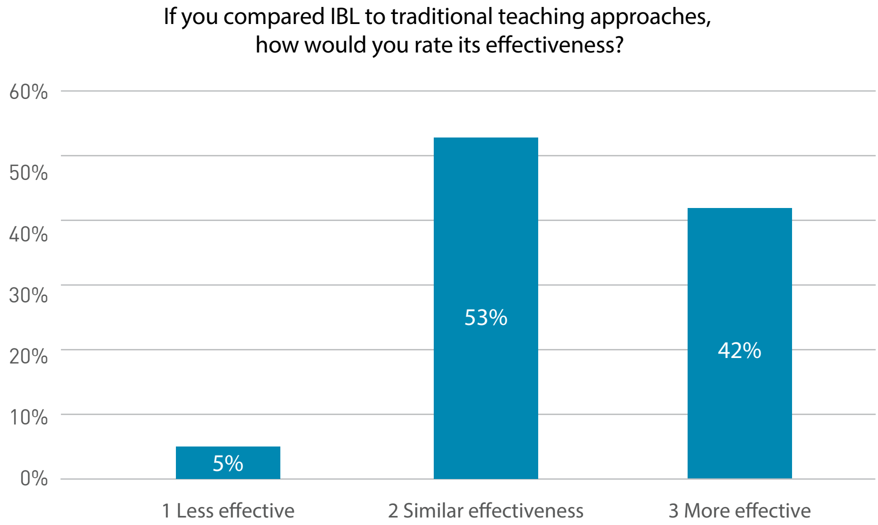
To address the first research question aimed at analysing the effectiveness of the IBL scenario, we conducted a detailed analysis utilizing the 5E ILPv2 scoring instrument. The findings are summarized in Table 2, which outlines the scores for each phase, highlighting the overall effectiveness of the IBL scenario in enhancing student learning outcomes.

As we can see from Table 4, the IBL scenario demonstrated strong effectiveness across most phases, with high scores in several areas. The *engagement* phase was particularly successful, with the teacher effectively eliciting students' prior knowledge, fostering motivation, and leading engaging discussions. During the *exploration* phase, students were provided with clear instructions and engaging hands-on activities. However, the need for greater emphasis on formative assessment during this phase was identified as an area for improvement. The *explanation* phase showed notable weaknesses. It

Table 2 Evaluation of the IBL Scenario According to the 5E Scoring Instrument

5E ILPv2	Item description	Scoring (0–4)
Engage item 1	The engage phase elicits students' prior knowledge (based upon the objectives).	4
Engage item 2	The engage phase raises student interest/motivation to learn.	4
Engage item 3	The engage phase provides opportunities for student discussion/ questions (or invites student questions).	4
Engage item 4	The engage phase leads to the exploration phase.	3
Explore item 1	During the exploration phase, teacher presents instructions.	4
Explore item 2	Learning activities in the exploration phase involve hands–on/minds–on activities.	4
Explore item 3	Learning activities in the exploration phase are student–centred.	4
Explore item 4	The inquiry activities of the exploration phase show evidence of student learning (formative authentic assessment).	2
Explain item 1	There is a logical transition from the exploration phase to the explanation phase.	3
Explain item 2	The explanation phase includes teacher questions that lead to the development of concepts and skills.	3
Explain item 3	The explanation phase includes mixed divergent and convergent questions for interactive discussion facilitated by teacher and/or students to develop concepts or skills.	2
Explain item 4	The explanation phase includes a complete explanation of the concept(s) and/or skill(s) taught.	1
Explain item 5	The explanation phase provides a variety of approaches to explain and illustrate concept or skill.	2
Explain item 6	The discussion or activity during the explanation phase allows the teacher to assess students' present understanding of concept(s) or skill(s).	3
Elaborate item 1	There is a logical transition from the explanation phase to the elaboration phase.	3
Elaborate item 2	The elaboration activities provide students with the opportunity to apply the newly acquired concepts and skills into new areas.	2
Elaborate item 3	The elaboration activities encourage students to find real–life connections with the newly acquired concepts or skills.	4
Evaluate item 1	The lesson includes summative evaluation, which can consist of a variety of forms and approaches.	3
Evaluate item 2	The evaluation matches the objectives.	4
Evaluate item 3	The evaluation criteria are clear and appropriate.	4
Evaluate item 4	The evaluation criteria are measurable (i.e. using rubrics).	4

became clear that students required more comprehensive guidance on the process of reviewing scientific literature, along with more opportunities to practice critically reading and interpreting academic texts, as well as extracting essential information. The results of the scoring for the *elaboration* and

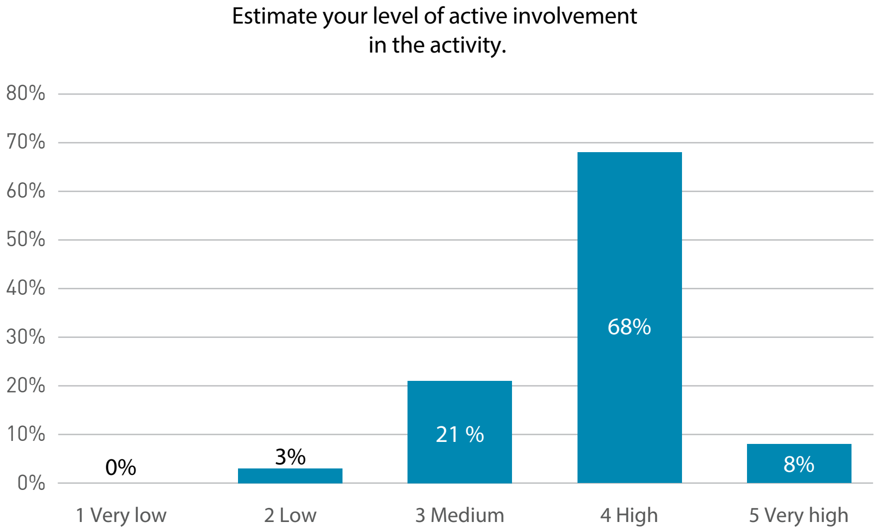


Graph 1 Effectiveness of IBL Compared to Traditional Teaching Approaches as Perceived by the Students

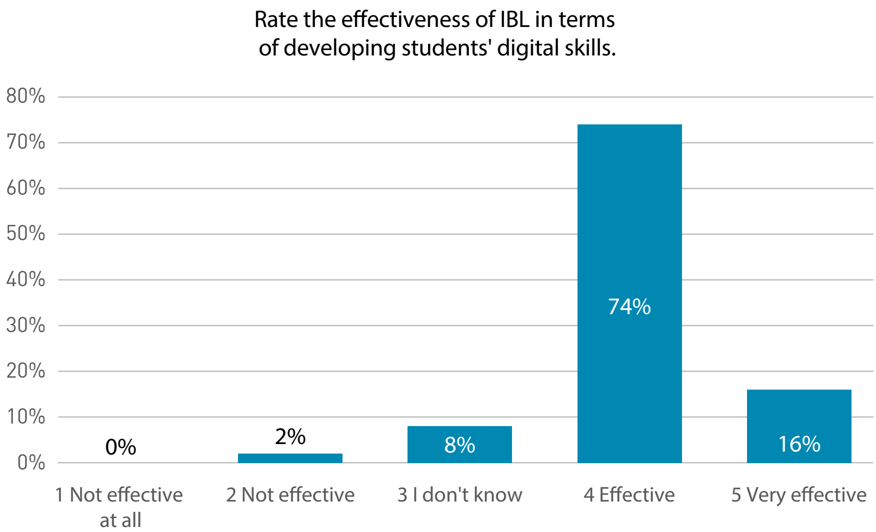
evaluation suggest that both phases were perceived as efficient. The *elaboration* phase allowed students to apply their newly acquired skills in practical contexts and make real-life connections, while the *evaluation* phase aligned well with the objectives, using clear, appropriate, and measurable criteria to assess students' performance.

With respect to the second research question aimed at identifying students' attitudes towards IBL, the data gained through the survey revealed that students generally hold positive attitudes toward IBL and independent research. When comparing IBL to traditional learning methods such as lectures, 53% rated the two methods similarly (see Graph 1). At the same time, 42% of respondents found IBL more effective, and only 5% considered IBL less effective.

In the survey and the focus group discussion, students noted several advantages of IBL. They reported that active involvement in their own research helped them retain more information, engage more deeply with the material, and take responsibility for their learning. They also indicated increased motivation while participating in the IBL scenario. Additionally, they appreciated the opportunity to collaborate and learn from their peers. However, they acknowledged that IBL was more time-consuming and demanding, requiring more effort compared to traditional methods. This was reflected



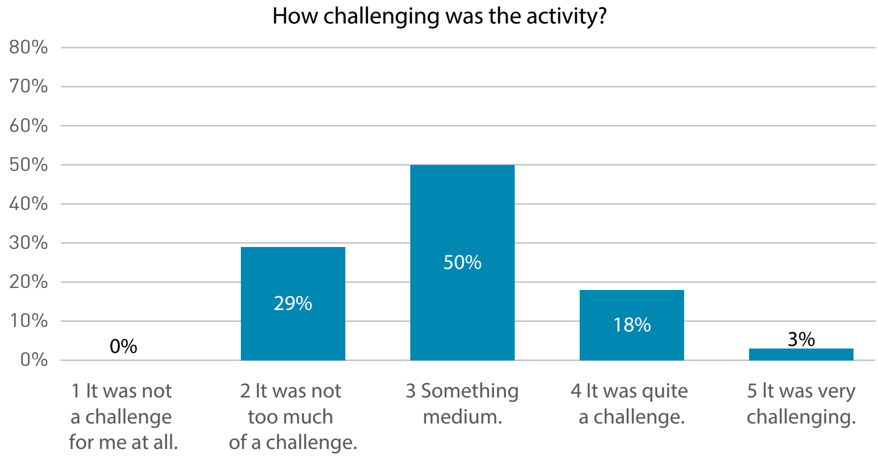
Graph 2 Students' Self–Reported Involvement Levels in the IBL Activities



Graph 3 Students' Perceptions of the Effectiveness of IBL in Enhancing their Digital Skills

in their self-reported involvement levels, where 68% of students rated their involvement in the activity as high and 8% as very high (see Graph 2).

As we can see from Graph 3, 74% of respondents felt that IBL was effective and 16% very effective in enhancing their digital competencies.



Graph 4 Students' Perceptions of the Difficulty of the IBL Activities

Students reported improvements in using online resources like Google Scholar, learning new apps, and using technology for presentations and collaborative work. A minority of students felt they had not developed significant digital skills, as they were already proficient in this area; however, they noted improvements in critical thinking and collaboration skills. Finally, 68% of students agreed that the IBL experience made the use of digital tools and applications easier, while 21% were undecided and the remaining students felt their pre-existing digital competence was already advanced.

The third research question was aimed at identifying the challenges of the participants in implementing the IBL approach. As we can see from Graph 4, the IBL scenario posed varying levels of difficulty for the students: 29% found it not too challenging, 50% perceived it as moderately challenging, 18% found it quite challenging, and 3% considered it very challenging.

The most significant challenge reported was the application of critical thinking skills to locate and evaluate relevant academic literature. Both the questionnaire and focus group discussions highlighted that students struggled with identifying appropriate sources, understanding the literature, and extracting key information. Other challenges included coordinating group work and structuring their workshops effectively.

Discussion

The results from this study suggest that the IBL scenario effectively engages students in active, self-directed learning, particularly in the phases of engagement, exploration, elaboration, and evaluation. Students demonstrated a strong appreciation for the active learning components of IBL, citing deeper engagement, increased retention, and greater responsibility for their learning outcomes. This finding is in line with previous studies that demonstrated the effectiveness of inquiry-based learning with undergraduate students in different subject areas (Apedoe et al., 2006; Levy & Petrulis, 2012). At the same time, the results show that the *explanation* phase surfaced as a critical area for improvement, particularly in equipping students with the skills necessary for conducting scientific literature reviews and critically evaluating academic sources. Addressing this gap through more targeted instruction and practice could further strengthen the overall effectiveness of IBL.

The positive student attitudes toward IBL, combined with their feedback on the challenges they faced, provide valuable insights into the balance between active learning and the demands it places on students. Students reported greater motivation and satisfaction with their learning, which is consistent with the findings of earlier studies which concluded that IBL approaches promote student motivation (Bayram et al., 2013; Tuan et al., 2005). At the same time, the participants in our study also acknowledged the increased time and effort required. This points to the need for carefully structured scaffolding to support students through more demanding tasks, such as literature review and group coordination. In terms of skill development, IBL was largely seen as beneficial, particularly in enhancing digital competencies and fostering collaboration. However, for students already proficient in digital tools, the gains were more aligned with critical thinking and teamwork, suggesting that differentiation may be necessary to cater to varying skill levels. Overall, while challenges remain, especially regarding critical thinking and information literacy, the positive impact of IBL on student engagement, motivation, and skill development is evident.

The data from the study revealed also several challenges faced by the students during the activity, such as identifying appropriate sources and coordinating group work. This aligns with the findings of Levy and Petrulis (2012) which suggest that in IBL teaching settings students need extensive guidance and formative feedback.

Conclusion

A key aspect of 21st-century education is the emphasis on developing critical thinking. The ability to analyze, evaluate, and synthesize information is vital for individuals to effectively engage with the vast array of information available in the digital age. Beyond technical proficiency, digital literacy requires the ability to discern reliable sources, critically interpret information, and utilize digital tools effectively for problem-solving and collaboration. One pedagogical approach that has proven highly effective in fostering these essential skills is inquiry-based learning. Originally well-established in science education, inquiry-based learning is now gaining importance across various disciplines. By placing students in active learning roles, prompting them to explore problems, formulate questions, and actively engage in the process of discovery, this approach not only promotes deeper understanding but also cultivates problem-solving skills and intellectual autonomy, and adaptability - skills that are indispensable in the modern educational and professional landscape.

This study underscores the effectiveness of inquiry-based learning (IBL) as a pedagogical approach that significantly enhances student engagement, motivation, and skill development. The analysis of the IBL scenario revealed that while students thrived in most phases, there is a critical need for improvement in the explanation phase to better equip learners with the skills necessary for conducting scientific literature reviews and critically evaluating academic texts. Students expressed strong positive attitudes toward IBL, highlighting its advantages over traditional teaching methods. However, they also acknowledged the heightened demands that IBL placed on their time and effort, suggesting that structured scaffolding is essential for supporting students through these challenging tasks.

Although we remain cautious about drawing too-strong inferences about the direct impact of IBL on students' digital competences based on this study alone, the findings stronglyindicate that IBL contributes positively to the development of digital skills and collaboration, while fostering critical thinking abilities. Although many students initially perceived themselves as already proficient in digital literacy, they recognized the importance of IBL in enhancing their analytical and cooperative skills. Furthermore, the study highlights the importance of balancing student autonomy with structured guidance to maximize learning outcomes. Finally, the outcomes of this study suggest several avenues for further research. In the area of education, a particularly valuable research focus would be different ways in which IBL fosters collaborative competences through group projects, peer discussions, and the use of digital collaboration tools. Further research could explore how digital tools facilitate inquiry-based group tasks and how students negotiate roles, communicate, and share knowledge in virtual environments.

As educational institutions continue to integrate digital technologies into learning environments, it is crucial to adopt pedagogical approaches that do more than teach students how to use digital tools – they must also empower them to think critically, collaborate effectively, and navigate an increasingly complex digital world. This study reinforces the idea that IBL, when thoughtfully implemented, offers a promising pathway for achieving these objectives.

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Uporaba raziskovalnega učenja za razvoj digitalnih kompetenc univerzitetnih študentov

V zadnjih letih smo bili priča vse močnejšemu spodbujanju razvijanja digitalnih kompetenc na vseh ravneh izobraževanja, zaradi česar so bili razviti številni inovativni pedagoški pristopi, katerih glavni cilj je razvijanje digitalnih kompetenc s poudarkom na spodbujanju aktivne participacije in avtonomije učencev ter razvoju kritičnega mišljenja. V pričujočem prispevku se osredotočamo na prednosti uporabe raziskovalnega pristopa k učenju (angl. *inquiry-based learning* – IBL) za razvijanje digitalnih kompetenc študentov pedagoških smeri. V ta namen smo izvedli raziskavo načrtovanih novosti (angl. *design-based study*) s študenti študijskega programa Razredni pouk (N = 38). Glavni cilj je bil raziskati stališča študentov do raziskovalnega pristopa k učenju ter preučiti njihove izkušnje in izzive, s katerimi so se srečali v procesu izvajanja raziskave. Izvedba načrtovane novosti je temeljila na petstopenjskem modelu raziskovalnega učenja (vključevanje, raziskovanje, razlaga, poglabljanje in vrednotenje; angl. *engagement, exploration, explanation, elaboration, evaluation*). Podatki so bili zbrani s pomočjo spletne ankete, fokusne skupine in poglobljene analize izvedenega učnega scenarija po modelu raziskovalnega učenja. Rezultati kažejo, da študenti izkazujejo pozitivna stališča do raziskovalnega pristopa k učenju, največji izziv, ki so ga zaznali, pa je bila uporaba kritičnega mišljenja pri iskanju in vrednotenju ustreznih raziskovalnih virov.

Ključne besede: digitalne kompetence, raziskovalno učenje, raziskava načrtovanih novosti, študenti razrednega pouka, kritično mišljenje

University Faculty Digital Literacy and Technology Integration: The Case of University of Primorska, Slovenia

Stanko Pelc
University of Primorska, Slovenia
stanko.pelc@pef.upr.si

This chapter presents an overview of digital literacy among university teachers at the University of Primorska, Slovenia. It examines the theoretical foundations of digital literacy, highlighting its significance and multifaceted nature. Furthermore, it examines the needs expressed by university teachers at the University of Primorska regarding the enhancement of their digital literacy, and highlights exemplary practices employed by individual teachers in the past, showcasing the effective integration of digital technologies into their teaching methodologies. Finally, this chapter presents the findings of a research study exploring the digitalisation of the educational process from the perspective of students enrolled in a teacher training program. It provides valuable insights into students' perceptions of the digitalization of their learning experiences.

Keywords: pedagogical digital competences, digital technologies, teacher education, Moodle

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Introduction: Digital Literacy and Digital Competencies

The digital revolution has fundamentally reshaped our world, and education is no exception. To effectively guide students in this dynamic landscape, higher education teachers themselves need a strong foundation in digital literacy and competencies.

Digital literacy can be understood as a combination of knowledge, skills, and attitudes that empower individuals to navigate the digital world. It forms the foundation of a teacher's digital competence, allowing them to function effectively within a digital learning environment (Vaskov et al., 2021). UNESCO emphasizes this ability to access, manage, understand, and create information safely using technology (Law et al., 2018).

However, digital competence extends beyond these core skills. Starkey (2019, pp. 41–44) identifies three key components:

Klančar, A., Štemberger, T., Prosen, M., & Ličen, S. (Eds.). (2025). *International Perspectives on Effective Teaching and Learning in Digital Education*. University of Primorska Press.

1. Generic Digital Competence: This focuses on fundamental computer skills like using the internet, creating presentations, or managing files. While these might seem basic in the digital age, research suggests some teacher education programs may need to address them if students lack these foundational abilities.
2. Digital Teaching Competence: This involves the strategic integration of technology into lessons. This can include incorporating digital tools like blogs, podcasts, or assessments to enhance or replace traditional practices. Crucially, teachers must also critically select the right technology for specific learning objectives and guide students in effectively using it.
3. Professional Digital Competence: This broader perspective explores how technology can be used to optimize all aspects of a teacher's job beyond just teaching. It encompasses technical skills, the ability to integrate technology with teaching methods, and the social awareness to navigate the ever-evolving educational landscape.

The distinction between digital literacy and competence can be blurry. Some researchers consider them synonymous, using definitions that highlight the ability to perform tasks, solve problems, and create knowledge effectively using technology (Joint Research Centre et al., 2012, as cited in Saltos-Rivas et al., 2023). This aligns with the European Union's DigCompEdu framework, which outlines six key areas of competence specifically for educators (Redecker & Punie, 2017). These encompass professional engagement, utilization of digital resources, assessment practices, teaching and learning strategies, empowering learners, and fostering their digital competence development.

By fostering both digital literacy and competence, we equip higher education teachers with the necessary tools to create engaging and effective learning environments. This empowers them to prepare students for academic success and thrive in a world increasingly driven by technology.

Studies About Faculty Digital Literacy

There are numerous articles in scientific literature about faculty digital literacy and digital competencies. The results of a comprehensive literature analysis on the digital competencies of higher education teachers (Saltos-Rivas et al., 2023) showed that many of the quantitative studies did not offer reliable and proven findings on the situation in this area. Thus, they highlight the finding that basic digital competences are a good indicator of competence in using digital technology for the needs of pedagogical work. They also warn of the danger of dividing teachers into those who are digitally competent and those who are less digitally competent and suggest that basic training in the use of digital technology should be provided in teacher training. Some teachers may have a negative attitude towards this, while for others it is inevitable in their work.

According to a recent study (Čotar Konrad & Štemberger, 2023), Slovenian teachers who teach future teachers are in favour of using digital technologies in their pedagogical work. They are particularly supportive of learner-centred teaching, which is supported using digital technology. They also have no concerns about the use of digital technology for individual and group work, but they are opposed to the use of digital technology for testing knowledge. In addition, the surveyed teachers gave a relatively low average rating to their skills in using digital tools and resources. Teachers are familiar with several digital tools and are not against using them. What might be holding them back from incorporating them into their teaching remains to be explored.

In parts of the world where technological equipment of educational institutions is low, attitudes towards the use of technology in the pedagogical process are, of course, also different. The kinds of attitude university teachers have towards the use of digital technology or ICT in teaching was also wondered about in Ethiopia a decade ago (Gebremedhin & Fenta, 2015). In conditions quite different from the University of Primorska, the attitudes were similar. However, it should be noted that at Adwa College of Education, where the research was conducted at that time, all departments were not yet connected to the Internet, and the technical equipment was very modest. Almost a fifth of the 72 teachers surveyed did not have the opportunity/ability to use the Google Chrome browser. However, or perhaps precisely because of this, the attitude towards the use of ICT in the pedagogical process was positive. On a five-point Likert scale, the values of the attitude towards individual factors of ICT use in teaching and learning ranged from 4.28 to 4.79.

A recent Russian study (Vaskov et al., 2021, pp. 4–5) reveals that according to the digital literacy index (based on information, computer, communication, and media literacy, as well as attitudes towards innovation), digital literacy of university teachers is relatively high (index 88 out of 100), but attitudes towards innovation are different from that of young people, who are more open to embracing new ideas than university teachers. The authors also cite data from a survey in which one-third of the surveyed university teachers believed that 40% of their colleagues do not use digital technology or use it very rarely. However, 85% of the respondents actively used the Internet, two-thirds were interested in new applications, and around 60% actively used social networks. The authors conclude that university teachers need to be trained for a more effective use of digital technology in the pedagogical process. To address this need, a special professional development program has already been developed by one university. This program can be implemented to provide the necessary training.

Systematic improvement of digital literacy of university teachers is undoubtedly a necessity, especially considering the arguments presented in the literature (Saltos-Rivas et al., 2023, p. 16772), ranging from the notion that digitally literate teachers can better support the development of digital competencies in their students, to the assertion that effective ICT-based learning is impossible without adequately digitally-literate teachers.

After a systematic mapping study of the literature published until 2021 in journals indexed by Scopus and Web of Science (WOS) (53 primary studies), Saltos-Rivas et al. (2023, pp. 16797–16799) concluded:

- There is a growing number of contributions aimed at understanding the acquisition of digital skills, especially from external factors.
- European, and more specifically Spanish, university professors from multiple disciplines are the most studied population.
- Most studies adopted quantitative approaches to explain, but not prove causality.
- There is a great heterogeneity of relationships and results that explain the digital competencies of university professors.

The authors emphasize that digital competence is an imperative for university teachers today, and therefore it is important to understand the factors that contribute to the acquisition of these competencies. The reviewed literature consisted predominantly of quantitative studies, which have not provided definitive answers to the question of which factors are decisive for the acquisition of digital competence by university teachers. The authors also point out that the issue should be approached in the future with in-depth studies focusing on several factors. They highlight that the digital competence of university teachers can be explained based on their general digital competence and their personality characteristics.

The Needs of University of Primorska's Teachers in the Field of Development of (Pedagogical) Digital Competences

The University of Primorska is one out of three public universities in Slovenia, with about 500 researchers and university teachers at 6 different faculties, as well as one research institute.

Within one of the university's projects – Green, Digital & Inclusive – qualitative research (Klančar et al., 2023) about university faculty's needs in the field of development of (pedagogical) digital competencies was conducted. Data was collected through departmental discussions and individual annual performance interviews (with the dean or the head of the department).

The departmental discussions showed that faculty and associates have a positive attitude towards the use of digital technologies (DT) in education. They recognize the importance of training for the appropriate use of DT in the pedagogical process and research and they also emphasize the importance of a critical approach to the use of digital technology in education. The use of digital technology in the pedagogical process varies depending on the member institution and department, the field of study, the available infrastructure, and the competence of the instructors.

Participants also identified the risks associated with the use of digital technology as the weakest of the four areas (teaching and learning using digital technologies; use and creation of digital content; communication and collaboration using digital technologies; risks associated with the use of digital technologies), followed by the area of use and creation of digital content.

In addition to identifying weak areas, participants also provided suggestions for training, which have been divided into four categories:

1. Online safety and intellectual property protection
2. Digital technologies for didactic support of learning and teaching
3. Digital technologies for supporting organizational processes and communication
4. Digital technologies for supporting research work

We received reports from 5 faculties where 131 annual performance interviews were held altogether.

The analysis of the reports confirms the departmental discussions' findings regarding weak areas. Regarding the use and creation of digital content, the weakest sub-area is 'programming,' where most users (83.7%) showed a low level (up to 40%) of competence development. In the field of risks associated with the use of digital technologies, three weak sub-areas were detected. Device protection, digital identity management, and online behaviour (where 50%, 38%, and 31% of users achieve a low level of digital competence). Communication and collaboration using digital technologies further exhibited two weak sub-areas. Almost half (49%) of the participants expressed a low level of digital competence development in online collaboration, and 39%

achieved a low level in communication using ICT and digital communication channels. Over half of the users (52.9%) achieved a low level of digital competence development. The weakest sub-area in the domain of teaching and learning using digital technologies is ICT-Supported Knowledge Assessment (52.9% respondents achieved a low level of digital competence development).

The findings highlight the need for targeted training and support in these specific sub-areas to enhance the digital competencies of faculty and associates. By addressing these weaknesses, institutions can empower their educators to effectively utilize digital technologies for teaching, learning, research, and communication.

Examples of the Use of Digital Technology in Pedagogical Process at the University of Primorska

Since 2018, the University of the Primorska hosts an annual conference dedicated to the exchange of ideas between its faculty and the presentation of good practices in the use of digital technology in the pedagogical process. The conference, called 'Lastovke,'[1] continues even after the completion of the project 'Innovative with Technology to Knowledge' (InoTeZ), under which it was designed. The mentioned project also played a very important role during the pandemic, as the project team members were equipped with the necessary knowledge and experience to quickly apply to the needs of transition to online lecturing with the support of appropriate digital technologies.

From the mid-2000s onwards, the University of Primorska has been using the Moodle learning management system. However, prior to the pandemic, its utilization was significantly below its potential, with only a handful of university teachers using it at a higher level of complexity. One of the primary goals of the aforementioned project was to change this, and unsurprisingly, the first conference focused heavily on Moodle, particularly on knowledge assessment using quizzes. In addition, some other tools that teachers can find useful in the pedagogical process were presented (e.g., Kahoot, Basecamp, Flipboard, Turnitin, WhatsApp, Web Quest, Notion, Obsidian, Jamovi, JASP, Mentimeter).

In pre-Covid years, university faculty from various departments presented numerous examples of the use of digital technology in teaching, such as how it can be used to support the thesis preparation process, facilitate

[1] Swallows: the birds bringing the spring (bringing something new, fresh; annnouncing the change).

cloud-based collaboration, and create media-supported textbooks, among others. One of the more frequently discussed topics was content creation using various tools, such as H5P for interactive content, audio and video editing tools for media content, and, more recently, the use of AI as a support for content creation. During the Covid years, a lot of attention was dedicated to online knowledge assessment (oral, quizzes) and addressing how to organize the learning of topics that require a student's physical presence (music, sport).

Presentations at the annual conferences on the use of digital technology in education have highlighted a wide range of innovative approaches being adopted by faculty members. These examples demonstrate the potential of digital tools to enhance teaching, learning, and research across various disciplines. Teachers are incorporating simulations and gamification techniques to engage students and make learning more interactive. The Faculty of Tourism has established a dedicated classroom, sTOUdio Turistica, equipped with advanced technology to facilitate collaboration between students and the tourism industry. At the Faculty of Education, students have experimented with creating stop-motion videos as a teaching aid. 3D modelling is being explored as a tool for creating engaging and interactive learning materials. Generative artificial intelligence is being used to develop innovative teaching materials. Interactive whiteboards are gaining popularity as a versatile tool for enhancing classroom instruction.

Overall, the presentations at the annual conferences demonstrate the creativity and enthusiasm of faculty members in embracing digital technology to transform teaching and learning. However, we must acknowledge that the presenters at these conferences are the most advanced digital technology users and do not represent the average.

Student's Opinion: The Case of a Teacher Training Study Program

Several myths have emerged regarding digital technology in education, and one of them is the notion that young people who have grown up with modern technologies are inherently digital natives and therefore more digitally skilled than older generations who grew up without the internet, smartphones, and social media. However, as the authors of a study aimed at debunking myths associated with the role of digital technology in education point out, this is not the case (Suárez-Guerrero et al., 2023, p. 611): 'Simple exposure to technology does not generate skill'. Therefore, we must be aware that 'the student body, apart from being born in the digital age, does not have this competence baggage automatically since it is necessary to develop it'.

Recognizing that only digitally competent university teachers can effectively equip students with digital skills, we sought to understand the perceptions of 'digitalisation' in their studies among students enrolled in the teacher training program.

At the beginning of the spring semester 2023/24, 46 out of 58 students enrolled in the study program Primary School Teaching were answering eight closed questions, and the key findings that we can make based on their answers are as follows:

- Perceived Digitalisation: Two-thirds of the respondentsbelieve their studies are more digitally supported than their high school education.
- Varying Digitalisation: Students perceive significant differences in digital technology use among instructors.
- Digital Competence of Teaching Assistants: Students are divided on whether younger teaching assistants use digital tools more frequently than older professors.
- Moodle Use: Most study materials are distributed through the Moodle learning management system.
- Digital Assessments: Quiz-based assessments are less common.
- MS PowerPoint Use: MS PowerPoint is widely used for presentations across most subjects.
- Social media and Study: YouTube is the most popular social media platform for study purposes. Facebook Messenger and Instagram are also used for communication and information sharing among students.

The presented short study provides insights into student perceptions of digitalisation in teacher training and indicates that the university should continue to support faculty and staff in effectively integrating digital technologies into teaching and learning.

A follow-up study was conducted on February 19–20, 2024, to gather the opinions of third-year students in the same program. This study used five open-ended questions posted in a Moodle forum. Out of the 58 actively participating students in the relevant course, slightly less than half (23) only provided their responses, all the others also commented on the responses of two of their classmates. The average student response length was 203 words (295 words for the initial response and 126 words for each comment).

The first question addressed the use of modern digital technologies in teaching: Only two student responses did not mention the leading role of MS PowerPoint. However, some students interpreted its use as modern digital technology, while others questioned its categorization due to its widespread adoption. Consequently, student responses regarding the extent of digital technology use varied. Some students took a broader approach, considering any use of MS PowerPoint as sufficient for modern digital technologies. Others, with a more critical perspective, believed their instructors primarily relied on MS PowerPoint with little to no use of other modern digital tools. This sentiment was expressed in many ways by 32 students. Only four students felt that using MS PowerPoint and uploading PPTs and other documents to the e-learning platform was a completely satisfactory approach to modern digital technology use.

Students in the study heavily favoured Microsoft Office for studying. They used Word for notetaking (mentioned 34 times) and PowerPoint for presentations (45 times), both in class and for creating seminar assignments. PowerPoint was also valued for taking lecture notes. For group projects, some students mentioned using Office 365 for collaborative work.

Less frequently mentioned were the digital tools such as Kahoot (5 mentions), Padlet (2 mentions), Wordwall (2 mentions), and Quizizz (1 mention), which were introduced in a first year 'Educational Technology' course.

Canva emerged as a popular alternative to PowerPoint (10 mentions), offering superior design capabilities for creating engaging learning materials. Prezi was mentioned for its ability to create dynamic presentations (1 mention). Some students also used Pinterest and Google Scholar to find ideas (both mentioned twice), while others mentioned Google Drive, Goodnotes, online calendars, and quizzes (all mentioned two times each). A variety of other programs, websites, and similar tools received one mention each.

In addition to Microsoft Office programs, students frequently mentioned using videos, primarily from YouTube channels, to aid their understanding of course material (12 mentions). Artificial intelligence, often in the form of ChatGPT, was equally popular for idea generation and explanations (12 mentions).

The study underscores some notable absences: LibreOffice, including LibreOffice Impress as a PowerPoint alternative, was not mentioned by any students. Similarly, Apple's Pages was absent from the discussion, even among students who likely use Apple devices. Google Slides, a free alternative to PowerPoint, was only mentioned once.

The dominance of PowerPoint is driven by a few factors. First, it is widely used in education at all levels, from kindergarten to university. Second, some students perceived it to be superior to free alternatives. There was also a surprising underutilisation of Google tools, despite students having Google accounts.

Tools like Nearpod, Padlet, Kahoot, Wordwall, and Quizizz can be replaced by Moodle plugins. Moodle's built-in H5P interactive content features and comprehensive quiz question options make this possible. Additional plugins like 'Sticky Notes' and 'Board' facilitate collaborative learning through commenting and idea sharing, while 'E-voting' enables quick knowledge and opinion checks.

Providing students with the opportunity to use Moodle as instructors, through student-led e-learning platforms, could encourage them to explore its features and integrate technology into their learning more effectively. However, in this study, only 7 students mentioned using e-learning platforms and only 6 mentioned using tools for creating interactive content. Students' responses focused on the tools they use most frequently. This may explain why they didn't mention using Moodle's built-in features and plugins to a greater extent. In other words, students might have simply reported on their usual study habits, overlooking the potential of Moodle in their responses.

The third question that students responded to concern the possible progress in the use of digital technologies by course teachers: Some wrote that it was difficult to judge this, as many teachers only teach their subject for one academic year. However, the majority of the students expressed their opinions on this in many ways, with the prevailing view being that there are also significant differences between teachers in this regard and that there is still much room for improvement. Twelve responses indicated that no progress had been observed, while fourteen responses indicated that progress had been observed only for specific teachers or even for one teacher alone. Since smart boards were newly purchased in the current academic year, nine responses expressed that some teachers are now using them, albeit to a modest extent.

The fourth question was about students' satisfaction with the digitalisation of their study process. Overall, they expressed that they are satisfied with the level of digital support for the study process, but that there is room for improvement. They want teachers to use more advanced Moodle features and not just for distributing study materials and collecting assignments. Many students mentioned smart boards and the underutilisation of them for anything more than projection by most teachers. Certain students even want more use of artificial intelligence in the classroom, while another one would like to see Zoom used more often so that some parts of the study (on Fridays) could be done remotely. Some students would like to see more interactive tasks and quizzes added to the Moodle online classroom. They also think that teachers should be role models for students who are training to be teachers in how to use modern technology in teaching. Some students on the other hand are not enthusiastic about the use of technology in teaching and believe that work could sometimes be more effective without the use of technological aids.

The last question was about students' experiences with artificial intelligence. Almost all students have some experience with artificial intelligence (AI) programs. They mentioned that ChatGPT (some spelled incorrectly as ChatGBT) can be a useful tool for getting ideas for assignments or presentations, but it cannot do the work for them. They also use AI programs to clarify concepts they do not understand.

Most students are aware of the limitations of AI programs. Students are aware that AI programs can provide inaccurate information and require some subject knowledge to be used effectively. Despite this, they still experiment with these programs to see what outputs they can generate. Some students enjoy exploring the possibilities of AI programs; they see it as a challenge to learn how to use these programs to get the best results.

A study of Vietnamese students (Ngo, 2023) found equivalent results. The students found that ChatGPT can save time, provide ideas, and generate personalized answers to questions. However, they also found that the program can provide incorrect information and does not properly cite sources. Despite these limitations, the students were mostly positive about ChatGPT and said they would continue to use it.

Overall, students are aware of both the benefits and limitations of AI programs. They use these programs cautiously but are also open to exploring their potential.

The Use of LMS Moodle: Faculty of Education

The use of the LMS Moodle is one of the indicators of the digital literacy of teachers and assistants who lead and guide the study process at the faculty. At the Faculty of Education, its use skyrocketed during the Covid19 pandemic: In Figure 1 we can see a sudden increase of both teacher and total posts at the beginning of the spring semester of 2020, when classrooms were empty from March onwards, and the study process was conducted using online tools.

The number of teacher posts increased slightly in the 2020/21 academic year, but in the following year there was a slight decrease, which continued in the following years. The number of student posts did not show such a decrease, but their posts increased significantly in the last two academic years. Obviously, many teachers have already taken advantage of the initial investment of work in designing e-learning platforms, which they can use in subse-

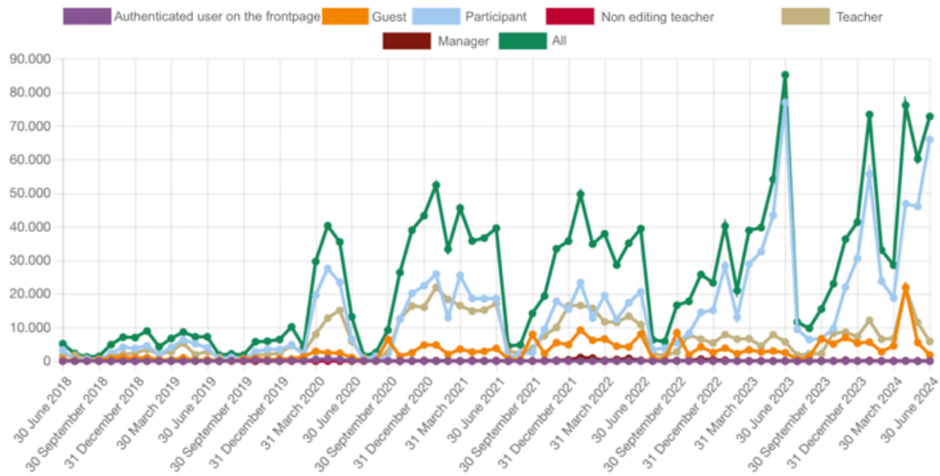

Figure 1 The use of LMS Moodle (Number of Posts by Roles) at the Faculty of Education from June 2018 to June 2024

quent academic years with only minor additions and improvements. However, students apparently have to do (submit) an increasing proportion of their assignments on e-learning platforms, which has resulted in an increase in the number of their posts.

We analysed the courses in Moodle of third-year students who participated in our research and assessed the courses based on the following criteria:

- Whether instructors only post teaching materials or also create them using Moodle
- Whether the courses include quizzes to test knowledge
- The extent to which forums are used for communication and discussion with students
- Whether submitted work is also graded (use of the gradebook)

Based on these criteria, the courses in Moodle were awarded points. Additional points were also awarded for the number of instructor posts.

Courses in Moodle with less than five points served primarily or exclusively for posting materials and sending messages to students: Lowest level of use.

Courses in Moodle with 5 to 8 points in which students also submitted their assignments fall into the category: Low level of use.

All courses in Moodle with more than 10 points were classified as Medium and higher level of use. However, there were significant differences among

Table 1 Number of Courses in Moodle, Classified by level of Use, for the Subjects in which Students Were Enrolled in the First Two and a Half Years of their Studies

Level of Use	1st Year	2nd Year	5th Semester
Lowest level of use	2	4	0
Lower level of use	5	5	4
Medium and higher level of use	6	1	1

these courses, as only two included quizzes to test knowledge. Additionally, not all of them had content created in Moodle. We did not divide these courses into two categories, as courses in Moodle with a higher level of use are more the exception than the norm.

As can be seen from the table, most courses in Moodle that offered a higher level of use in the first year, also because they had a subject in the field of educational technology in the first year, and one of the more advanced Moodle users was a lecturer in two subjects in this year. In the second year and in the 5th semester, the courses in which Moodle is intended primarily for the transmission of materials and the collection of student assessments predominate.

We also investigated whether it is possible to observe greater progress in the editing and use of the Moodle course by the same instructor in a higher year. As a rule, we did not observe any major differences (progress) and can claim that within the observed time interval, instructors use the LMS Moodle in approximately the same way in all analysed courses, although individual instructors also use some tools that they did not use in the course in the (pre-) previous year, but the same applies vice versa. Therefore, the students correctly assessed in their responses that there is no significant progress in the digital literacy of their teachers during their studies.

Conclusion

The findings of the case study presented in this chapter indicate that while the University of Primorska's 'Lastovke' conferences have highlighted the innovative use of digital technologies by several faculty members, such as the use of different tools for the support of teaching and learning as well as the creation of learning content using AI, 3D modeling, and interactive tools. However, these teachers represent a small portion of the faculty. Many university teachers are still cautious about fully integrating modern technologies into their teaching practices. What departmental discussions at the University of Primorska revealed is that the faculty acknowledges a relatively low level of digital empowerment. They identified several areas for improvement, including online safety, intellectual property protection, and of course the use of digital tools to support teaching, communication, and research processes.

Studying students' opinions provided valuable insights into the perceptions and usage of digital technologies among teacher-training students at the University of Primorska. However, given the relatively small and specific sample size (46 first-year and 58 third-year students from a single study program), the results may not fully represent the experiences of all students across different disciplines or institutions even within the University of Primorska. Nonetheless, the trends observed offer useful insights that could apply to similar educational contexts, particularly in teacher training programs, and can serve as a foundation for further research in this area.

Based on the above findings, several key conclusions can be drawn. First, the study reveals that most students perceive their university education to be more digitally supported than their high school experience, though they notice significant variation in how different instructors incorporate technology into their teaching. While MS PowerPoint is widely used, students expressed a desire for more advanced digital tools and interactive learning experiences. They also acknowledged both the potential and limitations of digital tools, such as AI programs like ChatGPT, using them cautiously but exploring their benefits.

Additionally, while some progress has been made in the digitalization of education, the study indicates that there is still substantial room for improvement. Many digital resources, such as Moodle's built-in features and smart boards, are underutilized by instructors. Students have expressed a need for greater integration of interactive tasks, quizzes, and AI into the learning process. These findings highlight the importance of continued support for faculty development in digital competence to better prepare students for the digital demands of modern education.

The analysis of the use of the Learning Management System (LMS) Moodle at the Faculty of Education, focusing specifically on its use in the courses that the third-year students were enrolled in during their first five semesters, revealed that Moodle use spiked during the COVID-19 pandemic, but it has since decreased, with teachers largely maintaining their initial setups with minimal updates. In contrast, student activity continues to rise, driven by the increasing submission of assignments through the platform. This suggests that students engage more with digital tools, but teacher adoption has not kept pace.

Most courses, especially in the second year and fifth semester, primarily use Moodle for posting materials and collecting assignments, with little content creation or interactivity. Even in courses with higher levels of use, features like quizzes remain underutilized. This lack of progress reflects the broader trend observed in the previous research, where students noted that instructors' digital literacy has not significantly improved over time.

In conclusion, while some advancements have been made, there is still a need for ongoing support and professional development for faculty to ensure more consistent and progressive use of digital tools in teaching. These findings highlight the gradual pace of digitalization in education and the need for more effective integration of technology across courses.

We may conclude that the level of digital literacy among teachers at the University of Primorska is lower than desired. Given the nearly two decades of experience with the Moodle learning management system and the recent forced transition to remote learning during the pandemic, one would expect teachers to have integrated Moodle into their teaching practices at a more effective level. However, as stated above, this is not the case.

To address this issue and enhance digital literacy among university teachers, it is imperative to establish an effective training system that goes beyond simply encouraging participation in relevant training programs and acquiring necessary competencies. As the current situation demonstrates, this approach has proven ineffective.

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Digitalna pismenost univerzitetnih profesorjev in integracija tehnologije: primer Univerze na Primorskem v Sloveniji

To poglavje podaja okvirni pregled digitalne pismenosti med univerzitetnimi učitelji na Univerzi na Primorskem. Obravnava teoretične temelje digitalne pismenosti ter poudarja njena pomen in večplastnost. Poleg tega predstavlja izražene potrebe visokošolskih učiteljev Univerze na Primorskem po izboljšanju njihove digitalne pismenosti in izpostavlja zgledne prakse posameznih učiteljev v preteklosti, ki prikazujejo učinkovito integracijo digitalnih tehnologij v njihove metodologije poučevanja. Na koncu so predstavljeni izsledki raziskave, ki je obravnavala digitalizacijo izobraževalnega procesa z vidika študentov, vpisanih v program za usposabljanje učiteljev. Poglavje zagotavlja dragocene vpoglede v to, kako študenti dojemajo digitalizacijo svojih učnih izkušenj.

Ključne besede: pedagoške digitalne kompetence, digitalne tehnologije, izobraževanje učiteljev, Moodle

Effective Technology-Enhanced Learning Methods of Increasing Knowledge and Practical Skills among Nursing Students

Martin Červený
Pavol Jozef Šafárik University in Košice, Slovak republic
martin.cerveny@upjs.sk

Kemal Elyeli
Near East University, Turkey
kemal.elyeli@neu.edu.tr

The utilisation of Technology-Enhanced Learning (TEL) methods in the field of nursing education provides students with the opportunity to engage in risk-free practice of clinical skills through the utilisation of interactive simulations and virtual laboratories. The incorporation of digital tools, such as e-learning modules and online assessments, facilitates enhanced knowledge retention and offers flexible learning opportunities that are tailored to the individual learning pace of the student. This literature review aims to summarize, analyze, and evaluate the effectiveness of TEL methods for developing knowledge and practical skills among nursing students. This literature review will assess methods utilized to enhance TEL skills among nursing students. Scientific publications in English languages published between 2013 and 2023 will be analyzed. Searches will be conducted in electronic databases including PubMed, Wiley library, SCOPUS, and Web of Science. The findings of seven studies were subjected to analysis. The findings of the review suggest that the utilisation of TEL learning methodologies has a beneficial impact on the skills and knowledge acquisition of nursing students. The integration of TEL educational interventions into nursing education has been demonstrated to be an effective approach for developing the knowledge and competencies of nursing students. The incorporation of digital educational interventions in nursing education has been demonstrated to result in higher knowledge scores and a reduction in cognitive load, thereby enabling students to engage more fully with the learning material.

Keywords: digital methods, nursing, students, skills, knowledge

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Introduction

The landscape of nursing education is undergoing a transformative shift, driven by the increasing complexity of healthcare demands and the necessity for nurses to possess a diverse set of competencies (Tiago & Mitchell, 2024).

Klančar, A., Štemberger, T., Prosen, M., & Ličen, S. (Eds.). (2025). *International Perspectives on Effective Teaching and Learning in Digital Education*. University of Primorska Press.

Using TEL in nursing education helps students learn in a more engaging way and gives them the skills they need to meet the changing needs of patients in the digital age (Raman, 2015). It has been demonstrated that TEL, including simulation-based learning and virtual training programmes, can markedly enhance the competencies of nursing students (Elendu et al., 2024). For example, Rahimi et al. (2023) showed that a virtual training programme for nurse educators aimed at improving cultural competence led to increased self-efficacy and cultural competence across various dimensions after the intervention. Similarly, Salifu et al. (2022) emphasised that immersive, student-centred, and experiential teaching strategies, including simulation-based clinical education, are more effective in developing clinical competence among nursing students in Ghana. These approaches facilitate student engagement while accommodating diverse learning styles, thereby enhancing overall educational outcomes (El-Sabagh, 2021). Altmiller et al. (2024) and Philip (2015) highlighted the value of screen-based patient simulations in providing nursing students with multiple opportunities to demonstrate their competencies in diverse contexts, which is crucial for competency-based education. This is consistent with the findings of Gradellini et al. (2023) who observed that educators with the requisite pedagogical competence can employ experiential learning to facilitate the development of intercultural competence among nursing students. The global health landscape calls for nursing education that embraces a broad spectrum of competencies, such as cultural competence, informatics, digital and clinical skills. As stated by Satoh et al. (2020), the World Health Organization (WHO) places significant emphasis on the incorporation of global health competencies within nursing curricula, with the objective of preparing nurses for practice in diverse environments. This integration is considered to be of paramount importance in order to develop a workforce capable of addressing the complex health needs of populations worldwide. The literature indicates that digital or simulation-based learning, competency-based education and the integration of informatics are crucial for enhancing the skills of nursing students. As the nursing education sector evolves to align with the demands of modern healthcare, it is vital to prioritise innovative teaching methods that foster a competent and capable nursing workforce.

The Aim of This Review

To evaluate the effectiveness of various TEL interventions in achieving significant improvements across different learning styles and competencies in nursing education.

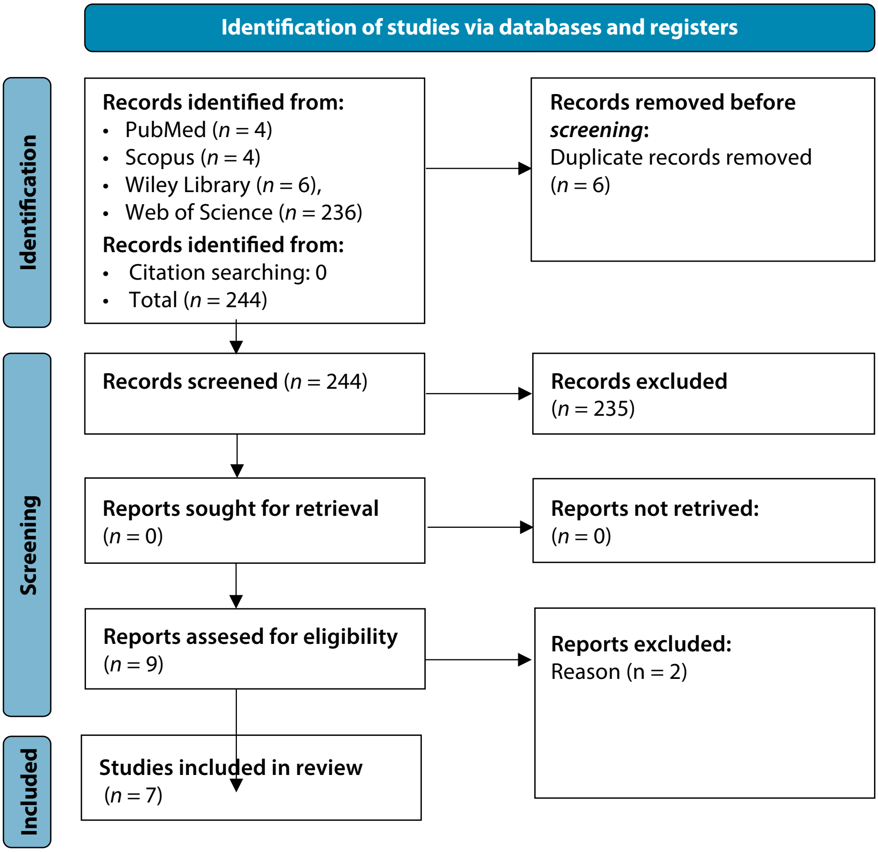

Figure 1 PRISMA Flow Diagram of this Scoping Review

Review Question

How effective are TEL interventions in enhancing learning outcomes across different learning styles and competencies in nursing education?

Materials and Methods

In this study, we conducted a literature review following the Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR (Triccco et al., 2018)) (Figure 1), and used the Participants, Interventions, Comparison, Outcomes (PICO) framework, as shown in Table 1.

Method of Searching for Evidence

The analyzed articles were collected from databases including PubMed, SCOPUS, Wiley Library, and Web of Science using specific keywords and

Table 1 Inclusion and Exclusion Criteria for the Review

Inclusion Criteria	Exclusion Criteria
Nursing students	Nurses
Published in English	Not original research: opinion, editorial, conference
Published from 2013–2023	abstract, systematic reviews,
Randmised controrold trials (RCTs)	articles not available in English

Boolean operators: Learning OR digital learning AND Digital skill* AND Nursing student* AND 'Randomized control trial.' All sources were academic publications featuring a randomized control trial research design and had undergone peer review. This review focused on the following elements:

- Population: nursing student(s)
- Intervention: TEL interventions in digital skills
- Comparison: nursing students without digital skills

Outcome: Effectivness of education interventions on digital skills

The source selection criteria are presented in Table 1. The search for sources was carried out from 01.08.2024 to 31.08.2024.

Data Charting and Extraction

A three-step screening process was used, with each step evaluated in MS Excel. In the first step, we reviewed the article titles and abstracts. In the second step, we identified and categorized articles that met the inclusion criteria and assessed their quality, with two co-authors independently applying the quality assessment method by Červený et al. (2022). The third step involved data extraction. The database search initially yielded 244 articles. After removing duplicates, we proceeded to analyze the titles and abstracts, resulting in the exclusion of 235 articles based on abstract analysis. Nine articles were selected for full-text review, but after further analysis, two more articles were excluded. We conducted the data analysis using MAXQDA Analytics Pro (version 24.5.1).

Qulity of Analysed Studies

The Jadad scale is a five-point tool used to assess the quality of randomised trials. A score of three or higher is indicative of high-quality studies (Jadad et al., 1996). The scale evaluates three key aspects: the description of random sequence generation (0 = no description, 1 = inadequate description, 2 = adequate description), the implementation of blinding (2 = properly described double-blinding, 1 = inadequately described double-blinding, 0 = incorrect use of double-blinding), and the reporting of participant withdrawals (1 = reasons and numbers provided, 0 = not reported).The assessment was conducted independently by the authors. All the studies included get more than three scores, which means they're all high quality.

Results

In total, we identified seven articles that met the inclusion criteria. The studies varied in their stated aims, settings, descriptions of participants, interventions and outcomes measured. Data extraction included author(s), year, country of research, study aim, design and main findings (Table 2).

Effectiveness of TEL Interventions on Knowledge and Skills among Nursing Students

In the study by Chang et al. (2021) the mobile app integrated interactive elements such as audio, visual, and haptic stimuli, allowing nursing students to actively engage with the material. The app provided immediate feedback, allowing students to detect and correct mistakes, leading to improved skill performance. The authors found that using a virtual simulation-based mobile learning method had a positive impact on the experimental group. Specifically, the group that used the app achieved significantly higher scores in knowledge, medication administration, and nasotracheal suctioning compared to the control group. Additionally, the experimental group reported notably lower levels of intrinsic and extraneous cognitive load than the control group. Participants in the experimental group also expressed significantly greater satisfaction compared to those in the control group. The effect sizes for these differences were large, indicating substantial practical significance. Furthermore, the statistical power ($p < 0.001$) of these findings was very high, suggesting that the results are highly reliable and unlikely to be due to chance.

According by the study Amaniyan et al. (2020) teaching by the conceptual map method had statistically significant differences with the control groups in the visual learning style ($p < 0.036$). However, no statistically significant differences were reported among the groups participating in the conceptual map method compared with the traditional lecture method in the following three learning styles including reading/writing ($p < 0.414$), auditory ($p < 0.249$), and kinesthetic ($p < 0.078$). Conceptual mapping proved to be an effective digital intervention feature for visual learners by enhancing interactivity, structuring information visually, and improving knowledge retention. However, it had limited impact on students with auditory, reading/writing, or

Table 2 Comparison of Included Studies

Author(s), year, country	Aim	Methods and Setting	Intervention	Main Findings
Chang et al. (2022), Taiwan	This study aimed to examine the effectiveness of an educational board game in improving nursing students' medication knowledge	Randomized controlled trial desing 100 nursing students	Board game Medication memory	Both groups improved in immediate medication recall after the intervention, regardless of learning method. However, after one month, the experimental group scored higher and reported greater satisfaction with the learning method than the comparison group.
Amaniyan et al. (2020), Iran	The aim of this study was to compare the effects of the conceptual map and the traditional lecture methods on students' learning based on the VARK learning styles model.	Randomized controlled trial 160 nursing and midwifery students	Conceptual map method	The conceptual map teaching method influenced students' learning outcomes differently depending on their learning styles. For students with a visual learning style, this method had a statistically significant positive impact in the intervention group compared to the control group ($p = .036$). However, no significant differences were observed between the groups for the other three learning styles.
Lee et al. (2016), South Korea	The purpose of this study was to identify the effects of a mobile–based video clip on learning motivation, competence, and class satisfaction in nursing students	Randomized Controlled Trial 71 nursing students	Mobil based video clips	The intervention group demonstrated significantly greater learning motivation and class satisfaction compared to the control group. Among fundamental nursing skills, the intervention group also showed higher confidence in performing catheterization than their peers in the control group.
Elzeky et al. (2022)	This study was designed to assess the efects of using gamifed flipped classroomss on the Fundamentals of Nursing students' skills competency and learning motivation	Randomized Controlled study 128 nursing students	Flipped classrooms	A significant difference was found between the two groups in terms of students' self–confidence ($p = 0.021$), skills knowledge ($p < 0.001$), preparation intensity ($p < 0.001$), and motivation ($p < 0.001$) after using gamified flipped classrooms. However, no difference was observed in students' skills performance ($p = 0.163$) between the groups.

Continued on next page

Author(s), year, country	Aim	Methods and Setting	Intervention	Main Findings
Fernandes Pereira et al. (2016), Brazil	To evaluate the influence of the use of digital applications in medicament calculation education for nursing students	Experimental study – Randomized Controll study 100 nursing students	CalcMed application	The study group achieved a mean score of 8.14, compared to an average of 5.02 in the control group. Additionally, the study group completed the test more quickly, with an average time of 15.7 minutes versus 38.9 minutes in the control group.
Long et al. (2016), United States of America	The purpose of the EBR tool is to guide students through the basic steps needed to locate and critically appraise the online scientific literature while linking users to quality electronic resources to support evidence–based practice (EBP)	Mixed–methods research – randomized controll trials 72 nursing students in BSc program 63 nursing students in MSc program 159 pharmacy students	Web–based, evidence based research (EBR) tool	The quasi–experimental nursing student group and the RCT nutrition student group showed a statistically significant improvement in overall research skills when using the EBR tool. Additionally, a significant proportional difference was observed in the RCT nutrition and PharmD intervention groups, where participants were better able to assess the credibility of online sources compared to controls. Most participants were also able to accurately apply the PICOTS framework to a case study using the tool.
Chang et al. (2021), Taiwan	The study's aim was to test the hypothesis that nursing students who used a mobile learning app would have significantly (1) higher levels of knowledge about medication administration and nasotracheal suctioning, (2) better development of skill performances on medication administration and nasotracheal suctioning, (3) higher satisfaction, and (4) lower cognitive load than a control group	Randomized experimental study 69 nursing students	Virtual simulation–based mobile learning	The experimental group that used the mobile app achieved significantly higher knowledge scores, experienced lower intrinsic and extraneous cognitive load, demonstrated better skill performance, and reported greater satisfaction compared to the control group.

kinesthetic learning styles, suggesting that blended approaches incorporating multiple features (e.g., videos, simulations, interactive quizzes) might be more universally effective.

In Lee et al. (2016) study, participants in the intervention group who received mobile-based learning videos showed significantly higher levels of learning motivation, practice confidence, and class satisfaction compared to the control group. Although the intervention group also scored higher in knowledge and skill performance key indicators of fundamental nursing competency these differences were not statistically significant. Notably, there were strong positive correlations between learning motivation and class satisfaction ($r = 0.725$, $P < 0.001$) as well as between learning motivation and practice confidence ($r = 0.717$, $P < 0.001$). Additionally, a significant positive correlation was found between class satisfaction and confidence ($r = 0.772$, $P < 0.001$). However, no significant correlations emerged between knowledge or skill performance and any other variables. Mobile-based video clips allowed students to access instructional materials anytime and anywhere, leading to greater convenience and autonomy.

Elzeky et al. (2022) found, that the performance of skills did not demonstrate any significant differences over time, between the groups, or in the interaction between time and group. In contrast, confidence in skills showed a significant increase over time, accompanied by a significant time-group effect and a notable difference between the two groups. Similarly, knowledge of skills exhibited a significant increase over time, along with a significant time-group effect and a significant difference between the two groups. Additionally, the intensity of skills preparation showed a significant increase over time, with both a significant time-group effect and a marked difference between the two groups. Gamification combined with flipped learning effectively increased motivation, confidence, and preparation but did not significantly improve hands-on skill performance. The most impactful features were leaderboards, points, levels, badges, and immediate feedback mechanisms.

In the study Fernandes Pereira et al. (2016) the mean age of the intervention group was 22.4 years, while that of the control group was 19.9 years. Upon examination of variables such as mode hits, average errors, and average test runs, it became evident that individuals utilising the application achieved markedly superior results, with an approximate 80% success rate on the proposed items. The intervention group exhibited a mean score of 8.14 ± 1.67 points, in comparison to 5.02 ± 3.21 points for the control group. This illustrates a discernible enhancement in efficiency with the app's usage. The distribution of test successes indicated that the lower range of the intervention group and the upper range of the control group were quite close, suggesting that using the app improves the likelihood of correct responses in medication calculations. Furthermore, the app provides a notable improvement over using calculators or relying solely on prior mathematical skills, thereby supporting better technique and significantly reducing errors in practical applications. The use of the application led to a notable reduction in calculation errors, improving the overall technique and minimizing potential mistakes in practical nursing scenarios.

The study by Long et al. (2016) revealed a statistically significant enhancement in overall research proficiency across all three groups (United States/BSN, Middle East/BSN, United States/MSN) based on pre- and post-test scores. The EBR tool was designed to be interactive, allowing users to engage actively with the content. The interactive nature of the tool encourages users to explore various components at their own pace, which can enhance understanding and retention of research skills for EBP. Although specific feedback mechanisms were not detailed in the contexts, the qualitative data indicated that users found the tool helpful in improving their online research skills. However, the study did not reveal a statistically significant proportional difference in pre- and post-test scores for the ability to distinguish the credibility of online sources in any of the three groups. Moreover, the study revealed a statistically significant enhancement in research skills, particularly within the nutrition population intervention group in comparison to the control group. This is evidenced by the observed increase in mean pre- and post-test scores (2.85–2.44 vs. 2.60–2.21). Additionally, the study observed a statistically significant proportional difference in pre- and post-test scores for the ability to assess the credibility of online sources, with the nutrition population intervention group demonstrating superior performance compared to the control group.

The study by Chang et al. (2022) revealed a notable enhancement in the experimental group's medication knowledge scores (PKQ) between the pre-intervention and post-intervention phases. Furthermore, these scores remained at an elevated level one month following the intervention. Similarly, the comparison group's medication knowledge scores (PKQ) demonstrated a significant increase from the pre-intervention phase to the post-intervention phase, and remained higher than the pre-intervention scores one month later. No significant differences were observed in medication knowledge scores between the experimental and comparison groups immediately following the intervention. However, one month after the intervention, the experimental group, which used the board game, demonstrated significantly higher medication knowledge scores than the comparison group. Furthermore, the experimental group (board game) reported significantly higher satisfaction with the learning experience compared to the comparison group, which received a lecture. Students who engaged in board game play demonstrated better long-term retention of knowledge compared to those who attended traditional lectures. Students also reported favorable reactions to the board game learning method, indicating that they found it enjoyable and effective for increasing their medication knowledge.

Discussion

The incorporation of TEL interventions in nursing education has become a prominent area of interest in recent years, particularly in view of the evolving demands of healthcare and the necessity for nurses to acquire a diverse set of competencies. The findings from analysed of studies highlight the efficacy of these interventions in enhancing knowledge, skills and overall satisfaction among nursing students. The advent of new digital technologies has had a profound impact on the field of nursing education, with virtual simulations emerging as a highly effective pedagogical instrument. A systematic review conducted by Tolarba (2021) highlighted the growing use of digital virtual simulation in nursing education. The review emphasised the potential of such simulations to enhance learning outcomes by providing realistic clinical scenarios that students can engage with in a controlled environment. This is consistent with the findings of Kim et al. (2021), who reported that nursing students perceived virtual simulation as beneficial during the pandemic caused by the SARS-CoV-2 virus, particularly when traditional clinical placements were disrupted. The capacity of virtual simulations to replicate real-world clinical situations allows students to practise critical skills without the associated risks, thereby fostering a deeper understanding of nursing competencies. The positive impact of simulation-based education on nursing performance and satisfaction has been further corroborated by Ahmed et al. (2022), who found that simulation significantly improved nurses' performance regarding peripherally inserted central catheters in a neonatal intensive care unit. This study demonstrates how targeted simulation training can facilitate the acquisition of specific clinical skills, thereby enhancing overall patient care. Similarly, Walsh et al. (2021) emphasised that virtual simulation experiences offer invaluable opportunities for nursing students to enhance their learning, reinforcing the notion that such interventions can effectively bridge the gap between theoretical knowledge and practical application. Furthermore, Lee et al. (2023) demonstrated that virtual reality programmes significantly enhanced nursing students' competencies during the pandemic caused by the SARS-CoV-2 virus. This was achieved by linking previously learned concepts through interactive learning. Aul et al. (2021) were unequivocal in their assertion that simulation-based education must be integrated into nursing curricula. They demonstrated that students who spend a significant portion of their clinical training in simulation environments demonstrate improved teamwork and clinical decision-making skills. This finding is of great significance, as it demonstrates the potential of digital interventions to not only enhance individual competencies but also foster collaborative skills, which are essential in modern healthcare settings. The use of digital educational interventions, particularly virtual simulations, in nursing education has been shown to significantly enhance the knowledge, skills and overall satisfaction of nursing students. In light of the ongoing evolution of the healthcare landscape, it is imperative that nursing education programmes adopt these innovative approaches in order to ensure that future nurses are adequately prepared to meet the challenges of modern healthcare. It is imperative that these digital interventions are subject to ongoing evaluation and refinement in order to ensure that they have the greatest possible impact on nursing education and, ultimately, on patient care outcomes.

Implication for Education

The integration of TEL in clinical training highlights the importance of leveraging technological advancements to optimise learning outcomes.Through the incorporation of mobile applications, gamification, and video-based learning methodologies, educators can facilitate interactive and engaging experiences that reinforce practical skills in students.This approach not only enhances knowledge retention but also fosters student confidence, ensuring they are better prepared for real-world clinical scenarios. The utilisation of digital tools in education has the potential to extend beyond nursing to various fields, thereby emphasising the role of technology in modernising learning environments. Future research should explore the long-term impact of gamification and mobile applications on clinical decision-making skills, assessing whether digital interventions improve not just knowledge retention but also critical thinking and adaptability in real-world healthcare settings. The investigation of personalised adaptive learning systems, which adapt content based on student progress, has the potential to further optimise nursing education outcomes.

Conclusion

The incorporation of TEL interventions in nursing education has been demonstrated to be an effective strategy for enhancing the knowledge and skills of nursing students. The studies analysed demonstrate that the utilisation of various digital tools, such as virtual simulations, mobile applications, and conceptual mapping, has been shown to significantly improve students' performance in critical areas such as medication administration and clinical competencies. These interventions have been shown to lead to higher knowledge scores and also contribute to reduced cognitive load, allowing students to engage more fully with the learning material.

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Učinkovite metode učenja s pomočjo tehnologije za povečanje znanja in praktičnih veščin med študenti zdravstvene nege

Uporaba metod tehnološko podprtega učenja (angl. *technology-enhanced learning* – TEL) v izobraževanju na področju zdravstvene nege študentom omogoča varno razvijanje kliničnih veščin preko interaktivnih simulacij in virtualnih laboratorijev. Vključevanje digitalnih orodij, kot so e-učenje in spletna preverjanja znanja, izboljšuje dolgoročno pomnjenje informacij ter ponuja prilagodljive učne možnosti, ki so usklajene s posameznikovim učnim tempom. Namen pričujočega pregleda literature je povzeti, analizirati in ovrednotiti učinkovitost metod TEL pri razvijanju teoretičnega znanja in praktičnih veščin študentov zdravstvene nege. Pregled literature bo zajemal analizo metod, uporabljenih za izboljšanje TEL-spretnosti pri študentih zdravstvene nege. Analizirane bodo znanstvene publikacije v angleškem jeziku, objavljene med letoma 2013 in 2023. Iskanje virov bo potekalo v elektronskih bazah podatkov, vključno s PubMed, Wiley Library, SCOPUS in Web of Science. Analiza je zajela ugotovitve sedmih raziskav. Pregled literature nakazuje, da imajo metode TEL pozitiven vpliv na pridobivanje znanja in razvoj veščin pri študentih zdravstvene nege. Integracija izobraževalnih intervencij TEL v izobraževanje na področju zdravstvene nege se je izkazala za učinkovito strategijo pri razvijanju znanja in kompetenc študentov. Uporaba digitalnih izobraževalnih pristopov vodi do boljših učnih rezultatov in zmanjšanja kognitivne obremenitve, kar študentom omogoča poglobljenejše učenje.

Ključne besede: digitalne metode, zdravstvena nega, študenti, veščine, znanje

Maximizing Nursing Students' Engagement in Distance Learning: Strategies and Insights

Boris Ilić
University of Applied Health Sciences Zagreb, Croatia
boris.ilic@zvu.hr

Irena Kovačević
University of Applied Health Sciences Zagreb, University of Rijeka, Croatia
irena.kovacevic@zvu.hr

Danko Relić
University of Zagreb, Croatia
danko.relic@mef.hr

Vesna Švab
University of Ljubljana, National Institute for Public Health, Slovenia
vesna.svab@mf.uni-lj.si

Vedrana Vejzović
Malmö University, Sweden
vedrana.vejzovic@mau.se

Seher Yurt
Istanbul Kent University, Türkiye
seher.yurt@kent.edu.tr

The increase of online nursing education, driven by technology and the demand for flexible learning, has emphasized the importance of student engagement. Participation plays a key role in shaping both academic achievement and the acquisition of crucial nursing skills. This chapter explores the impact of technological factors such as audio and video quality, as well as internet speed, on student engagement. Moreover, it delves into how the ERR framework – a teaching approach that includes *Evocation, Realization of Meaning* and *Reflection*, along with other interactive tools can be used in online learning settings to improve nursing students' participation. This work aims to provide educators with practical insights for improving online nursing education by combining technological considerations with innovative teaching strategies.

Keywords: nursing education, distance learning, student engagement, ERR framework, Technological factors

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Introduction

Recent technological advancements have significantly changed the educational field, with online learning becoming an important part of nursing education (O'Doherty et al., 2018). The worldwide COVID-19 outbreak hastened this change by requiring remote learning choices to address health and safety worries (Huang et al., 2020). In this new setting, it is crucial to prioritize keeping students engaged, as instructor-learner interaction significantly influences student satisfaction and perceived learning outcomes in online education (Kang & Im, 2013).

Participation in education involves various aspects like behavior, emotions, and thinking (Fredricks et al., 2004). *Behavioral engagement* involves participation in academic activities, *emotional engagement* refers to students' feelings and attitudes towards learning, and *cognitive engagement* relates to the investment in understanding complex ideas. Engaging individuals in online settings can be more challenging because there is no physical presence and immediate feedback (Hrastinski, 2009).

Nevertheless, there are specific challenges to involving students in a virtual setting. Students may feel isolated when they lack face-to-face interaction, causing disengagement and decreased motivation (Brown et al., 2015). Technical problems such as low-quality audio and video or unreliable internet can interrupt the learning process and worsen these emotions. Hence, educators must comprehend the factors that impact engagement in online nursing education to provide effective distance learning.

This chapter seeks to investigate the impacts of both technological and pedagogical elements on student involvement in remote education. It examines the roles of audio and video quality and internet connection speeds, relying on empirical studies for an objective assessment. Furthermore, it explores how the ERR framework – a teaching approach that includes *Evocation, Realization of Meaning*, and *Reflection* – can be used to boost engagement in online learning settings.

Factors Affecting Engagement in Distance Learning

Technological Factors

From a technological standpoint, investing in high-quality audio and video equipment for recording lectures and demonstrations ensures that students receive clear visuals and sound, which enhances comprehension and keeps them engaged. Institutions should aim to provide faculty with training and resources to produce professional-quality content.

Sun and Chen (2016) emphasize that effective online education depends on well-structured courses that integrate interactive content, strong instructor presence, and active learning communities. These findings are consistent with those of Clark and Mayer (2016), who highlight the importance of applying multimedia design principles to reduce cognitive load and improve learning outcomes in digital instruction. While technology, such as LMS and multimedia, supports engagement, student interaction and instructor facilitation remain central to success. Research highlights that peer collaboration and structured discussions are essential for fostering meaningful learning experiences (Sun & Chen, 2016). Features such as progress tracking and gamification elements can further enhance engagement.

Offering technical assistance to assist students in enhancing their internet connections and resolving problems reduces interruptions and guarantees that technical issues do not impede involvement (O'Doherty et al., 2018). Providing extended virtual office hours for IT support or developing FAQs and tutorials can enable students to address typical problems independently.

Making sure all content is accessible to students with disabilities by including captions, transcripts, and compatibility with assistive technologies, promotes inclusivity and equal participation. Universal Design for Learning (UDL) principles can guide the creation of accessible materials (CAST, 2018).

Audio and Video Quality

The quality of audio and video content is essential in distance learning. High-quality sound enables students to comprehend lessons easily, avoiding mental strain, lowering cognitive burden, and minimizing misinterpretations. According to Clark and Mayer (2016), well-designed multimedia materials – particularly when audio and visual elements are properly aligned – can significantly enhance understanding and retention while minimizing extraneous cognitive processing. High-definition video may help keeping students visually engaged and aiding them in picking up on non-verbal cues, which are crucial for grasping complex material and maintaining attention.

While some studies suggest that high-quality video production enhances student engagement, research findings remain mixed. Guo et al. (2014) found that shorter, more interactive videos and informal settings often led to higher engagement than highly polished, studio-produced content (Guo et al., 2014). This highlights the need for further investigation into the specific factors that influence student interaction with educational videos.

Some studies noted that issues with media quality could result in irritation and reduced drive, potentially leading students to become less engaged. Clear audio and visuals are considered especially crucial in nursing education, where a strong grasp of detailed procedures and concepts is crucial.

Internet Connection Speeds

Another crucial factor is internet connectivity. A fast and reliable internet connection allows for smooth streaming of lectures, real-time interactions, and quick access to resources. Slow or unstable connections can disrupt live sessions, causing students to miss important information and reducing their ability to participate actively. Banna et al. (2015) highlighted that technical difficulties, such as poor internet connections, can hinder engagement in synchronous learning sessions (Banna et al., 2015).

O'Doherty et al. (2018) highlighted multiple barriers to online learning in medical education, including inadequate infrastructure, time constraints, and limited institutional support. While technical issues such as internet connectivity can contribute to disengagement, a comprehensive approach addressing faculty training and strategic support is essential for effective distance learning (O'Doherty et al., 2018). The asynchronous nature of some online courses can mitigate this issue, but it often lacks the immediacy and interactive benefits of synchronous learning (Hrastinski, 2009).

Furthermore, disparities in high-speed internet access can exacerbate educational inequities for some individuals. Students who come from rural areas or low-income families may not have access to dependable internet, which can put them at a disadvantage (Anderson & Perrin, 2018). Educational institutions should acknowledge these discrepancies and offer assistance or options for students experiencing connectivity problems. This could involve giving access to downloadable content, supplying internet allowances, or guaranteeing campus facilities are open with appropriate health and safety protocols.

The digital divide impacts both access and the level of engagement. Kay and Lauricella (2011) stated that students who have improved internet access are more inclined to utilize advanced aspects of online platforms, which enriches their educational experience. Hence, it is crucial to focus on internet connectivity for fair and successful distance education.

Pedagogical Factors

Teaching Strategies and Interactivity

While technology provides the platform for online learning, the teaching methods used play a significant role in how engaged students are. A meta-analysis found that active learning approaches, such as peer discussions and problem-solving exercises, significantly increased exam performance and reduced failure rates compared to traditional lectures (Freeman et al., 2014). Techniques like collaborative projects, discussions, and problem-based learning prompt students to participate actively rather than passively absorbing information.

Hrastinski (2009) argues that online learning should be seen as an active participatory process rather than passive information transmission (Hrastinski, 2009). This point of view stresses the significance of students and instructors interacting, as well as students interacting with each other. Studies have found that the interaction between students and instructors in online settings was a significant factor in determining how much students believed they had learned.

The *Community of Inquiry* model emphasizes the significance of social, cognitive, and teaching presence in online learning, as proposed by Garrison et al. (2000). *Social presence* refers to participants' capacity to connect with the community, communicate with intention, and foster relationships. *Cognitive presence* refers to how well students can create and validate meaning by engaging in continuous reflection and discussion. *Teaching presence* involves planning, guiding, and leading cognitive and social activities in order to reach desired learning results. Maintaining a balance of these elements is essential for promoting involvement.

Communication and Feedback

Effective communication is key to creating a supportive learning environment. Regular, meaningful interactions between instructors and students can help reduce feelings of isolation that are common in distance learning Research highlights that instructor availability, timely feedback, and clear communication are the most critical factors in fostering student engagement (Sheridan & Kelly, 2010). Providing prompt and constructive feedback helps students understand how they're doing and where they can improve, which can enhance motivation and engagement (Garrison & Vaughan, 2008).

Feedback should be timely, specific, and actionable. Effective feedback involves more than just giving information to students; it also entails having a conversation with them about their learning. This bidirectional communication can assist students in becoming self-regulated, increasing their ability to oversee and enhance their performance.

Moreover, the use of multimodal communication channels – such as video calls, emails, discussion boards, and instant messaging – can cater to different communication preferences and needs. In addition, instructors who were accessible and responsive across multiple channels played a crucial role in influencing student help-seeking behavior and engagement in online courses (Whipp & Lorentz, 2009).

Strategies to Maximize Engagement

The ERR Framework in Distance Learning

The ERR framework – Evocation, Realization of Meaning, and Reflection – offers a structured approach to learning that promotes deep understanding and engagement (Buehl, 2017). Rooted in constructivist theory, it emphasizes the active role of students in building their own knowledge through experience and reflection.

– *Evocation:* This initial stage involves activating students' prior knowledge and experiences to prepare them for new learning. By connecting new information to what they already know, students can better understand and retain new concepts (Ausubel, 1968).
– *Realization of Meaning:* In this phase, students engage with new content, integrating it with their existing knowledge. Active learning strategies and practical applications are crucial here to help solidify understanding (Bransford et al., 2000). This stage often involves problem-solving, application of theories, and critical analysis.
– *Reflection:* The final stage encourages students to critically analyze what they've learned, consider its implications, and think about how they can apply it in future contexts. This fosters deeper learning and helps students internalize new knowledge. Reflective practice is particularly important in nursing education, where self-awareness and continuous improvement are essential.

Application of ERR in Distance Learning

There are several tools and methods that can be easily implemented into the distance learning, depending on the appropriate phase of the ERR concept, listed in table below, and further discussed in more detail.

Evocation in Online Settings

Utilizing interactive tools in an online setting can engage students' existing knowledge (Filej et al., 2023). Instructors can utilize pre-class surveys, discussion forums, or interactive polls to encourage students to remember and discuss their experiences relevant to the upcoming content, as illustrated by Sheridan and Kelly (2010). Prior to a lesson on communicating with patients, students may discuss difficulties they have encountered in this area, helping them get ready for new knowledge and fostering a sense of unity.

Table 1 Online Tools and Methods Aligned with the ERR Framework

ERR Phase	Tools/methods
Evocation	Pre–class Surveys: Gauge students' prior knowledge and experiences related to upcoming content. Discussion Forums: Facilitate sharing of thoughts and experiences to activate prior learning. Interactive Polls: Engage students with questions that prompt reflection on existing knowledge. Concept Mapping Tools: Allow students to visually represent their understanding of a topic before delving into new material.
Realization of Meaning	Virtual Simulations: Provide immersive, practical experiences that replicate clinical scenarios. Interactive Multimedia Resources: Utilize videos, animations, and modules to explain complex concepts. Collaborative Projects: Encourage teamwork and application of knowledge to solve problems. Synchronous Discussions and Breakout Rooms: Promote real–time interaction and deeper exploration of content. Adaptive Learning Technologies: Personalize learning paths based on individual performance. Virtual escape rooms: Promotes interactivity and collaboration.
Reflection	Electronic Reflective Journals: Enable students to document and analyze their learning experiences. Peer Review Activities: Foster critical thinking through feedback on peers' work. Structured Reflection Prompts: Guide students to reflect on specific aspects of their learning. Discussion Boards: Allow for sharing reflections and insights with classmates and instructors.

Multimedia introductions or storytelling can also evoke students' interest and connect new content to real-life scenarios. By presenting a case study or a real-world problem at the beginning of a lesson, instructors can pique students' curiosity and encourage them to draw upon their existing knowledge.

Facilitating discussion forums where students share their thoughts before new content is introduced can also encourage engagement and peer learning (Rovai, 2002). Sharing perspectives helps build connections among students, fostering a sense of community that's essential in online learning. Instructors can prompt discussions with thought-provoking questions or scenarios related to the upcoming content.

In addition, collaborative tools for concept mapping can assist students in seeing their existing knowledge and pinpointing topics to delve deeper into (Novak & Cañas, 2008). These visuals can act as a base for acquiring new information while learning.

Realization of Meaning Remotely

Engaging students with new content in a meaningful way is essential for understanding. In distance learning, this can be facilitated through multimedia resources, virtual simulations, and interactive case studies. For nursing students, virtual simulations offer a chance to practice clinical skills in a safe environment. These simulations can mimic patient interactions, clinical procedures, and emergency situations, providing hands-on experience without the risks associated with real-life practice.

Interactive case studies allow students to apply theoretical knowledge to real-world scenarios, enhancing critical thinking and problem-solving skills (Popil, 2011). For instance, using 3D models to demonstrate anatomy or interactive timelines to illustrate disease progression can make complex concepts more accessible. In addition, online platforms can facilitate branching scenarios in which students engage in decision-making that results in various outcomes, strengthening their understanding of the outcomes of their choices.

Furthermore, synchronous online discussions and breakout rooms can further promote active engagement by allowing students to collaborate and learn from each other. Collaborative tasks that involve working together to address issues or create care plans foster important abilities such as communication and cooperation (Brindley et al., 2009). They not only enhance understanding, but also build communication and teamwork skills, which are vital in nursing practice. Using online platforms like shared documents or virtual whiteboards can further allow students to collaborate efficiently, even if they are not in the same location.

Another innovative approach in the realization phase are virtual *Escape rooms*. They provide an opportunity for students to actively engage with new content, integrate it with prior knowledge, and apply it in practical situations, thereby solidifying their understanding and promoting meaningful learning. These interactive experiences require students to collaborate, think critically, and apply their nursing knowledge to solve a series of puzzles and challenges within a set time limit (Bramhagen et al., 2023).

Moreover, integrating adaptive learning technologies allows for a personalized learning experience by adapting the content and pace to individual student performance. This customization aids in keeping interest by ensuring the content is not excessively simple or overly difficult.

Encouraging Reflection in Distance Learning

Reflection is a key part of professional development in nursing. Online platforms provide various tools for facilitating reflection, such as electronic journals, blogs, or discussion boards. Instructors can promote reflective thinking by posing open-ended queries that motivate students to reflect on their learning encounters and contemplate how they can utilize fresh information in practical situations.

Following a virtual simulation, students may be prompted to think about their successes, obstacles encountered, and possible approaches for future similar scenarios. This process of reflection aids in reinforcing learning and encourages ongoing enhancement.

Peer feedback can also enhance reflective practices, as students gain new perspectives by reviewing and commenting on each other's reflections (Boud & Molloy, 2013). This collaborative reflection fosters a community of practice where students support each other's development.

Providing structured reflection prompts with guiding questions can help students focus on specific aspects of their learning, enhancing self-awareness and professional competency. Questions might include:

- What new knowledge or skills did you acquire?
- How does this learning relate to your previous experiences?
- How can you apply this knowledge in your future practice?

Moreover, incorporating reflective activities into assessments ensures that students recognize the importance of reflection in their professional growth (Mann et al., 2009).

Insights and Best Practices

Bringing together technology and effective teaching strategies is key to boosting engagement in distance learning. Educators should be trained in online teaching methods and how to use interactive tools to make the most of the digital environment. Professional development programs can equip instructors with skills in instructional design, multimedia production, and online facilitation.

Building a supportive online community is crucial for reducing feelings of isolation and encouraging collaboration among students. Tactics involve establishing social areas on the online platform for casual interactions, employing icebreakers to facilitate student introductions, and encouraging peer support systems.

Case studies have shown that when students feel their instructors are present and actively involved, their satisfaction and engagement levels increase. Instructors should strive to be visible in the online environment by regularly interacting with students, providing timely feedback, and showing enthusiasm for the subject matter (Sheridan & Kelly, 2010).

Addressing technical barriers is also essential for fair access to education. Institutions should consider providing resources or support to students who may lack adequate technology or internet access. Partnerships with technology companies or government programs might offer solutions such as discounted equipment or subsidized internet plans.

Continuous evaluation and adjustment are also crucial. In blended learning environments, collecting input from students regarding their experiences can help instructors identify areas for improvement and make instructional adjustments that foster deeper engagement (Garrison & Vaughan, 2008). This could include frequent surveys, comment boxes, or focus groups.

Staying up to date with emerging technologies and teaching innovations allows educators to refine their approaches and meet the evolving needs of students. For example, exploring the use of virtual reality for immersive simulations or artificial intelligence for personalized learning can open new avenues for engagement (DeVaney et al., 2020).

Ethical considerations should also be taken into account, particularly regarding data privacy and security when using online platforms (Krutka et al., 2021). Ensuring compliance with regulations like FERPA or GDPR protects students and maintains trust.

Conclusion

Achieving high levels of involvement in online nursing education necessitates a comprehensive strategy that considers both technology and instructional elements. High-quality audio-video material, coupled with dependable internet connections and other technological prerequisites are essential for a successful online learning experience. The ERR framework provides a structured method to increase involvement by using current knowledge, enabling meaningful learning, and encouraging reflection.

By combining technology with interactive and student-centered teaching methods, educators can create engaging and effective online nursing programs. This approach improves academic performance and prepares students for the real-life obstacles of nursing professions. Continuous research and adaptation are essential to meet the needs of different student demographics and the ever-evolving healthcare landscape as remote learning advances.

Establishing a culture that prioritizes ongoing enhancement, values feedback, and fosters innovation can keep institutions ahead of challenges and ensure the delivery of excellent education. Working together, educators, technologists, and students can create best practices that are beneficial for everyone involved.

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Maksimiranje vključenosti študentov zdravstvene nege v učenje na daljavo: strategije in vpogledi

Povečanje spletnega izobraževanja na področju zdravstvene nege, ki ga spodbujata tehnologija in povpraševanje po prilagodljivem učenju, je poudarilo pomen vključenosti študentov. Sodelovalne igre imajo ključno vlogo pri oblikovanju tako akademskih dosežkov kot tudi pridobivanju ključnih negovalnih veščin. To poglavje raziskuje vpliv tehnoloških dejavnikov, kot sta kakovost zvoka in videa ter hitrost interneta, na vključenost študentov. Poleg tega se poglablja v to, kako se lahko okvir ERR (iz angl. *evocation, realization of meaning, reflection)* – učni pristop, ki vključuje *evociranje, uresničevanje pomena* in *refleksijo* ter druge interaktivne elemente – uporablja v spletnih učnih okoljih za izboljšanje sodelovanja študentov zdravstvene nege. Namen prispevka je ponuditi izobraževalcem praktične vpoglede za izboljšanje spletnega izobraževanja na področju zdravstvene nege s kombiniranjem tehnoloških vidikov in inovativnih učnih strategij.

Ključne besede: izobraževanje v zdravstveni negi, izobraževanje na daljavo, vključenost študentov, okvir ERR, tehnološki dejavniki

Culturally Sensitive and Congruent Digital Learning Initiatives for Health Professions across Europe: Towards an Inclusive European Professional Mobility

Manuel Lillo-Crespo
Universidad de Alicante, Spain
manuel.lillo@ua.es

The importance of digital education seems to have gained momentum since Covid-19 pandemic especially in the field of health professions. Since then more innovative options, new terms, frameworks and uses, introduced in this chapter, have emerged with the aim to assure at least the same quality as the face-to-face traditional educational approaches and recently by including the culturally competent perspective. This progress may contribute positively by avoiding high expenses for organizations and promoting values in digital education such as equity, inclusion and diversity recognition, even when mobility restrictions happen for any reason. The chapter presents the routing guide to developing culturally sensitive and congruent digital learning initiatives for health professionals, according to international organizations and experts, that could be applied worldwide, by outlining the experiential learning and good practices from projects conducted across Europe.

Keywords: Digital health, Cultural Competency, Europe; Education, [Diversity, Equity, Inclusion]

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Introduction

Even though many authors have published on this, a *culturally sensitive learning* context could be understood broadly as a welcoming environment for people of all cultures, where everyone feels recognised, safe and respected, with inclusion of their similarities and differences, free from bias and prejudice (Nijhuis, 2019). *Cultural Sensitivity* is defined as being aware that cultural differences and similarities between people exist without assigning them a value – positive or negative, better or worse, right or wrong – resulting in acceptance, adaptation and integration (Foronda, 2008). Moreover, *cultural congruence* is a process of effective interaction between the provider – understood as the heath professional or the educator – and client or user levels – such as the patients or the students – in which providers must continue to improve their quality of communication (Au & Kawakami, 1994). When it comes to learning initiatives, a *culturally sensitive and congruent learning environment* is, according to the previous statements and definitions published by many authors along the years, understood as the context – real, online or virtual scenarios – where a exposure to cultural differences and similarities takes place, by working in multicultural contexts, by recognising others' education and trainingships in health professions used to focus on one's own cultural aspects and settings throughout face-to-face learning in simulated and real practice. Additionally, mobility programmes have contributed to such traditional learning with a complementary view of other cultural perspectives though being a limited option, only available for some students (El-Messoudi et al., 2023). However, in the last years digital learning initiatives facilitated by distinct forms of technology have appeared providing potentially all students with some element of control over time, place, path and pace; being no longer restricted to the school day or the academic year; and no longer restricted to one's own culture or just very few cultural perspectives (Stork, 2018). These digital learning initiatives may allow people to learn wherever or whenever they choose since these learning materials are online and accessible at any time and can provide students with a broader cultural perspective, consequently preparing future health professionals, whatever their condition is, not only for a professional free mobility across Europe but also for a wider cultural competent professional mobility in a global world. Thus, along the years mobile devices have become especially enticing to educational institutions because of their portability, flexibility, and intuitive interfaces. A growing number of organizations have begun using tablets as a cost-effective strategy in a digital learning environment. Other institutions have embraced a *bring your own device* (BYOD) policy, which addresses pedagogical goals as well as the lack of funds many schools struggle with to support digital learning. BYOD makes digital learning easier by leveraging the devices students already have.

The *digitalisation* process understood as the material process of converting analog streams of information into digital bits and consequently the way many domains of social life are restructured around digital communication and media infrastructures (Brennen & Kreiss, 2016) is an-umbrela concept that falls not only on the side of education and training but also on the communities' and organizations' side. Under the umbrella of *digitalization* the concept of *digital health* represents one important branch that continues to evolve and especially since the Covid-19 pandemic appeared in our lives. First introduced in 2000 by Seth Frank, *digital health* largely encompassed internet-focused applications and media to improve medical content, commerce, and connectivity (Frank, 2000). The term *digital health* has expanded to encompass a much broader set of scientific concepts and technologies, including genomics, artificial intelligence, analytics, wearables, mobile applications, and telemedicine (Boodoo et al, 2017) all of them used not only with patients but also in the training process of health professionals, either in classrooms, during simulation or in practice. In addition, digital health technologies are being applied much more broadly in health professions to include diagnosis, treatment, clinical decision support, care management, and care delivery. In 2018, the *World Health Organization* issued a detailed *taxonomy of Digital Health*, articulating dozens of facets of this expanding space (World Health Orgaanization, 2018). The classification of *digital health interventions* (DHIs) categorizes the different ways in which digital and mobile technologies are being used to support health system needs. Historically, the diverse communities working in *digital health* – including government stakeholders, technologists, clinicians, implementers, network operators, researchers, academics, donors – have lacked a mutually understandable language with which to assess and articulate functionality. A shared and standardized vocabulary was recognized by the World Health Orgaanization as necessary to identify gaps and duplication, evaluate effectiveness, and facilitate alignment across different digital health implementations. Targeted primarily at public health audiences, this Classification framework aimed to promote an accessible and bridging language for health program planners to articulate functionalities of digital health implementations. However, when it comes to education and in relation with *digitalization* and *digital health*, another term *digital learning* appears and many people use it interchangeably in the form of synonim terms such as *distance learning*, *e-learning*, *online learning*, and *virtual learning*. *E-learning*, *online learning*, and *virtual learning* all fall into the umbrella concept of *technology-enhanced learning*. However, they mean different things, and all focus on a different aspect of education. In order to distinguish them, it's useful to think about where and how the learning process happens. The location can be onsite or remote, the communication can be synchronous or asynchronous, the delivery can be online or offline, and the device can be digital or analogue. Here is an overview of how *distance learning, e-learning, online learning,* and *virtual learning* differ in terms of location, communication, delivery mode, and device according to the major assumptions of World Health Orgaanization (2018):

- *Distance learning* simply means that educators and students are in a different location. It doesn't mean the instruction is necessarily delivered online. *Distance learning* has existed for a long time, way before the advent of the Internet.
- *E-learning* means *electronic learning*. An interactive learning application on a tablet not connected to the Internet would be considered an e-learning application, even though it is not online. In fact, in *e-learning*, communication is entirely optional. An in-app curriculum could be crafted in advance, with content being dripped whenever a learner progresses to the next module, without the need for an educator to interact with the students. *E-learning* also doesn't need to be remote. That same e-learning application could be used onsite by students in a classroom with the help of their teacher. Again, *e-learning* simply focuses on the digital aspect of education.
- *Online learning* is about learning over the Internet. However, perhaps counter intuitively, communication is optional in *online learning* as well. Video lectures could be recorded and uploaded in advance, without the option for students to connect together or ask questions to an educator. That probably would not be the optimal instructional design, but it would still be considered *online learning*, as the learning experience is delivered over the Internet. A wider definition of *online learning* would even include any self-directed studies conducted online, such as looking up information on search engines, watching educational videos, or reading blog posts about a study topic.
- The most recent incorporation of these *technology-enhanced learning* approaches is *virtual learning*, which was propelled to the forefront of education during the pandemic. In a virtual classroom, the teacher and the students join the class at the same time, which helps facilitate real-time interactions. Similarly to the traditional classroom, virtual classrooms offer a synchronous experience by allowing students to ask questions and interact with their teachers and their peers. The same way a traditional classroom is usually part of a school, a virtual classroom is often part of a wider *virtual learning environment*, which can include additional resources, such as study material, schedules, assessments, and ways to reach out to members of the school staff outside of class.

Nowadays the challenge is mainly focused on integrating the culturally sensitive and congruent perspective – also understood as culturally competent – into the digital health initiatives. In the following lines we are clarifying key terms and frameworks as well as introducing cases according to the author experience regarding this topic and presenting a routing guide to developing culturally sensitive and congruent digital learning initiatives for health professionals that could be applied worldwide by outlining experiencial learning and good practices from projects conducted across Europe. Once having read this chapter the questions and reflections that come up should make readers wonder if the digital learning initiatives they use and apply daily, could be considered as culturally sensitive and congruent, and if they really fit with the recommendations, principles and characteristics presented.

The Bridge Between European Health Professions' Education and Digital Health

Digitalisation has brought both significant challenges and opportunities in the last years, fundamentally shaping the contemporary educational landscape. However, *digitalisation* applied to health professions' education and trainingship does not only consist on using digital tools with future and current health professionals. It seems obvious that a new scope, framework and major assumptions should be developed and thus understood under the umbrella of a broader term such as *digital health*. In line with this, the *Regional Digital Health Action Plan for the World Health Organization (WHO) European Region 2023–2030* published in september 2022 (World Health Orgaanization, 2022) aimed to contribute to the achievement of health-related and education-related *Sustainable Development Goals*, the *WHO European Programme of Work 2020–2025* (World Health Orgaanization, 2021), the *WHO Thirteenth General Programme of Work 2019–2025* (World Health Orgaanization, 2019); as well as the operationalization of the previous *WHO Global strategy on digital health 2020–2025*. The last Action Plan submitted in 2022 intends to support countries in leveraging and scaling up digital transformation for better health and in aligning digital technology investment decisions with their health and educational systems' needs, while fully respecting the values of equity, solidarity and human rights. The vision of the global strategy is to improve health outcomes for everyone, everywhere, with the recognition of the cultural differences and similarities, by accelerating the development and adoption of appropriate, accessible, affordable, scalable and sustainable person-centred digital health solutions to prevent, detect and respond to epidemics and pandemics, and developing infrastructure and applications that enable countries to use health data to promote health and wellbeing. Therefore it not only consists on providing health professionals and future ones with digital tools during their education but also providing them with a holistic perspective that could be inclusive for cultural aspects. By urging European Member States to promote the digitalization of their health systems including the training of their health professionals, the last regional action plan provides a framework that aims at:

1. recognizing digital technologies as a key determinant of health, both directly and through their interactions with traditional health determinants;
2. developing guidance and building capacity for the digitalization of health systems;
3. transforming health systems and strengthening prevention and well-being;
4. promoting an appropriate enabling environment and foundations for digital health transformation, ensuring equity and building trust;
5. engaging with key partners and leveraging regional networks to foster digital health development and innovation and promote knowledge-sharing; and
6. promoting evidence-informed investments and facilitating the implementation, evaluation and scale up of digital solutions.

Therefore, all the digital learning initiatives designed for and used with health professionals across Europe should be understood under this framework submitted by the *Regional Digital Health Action Plan for the World Health Organization (WHO) European Region 2023–2030* (World Health Orgaanization, 2022) which is characterised for being culturally sensitive and congruent.

Prior to the WHO initiatives for Europe exposed until now, The Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 in the United States (US) sparked the long-awaited adoption of electronic health records (EHRs) by healthcare systems across the country and eventually the development of patient portals, allowing patients online access to key elements of their medical charts. Nowadays high percentages of hospitals in the US and Europe use a government-certified EHR, allow their patients to view health information online and train their staff also in a digitalised and personalised way. HITECH additionally spurred private industry investment in digital health, including mobile health, wearable devices, remote patient monitoring (RPM), and telehealth. Since 2009 HITECH has developed a comprehensive Framework for Digital Health Equity, detailing key digital determinants of health (DDoH), to support the work of digital health tool creators in industry, health systems operations, and academia (Richardson et al., 2022). Later the coronavirus disease 2019 (COVID-19) pandemic highlighted both the continued impact of long-standing systemic oppression on disparate health outcomes as well as the growing importance of digital healthcare.

The Guiding Principles of Health Professions' Digital Learning Initiatives across Europe.

In the implementation of the most recent WHO framework, the guiding principles that should lead all digital learning initiatives for health professions towards the appropriate and sustainable adoption of digital health solutions according to the last Action Plan, within the context of national health sectors and health and digital transformation strategies in Europe, and characterised for being culturally sensitive and congruent (World Health Orgaanization, 2022) are:

1. *Place the individual at the centre of trustworthy care delivered digitally*. The successful uptake and use of digital technologies in health and health professions' education is contingent on a patient-centred approach. Individuals, health workers and patients should be empowered through digital health to make informed choices that benefit the health and wellbeing of themselves, their families and their communities.
2. *Understand health system challenges, including health needs and trends, and acknowledge the needs and expectations of citizens and health workers*. Digital technologies, when used appropriately, can make a substantial contribution to advancing universal health coverage, aiding the work of health professionals, protecting the public in times of emergencies – like for instance the Covid-19 pandemic – and enhancing health and wellbeing.
3. *Recognize the need for policy decision-making based on data, evidence and lessons learned while allowing for continuous learning, adaptation and innovation.* There are still gaps in the evidence base on digital health, and there is a role for WHO and Europe to work with other agencies, Member States, international organizations, academic institutions, civil society and the digital technology industry to learn from previous experiences and strengthen this evidence base. A comprehensive evidence base will help ensure that digital technologies contribute effectively to health outcomes, while minimizing potential risks, and that decisions and investments relating to digital health are sustainable, evidence informed and driven by needs and by lessons learned.

4. *Leverage digital transformation to reimagine the future of health systems.* As countries seek to build more resilient health systems within the context of socioeconomic recovery from the COVID-19 pandemic, national health plans and agendas are being reviewed and enhanced, new and innovative ways of working are being introduced, and significant investments are being made in digital technologies in consultation with stakeholders. It is therefore timely to work with countries to ensure that the innovation agenda, through the adoption of digital solutions, leaves no one behind, improves patient pathways and the delivery of care, and considers the current environment and the necessary changes in financial, infrastructural, human, organizational and cultural resources as part of the digital ecosystem.
5. *Recognize that institutionalization of digital health requires a long-term commitment and an integrated care approach.* Whether at the national, regional or local level, this action plan acknowledges that the institutionalization of digital health requires leadership and a long-term commitment by countries to achieve transformation of health systems and improvement in people's health and well-being.

The strategic Priorities to Develop a Real Digital Learning for Health Professions in Europe.

This Action Plan (World Health Orgaanization, 2022) that apparently focuses only on the field of European population health outcomes and Healthcare systems is strongly linked with health professions´ education and trainingships across the European regions and therefore identifies four strategic priorities for the achievement of this vision that should be considered when designing learning initiatives and innovation proposals:

1. setting norms and developing technical guidance and formulating direction to support decision-making in digital health;
2. enhancing country, regional or local – in any environment – capacities to better govern digital transformation in the health sector and advance digital health literacy;
3. building networks and promoting dialogue and knowledge exchange to facilitate interaction between partners, stakeholders and the wider public to steer the agenda for innovation in digital health;
4. conducting horizon-scanning and landscape analysis for patient-centred solutions that can be scaled up at country or regional level to help

shape public health and health systems, as well as the educational systems, in the digital era.

In an age where digital technology permeates every aspect of our lives; accessing, understanding, and utilising digital health information and systems is paramount, not only to care of populations' health but also towards training those who will be attending those populations – the health professionals. This is not just a matter of convenience, it is necessary for equitable healthcare delivery, empowerment of individuals in managing their health and inclusive education. It is also important to create environments, which are favourable and supportive to the health-related behaviours we want the individuals to engage in. It is not enough to merely provide digital health services, literacy and education for professionals, populations and stakeholders; it must also be ensured that they are culturally sensitive and congruent, appropriate, accessible, and convenient, that individuals whether they are health systems' users or professionals, have the skills and knowledge to use these services effectively, and the systems support them.

The Traditional European Mobility Action for Health Professions' Education and the Potential Contribution of Digital Learning Initiatives to its Improvement.

According to the information provided by the European Union programme for education, training, youth and sport (European Commission, n.d.), the *Erasmus* programme was originally established by the European Union in 1987. It looked to promote closer cooperation between universities and higher education institutions across Europe. This meant setting up an organised and integrated system of cross-border student interchange. Over time, the programme has expanded in its breadth and depth and is now known as *Erasmus+*. Its extended form is a broad umbrella framework which combines former EU's different schemes for transnational cooperation and mobility in education, training, youth and sport in Europe. Increasingly, it is also looking beyond Europe. Since the start of the programme in 1987, over 16 million people have taken part in Erasmus+, thanks to enthusiastic take-up of opportunities by staff, students, young people and learners of all ages. Erasmus began as stand-alone programme for European cooperation and mobility which ran through two programme phases between 1987 and 1994. It became the higher education sectoral programme within the broader *Socrates* programme for education (1995–2006) and the *Lifelong Learning* programme (2007–2013). EU programmes on education and culture expanded, with *Socrates* and *Leonardo* *da Vinci* covering education and training (in the period 1995–2006) and the *Lifelong Learning* programme succeeding these from 2007–2013. In 2014 the EU created a single overarching programme for Education, Training, Youth and Sport. Given its resounding success over the years and the fact that *Erasmus* was far more widely known than the other programme titles, it was decided to extend the *Erasmus* brand name to the whole of the new programme. The '+' is meant to recall that the programme supports more sectors than just higher education as it did at its origins. In this second phase, nowadays the programme is focused on four overarching priorities: (a) supporting the green transition, (b) addressing the digital transformation, (c) promoting social inclusion and diversity and (d) fostering stronger participation in democratic life, common values and civic engagement. In the fields of health professions, until now the European higher education mobility action only supported physical and blended mobility of higher education students in any study field and cycle (short cycle, bachelor, master and doctoral levels). Students could either study abroad at a partner higher education institution or carry out a traineeship in an enterprise, a research institute, a laboratory, an organisation or any other relevant workplace abroad. Students could also combine a study period abroad with a traineeship, further enhancing the learning outcomes and development of transversal skills. While long term physical or face-to-face mobility used to be strongly encouraged, nowadays and especially since Covid-19 pandemic this action plan recognises the need to offer more flexible physical mobility duration to ensure the programme is accessible to students from all backgrounds, circumstances and study fields and therefore digital learning options could be the key solution. Specifically in the case of European health professions' education, *digitalisation* under the umbrella of the European *digital health* framework -presented until now- seems to be the path to be followed. The Mobility action has also aimed until now to foster employability, social inclusion, civic engagement, innovation and environmental sustainability in Europe and beyond by enabling students from all study fields and at all study cycles to have the opportunity to study or train abroad as part of their studies and again digitalision could guarantee this as everyday the number of jobs based on technologies and digital tools are increasing without any need to move from home. The objectives of the traditional mobility action – apart from the main one based on the cultural approach and immersion – that could be assured by including digitalisation are, among others (Pereira et al., 2024):

1) expose students to different views, knowledge, teaching and research methods as well as work practices in their study field in the European

and international context; and not only one – as it used to be with the traditional way;

2) develop their transversal skills such as communication skills, language skills, critical thinking, problem solving, inter-cultural skills and research skills;
3) develop their forward looking skills, such as digital and green skills, that will enable them to tackle the challenges of today and tomorrow;
4) facilitate personal development such as the ability to adapt to new settings, situations and self-confidence.
5) share their expertise with others from other contexts;
6) experience new teaching environments;
7) acquire new innovative pedagogical and curriculum design skills as well as digital skills;
8) connect with their peers abroad to develop common activities to achieve the programme's objectives;
9) exchange good practices and enhance cooperation between higher education institutions;
10) better prepare students for the world of work.

In addition, the digital learning initiatives achieve the objective to foster the development of transnational and transdisciplinary curricula as well as innovative ways of learning and teaching, including online collaboration, interprofessional approach, research-based learning and challenge-based approaches with the objective of tackling societal challenges.

Integrating New Terms Such as Artificial Intelligence, Big Data, E-health, Telemedicine and Nursing Informatics in Health Professions' Knowledge

The interpretation of the concept *digital health* and other related ones remains confussing. As we introduced previously *Digitalisation* means much more than simply using the technology in the classroom. It is a paradigm in which information is accessed, stored, distributed and processed in a digital way. This fundamental change in the way the educational process itself takes place has a profound impact on the entire educational system. One of the most obvious transformations is the increased accessibility to educational resources. *Digital health* expands the concept of *E-health* to include digital consumers, with a wider range of smart devices and connected equipment. It also encompasses other uses of digital technologies for health, such as the *artificial intelligence*, *big data* and *robotics*. Through online platforms, courses and educational materials can be accessed at any time and from anywhere, removing geographical and time barriers. This opens doors to education for those who would otherwise have difficulty accessing traditional learning resources or even difficulties in mobility. *Digitalization* is not just about providing educational content online then. It is also redefining the way educators teach and learn. Consequently, it is not posible to move all the educational resources utilized in the traditional face-to-face directly into the digital ones. The process definetely needs an adaptation that includes a holistic perspective and a culturally sensitive and congruent scope. In fact, emerging technologies, such as *virtual* and *augmented reality*, understood as an interactive experience that enhances the real world with computer-generated perceptual information, enable interactive and immersive learning experiences that may improve comprehension and retention and had not any previous equivalent in the traditional education. It also happens with data analytics tools which can also provide valuable insights into individual student progress and needs, allowing teachers to better personalize learning, something that was unbelievable just some years ago.

Other related terms with digital learning that were defined by the *Global strategy on digital health 2020–2025* (Mariano, 2020) are *Artificial intelligence* which is an area of computer science that emphasizes the simulation of human intelligence processes by machines that work and react like human beings*; Big data* which means rapidly collected and complex data defined by four dimensions: volume, velocity, variety and veracity; *Blockchain* understood as a digital database containing information, such as records of financial transactions, that can be simultaneously used and shared within a large decentralized, publicly accessible network; *e-Health* defined as the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health care services, health surveillance, health literature, and health education, knowledge and research; and *Telemedicine* considered as the delivery of health care services where distance is a critical factor by health care professionals using information and communications technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and the continuing education of health care workers, with the aim of advancing the health of individuals and communities. In the last years another key term that has emerged in the field of Nursing and healthcare is *Nursing Informatics* whic is the specialty that transforms data into needed information and leverages technologies to improve health and health care equity, safety, quality, and outcomes (Abdrbo, 2015). *Nursing informatics* is a field that integrates nursing and Technology and this professional role guarantees the holistic and human perspective in the use of technologies, that is to say the culturally sensitive and congruent scope. Examples of this specialty include using data to make patient care decisions, using technology to collect and store data, and analyzing data to update nursing practices and protocols. Advancements in the future of *Nursing informatics* will center on automated patient and clinical data records, improved operations at health care facilities, simplified data collection, tracking, and analysis, and real-time access to patient information anytime, anywhere.

The Covid-19 as an Outstanding Milestone for the Development of Health Professions' Digital Learning Initiatives

The importance of digital learning, understood as the type of learning facilitated by Technology, seems to have gained momentum since Covid-19 pandemic appeared in our lives. In the aftermath of the lockdown, considerable scholarly attention has been devoted to the examination of online education, encompassing an extensive range of investigations pertaining to its merits and drawbacks. Although the development speed of digital education used to be slower before the historical milestone of Covid-19, since then more innovative options and new uses have emerged with the aim to assure at least the same quality as the face-to-face educational approaches, and in some cases even enhancing the traditional education and permitting higher accessibility. Apart from the barriers related with the existing digital gaps for some populations in the world, like for instance older adults as well as vulnerable and low income people, many stakeholders are scaling up its usability and demanding each day more and more applications to face future challenges. Such is the case of health professions' education in which a range of digital educational options are being refined with special emphasis on simulation. Thus the emergence of online education seems to have revolutionized the learning landscape offering flexibility, accessibility and interactivity. While traditional classrooms are quite effective, digital learning solutions will elevate education to a whole new level by increasing accessibility, engagement, and customization (Lillo-Crespo, 2022).

Teaching and learning digitally and through electronic media are not inherently better or worse than traditional classroom methods, but rather offers a diferent experience for both educators and learners. It brings forth certain challenges tha can be more difficult, as well as certain advantages that can be easier to achieve compared to a traditional classroom setting. Simulated practice in real places settled within the Higher Education Institutions (HEIs) that try to show real scenarios and performing to the maximum the reality of health organizations and other settings where interactions between professionals and patients happen with relation to health and illness, has been for many years the gold standard of the health professions' formal education before students could put one step into real practice settings. However, these simulated environments usually represent only one social and cultural reallity, mainly the one of the context. The reflection at this point should make us wonder who decided the characteristics of such rooms for simulation, what those individuals had in mind and from what cultural perspective.

Even though today we tend to think that online courses refer only to educational programs or classes that are primarily delivered over the internet, progress is demonstrating to us that digital simulation in different forms is much complex than this and may contribute as positively as the traditional real face-to-face simulation avoiding important expenses such as the investment in resources that unfortunately have a quite short timeline and only represent one context, usually the typical one for that audience. However one improvement that has arisen in relation with the latest digital simulation initiatives has to do with the provision of social and cultural scope, something that exists and happens in real life and previous experiences had not taken into account so far. Our students used to be trained even in simulation with just one cultural perspective, one context and in many cases with just one professional view. Nevertheless the social and cultural perspectives stress the provision of important insights and views regarding gender perspective, age perspective, cultural and ethnic perspective, inclusivity and recognition of other gender identities, realities and life experiences, as well as the inclusion of vulnerable populations, far away from the traditional clinical-based simulation style mainly focused on the physical perspective of health and standard population, and being nearer the person-centred and holistic trends.

Therefore, governance of data and digital technology use is a key lesson learned from the pandemic. It has been demonstrated that it is necessary to establish and update digital health platforms. Having well-articulated principles, standards and governance of data and digital technologies during pandemics and other health emergencies is vital to ensure that trust is established in their use and, in turn, for the delivery of an effective and proportionate public health response. Accountability and oversight mechanisms need to be included as part of good governance, in addition to the monitoring and evaluation of the public health impact. The role of publicly owned digital platforms should be strengthened to ensure public trust in and security of public data. In fact, COVID-19 has had a crippling effect on the health care systems around the world with cancellation of elective medical services and disruption of daily life. Experts and authors such as Iyengar et al. (2020) have highlighted the learning opportunities offered by the pandemic and their implication for a better future health care system through a comprehensive review of the current literature undertaken to analyse the consequences of COVID-19 on health care system by using suitable keywords like COVID-19', ‹telemedicine', ‹health care' and ‹remote consultations' on the search engines of PubMed, SCOPUS, Google Scholar and Research Gate. Virtual and remote technologies have been increasingly used in health care management. COVID-19 has offered unique learning opportunities for the health care sector. Yet, according to *Age Platform Europe* this fast digitalization is also pushing aside a growing number of people in preventing them to access essential services, as many older people's organisations across Europe have warned (Kucharczyk, 2021). Therefore not all the results of digitalisation are positive as some of them can be experienced as negative by other populations who do not have the adequate resources. Some paradoxes observed are the advantages of online tools versus the dependency on their smartphone and social media, the availability of a wide range of news sources versus the dangers of disinformation, the ease of use of data-driven services versus the concern for our privacy, security and control over their personal data.

Furthermore, the current epidemic situation has made every HEI acutely aware of the need to create digital, or distance, or blended learning courses. It is vital that these are created in a way that optimizes learning and ensures the students' further development of their skills and competences in the future.

Experiential Learning and Good Practices Across Europe to Develop Culturally Sensitive and Congruent Digital Learning Initiatives

The digital scope is also gaining stakeholders into other sorts of education: *blended simulation* – described as combining hands-on simulation, such as the use of high-fidelity manikins, with computer-based simulation in the same course, *continuing professional development* (CPD) – any type of learning undertaken which increases your knowledge, understanding and experiences of a subject area or role, *combined mentoring* – by combining traditional face-to-face and digital ones, among others. Several proposals have succeeded in international calls funded by the *European Commission* (EC) especially Erasmus+ calls under the purpose to fill the gap of a new digital education paradigm that could cover the current situation lived in different parts of the world and overcome one future characterized by population mobility and the possibility of public health and epidemiological lockdowns and isolations. Digital education also advocates for those unable to move for different reasons (pathologies, disabilities, movement restrictions, among others). Since the beginning, the EC has been witnessing and continuously advancing the idea of one world without boundaries where free mobility of citizenship, including professionals from different fields, is the target. Some of these proposals directly included one digital outcome compared with other previous projects whose objectives resulted in the production of knowledge and outcomes ready to be transferred later on to the digital world.

In the case of the ISTEW Project, *Improvement Science Training for European Healthcare Workers,* several modules were developed though not digitally approached. With the principle aim to develop shared academic and practice based programmes that could enable European universities to build improvement capability and capacity within their own healthcare workforce, through engagement with students based on an agreed scope of practice, essential knowledge base, and improvement science competence across partner countries; ISTEW ended in 2015 and resulted with: four new accredited evidence informed healthcare improvement science modules, a new consensus definition of Healthcare Improvement Science, the evidence on the specific nature of Healthcare Improvement Science in seven European countries, the current state of Healthcare Improvement Science education in seven European countries, and a framework to evaluate the impact of education on practice (MacRae et al., 2016; Lillo-Crespo et al., 2017; Lillo-Crespo & Sierras-Davó, 2019; Lillo-Crespo et al., 2019; Skela-Savič et al., 2017; Sierras-Davó et al., 2021). The Dementia Palliare Project*, Equipping the qualified dementia workforce to champion evidence informed improvements to Advanced Dementia Care & Family Caring through education,* did one step further by designing and creating a *Community of Practice* (CoP) based on the best available evidence on experimental learning. The Community of Practice gives practitioners access to resources and an opportunity to participate in discussion forums in multiple languages. It was a space for those interested in advanced dementia to share an learn from one another. Moreover four modules on advanced dementia care for health and social care professionals across Europe were developed and delivered online by the consortium from seven countries and are accessible to professionals across the globe. These will enhance the impact of modern universities to provide professional life long learning and their commitment to offer evidence based education that maximises the quality of the student experience (Tolson et al., 2016; Lillo-Crespo et al., 2018). E-motion Project, Lights4Violence Project and Demophac Project as well as the previously mentioned only produced podcasts, videos, educational resources, digital books and papers on high sensitivity, dating violence in youth and pharmaceutical care, respectively. The main goal of the E-motion project was to develop, test and implement a comprehensive model of support for highly sensitive children in preschool and early-school age. E-motion resulted in the preparation of an online platform containing a set of questionnaires for high sensitivity assessment as well as educational materials and materials that support work with highly sensitive children for parents and teachers (for teaching staff), the organization of workshops for teaching staff at the international and national levels by every partner institution, as well as theoretical documents such as handbooks, compendiums and frameworks regarding high senstivity (Baryła-Matejczuk et al, 2022). Lights4Violence Project, *Lights, Camera and Action against Dating Violence*, focused on promoting adolescents' capabilities to improve their intimate relationships with their peers through different activities such as seminars with teachers 'Promoting Protective Assets Related to Violence Together', Workshop with adolescents from different countries 'Filming Together to See Ourselves in a New Present', Short film exhibitions with participants, their families, authorities and other stakeholders from different cultural backgrounds; Teaching guides for the use of short films and Computer-based evaluation system (Vives-Cases et al., 2019). However the new era projects have contributed further to a one-world digital education characterised for being inclusive, gender-based, culturally-sensitive, congruent and competent as well as environmentally-friendly, which is another positive point of digital education compared with traditional face-to-face education. In this context, the objectives of *GNurseSIM*, a European Commission funded Project under Erasmus+ are to support HEIs to provide students in geriatric nursing with opportunities during their training to practise skills of adopting a multidisciplinary holistic approach to the care of older patients throughout the High Fidelity Simulation approach (Lillo-Crespo, 2022; Grochowska et al., 2023). This will be achieved by combining elements from different approaches to arrive at a unified model and develop an intercultural, culture-sensitive geriatric nursing course, as well as recommendations and guidelines regarding the implementation of the course and possibilities it offers to other areas of nursing. Moreover another case of good practice to be pointed out are *HEALINT* and *HEALINT4ALL* Projects, both of them supported by the European Commission, whose aim was to support students from the field of health in participating in best practice environments (Jankowicz-Szymańska et al., 2023). They started from the rationale that quality processes must be in place and these require innovation to assure audit material resources that are fit for purpose, can work well within the situation and provide the correct teaching and learning to train auditors. Quality assured clinical learning, including evidence shared across boundaries, will support a globally prepared Medical international workforce able to transfer skills and practice and offer best interventions to enhance patient treatment throughout digital development. Shared evidence is essential within the EU, due to benefits of free movement, of health professionals across borders and cross border healthcare, which includes movement of patients to receive treatment. Such perspective includes requirements to ensure parity of competence and standards of professional proficiency, and their very presence points to the necessity of cultural appreciation and understanding of the needs of patients across borders. *HEALINT* and *HEALINT4ALL* were focused on providing Medical Education and Professionals Allied to Medicine a digital interactive audit system to facilitate quality assurance of EU clinical learning environments so that european Healthcare students will be confident that they can obtain an increased number and variety of safe optimised learning placements through extensive partnerships developed, thus fostering inclusivity. In all these projects one of the most difficult parts was the inclusion of the culturally sensitive and congruent perspective, especially by partnerships in which different cultural groups were represented. In fact, consensus methods were needed in all of them to guarantee the culturally sensitive and congruente scope. All these lessons learned and good practices from the European experience of creating culturally sensitive and congruent digital education and learning initiatives and projects for health professions across Europe are essential for fostering true effective professional Mobility. From the experience of the participants in those projects here are some key components and good practices to be considered that could guide others:

1. Curriculum Development through:
   - Inclusive Content by Integrating diverse cultural perspectives in health education, emphasizing the importance of understanding local health practices and beliefs.
   - Use of Standardized Competencies by creating a framework of core competencies that all health professionals should achieve, allowing for consistency across countries while respecting local contexts.

2. Technology Utilization through:
   - Digital Platforms by using adaptable e-learning platforms that cater to various learning styles and languages, promoting accessibility.
   - Telehealth Training by Incorporating telehealth modules that prepa-

re professionals to engage with diverse populations remotely.

3. Cultural Competence Training through:
   – Workshops and Simulations by implementing training sessions that focus on cultural competence, using role-playing and simulations to address real-world scenarios.
   – Collaboration with Local Experts by partnering with local health professionals to provide insights into regional health issues and cultural nuances.

4. Assessment and Feedback through:
   – Formative Assessments by using ongoing assessments that allow learners to receive feedback on their cultural competence and adaptability.
   – Peer Reviews by fostering peer evaluations across countries to promote cross-cultural understanding and collaboration.

5. Policy and Accreditation
   – Harmonization of Standards by working towards common accreditation standards for health professions that incorporate cultural sensitivity.
   – Support for Mobility by advocating for policies that facilitate easier recognition of qualifications across Europe.

6. Community Engagement
   – Partnerships with Local Communities by involving community stakeholders in the design and implementation of educational programs to ensure relevance and effectiveness.
   – Service-Learning Opportunities by encouraging students to engage in service-learning projects that immerse them in diverse cultural settings.

7. Research and Evaluation
   – Data Collection by gathering data on the effectiveness of digital learning initiatives in improving cultural competence among health professionals.
   – Continuous Improvement by regularly updating programs based on feedback and research findings to ensure they remain relevant and effective.

By prioritizing cultural sensitivity in digital learning initiatives, Europe can enhance professional mobility in health professions, ultimately leading to improved health outcomes and a more collaborative healthcare environment across borders.

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Kulturno občutljive in skladne pobude za digitalno učenje za zdravstvene poklice po vsej Evropi: na poti k vključujoči evropski poklicni mobilnosti

Pomembnost digitalnega izobraževanja je pridobila na pomenu po pandemiji covida-19, zlasti na področju zdravstvenih poklicev. V pričujočem poglavju predstavljamo inovativne možnosti, nove pojme, okvire in načine uporabe digitalnih tehnologij v izobraževanju, ki so se razvili v tem času z namenom zagotavljanja enake kakovosti, kot jo zagotavljajo tradicionalni pristopi k izobraževanju v živo, pri čemer se v zadnjem času vse bolj vključuje tudi kulturno kompetentna perspektiva. Ta napredek lahko pozitivno prispeva k zmanjšanju visokih stroškov za organizacije ter spodbujanju vrednot digitalnega izobraževanja, kot so enakost, vključenost in prepoznavanje raznolikosti, tudi v primerih omejitev mobilnosti zaradi različnih razlogov. Poglavje predstavlja smernice za razvoj kulturno občutljivih in skladnih digitalnih učnih pobud za strokovnjake s področja zdravstva, ki temeljijo na priporočilih mednarodnih organizacij in strokovnjakov ter so lahko uporabne na globalni ravni. Pri tem so izpostavljeni pristopi izkustvenega učenja in dobre prakse iz projektov, izvedenih po Evropi.

Ključne besede: digitalno zdravje, kulturna kompetenca, Evropa, izobraževanje, raznolikost, enakost, vključenost]

Digital Technology in Healthcare: Enhancing Education and Patient Care

Mateja Lorber
University of Maribor, Slovenia
mateja.lorber@um.si

Lucija Gosak
University of Maribor, Slovenia
luucija.gosak2@um.si

Gregor Štiglic
University of Maribor, Slovenia, University of Edinburgh, United Kingdom
gregor.stiglic@um.si

Adrijana Svenšek
University of Maribor, Slovenia
adrijana.svensek1@um.si

The implementation of digital tools, systems, and technologies in healthcare improves education, lowers the risk of errors, and enables the provision of comprehensive, high-quality care to patients. Our study analyzed healthcare students' comprehension and viewpoints on the use of digital technologies in their education and practice. We aim to investigate how healthcare students are educated about digital technology's potential applications during their studies and in clinical practice. Healthcare students provided several practical illustrations of digital technology employment, including e-health records, documentation access, diagnoses, electronic medical records, and mobile health. These examples effectively demonstrate improved communication between healthcare professionals, streamlined data analysis and management, and better patient monitoring. Although digital technology brings significant benefits to healthcare education, students remain mindful of the challenges it poses. We assert that digital technology is essential for improving the quality of healthcare education and providing comprehensive, evidence-based patient care.

Keywords: digital technologies, education, healthcare, teaching effectively

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Introduction

In the age of the digital revolution, educational processes are changing rapidly. According to a UNESCO survey in yeare 2023, 80% of schools worldwide use digital technologies in their daily teaching (UNESCO, 2023). New technologies available to all people that we have unconsciously aligned schooling and learning, as children and adults spend more and more time learning on their own and using the new technologies (Lattouf, 2022). Digital education is an umbrella term for a variety of learning approaches involving many concepts, methods and technologies (Alenezi et al., 2023; Ruzimatov, 2024; Williamson, 2016; Zawacki-Richter & Bozkurt, 2023). It is also often called blended learning and combines online digital education with classroom learning, or fully uses distance learning (asynchronous or combination of asynchronous and synchronous learning) (Ødegaard et al., 2024). Digital eduaction also include, for instance, learning management systems that have become widespread and essential for many institutions (Dobre, 2015), lecture capture and live streaming applications (Bišćan et al., 2021), learning analytics solutions (Viberg et al., 2018), mobile or web-based applications for self-paced or supplementary learning (Gladman et al., 2021, 2023), and virtual reality and artificial intelligence applications (Dhar et al., 2023; Gasteiger et al., 2024). Digital educations are also constantly being introduced into healthcare education, albeit in different forms, with the aim of improving or even revolutionising the way education is delivered. These tools, which are widely used in contemporary teaching and learning, are based on common advances in information and communication technologies (Grainger et al., 2024).

Integration of Digital Technology in the Educational Process of Healthcare

The importance of digital skills for students in higher education is enormous. In today's world, digital technologies are ubiquitous, transforming the way we live, work and learn (Gonzalez-Moreno et al., 2023; Ruzimatov, 2024). To be successful in studying digital technologies, students need to develop the skills and knowledge to use these tools effectively (Falloon, 2020; Kallas & Pedaste, 2022). Digital literacy is particularly important in higher education, where students are expected to be independent researchers, critical thinkers and collaborative learners (Al-Saeed, 2024). The strategic integration of digital technology in healthcare education is crucial to balance its benefits and drawbacks, ensuring personalised, immersive learning while maintaining humanistic values (Khafizova et al., 2023). Healthcare education is an interdisciplinary science that draws on different fields and often uses a biopsychosocial approach to promote health and prevent disease. It is continuous, dynamic and complex teaching and learning process that takes place throughout life and in a variety of settings (Alenezi et al., 2023; Ruzimatov, 2024; Williamson, 2016; Zawacki-Richter & Bozkurt, 2023). It includes education about hygiene, reproductive health, nutrition and other aspects, and helps to address global health challenges by providing community members with the tools they need to implement preventive measures. Most health education programmes are delivered in schools or organisations and follow standardised curricula (Rizvi, 2022). Recently, however, health education has been moving towards a more creative and digital approach and has also included mental health, preventive care and other aspects (Lattouf, 2022; Maria et al., 2023). Although the focus and emphasis on 21st century digital literacies and skills was strong before the pandemic, it has certainly accelerated their recognition and importance (Howard et al., 2021; Scherer et al., 2021; Siddiq et al., 2024). This has been driven in particular by the Covid-19 epidemic has been one of the biggest drivers of change in recent years. The epidemic has in some ways forced health and education systems to introduce new technologies into the learning and working process. As a result, the digital transformation of health and education systems has begun to spread (Glaser & Shaw, 2024; Lattouf, 2022).

However, it has also been noted that there is a lack of empirically tested university curricula that combine humanisation and digital technology education for future health professionals (Gonzalez-Moreno et al., 2023). Accessible technology and universal design have opened up opportunities for students with disabilities. Some 87% of adults with visual impairments reported that accessible technology replaces traditional assistive devices (UNESCO, 2023).

Integration of Digital Technologies in the Education of Nursing Students and Their Use in Clinical Practice

The nursing education process uses a variety of digital tools, including simulation-based learning (Bray et al., 2023; Coyne et al., 2021; Saleem & Khan, 2023), virtual and augmented reality (Kacmaz & Kaçmaz, 2024; Lin et al., 2023; Mehta et al., 2023; Wang et al., 2024), and e-learning platforms (Aouifi et al., 2024; Masalimova et al., 2024). Simulation-based learning, using realistic manikins and interactive software, provides students with the opportunity to acquire practical skills in a safe environment, which contributes to improved clinical skills and decision-making. Virtual and augmented reality enhances these experiences by engaging students in realistic scenarios that allow them to safely practice and improve their skills without putting real patients at risk (Bray et al., 2023; Lee et al., 2024; Zhang et al., 2024). As well as learning through new digital tools, it is important that students are familiar with the technologies used in healthcare. Digital health technologies, such as mobile apps and sensors can continuously collect objective data outside of office visits to improve performance and safety information. These technologies are increasingly being used in healthcare (Beck et al., 2017; Hervás et al., 2013; Kańtoch, 2018; Svenšek et al., 2023). Also Electronic Health Records (EHRs) and telemedicine is playing a crucial role in enhancing the quality of patient care. EHRs simplify the documentation process, improve communication between health care providers, and ensure the continuity of care (Elkefi et al., 2023; Kariotis et al., 2022).

Methodology

The aim of the study was to gain insight into the perceptions and understanding of first year students on a first cycle higher education nursing programme regarding the use of ICT in nursing. We focused on identifying the strengths and weaknesses that students perceived in the use of ICT in nursing and on identifying concrete examples of technologies used in nursing practice. This was done to assess the level of students' awareness and knowledge in this area.

We used a questionnaire with two open-ended questions 'What are the advantages and disadvantages of using ICT in nursing?' and 'Examples of ICT in nursing?' using the digital tool Mentimeter.

As part of a lesson or lecture, students were introduced to Mentimeter, where they entered their answers to the question using their smart devices (phones, tablets, or computers). The answers students entered were anonymous, which helped to keep their answers relaxed and honest. We received 71 responses to the question in which students identified advantages of using information and communication technologies, while 56 students identified disadvantages. The data was then stored and analysed. For the first question, 'What are the advantages and disadvantages of using ICT in nursing?', a qualitative data analysis method was used.

The students' responses were coded and grouped into categories according to similarities in content. In this way, key categories were identified that reflected their views on the advantages and disadvantages of using ICT in nursing.

For the second question, 'Examples of ICT in nursing', we used a data visualisation approach using a cloud presentation. We received 126 student responses. This showed the frequency and variety of examples used, which allowed us to identify the most frequently mentioned technologies and tools that students identified as being used in healthcare.

Results

We have identified the following sub-categories as benefits of using ICT: (1) Easier organisation of work; (2) Control over data; (3) Quality treatment for patients; (4) Access to data; and (5) Learning and gathering evidence-based information. The most commonly cited benefit was easier organisation of work, as data is better organised and more accessible to all health professionals. The use of digital technology also reduces paperwork. All of this contributes to time savings, allowing healthcare professionals more time to provide quality care to patients. Students also pointed out that rapid detection of changes and deviations in patients' health status contributes to quality patient care. It also makes it easier for all healthcare professionals to access patient information. It also gives us more control over the data, allowing us to store, protect and secure it. Some of the students also highlighted the possibility for health professionals to learn and become familiar with new concepts, as well as access to reliable information and communication with other professionals as an advantage of digital technology.

In the Table 1 we have identified the following sub-categories as disadvantages of using information and communication technology: (1) System intrusion and data misuse/loss; (2) Lack of knowledge of how to use information and communication technologies; (3) Information and communication technology failures; (4) Staff workload; (5) Inadequate service delivery; and (6) Misinterpretation of data or inadequate data. The most common disadvantage or danger of using digital technology was described by students as the risk of various types of intrusion into the healthcare system and misuse of data. In addition to intrusions, there may also be failures of computer equipment or networks. Ignorance of the use of digital technology was also identified as an important limitation, particularly among older staff. This can also lead to a burden on staff in terms of time spent, the need for additional training and psychological strain. They also point out that the use of digital technology can lead to misinterpretation of data or miscommunication. It can also lead to a lack of face-to-face contact with patients.

The most common tool or method of using digital technology was the use of data entry using various digital technologies (e.g. tablet, computer, etc.) Students also highlighted the use of e-procurement and the use of electronic filing cabinets as common examples.

technologies recognized and used by nursing students. The size of each word in the cloud reflects its frequency of mention, providing a visual representation of the most common technologies, such as electronic health records, telemedicine, and mobile health monitoring apps (Mediately, zVem). This visualization offers insight into the understanding and adoption of digital technologies among nursing students.

Discussion

The results of our study clearly show that ICT not only facilitate the organisation and control of work, but also provide better access to data, support learning and evidence-based information gathering, and improve the quality

Table 1 Benefits and Disadvantages of Using Communication Technology in Nursing

Benefits of using information and communication technology in nursing	Easier organisation of work	Easier organisation; more organised data; better data organisation; accessibility; less paperwork; more transparency; saves time
	Control over data	All data is stored; no data loss; no data mix–up; backup option
	Quality treatment for patients	Quick access to data; rapid reaction in case of changes; reduced number of errors; improved practice
	Access to data	Fast data accessibility; all data in one place; access to patient data; collection of more data in less time
	Learning and gathering evidence–based information	Learning new concepts; answering health questions; gathering reliable information; corresponding with different experts
Disadvantages of using information and communication technology in nursing	System intrusion and data misuse/loss	Hacking; system intrusion; access to medical records; theft of patient data; deletion of data; pirate attacks
	Lack of knowledge of how to use information and communication technologies	Lack of knowledge of computer use; incorrect data collection; additional training needed; older employees not familiar with use
	Information and communication technology failures	Computer crashes; internet problems; loss of data; no use when power is lost
	Staff workload	Time of use; mental strain on employees
	Inadequate service delivery	We are not focused; incomplete remote treatment of patients during COVID; not accessible to all patients; addiction to technology; more radiation; loss of contact with people; loss of physical contact; less attention to persons; communication gap
	Misinterpretation of data or inadequate data	Misunderstanding of data; misinterpretation of data; plagiarism; not all data relevant/correct; unpredictable sources; use of inappropriate sources (Google)

Figure 1 *Examples of the Use of Digital Information Technology in Nursing*

of patient care. These aspects highlight the key role of ICT in improving efficiency and accuracy in the modern working environment. In what follows, we discuss the wider implications of these findings and explore how further developments in ICT can continue to shape ways of working and producing knowledge.

Already in 2018 in America, Collins et al. (2018) indicate the new era of education, with innovative approaches and either home schooling, online learning, distance learning, etc. It is clear that new skills and approaches are needed if students are to compete effectively in a changing international landscape (Broich, 2015; Siddiq et al., 2024; Wang et al., 2024).

The data show a good knowledge of students' use of technology in terms of computers, tablets and mobile phones. Consequently, we agree with Siddiq et al. (2024), who state that schools must use technology not only to implement the existing educational paradigm, but also to introduce alternative approaches to teaching in order to improve this situation in education. The use of e-procurement and the use of electronic filing cabinets were also highlighted by our students as examples of common practice. Digital technology must make education more learner-centred, interest-based, results-oriented and personalised. Teachers must take on a broader role as coaches and mentors, and assessment must be more nuanced than annual standardised tests allow (Collins et al., 2018; Wang et al., 2024). Digital technology reduces the time that teachers and students spend on irrelevant tasks, time that can be spent on other, more educationally relevant activities and also reduce the cost of test administration, improve the quality of measurement and allow rapid scoring. It also help teachers personalise feedback and teaching by providing immediate feedback (UNESCO, 2023; McClelland & Cuevas, 2020).

Students in our research cited positive examples, noting that rapid detection of health changes through technology improves patient care, increases access to patient information and enables better health monitoring, the latter of which was also cited in the research by Forde-Johnston et al. (2023). Students in our research also highlighted the benefits for healthcare professionals, including learning new concepts, accessing reliable information, and communicating with peers. In addition, the use of digital tools has some negative aspects, such as hacking and misuse/loss of data, lack of knowledge on the use of ICT, ICT failures, etc. and because of this negative aspect is recommended to requires strong cybersecurity measures to protect sensitive patient information. Educators and institutions should prioritise training in digital literacy and data security to ensure that nursing students are competent and confident in the responsible use of these technologies (Nifakos et al., 2021; Singh et al., 2023).

Mobile apps as a digital technology empower healthcare professionals with tools for patient education, medication management, and remote monitoring, thus improving patient outcomes. Students in our research highlighted two mobile apps that they are familiar with (Mediately and zVem). These two mobile apps are also well used in clinical practice in Slovenia. Akhu-Zaheya et al. (2023) concluded significantly improve patients' knowledge of heart failure, making it a cost-effective approach to chronic disease management. Either for calculating units, predicting illnesses, checking medication, etc., mobile apps are most commonly used (Haque & Rubya, 2023; Milne-Ives et al., 2020; Wang et al., 2023). In Slovenia is one of the most used mobile app not only for health professionals but also patients and other people, named *zVem*. The mobile app enables e-ordering, e-prescriptions, triage sheets, and includes medical records (https://zvem.ezdrav.si). The Mediately mobile app is also used in healthcare and well known from students of healthcare. It provides information on medicines, includes various predictive models such as body mass index (BMI) calculations, fracture risk scales, medication dosages, cardiovascular risk calculators and other calculators. It also includes ICD diagnosis codes and various training courses (https://mediately.co/si).

Our research has some limitations that need to be taken into account when interpreting the results. Firstly, it was carried out on a limited sample, which may affect the generality of the findings. We recommend that further research is carried out on larger and more diverse samples to ensure more representative results. Second, technology is changing rapidly, which means that our findings may quickly become outdated. Thirdly, some of the data collected in our study is based on participants' self-assessment, which may lead to subjective bias. These limitations should be taken into account in further research and application of our findings. Our findings clearly show that ICT has an important role to play in improving the efficiency and quality of work and patient care. However, more research is needed to understand the long-term effects and to adapt to rapid technological change.

Conclusion

Our research clearly shows that ICT not only facilitates the organisation and control of work, but also improves access to data, supports learning and evidence-based information gathering, and improves the quality of patient care. These findings highlight the key role of ICT in improving efficiency and accuracy in the modern working environment. Further developments in ICT will continue to shape the way we work and acquire knowledge, and it is important that we focus on research that supports these changes and ensures the safe and effective use of technology.

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Digitalna tehnologija v zdravstvu: izboljšanje izobraževanja in oskrbe pacientov

Uporaba digitalnih orodij, sistemov in tehnologij v zdravstvu izboljšuje izobraževanje, zmanjšuje tveganje napak in omogoča zagotavljanje celovite ter kakovostne oskrbe pacientov. V naši raziskavi smo analizirali razumevanje in stališča študentov zdravstvenih ved o uporabi digitalnih tehnologij v njihovem izobraževanju ter praksi. Naš cilj je bil raziskati, kako se študenti zdravstvenih ved izobražujejo o možnostih uporabe digitalnih tehnologij med študijem in v klinični praksi. Študenti zdravstvenega varstva so navedli več praktičnih primerov uporabe digitalne tehnologije, vključno z e-zdravstvenimi kartotekami, dostopom do dokumentacije, diagnozami, elektronskimi zdravstvenimi kartotekami in mobilnim zdravjem. Ti primeri učinkovito prikazujejo izboljšano komunikacijo med zdravstvenimi delavci, poenostavljeno analizo in upravljanje podatkov ter boljše spremljanje pacientov. Čeprav digitalna tehnologija prinaša pomembne koristi za zdravstveno izobraževanje, se študenti še vedno zavedajo izzivov, ki jih prinaša. Trdimo, da je digitalna tehnologija bistvena za izboljšanje kakovosti zdravstvenega izobraževanja in zagotavljanje celovite, z dokazi podprte oskrbe pacientov.

Ključne besede: digitalne tehnologije, izobraževanje, zdravstvo, učinkovito poučevanje

Exploring Student Perspectives on E-Learning in Nursing Education

Mirko Prosen
University of Primorska, Slovenia
mirko.prosen@fvz.upr.si

Sabina Ličen
University of Primorska, Slovenia
sabina.licen@fvz.upr.si

E-learning has rapidly gained prominence in nursing education, offering flexible alternatives to traditional learning. This study aimed to explore nursing students' experiences with e-learning, focusing on perceived benefits, challenges, and its impact on skill acquisition. Using a qualitative design, data were collected from four face-to-face focus groups comprising 20 nursing students. Thematic analysis was employed to examine the data, yielding six key themes: Flexibility and accessibility benefits, Impact on student engagement and interaction, Technological and infrastructure challenges, Effect on practical skills and learning outcomes, Diverse preferences in learning approaches, and Self-management and motivation in e-learning. The findings indicate that, while e-learning provides accessibility and flexibility, it poses challenges in practical skill development and engagement. This study emphasises the need for adaptive e-learning models to meet diverse learning requirements effectively.

Keywords: online learning, blended learning, thematic analysis, skill development, student engagement

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Introduction

E-learning, defined as the use of digital technologies to facilitate education, has rapidly evolved into a core instructional medium, particularly in higher education. The Organisation for Economic Co-operation and Development (OECD) defines e-learning as a system that is interactive, adaptive, self-determined, and decentralised, overcoming temporal and spatial limitations of conventional learning settings (Prosen et al., 2022). E-learning's flexibility and adaptability make it a compelling alternative to traditional face-to-face teaching, allowing students greater control over the pace and location of learning (Milićević et al., 2021). This shift has not only democratized access to education by breaking down geographical barriers but has also introduced new pedagogical challenges. These, among other things, include maintain-

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ing engagement and ensuring the quality of interaction in a virtual learning environment (Sayaf, 2023).

In addition to providing a flexible approach to learning, e-learning fosters a learner-centred environment where students control the pace and direction of their study, making it particularly beneficial in diverse fields such as healthcare, where students can often customise their learning path to match their specific needs and competencies (Ličen et al., 2022, 2023). Recent studies indicate that students' engagement and academic performance improve through personalized adaptive learning approaches (du Plooy et al., 2024). These systems adapt content to meet individual learners' needs, using indicators such as pre-knowledge assessments and confidence levels to tailor learning experiences. Adaptive platforms, like Moodle for example, play a significant role in enabling these personalized pathways, which have shown promise in increasing both engagement and academic success (du Plooy et al., 2024; Ullah et al., 2023).

Moreover, the COVID-19 pandemic[1] initiated the adoption of e-learning globally, creating an urgency for educational institutions to adapt. In response, higher education institutions have moved from cautious integration of e-learning to a more widespread adoption, which has, in turn, highlighted the need for a robust, supportive infrastructure to ensure smooth delivery and engagement (Chow & Croxton, 2017). This systemic change has led to increased interest in sustainable e-learning models that are resilient to future disruptions (Mashroofa et al., 2023).

However, the expansion of e-learning is not without socio-cultural challenges, especially in culturally diverse regions like Africa (Njenga, 2018), where local culture and technological readiness play crucial roles in technology acceptance. In some settings, deeply-rooted traditions and values can sometimes conflict with the rapid advancement of digital learning, creating resistance among certain student populations (Luppicini & Walabe, 2021). For instance, high-power distance cultures[2] may favour more instructor-led, structured learning, which can sometimes clash with the autonomous nature of e-learning, requiring careful integration of cultural sensitivity into instructional design. These barriers underline the need for contextually adaptive solutions that consider the socio-cultural contexts of the user population

[1] Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus (World Health Organization, 2024).

[2] Power distance refers to the degree to which people in a society accept inequities in power distribution. In high power distance cultures, individuals often show respect for authority, which may affect their decision-making (Hofstede, 2011).

(Njenga, 2018) as well as the needs of a multi-generational, diverse student body, each with distinct learning styles and preferences (Eshun Yawson & Amofa Yamoah, 2021).

The aim of this chapter is to explore the varied experiences of nursing students with e-learning, examining their perceptions, challenges, and insights as they adapt to a digital learning environment. Through a qualitative study, data collected from focus groups were analysed thematically to gain insight into the perspectives of nursing students, revealing both the benefits and limitations of e-learning in their educational journeys. In this study, we aimed to answer two key research questions: What are the experiences and challenges nursing students face with e-learning in health science education? and How do nursing students perceive the impact of e-learning on their engagement, skill acquisition, and overall educational experience?

Student-Centred E-Learning and Constructivist Theories

Student-centred e-learning approaches have gained significant attraction in educational pedagogy, focusing on fostering active participation, critical thinking, and collaborative problem-solving among students. Constructivist learning theory, which underpins many student-centred e-learning models, promotes knowledge construction through interactive, learner-led experiences rather than passive reception of information (Wu et al., 2023). In this model, students actively engage with materials, instructors, and peers, thereby building their understanding through real-world context and social interaction (Tsai et al., 2023).

Constructivism, as detailed in the works of Vygotsky and Piaget, posits that learning occurs most effectively when students are provided with opportunities to explore, inquire, and relate knowledge to prior experiences (Tsai et al., 2023; Tsai, 2008). This approach is particularly relevant in online settings, where digital tools facilitate learner-content, learner-instructor, and peer interactions. For instance, interactive platforms and multimedia resources allow students to construct knowledge dynamically, fostering a deeper engagement with content and a stronger sense of ownership over their learning journey (O'Connor et al., 2022).

In healthcare education, constructivist theories help address complex, real-world challenges by simulating clinical environments through e-learning. For example, problem-based learning (PBL),[3] a constructivist approach

[3] Problem-Based Learning (PBL) is a student-centred educational approach designed to

commonly used in medical training, enhances learners' critical thinking and prepares them for professional scenarios. PBL encourages students to work through real-case scenarios, thus aligning theoretical knowledge with practical application (Wu et al., 2022; Wu et al., 2023). Studies have shown that e-learning platforms using constructivist models improve students' confidence and readiness to face clinical realities (Wu et al., 2023).

Incorporating peer assessment into student-centred e-learning, as guided by constructivist principles, has also been shown to promote critical thinking and self-efficacy. This approach according to Wang et al. (2024) enables students to engage in reflective learning, where they analyse their own and others' work, fostering a deeper understanding and continuous improvement. For example, the 'Understanding-Evaluation-Backward Evaluation-Reflection Peer Assessment – UEBR-PA[4] approach', which includes stages of understanding, evaluation, and reflection, has been demonstrated to enhance students' critical thinking, self-assessment skills, and learning performance in e-learning environments (Wang et al., 2024).

Another valuable application of constructivist principles in e-learning is design thinking, which supports complex problem-solving and fosters innovation (Stefan, 2017). This approach highlights the constructivist emphasis on (e-)learning through experience and iterative processes. By embedding design thinking in e-learning, students are encouraged to approach problems creatively, test solutions iteratively, and learn from experimentation. Research suggests that such methods increase students' motivation and problem-solving abilities, making them better equipped to tackle real-world challenges (Tsai et al., 2023; Wang et al., 2024).

Constructivist learning, therefore, not only enhances academic performance but also prepares students for lifelong learning. By promoting a sense of au-

engage students in active learning by working through complex, real-world problems. This method places students in collaborative groups, where they analyse a given problem, identify knowledge gaps, and develop self-directed learning strategies to find solutions. The underlying philosophy of PBL is constructivist, encouraging students to build their understanding through exploration, discussion, and reflection, aligning new information with prior knowledge (Yew & Goh, 2016).

[4] This constructivist-based peer assessment method is designed to improve the quality and depth of peer evaluations in educational settings by guiding students through four structured phases: (1) Understanding – Students start by thoroughly understanding their peers' work, often using tools like mind mapping to visualise and analyse projects; (2) Evaluation – They then perform a detailed evaluation of their peers' work, using an online forum or similar platforms to provide structured feedback; (3) Backward Evaluation – Students reflect on the feedback they've received, either agreeing with or constructively responding to evaluations made by others; (4) Reflection – Finally, they summarise the entire feedback process, incorporating insights to enhance their own projects (Wang et al., 2024).

tonomy and critical engagement with content, constructivist student-centred e-learning contributes to developing professionals who are adaptive, reflective, and resilient – qualities essential for success in healthcare and other fields that demand continuous learning and adaptation (Berestova et al., 2022).

Challenges of E-Learning in Health Science Education

E-learning has increasingly become a core component in health science education, offering a flexible and accessible means of learning that addresses geographical and temporal barriers. However, this shift brings several significant challenges. One primary challenge in health science education, where hands-on training is crucial, is the lack of practical skill acquisition. Clinical skills traditionally rely on face-to-face training, and many students report that digital learning environments lack the interactive, hands-on elements essential for mastering clinical competence and patient communication. This gap is particularly prominent in areas like nursing, where practical application and direct feedback are integral to student confidence and competence (Mojarad et al., 2023; Ongor & Uslusoy, 2023).

A notable issue within e-learning is the reliance on digital literacy and self-regulation, both of which can be challenging for students unaccustomed to managing their own schedules and learning without in-person guidance. This aspect has been shown to impact motivation and focus, with students finding it difficult to maintain attention during long, screen-based sessions (Choi & Kim, 2024). Moreover, this challenge is exacerbated by limited interaction with instructors and peers, leading to a sense of isolation. In particular, synchronous e-learning settings, which aim to mimic in-person interactions, often fall short of replicating the community and immediacy of face-to-face learning, resulting in diminished engagement (Jin & Kim, 2024).

The technological infrastructure required for effective e-learning also poses challenges. In regions with limited digital resources, students often encounter connectivity issues and lack access to necessary equipment, creating disparities in educational quality and learning experiences (Shahmoradi et al., 2018). Even in well-equipped areas, technical difficulties can disrupt learning flow, and students and instructors alike may lack training on digital platforms, impeding smooth course delivery (Abuzaid et al., 2024).

Academic integrity is another area of concern within e-learning. The digital format, with less direct supervision, can lead to increased opportunities for academic misconduct, raising concerns about the validity and reliability of assessments, particularly in fields that require rigorous competency verification, such as healthcare (Ličen et al., 2023).

Finally, cultural and generational differences in health science classrooms can create additional barriers to e-learning adoption and engagement. Students from high power distance cultures may favour structured, instructor-led learning over the autonomous nature of e-learning, and generational differences in digital familiarity can create further discrepancies in engagement and learning outcomes. These cultural dimensions necessitate tailored, context-sensitive approaches to e-learning design, ensuring that the diverse needs of a multi-generational student body are met (Ličen et al., 2022, 2023; Njenga, 2018; Prosen et al., 2022).

Methods

This study employed a qualitative research design, specifically using thematic analysis to explore the perceptions and experiences of nursing students in relation to e-learning. Thematic analysis, as outlined by Braun and Clarke (2006), provides a flexible yet systematic approach to analysing qualitative data, allowing researchers to identify, organise, and report on patterns or themes within a data set (Kiger & Varpio, 2020). The approach is particularly suited for exploring participant experiences across complex topics, as it provides both a structured and adaptable framework for examining diverse viewpoints (Nowell et al., 2017).

The study sample consisted of 20 nursing students. All students had prior experience with e-learning. This purposeful sampling approach allowed for a range of perspectives, capturing insights from students at different stages and modalities within nursing education.

Data were collected through four face-to-face focus group discussions, each lasting approximately one hour. Focus groups were chosen for their ability to foster interaction and discussion, thus generating a rich exchange of experiences and insights. The decision to conduct four focus groups was guided by research suggesting that data saturation in focus group studies often occurs within three to six groups, particularly when the participant pool is relatively homogenous and the topic complexity moderate (Guest et al., 2016). Each session was audio-recorded and later transcribed verbatim to ensure the accuracy of data for analysis. The use of a semi-structured topic guide allowed for consistency across groups while providing flexibility to pursue emerging topics relevant to participants' experiences (Schweitzer et al., 2024). Some examples of interview questions include: What are your expectations of e-learning? How did you experience e-learning during the COVID-19 pandemic? What infrastructure did you have at home to support your participation in e-learning? How do you see the role of the teacher in e-learning? and What forms of e-learning do you prefer: active participation, a mix of active and passive participation, or more passive forms?

The text analysis was conducted using the software program NVivo, version 1.7.2 (QSR International, Australia). The data were analysed using the six-step process for thematic analysis as outlined by Braun and Clarke (2006) and adapted by Kiger and Varpio (2020). The steps included:

- *Familiarisation with the data:* The researchers reviewed each transcript multiple times to gain a thorough understanding of the content.
- *Generating initial codes:* Key segments of the transcripts were coded based on patterns observed in the data, using both inductive and deductive approaches.
- *Searching for themes:* Codes were then grouped to identify broader themes that represented underlying patterns in the data.
- *Reviewing themes:* Themes were refined and reorganised to ensure coherence and alignment with the research objectives.
- *Defining and naming themes:* Each theme was defined to capture the essence of the grouped codes and was given a descriptive label.
- *Producing the report:* A narrative was developed to present the themes, supported by direct quotes from participants to illustrate key points. The transcripts were originally in Slovenian, and the thematic analysis was conducted in Slovenian to ensure authenticity and accuracy in capturing participants' perspectives. The final results were then translated into English by the authors, who are fluent in both languages, to facilitate reporting and ensure clarity for an international audience.

To ensure the trustworthiness of the findings, the study adhered to criteria including credibility, dependability, confirmability, and transferability as defined by Lincoln and Guba (1985). Credibility was enhanced through member checking, where summaries of findings were shared with participants to validate interpretations. Ten participants confirmed the final conceptualisation of findings. Dependability was supported by maintaining a detailed audit trail documenting each step of data collection and analysis, enabling replication of the methodology (Elo et al., 2014). Confirmability was achieved by maintaining reflexive journals throughout the study, reducing researcher bias, while transferability was considered by providing detailed descriptions of the sample and setting to allow others to assess the applicability of findings to similar contexts (Manojlović et al., 2023).

Ethical approval was obtained from the Commission of the University of Primorska for Ethics in Human Subjects Research (Approval No: 4264-16-3/2022), ensuring compliance with ethical standards in qualitative research. Participants provided informed consent, were assured of their right to withdraw at any point, and were guaranteed anonymity in any publications resulting from the study. The study was co-funded by the ARIS – Slovenian Research and Innovation Agency (Development of a digital education standard in higher education for ensuring equity and accessibility in digital education, J5-4572).

Findings

Sample Strength, Vocabulary Structure and Key Themes: An Initial Analysis

The sample including 15 students enrolled in the Bachelor of Nursing programme and 5 in the Master's of Nursing programme at the University of Primorska, Faculty of Health Sciences, during the academic year 2022/23. Of the Bachelor's group, 6 participants were part-time students. The sample was composed of 13 female and 7 male participants, with an average age of 27.6 years.

The review and analysis of the interview sample indicated a high level of reliability and homogeneity, as confirmed by Pearson's correlation coefficient, which measures word similarity among sources ($r = 0.859$). In this context, the Pearson coefficient suggests a strong correlation, meaning that the vocabulary across different transcripts is highly similar, which reinforces the consistency of responses within the focus groups. This high level of similarity allows for robust analysis as it indicates that the transcripts can be grouped together effectively, highlighting patterns and themes common to the participant group.

As part of the preliminary analysis of transcript characteristics, our initial goal was to identify vocabulary features from a structural perspective. In the early steps, we analysed the most frequently used words across all transcripts (minimum length of 7 letters) and presented this visually through a word cloud (Figure 1) and cluster analysis (Figure 2).

The word cloud in Figure 1 is providing a visual representation of key terms that emerged during the focus group discussions. The words 'education', 'students', 'learning', 'lectures', and 'professors' appear prominently, indicating that these concepts were central to the participants' experiences and discussions. This prominence reflects the primary themes around educational practices, student engagement, and the role of educators in the e-learning context. Smaller but notable words, such as 'support', 'technology', and 'interaction' may suggest additional areas of concern or interest.

Figure 1 Word Cloud of the Most Frequently Used Words

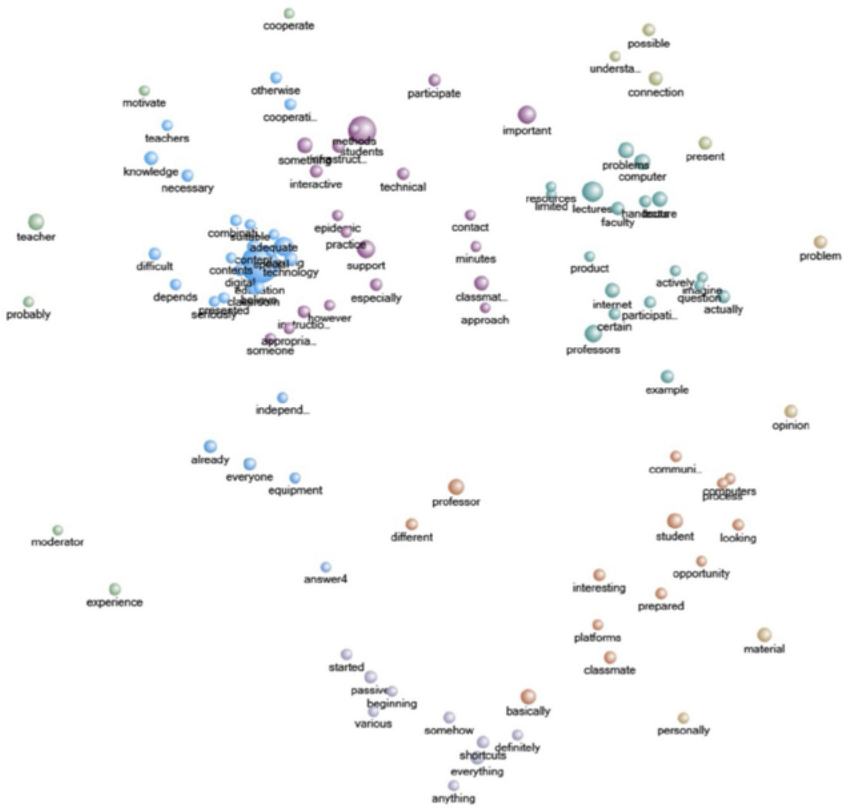

Figure 2 Cluster Analysis

Figure 2 shows the cluster analysis, illustrating how frequently used words are grouped based on their co-occurrence within the transcripts. This clustering provides insight into the relationships between terms, showing which words tend to appear together and may thus represent connected ideas or themes. For instance, clusters around words like 'education', 'students', and 'support' may suggest a thematic focus on the importance of supportive educational structures. Another cluster linking 'internet', 'computer', and 'resources' highlights discussions related to the technological aspects of e-learning, such as the availability of reliable internet and appropriate hardware, which are essential for effective digital learning experiences.

The clustering also reveals smaller, context-specific groups. For example, terms such as 'participate', 'interaction', and 'classroom' may indicate themes around student engagement and the effectiveness of interaction within virtual classrooms. This clustering analysis adds depth to the word cloud by perhaps revealing underlying patterns of association, offering a more nuanced view of the thematic structure within the discussions. These visualisations collectively demonstrated, at least at this stage, that while fundamental elements of education and student support were recurring topics, practical issues related to technology and engagement emerged as significant challenges in the e-learning experiences of nursing students.

Thematic Analysis

The analysis of nursing students' experiences with e-learning revealed six main themes: (1) Flexibility and accessibility benefits; (2) Impact on student engagement and interaction, (3) Technological and infrastructure challenges; (4) Effect on practical skills and learning outcomes; (5) Diverse preferences in learning approaches, and (6) Self-management and motivation in e-learning (Table 1). Each theme presents distinct aspects of the e-learning experience, from the practical benefits of flexible access to the challenges faced in maintaining engagement, overcoming technical obstacles, and adapting learning approaches.

Flexibility and Accessibility Benefits

The theme 'Flexibility and accessibility benefits' emerged strongly across all focus group discussions, highlighting the significant advantages e-learning offered nursing students. This theme illustrates how students appreciated the adaptability of e-learning, which allowed them to balance academic and personal responsibilities more effectively.

Table 1 Identified Themes and Sub–themes

Themes	Sub–themes	Codes
Flexibility and accessibility benefits	Time and cost savings	Saved commuting time; Reduced travel and accommodation costs; Financial accessibility; Flexibility to manage work and studies simultaneously
	Flexible learning environment	Ability to work from home; Coordination with work and study; Balancing personal commitments; Increased comfort from studying in home settings
Impact on student engagement and interaction	Reduced peer and instructor interaction	Lack of in–person socialising; Reduced class discussions; Limited opportunities for peer collaboration
	Distractions and reduced focus	Distractions at home (e.g., family obligations); Challenges with focus in a non–classroom setting; Interruptions from multitasking during lectures; Lowered attention span over extended online sessions
	Passive participation	Reduced motivation to actively engage; Absence of immediate feedback; Tendency toward passive learning
Technological and infrastructure challenges	Connectivity issues	Unreliable internet; System crashes; Inconsistent signal quality
	Equipment limitations	Outdated computers or devices; Lack of access to cameras; Insufficient funds for new equipment
	Software and platform issues	Difficulties with Zoom or Teams; Lack of familiarity with e–learning tools; System outages and crashes; Trouble accessing learning materials
Effect on practical skills and learning outcomes	Limited practical skill development	Reduced hands–on practice; Challenges in clinical skill acquisition; Lack of real–world application; Difficulty applying theoretical knowledge in practice
	Reduced confidence and preparedness	Feeling underprepared for meeting professional standards; Decreased confidence in clinical settings
	Adaptation to digital tools	Navigating new learning platforms; Adapting to online assessments; Learning through digital simulations; Increased familiarity with technology as a learning tool
Diverse preferences in learning approaches	Learning format preferences	Preference for active learning; Hybrid or mixed learning preferences; Interest in synchronous vs. asynchronous learning
	Tool and content preferences	Favouring videos and visual aids; Preference for interactive content; Interest in quizzes and hands–on activities; Preference for materials that allow self–paced learning
Self–management and motivation in e–learning	Self–discipline and time management	Time management difficulties; Procrastination tendencies; Challenges with self–regulation; Struggles with prioritising study tasks over personal activities
	Motivation and engagement barriers	Struggling to maintain motivation; Reduced engagement over time; Loss of interest in online learning; Increased reliance on external reminders or deadlines
	Use of shortcuts in e–learning	Seeking shortcuts during lectures; Multitasking while attending online classes; Engaging in passive learning methods

A key benefit identified by the students was the considerable time and financial savings that e-learning facilitated. By eliminating the need for commuting, students were able to save time, which they could reallocate to other activities, such as work or family obligations. As one participant noted:

> The best thing was that the drive to lectures or to the college was somehow saved. It was physically less tiring, given that we were in our own rooms. [F3]

Similarly, another student shared:

> Yes, maybe this economy of time, so that we also arranged certain things more easily. You could also arrange something during the lectures, because you were on ZOOM and could use the computer for something else at the same time. [F2]

The financial aspect was also highlighted, with one student saying:

> Good things: when the lectures ended, I could immediately focus on work and the things that were waiting for me at home, it was also better because of the logistics – less worries about transportation to the university. [F1]

These savings were especially beneficial to part-time students, who could juggle their studies with employment more conveniently. In addition, the flexible nature of e-learning was also highly valued, as it allowed students to adapt their study schedules to fit around other responsibilities. This flexibility enabled students to balance both work and study commitments more seamlessly. One participant highlighted this benefit by stating:

> I think it was basically great, and because of the job itself, it was easier for me to follow the lectures, because I took advantage of this so that I could actually listen to some lectures from work, which I otherwise wouldn't have been able to. [F4]

Another student reflected on the convenience of e-learning by sharing:

> Among the good sides, I count the fact that you are more flexible, that you can monitor your education retrospectively. [FG2]

Furthermore, some students appreciated the comfort and independence that learning from home afforded, as one participant mentioned:

> The positive sides of e-education were that we were spared the drive, the time that I could schedule my work during the day parallel to the lectures, and I could sleep longer. [FG3]

Impact on Student Engagement and Interaction

This theme highlights the ways in which e-learning affected students' ability to engage actively with both their peers and instructors, reflecting the social and cognitive challenges of e-learning. While the virtual environment offered convenience, it also introduced barriers to effective communication, focus, and active participation.

One of the prominent issues identified by students was the decrease in face-to-face interaction, which impacted their ability to engage fully with both their peers and instructors. This lack of in-person socialisation was highlighted as a significant drawback, as students missed the opportunity to engage in discussions and collaborative activities. One student expressed this sentiment, stating:

> The negative aspect for me was mainly the lack of communication, which led to a weaker relationship with other students. We hardly knew each other by the end of the term. [FG3]

Another student elaborated on the difficulty in connecting with instructors, saying that:

> It was harder to get feedback and clarification immediately. You had to email or wait for a response, unlike in class where you could just ask. [FG2]

This limitation in spontaneous interaction added to a sense of isolation and diminished the collaborative learning experience. Students also faced numerous distractions in the home environment, which hindered their ability to concentrate fully on their studies. The absence of a formal classroom setting, combined with household obligations, often made it challenging for students to remain focused. One student commented:

> It was hard to concentrate at home. There were always family members around, and it's easy to get distracted with other things like cooking or even using the phone during lectures. [FG4]

Another student shared similar concerns, saying:

> I found it hard to keep my attention on the lecture for long periods, especially when it was all on a screen. [FG1]

This lack of focus not only affected their learning experience but also led to gaps in knowledge retention. Furthermore, the structure of e-learning, as experienced by these nursing students, often led to a tendency toward passive participation, where students engaged less actively compared to in-person classes. This shift towards passivity was largely attributed to the absence of immediate feedback and a structured learning environment that encourages active engagement. One student noted:

> When you're just sitting in front of a screen, it's easier to switch off. There's no pressure to participate actively, so it's more passive learning. [FG3]

Another student remarked on the limited motivation to engage actively in online settings, which highlighted a gap in maintaining the same level of engagement and accountability that students were accustomed to in traditional classrooms:

> Sometimes you're just listening, but not really involved. Without the professor physically there, it's easy to zone out. [FG2]

Technological and Infrastructure Challenges

The theme 'Technological and Infrastructure Challenges' highlights the critical role that technology plays in shaping the e-learning experience, especially when students face issues with access, quality, and reliability.

A significant challenge emphasised by many students, especially those living in rural areas, is unreliable internet connectivity, which frequently interrupted their learning process. Many students shared that weak signals and system crashes often led to disruptions during lectures and exams, impacting their ability to focus and retain information. For instance, one participant mentioned:

> The biggest weaknesses were technical problems with the Internet connection. After a whole week of watching the screen, these would be the biggest weaknesses, and maybe there weren't really enough short breaks. [FG3]

Another student expressed frustration over inconsistent signal quality, saying 'I was afraid when it would cut the connection, especially during exams.' (FG4). In addition to connectivity, equipment issues emerged as a significant barrier. Students reported having outdated computers and insufficient funds to upgrade or purchase necessary devices. The lack of cameras, microphones, and other essential equipment hindered active participation in e-learning sessions. As one participant noted, 'I had a bad computer, which also shut down and failed several times during the exam.' (FG3). Another student shared that for some, it was a 'financial challenge' to acquire new equipment, especially during the pandemic.

Students also addressed the difficulties they encountered with the communication/e-learning platforms, such as Zoom and Microsoft Teams. Some students faced frequent system crashes and were sometimes unfamiliar with the platforms, which led to additional stress and time lost during lectures. One participant shared:

> The system went down a lot. We had times when the wrong links were given, and we'd be waiting with no idea what happened [FG2]

Others expressed frustration with the lack of training provided for using these platforms, which often complicated their learning experience.

Effect on Practical Skills and Learning Outcomes

The theme illustrates both the limitations and adjustments that nursing students experience with e-learning in terms of skill development and learning outcomes. While digital platforms offer certain advantages, the lack of hands-on practice remains a significant barrier to students feeling fully prepared for clinical roles.

Many students expressed frustration with the lack of real-world application in the online setting, as practical nursing skills are best learned through in-person experiences. For instance, one participant shared:

> It's hard to apply theoretical knowledge when you don't get the chance to practice it in a real environment. [FG2]

E-learning often left students feeling under-confident in their skills, which in some cases points to the gap between theoretical knowledge and practical competence, exacerbated by the online format. One student noted:

> I don't feel ready to meet the professional standards required in clinical settings. I feel like I'm missing critical hands-on experiences. [FG1]

Many students appreciated learning through online assessments and digital simulations, which helped them become more proficient in navigating new learning technologies. Some also adapted very quickly. One student mentioned:

> While I miss in-person training, I've become more comfortable with digital tools that I know will be part of my career. [FG3]

This adaptation reflects a form of resilience and a willingness to engage with digital learning tools despite the challenges.

Diverse Preferences in Learning Approaches

This theme captures the various learning preferences nursing students exhibited in an e-learning environment, reflecting the need for educational flexibility to accommodate diverse student needs.

Students expressed varied preferences for different learning formats, with some showing a strong inclination toward active learning environments, while others preferred hybrid or mixed approaches that combined synchronous and asynchronous sessions. For instance, one participant noted:

> Active participation helps me stay engaged, but I find that a mix of both live and recorded sessions works best, allowing flexibility around my schedule. [FG2]

Another participant highlighted their interest in synchronous learning to maintain a structured routine, stating:

> Synchronous sessions keep me on track, whereas asynchronous ones sometimes make it easy to procrastinate. [FG3]

Students showed preferences for specific types of educational tools and content, such as videos, visual aids, quizzes, and interactive activities, which support different learning styles and help maintain engagement. Two participants said:

> I learn best with interactive content, especially quizzes and hands-on activities that make the material more engaging. [FG4]

> Videos are incredibly helpful for visualising concepts, and I appreciate self-paced materials that let me take my time. [FG3]

Self-Management and Motivation in E-Learning

In the context of e-learning, nursing students highlighted challenges related to self-management and sustaining motivation. This theme demonstrates the personal discipline required to balance study with other responsibilities and maintain engagement without the structure of in-person learning.

Students frequently mentioned difficulties with time management and procrastination in e-learning, pointing to the need for greater self-regulation to stay on track with assignments and study routines. As one participant described:

> It's easy to fall behind because you're not physically in class. Without someone reminding you, managing time becomes a personal struggle. [FG2]

Another student added:

> I sometimes found myself prioritising personal tasks over studying, thinking I could catch up later, but it often didn't work out. [FG3]

Many students experienced reduced motivation over extended periods of online learning. The lack of face-to-face interaction seemed to diminish their enthusiasm and engagement, making it harder to stay committed. As some explained:

> At first, I was motivated, but over time, I found it difficult to remain engaged. There was no one to push me, and it felt isolating. [FG4]

> The novelty wore off quickly, and I started losing interest because there was no immediate feedback or real human connection. [FG1]

Some students admitted to taking shortcuts during online classes, a tendency linked to the flexibility of the format. For instance, participants noted using their phones or multitasking during lectures, which detracted from the depth of learning.

> Sometimes, I just logged in and then went back to doing other things at home. It was tempting to do so, especially when you had other responsibilities. [FG3]

> I would occasionally just tune in for attendance, not paying full attention to the lecture. [FG4]

Discussion and Conclusion

This study highlights the nursing students' experiences with e-learning, revealing both the benefits and challenges inherent to digital learning environments in health sciences. Consistent with findings by Mashroofa et al. (2023), e-learning's flexibility emerged as a significant advantage, particularly for students balancing academic, work, and personal commitments. However, as highlighted in similar studies (Ličen et al., 2022; Mojarad et al., 2023), these benefits are often tempered by unique challenges, especially in disciplines like nursing that depend on hands-on skill development.

Flexibility associated with e-learning was widely valued by students, aligning with global findings on the advantages of asynchronous learning in enabling self-paced study (Sareen & Mandal, 2024). While this adaptability supports accessibility, it also emphasises the need for robust technological infrastructure. Sayaf (2023) and Mojarad et al. (2023) further noted that flexible learning alone does not ensure quality engagement, with infrastructural inconsistencies often amplifying accessibility issues.

Our study also identified challenges in maintaining engagement, consistent with research by Njenga (2018) and Wu et al. (2022), who found that while e-learning supports knowledge dissemination, it often lacks the interpersonal dynamics necessary for effective learning (Luppicini & Walabe, 2021). The absence of direct interaction can undermine collaborative learning and skill-building, particularly in fields like nursing, where peer and instructor interactions are integral to professional development (Eshun Yawson & Amofa Yamoah, 2021).

Technological challenges, such as unreliable internet and insufficient equipment, were also highlighted. These limitations align with findings from Wu et al. (2022), which suggest that technology infrastructure is often a barrier to e-learning success, particularly in low-resource settings where students face inequitable access to essential tools (Luppicini & Walabe, 2021). Ensuring access to reliable technology and internet resources still remains a critical component in supporting effective digital education.

A core concern for nursing students was the difficulty in acquiring practical skills through e-learning alone. The importance of hands-on experience is well-documented in constructivist learning theory, which emphasises experiential and applied learning as essential for knowledge retention (O'Connor et al., 2022). Research indicates that while e-learning can support theoretical knowledge acquisition, practical competencies require blended learning approaches that incorporate real-world application (Ličen et al., 2023). Thus, hybrid models that integrate digital learning with in-person practical sessions may offer a more comprehensive learning experience in health sciences.

Our study's findings on varied student preferences for learning styles indicate a need for more personalised pathways in e-learning. Research by Tsai et al. (2023) supports this, showing that constructivist approaches that accommodate individual preferences enhance both engagement and academic outcomes. Adaptive platforms that allow students to interact with content in diverse ways could be instrumental in meeting these varied needs effectively.

Many students highlighted self-management and motivation as ongoing challenges in e-learning. While e-learning enables self-directed learning, it also demands high levels of intrinsic motivation, as found in other studies examining the motivational aspects of digital education (Ličen et al., 2022).

Self-regulation tools, such as mentoring programs and digital progress-tracking, may offer valuable support in this regard.

While this study provides valuable insights, there are limitations to consider. First, the generalizability of these findings is inherently limited due to the single-institution sample size. Qualitative research, by design, does not aim for statistical generalisability, yet transferability is possible through rich, descriptive analysis (Polit & Beck, 2017). Future studies should include participants from various institutions and cultural backgrounds, allowing for greater transferability and broader applicability. Moreover, sample diversity within this study focused solely on nursing students, potentially limiting applicability across other healthcare disciplines. Future research should consider expanding to include multiple healthcare fields, which could reveal discipline-specific differences in e-learning engagement. Methodologically, future studies could employ mixed methods to provide a comprehensive view of e-learning's impacts, blending quantitative and qualitative data for richer insights (Flick, 2018). A longitudinal design could further explore how students' e-learning experiences and engagement evolve over time, providing a dynamic understanding of adaptation to digital platforms.

In conclusion, while e-learning provides flexible, accessible opportunities for nursing students, challenges in engagement, infrastructure, and skill development highlight areas for improvement. Adaptive, blended models with robust support structures will be essential to ensure e-learning can fully support the development of competent healthcare professionals.

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Raziskovanje študentskih perspektiv o e-učenju v izobraževanju zdravstvenih delavcev

E-izobraževanje je hitro postalo pomemben pristop v izobraževanju za zdravstveno nego, saj ponuja prilagodljive alternative tradicionalnemu učenju. Namen pričujoče raziskave je bil preučiti izkušnje študentov zdravstvene nege z e-izobraževanjem, s poudarkom na zaznanih prednostih, izzivih in vplivu na pridobivanje veščin. S kvalitativnim pristopom so bili podatki zbrani s štirimi fokusnimi skupinami, v katerih je sodelovalo 20 študentov zdravstvene nege. Za analizo podatkov je bila uporabljena tematska analiza, ki je izpostavila šest ključnih tem: prednosti prilagodljivosti in dostopnosti, vpliv na vključenost in interakcijo študentov, tehnološki in infrastrukturni izzivi, vpliv na praktične veščine in učne izide, različne preference v učnih pristopih ter samoregulacija in motivacija pri e-izobraževanju. Ugotovitve kažejo, da e-izobraževanje ponuja dostopnost in prilagodljivost, vendar predstavlja izziv pri razvoju praktičnih veščin in vključenosti. Raziskava poudarja potrebo po prilagodljivih modelih e-izobraževanja za učinkovito zadovoljevanje raznolikih učnih potreb.

Ključne besede: spletno učenje, kombinirano učenje, tematska analiza, razvoj veščin, vključenost študentov

The Use of Simulations for the Development of Cultural Competencies in Nursing Education: An Integrative Review of the Literature

Igor Karnjuš
University of Primorska, Slovenia
igor.karnjus@fvz.upr.si

Sabina Ličen
University of Primorska, Slovenia
sabina.licen@fvz.upr.si

Mirko Prosen
University of Primorska, Slovenia
mirko.prosen@fvz.upr.si

Simulation-based learning is a creative teaching method that provides a platform for the integration of cultural concepts and promotes interactive encounters that can be further analysed and developed. The aim of this integrative review was to determine the validity and effectiveness of simulation as a teaching and learning method for the acquisition of cultural competence in nursing students. The CINAHL, PubMed and Science Direct databases were searched for articles, which resulted in 17 papers being included in the review. Results revealed that the standardized patient is most commonly used in simulation scenarios for the development of cultural competencies. The most commonly defined objective was to increase knowledge of cultural competences, and learning elements within the cognitive and affective domains were best developed. Our findings support the continued use and development of simulation for educational purposes to improve the cultural competence of nursing students.

Keywords: cultural competencies, nursing, simulations, transcultural nursing

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Introduction

Since 2015, Europe has been facing a migration crisis and an increasing number of asylum seekers (Eurostat, 2022). Although immigrants are entitled to equal healthcare, they often encounter barriers in communication and in obtaining adequate information about their rights due to different cultural characteristics. The staff providing care may not be 'diversity-sensitive' and are often inadequately educated about the characteristics of other cultures (Permanand et al., 2016). Because people are associated with their respective cultures, a lack of knowledge can lead to stereotyping, prejudice, and discrimination (Loredan & Prosen, 2013). Consequently, the quality of healthcare decreases, and immigrants may be discouraged from seeking care again (Permanand et al., 2016). The importance of cross-cultural knowledge among nurses has been highlighted by many theorists, with Madeleine Leninger and Campinha Bacote being particularly central in the theory of cross-cultural nursing. To provide culturally competent nursing care, the nurse needs to be able to effectively transfer the knowledge and skills acquired to the care of the individual, family or community, while incorporating the cultural characteristics of those caring for them into the planning and delivery of care (Prosen, 2018).

Permanand et al. (2016) note that the knowledge and skills acquired in cross-cultural nursing education are often not successfully transferred to the clinical setting. The need for experiential learning that would facilitate the easier transfer of the aforementioned acquired knowledge into the daily care of foreign patients, was the reason for the introduction and use of simulations in the educational process, both in formal and informal healthcare education (Lavoie & Clarke, 2017). The main benefit of simulations is the opportunity to acquire new knowledge and skills in a safe and controlled environment, while also encouraging critical thinking (Murphy et al., 2011). In nursing, various types of simulators are used to conduct simulated experiences depending on the purpose and objectives of the educational process (Karnjuš & Pucer, 2012). As clinical scenario-based simulations are a recognized teaching method in nursing education, scenarios that incorporate culturally significant variables have been developed over the past decade through simulations to assist nurses and nursing students in acquiring cultural competencies (Ozkara San, 2015). When conducting a simulation aimed at teaching cultural competency, it is important to choose the type of simulation wisely and include the cultural characteristics to be considered in the scenario. Elements such as religious beliefs, dietary practices, language barriers and non-verbal communication, culture-specific dress and family dynamics can be included in the scenario used during the simulation (Haas, 2010).

Simulation learning outcomes can be measured by changes in learner satisfaction with the learning process, knowledge acquired, skills mastered, changes in attitudes toward specific content (Warren et al., 2016), and awareness of content covered (Noji et al., 2017). These outcomes can be categorized into three different domains: psychomotor domain (manual/physical skills), affective domain (attitudes, self-esteem, interests), and cognitive domain (knowledge) (Alexander et al., 2015). However, the use of simulations solely for the acquisition of cultural competencies is still a relatively unexplored area (Ozkara San, 2015). Therefore, the aim of this integrative literature review is to determine the effectiveness and established use of simulations as a teaching and learning method for acquiring cultural competencies.

Based on this aim, we have formulated the following research questions:

1. What types of simulators and learning objectives have been most commonly identified for developing cultural competencies among nursing students and professionals?
2. Which learning elements (knowledge, skills, attitudes and cultural sensitivity and awareness) are best developed through simulations in the training of cultural competencies among nursing students and professionals?

Materials and Methods

A comprehensive integrative literature review was conducted (Whittemore & Knafl, 2005) to encompass both experimental and non-experimental studies, thereby aiming to garner a comprehensive understanding of the extant evidence concerning the utilisation of simulation as an educational tool in the cultivation of cultural competence in nursing students.

Method of Review

The literature search was carried out in the international databases CINAHL, PubMed and Science Direct. By combining the keywords and using Boolean operators (AND, OR), we formulated the following search strategy: (simulation* OR Patient simulat* OR Standardized patient* OR Computer-based simulation* OR Screen based simulation*) AND (Cultural* competen* OR Transcultural education OR Multicultural education OR Cultur* care) AND (Nursing OR Nursing student*). The asterisk (*) represents all possible attachments to the root of the word. We included literature published from January 2012 to December 2023. The inclusion criteria used are shown in Table 1.

Table 1 nclusion criteria for the literature search

Inclusion criteria	
Topic	Cultural competence, simulation, transcultural nursing.
Type of publication	Original and review scientific article
Accessibility	Full text accessible
Population	Nursing students
Publication time period	2012–2023
Language	English

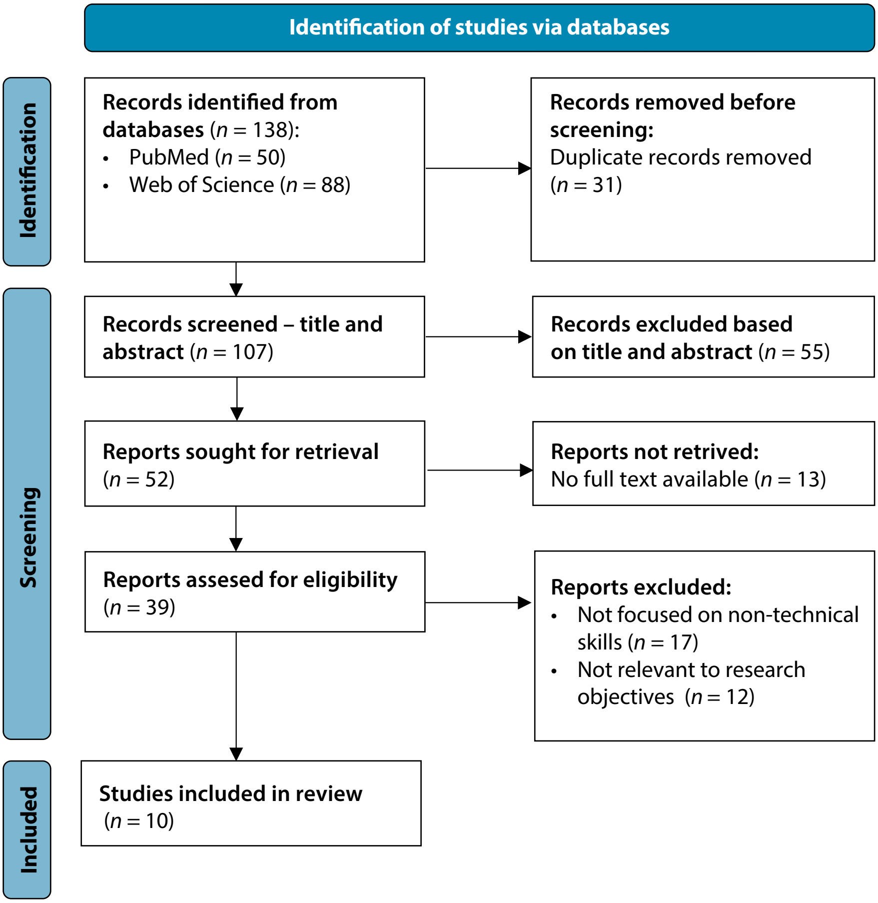

Figure 1 The Literature Search and Study Selection Process, Presented With PRISMA Statement Flow Diagram (Moher et al., 2009)

Review Results

Figure 1 shows the literature search process according to the PRISMA methodology (Moher et al., 2009). We identified 168 hits in CINAHL, 137 hits in PubMed and 401 hits in Science Direct. All hits were imported into Zotero for easy organization, citation and referencing. After removing 293 duplicates, we screened 413 hits based on title and abstract, of which 373 were removed for thematic inappropriateness. In the next step, we screened 40 articles in full-text and retained 21 of them, after which we additionally excluded 4 articles on the basis of inadequate quality. Finally, 17 articles were included in the detailed literature analysis, as shown in Figure 1.

The selection of the literature was based on the relevance and quality of the articles selected. The quality of the articles was assessed using the Joanna Briggs Institute (JBI) critical appraisal tools: the JBI Systematic Reviews Checklist, JBI Checklist for Quasi-Experimental Studies and JBI Checklist for Qualitative Research. The articles were primarily separately evaluated by two researchers, with a third author involved in case of differences in the ratings for each study. Each article could be graded on one of four levels: inadequate, sufficient – C, good – B, excellent – A. If an article was graded as inadequate, it was excluded from further analysis. Following an assessment of the quality of the articles, it was determined that 11 studies were of excellent quality, four were of good quality, and two were of sufficient quality.

Data Analysis

The data were analysed using an inductive, descriptive synthesis approach (Polit & Beck, 2012). The research questions served as the foundation for identifying relevant expressions within the data, which were subsequently tabulated. To synthesize the findings, tabulation was employed to identify similarities and differences, organizing the data into categories that were named based on their content.

Results

In the final analysis, we included 17 studies investigating the effectiveness and established use of simulations as a teaching and learning method for the acquisition of cultural competencies.

Types of Simulators and Educational Content Related to Cultural Competence in Nursing Students

In this part of the results, we focused on the type and purpose of the research, the specific simulation techniques used, the educational content covered in the scenarios, and the main findings. Table 2 shows the main characteristics of the individual studies included in the final analysis.

The simulation methods employed in this integrative literature review were diverse (Table 2). The simulations included high-fidelity simulations, standardized patient simulation, virtual simulations, screen-based simulations, and role play. A study on low-fidelity simulation (Phillips et al., 2012) demonstrated the significance of the visual representation of task trainers, such as the skin colour used in the training device, for cultural learning. Furthermore, it was essential to reinforce the simulation environment with culturally specific elements. In another study, cultural competency was practised in the con-

Table 2 Key Information from Studies Investigating Simulations as a Learning Method for Acquiring Cultural Competencies

Author, year/Country	Aim of the study	Research design	Type of simulation	Educational content	Main findings
(Grossman et al., 2012)/ USA and Norway	To evaluate the impact of two simulation scenarios with cultural content, on two groups of nursing students, one in Norway and one in the United States.	Mixed methods study (questionnaire + focus group)	Standardized patient	Religion (Muslim and Italian/Catholic patients/ families)	The study demonstrated an enhancement in nursing students' cultural awareness following their participation in a simulation experience.
(Phillips et al., 2012)/USA	To ascertain how the utilisation of simulations can facilitate the acquisition of culturally competent care skills within the patient's home environment.	Qualitative research (focus group)	Low–fidelity patient simulator	Ethnicity (multi–member family of Hispanic cultural background)	The simulated home visit helped students synthesize concepts relevant for community and public health nursing, occupational and environmental health, and cultural awareness.
(Seckman & Diesel, 2013)/ USA	To explore the concepts of teaching cultural competences using a high–fidelity simulator and to show how these simulation situations affect students' confidence in providing culturally competent care.	Qualitative research (focus group)	High–fidelity simulator	Ethnicity (patient of Arab cultural background)	Nursing students gained a better appreciation of the importance of obtaining culturally appropriate assessments in order to provide culturally competent care.
(Garrido et al., 2014)/USA	To describe the development and integration of the simulation experience, integrating interprofessional and cultural competences into the health professions curriculum.	Mixed methods study (questionnaire + focus group	Role play	Race, ethnicity and religion (Korean Christian, Mexican migrant worker and Jehovah's Witnesses)	There has been a notable enhancement in the students' cultural awareness, accompanied by a discernible advancement in their communication abilities and an elevated proficiency in discerning the distinctive attributes of a given culture.
(Ndiwane et al., 2014)/ USA	To assess the efficacy of a culturally competent nursing curriculum among nursing students.	Mixed methods study (questionnaire + focus group)	Standardized patient	Race and ethnicity (pregnant South American woman, African American with hypertension, South American with diabetes)	The objective scoring of nursing student competency from the SPs was positive. The students perceived that their critical thinking skills were enhanced.
(Everson et al., 2015)/ Australia	To determine the impact of an in–depth simulation on nursing students' empathy towards culturally and linguistically diverse patients.	Mixed methods study (questionnaire + interview)	Screen–based simulation	Ethnicity (Anglo-Celtic Australian society)	Students' empathy towards culturally and linguistically diverse patients significantly improved after exposure to the 3D simulation experience.
(Hamilton, 2016)/USA	To ascertain the level of cultural competence among nursing students who took part in a simulation designed to enhance their cultural competence.	Mixed methods study (questionnaire + interview)	Standardized patient	Race and ethnicity (Indian minority and African Americans)	The study suggests that bringing attention to cultural competence through participation in Transcultural Humility Simulation Development could raise awareness and foster developmental growth among student participants through transformative learning.

Continued on next page

Author, year/Country	Aim of the study	Research design	Type of simulation	Educational content	Main findings
(Tiffany & Hoglund, 2016)/USA	To explore topics on cultural awareness, diversity, and cultural sensitivity.	Qualitative research (essay–type questionnaire + focus group)	Screen–based	Race and ethnicity (homeless veteran, overweight woman, Somali migrant and paraplegic)	Nursing students indicated that they increased their own capacity to understand, appreciate, and relate to people different from themselves. This case study demonstrated that valuable learning regarding complex topics can take place in the virtual world.
(Hickerson et al., 2018)/USA	To determine the level of knowledge, skills and attitudes of nursing students in relation to the health of LGBT patients.	Mixed methods study (questionnaire + focus group)	Standardized patient	LGBT patients	After standardized patient simulation, the students were better able to interview, provide safe space and use open language with lesbian, gay, bisexual and transgender patients and were more confident discussing safe sex practices.
(Ozkara San, 2019)/USA	To evaluate the impact of an educational strategy for teaching cultural competences using simulations.	Mixed methods study (questionnaire + focus group)	Standardized patient	LGBT patients	The standardized patient simulation influenced statistically significant increase in students' transcultural self–efficacy perceptions. Evidence–based strategies such as the standardized patient simulation can offer a valuable guide for educators to foster cultural competence education.
(Ozkara San et al., 2019)/USA	To evaluate the level of knowledge, skills, attitudes and confidence of students in caring for an LGBT patient experiencing an oncological emergency.	Mixed methods study (questionnaire + focus group)	Standardized patient	LGBTQ patients	Nursing students strongly agreed that the Transgender SP simulation met with their learning expectations and needs and improved their ability to provide culturally sensitive care.
(Englund et al., 2019)/USA	To ascertain whether role–playing among students had an impact on their confidence in taking medical histories and providing culturally competent care for patients in the LGBTQ community.	Mixed methods study (questionnaire + focus group)	Role play	LGBTQ patients	The results demonstrated a statistically significant difference in knowledge regarding LGBTQ–specific health issues following the course. The findings from this study indicate that the role–play is an effective method of teaching, resulting in improved students' gay–affirmative practice beliefs.
(Byrne, 2020)/USA	To ascertain the level of cultural competence among nursing students and to make a comparison between traditional teaching (lectures) alone and combined with the use of a standardized patient.	Mixed methods study (questionnaire + focus group)	Standardized patient	Race and ethnicity (African Americans and South Americans)	The study showed that the use of SP is an effective strategy for teaching cross–cultural care in nursing education, especially as a supplement to traditional lectures.

Continued on next page

Author, year/Country	Aim of the study	Research design	Type of simulation	Educational content	Main findings
(Marja & Suvi, 2021)/ Finland	To identify the current evidence available on the learning of cultural competence among health care students using simulation pedagogy.	Literature review (The CINAHL, PubMed and ERIC databases were searched for articles published between 2009 and 2019, resulting in including 17 articles in the review.)	Literature included a review of various type of simulation (LFS = Low fidelity simulation; SPS = Standardized Patient Simulation; VR = Virtual simulation; HFS = high–fidelity (manikin).	Various aspects of transcultural care (ethnicity, religion, cultural difference)	Various simulation methods could be accompanied with traditional teaching methods, as these improve both culturally important skills and knowledge as well as promoting the acquisition of culturally aware attitudes and, finally, improving patient–centred care.
(Qin & Chaimongkol, 2021)/Thailand	To explore the literature on the effectiveness of using standardized patients to increase nursing students' cultural competence.	Literature review (The PubMed, ISI, Scopus, CINAHL, Medline, Eric and Science Direct databases were searched for articles published between 2009 and 2019, resulting in including 10 articles in the review.)	Standardized patient	Various aspects of transcultural care (ethnicity, religion, cultural difference)	A combination of lecture, case–based learning, and simulation with standardized patient can increase nursing students' cultural competence.
(Fung et al., 2023)/five Asian regions (Hong Kong, Mainland China, Thailand, Korea, and Taiwan)	To compare the effectiveness of virtual simulation and PBL on the perceived clinical and cultural competence for nursing students.	Quantitative method (Three self–reported questionnaires)	Virtual reality patient	Ethnicity, religious and linguistic barriers (different Asian ethnicity). Cultural questions were added to the discussion, such as sharing how different countries prioritize different nursing diagnoses.	The virtual simulation group exhibited greater improvement in perceived clinical and cultural competence than the PBL group.
(Altmiller et al., 2023)/ USA	To determine the effect of a virtual patient simulation scenario of caring for a transgender adult on nursing students' attitudes and beliefs about transgender people.	Quantitative method (questionnaire)	Virtual reality patient	LGBTQ+ community	Virtual reality patient is an effective tool in teaching cultural competence and sensitivity when caring for transgender patients.

Legend LGBTQ – lesbian, gay, bisexual, transgender and queer text of different cultural and ethnic backgrounds in a high-fidelity simulation (Seckman & Diesel, 2013). In the studies examined, the use of a standardized patient was the most frequently mentioned simulator for the development of cultural competencies. These competencies were most frequently mentioned in the context of caring for racially and ethnically diverse patients (Byrne, 2020; Grossman et al., 2012; Hamilton, 2016; Ndiwane et al., 2014) or patients' sexual orientation and gender identity (Hickerson et al., 2018; Ozkara San, 2019; Ozkara San et al., 2019). Two studies employed the virtual simulation method (Altmiller et al., 2023; Fung et al., 2023), which addressed a range of topics, including the implementation of culturally appropriate care plans, the exploration of concepts related to cultural competency, and the assessment of advanced communication skills. Two studies employed screen-based simulations to explore cultural, environmental needs and attitudes towards poverty in care (Everson et al., 2015; Tiffany & Hoglund, 2016). Two further studies utilised role play as a simulation method (Englund et al., 2019; Garrido et al., 2014), with one of these studies focusing on patients' sexual orientation and cultural needs. In designing the scenarios, authors most frequently utilized the Campinha-Bacote model of cultural competence, Jeffreys' Cultural Competence and Confidence Model, and the Purnell Model for Cultural Competence. Alongside the selected cultural model, some studies also incorporated the International Nursing Association for Clinical Simulation and Learning standards, which were designed to provide evidence-based guidelines for the practice and development of simulations.

Learning Elements Addressed by Simulations for the Development of Cultural Competence

In this section, we categorized the studies based on the learning elements that students aimed to acquire during simulations for the development of cultural competence (Table 3). The cognitive domain of learning cultural competence is the learning domain in which the greatest progress was made by the nursing students. In the studies examined, the cognitive knowledge component of cross-cultural competence learning was the most developed among nursing students (Fung et al., 2023; Grossman et al., 2012; Hamilton, 2016; Ndiwane et al., 2014; Ozkara San, 2019; Ozkara San et al., 2019; Phillips et al., 2012; Tiffany & Hoglund, 2016). Additionally, Ozkara San (2019) and Hickerson et al. (2018) highlight that simulation experiences afforded students the chance to cultivate a secure and respectful environment for patients and to engage in discourse on cultural practices, which proved to be a highly effective strategy for enhancing their self-esteem.

Table 3 Characteristics of Studies Based on Learning Domains and Elements Within the Domains

Learning domains	Author/s
Affective or behavioral domain	
Cultural desire	(Byrne, 2020; Hamilton, 2016)
Cultural beliefs	(Grossman et al., 2012)
Attitudes towards a culturally different group of persons	(Altmiller et al., 2023; Englund et al., 2019; Fung et al., 2023; Grossman et al., 2012; Hickerson et al., 2018; Ozkara San, 2019; Ozkara San et al., 2019)
Cultural encounters	(Hamilton, 2016)
Empathy	(Altmiller et al., 2023; Everson et al., 2015)
Cognitive domain	
Awareness/knowledge/perception	(Fung et al., 2023; Garrido et al., 2014; Grossman et al., 2012; Hamilton, 2016; Ndiwane et al., 2014; Ozkara San, 2019; Ozkara San et al., 2019; Phillips et al., 2012; Tiffany & Hoglund, 2016)
Understanding of another culture	(Seckman & Diesel, 2013)
Culturally competent communication	(Altmiller et al., 2023; Byrne, 2020; Garrido et al., 2014)
Self–confidence (cognitive ability)	(Hickerson et al., 2018; Ozkara San, 2019)
Psychomotor domain	
Ability to interview the patient	(Grossman et al., 2012; Hamilton, 2016; Hickerson et al., 2018; Ozkara San, 2019)

Given that interactions between different cultures often elicit emotional responses, simulations can also facilitate the transition from the cognitive to the affective domain of cultural competence. The studies conducted by Grossman et al. (2012) and Garrido et al. (2014) revealed a notable enhancement in the affective dimension of cultural competence acquisition, particularly in attitudes towards culturally diverse groups. This was observed in research where students provided care to a standardised patient of a different religion or ethnicity during a simulation experience. The affective domain also encompasses cultural desire and cultural awareness, which are anticipated to be attained when the participant engages voluntarily and actively in the simulated learning activity (Byrne, 2020). The simulated encounter with the patient enabled students to engage in a cultural interaction and make a cultural assessment (Byrne, 2020; Ndiwane et al., 2014). During these organised cultural encounters, students began to recognise many of their own beliefs that were not evidence-based and to realise that they did not even know themselves well.

The psychomotor skill developed during the transcultural nursing simulation was the ability to conduct patient interviews in a culturally sensitive manner. In order to conduct an effective interview, students first acquired cross-cultural knowledge and skills during the simulation experience (Grossman et al., 2012; Hamilton, 2016; Hickerson et al., 2018; Ozkara San, 2019). They then applied this knowledge and skill during the interview in order to gather the necessary information about the patient. As observed by Grossman et al. (2012), while statistically significant improvements were noted in the psychomotor domain (interview), this domain exhibited the lowest pre-test and post-test scores in comparison to the cognitive and affective domains. Additionally, as posited by Hamilton (2016), the outcomes in the psychomotor domain were also influenced by students' demographic characteristics, with those from multicultural families demonstrating enhanced proficiency in conducting interviews.

Discussion

The process of international migration and globalisation presents a challenge to the healthcare system in an increasingly diverse society, which must provide culturally competent care. It is imperative to implement strategies that can effectively address the linguistic and cultural barriers that exist at the systemic, organisational and individual levels (Oikarainen et al., 2019). Consequently, it is becoming increasingly important for educators and mentors in clinical settings to impart cultural knowledge to students and create learning experiences that help them become culturally competent. Cultural competence is a process that can be effectively learned through appropriate forms of education (Foisy-Doll, 2013). Therefore, the aim of this integrative literature review was to determine the effectiveness of simulations as a teaching and learning method in acquiring cultural competencies among nursing students.

The integrative literature review revealed that the most prevalent simulator employed for the development of cultural competencies among nursing students is the standardized patient or a related simulation method, such as role-playing, in the context of providing care to patients from diverse racial, religious, and ethnic backgrounds, as well as in the context of culturally competent care for LGBT patients. In recent years, there has also been an increase in the use of virtual reality as a simulation method for learning cross-cultural nursing. The popularity of using standardised patients can be attributed primarily to their realism, the accuracy of information delivery (Webster, 2014), the provision of high-quality feedback, and the ability to assess students (Schram & Mudd, 2015). The use of the standardised patient is considered an optimal method for the development of cultural competencies, as it offers a unique opportunity for human interaction that can influence both the sociological and psychological aspects of students (Harder, 2018). While the standardized patient offers numerous advantages, it is not without limitations, particularly in the representation of certain injuries or conditions that require invasive procedures, such as catheter insertion and establishing intravenous access (Schram & Mudd, 2015). Furthermore, virtual standardised patients represent an additional option for providing authentic experiences during simulations, which students can access through various applications. Their use has increased in recent years for training new generations, especially during the COVID pandemic (Altmiller et al., 2023). Role-playing has also been demonstrated to be an effective pedagogical approach for teaching transcultural nursing to nursing students (Englund et al., 2019). In role-playing, students assume the roles of both patient and nurse, thereby facilitating comprehension of the intricacies of providing care to culturally diverse patients and the dynamics between both parties. Compared to the use of standardized patients, role-playing is typically more cost-effective; however, it necessitates meticulous planning, the availability of sufficient time, and the willingness of students to participate (Paramasivan & Khoo, 2020).

The definition of learning objectives is typically contingent upon the content of the simulation in question, as well as the cultural context that is being addressed within the simulation experience. The most frequently identified cultural contexts within the analysed studies were ethnicity and race, religion, and sexual orientation – LGBTQ. It is notable that studies focusing on culture in the context of sexual orientation are more recent, which aligns with the increasing discussion on healthcare issues within the LGBT community (Bass & Nagy, 2024).

The distinctive nature of each simulation experience is also supported by learning strategies that encompass a range of multidimensional domains, including cognitive, practical (psychomotor), and affective domain. These strategies assist students in developing confidence and a sense of self-efficacy (Alexander et al., 2015). The most frequently identified learning objective within simulations for developing cultural competencies among nursing students was the enhancement of knowledge about cultural competence. Furthermore, notable enhancements were observed in the domains of communication and confidence, particularly in the cognitive domain. Overall, the cognitive domain was identified as the most frequently addressed area in studies seeking to enhance cultural competence among nursing students through simulations. As postulated by Grossman et al. (2012), an understanding of another culture is pivotal for the development of cultural awareness.

This is because awareness and knowledge of people's backgrounds extend beyond the mere recognition of ethnic affiliation when conducting cultural assessments. It also encompasses the understanding that people are diverse and capable of communicating with individuals who adhere to different beliefs and values. The affective domain was the second most commonly identified domain, which pertains to the domain of learning that concerns the emotional responses of individuals to those around them and encompasses their feelings, values, and attitudes (Ozkara San, 2019). Attitudes are constituted by beliefs and values, and in the context of culturally competent nursing care, they are significant because they convey how we comprehend the behaviour of others and how we utilise this comprehension to provide care (Altmiller et al., 2023; Byrne, 2020).

The studies examined focused on assessing various aspects of cross-cultural interactions, such as cultural humility, knowledge, awareness, empathy, sensitivity, interviewing skills, and the ability to relate to culturally diverse patients. Most results suggest that the different types of simulations contribute to improving cultural competence and are well received by nursing students, who express high levels of satisfaction with the usefulness, relevance, meaningfulness, and effectiveness of the simulations. Sales et al. (2013) suggest that integrating more cultural learning opportunities into healthcare education through a blend of teaching methods may be the most effective approach to improving cultural competence.

Nurse educators are essential in imparting cultural competence to their students, and the cultural competence of both educators and nurses remains a significant area of concern (Qin & Chaimongkol, 2021). The combination of different simulation techniques with traditional teaching methods has the potential to enhance culturally significant skills and knowledge while fostering the development of culturally sensitive attitudes, which in turn can lead to improved patient-centred care. Therefore, it is of paramount importance to enhance our understanding of how simulation functions within the framework of cultural competence and patient-centred care (Walkowska et al., 2023). This will enable learners, instructors and designers to optimise the benefits of simulation-based education in a cost-effective way. The generation of new data allows educators to phase out outdated, inefficient and passive learning methods while adopting these more effective, modern learning strategies (Marja & Suvi, 2021).

This integrative review may be subject to publication bias, as grey literature beyond electronic databases was not included, thus narrowing the perspective. The focus on peer-reviewed articles published exclusively in English further narrows the perspective, predominantly reflecting research from the United States, limiting the generalizability of the findings to other cultural and educational settings. Future research should aim to address this limitation by including studies from a wider range of geographical contexts to ensure broader applicability. In addition, there is a clear need for well-structured longitudinal studies to further validate these findings.

Conclusion

The literature reviewed in this paper suggests that as patient populations become increasingly diverse, the demand for patient-centred care is rising, highlighting the importance of equipping future health professionals with training that fosters culturally congruent care. The studies consistently demonstrate the effectiveness of simulation in training nursing students to be culturally competent, with standardized patients being the most commonly used. Furthermore, findings suggest that learning through simulations can complement and enhance traditional teaching methods such as lectures and case-based learning. It is therefore important to find a blend of approaches that goes beyond traditional teaching methods by incorporating more innovative and adaptable techniques that impact learners in diverse ways.

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Uporaba simulacij za razvoj medkulturnih kompetenc v izobraževanju zdravstvene nege: integrativni pregled literature

Simulacijsko učenje je eden od načinov ustvarjalnega poučevanja, ki zagotavlja platformo za vključevanje kulturnih konceptov in ustvarjanje interaktivnih srečanj, ki jih je mogoče nadalje analizirati in nadgrajevati. Namen našega integrativnega pregleda je bil ugotoviti veljavnost in učinkovitost simulacije kot metode poučevanja in učenja za pridobivanje kulturnih kompetenc pri študentih zdravstvene nege. V podatkovnih zbirkah CINAHL, PubMed in Science Direct so bili poiskani članki, na podlagi katerih je bilo v pregled vključenih 17 člankov. Rezultati so pokazali, da se v simulacijskih scenarijih za namen razvijanja kulturnih kompetenc najpogosteje uporablja standardizirani pacient. Najpogosteje opredeljen cilj je bil povečati znanje o kulturnih kompetencah, najbolje pa so bili razviti učni elementi znotraj kognitivnega in afektivnega področja. Naše ugotovitve podpirajo nadaljnjo uporabo in razvoj simulacij v izobraževalne namene za izboljšanje kulturnih kompetenc študentov zdravstvene nege.

Ključne besede: kulturne kompetence, zdravstvena nega, simulacije, transkulturna zdravstvena nega

Assessment Tools for Non-Technical Skills in Multidisciplinary Healthcare Team Simulation-Based Education: A Scoping Review

Igor Karnjuš
University of Primorska, Slovenia
igor.karnjus@fvz.upr.si

Jakob Renko
University of Primorska, Slovenia
jakob.renko@fvz.upr.si

Kristina Martinović
University of Primorska, Slovenia
kristina.martinovic@fvz.upr.si

Patrik Pucer
University of Primorska, Slovenia
patrik.pucer@fvz.upr.si

In recent years, the importance of training healthcare professionals in non-technical skills (NTS) using effective methods to prevent clinical errors in health care has been increasingly recognised. Healthcare professionals are frequently taught NTS through simulation. The aim of our scoping review was to examine the validation evidence for tools used to assess NTS in multidisciplinary teams in simulation-based clinical education. A literature search was conducted in the PubMed and Web of Science databases using predefined inclusion and exclusion criteria. A total of ten studies were included in the final analysis. Seven different assessment tools were identified, with the Team Emergency Assessment Measure (TEAM) and the Non-Technical Skills for Trauma (T-NOTECHS) used more than once. The most frequently assessed NTS within each tool were communication skills, situation awareness, teamwork/cooperation, and leadership skills. While many of the examined assessment tools undergo validation for scoring and generalisation inference, there is a scarcity of tools validated for extrapolation inference such as factor analysis.

Keywords: simulation-based education, multidisciplinary teams, team training, assessment tools, non-technical skills.

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Introduction

Non-technical skills (NTS) are defined as cognitive, social and personal skills that complement technical skills and contribute to a safe and efficient execution of tasks (Flin et al., 2010). Failures in NTS have been shown to increase the risk of serious adverse events in the workplace (Uramatsu et al., 2017). Clinical errors that occur in the performance of healthcare activities have a significant impact on patient safety, and increase mortality and morbidity, as well as financial costs to healthcare systems (Anderson & Abrahamson, 2017; Kavanagh et al., 2017), with poor communication and teamwork being the leading causes of clinical errors (Müller et al., 2018). Traditionally, nursing students are trained in environments that focus on the acquisition of clinical knowledge and the development of technical skills, while NTS are not commonly emphasised (Pires et al., 2017), leading to errors in patient care (Asensi-Vicente et al., 2018).

Compared to conventional methods, simulation-based learning has been shown to be a more effective strategy for obtaining NTS in a safe and controlled environment (Chernikova et al., 2020; Lynch, 2020). Research shows that simulation helps healthcare professionals to improve teamwork, communication and critical decision-making in complex patient care (Schmidt et al., 2024; Tofil et al., 2014). Integrating simulation into healthcare education and training programmes offers several advantages. First, simulation provides a structured and standardised platform for healthcare professionals to learn and apply NTS in realistic settings (Lee et al., 2024). This hands-on approach allows for immediate feedback and reflection, which are essential for continuous improvement and skills development. Moreover, simulation encourages interdisciplinary collaboration by bringing together healthcare professionals from different disciplines to work as a cohesive team. Such a collaborative environment mirrors the real-world clinical setting where effective teamwork is essential for high-quality patient care (Babiker et al., 2014; Rosen et al., 2018). Through simulation, healthcare professionals can learn to manage team dynamics, enhance their leadership skills and adapt to different healthcare scenarios (Schram et al., 2024; Schram et al., 2021). Due to its positive impact on patient-centred care, multidisciplinary teamwork in healthcare, involving physicians, nurses, and other professionals, has received considerable research attention (Baek et al., 2023; Gantayet-Mathur et al., 2022).

Assessing the effectiveness of simulation-based training in teaching NTS requires valid and reliable assessment tools (Gourbault et al., 2022). Such tools must provide accurate measurement of individual and team competencies in different simulation scenarios (Hofmann et al., 2021). Validity in this context means ensuring that the assessment tools used assess the intended NTS comprehensively and reliably (Flin et al., 2003). It is essential that crew resource management training and assessment tools are specifically tailored to address the identified NTS required in a given profession (Hamilton et al., 2019). The aim of this scoping review was therefore to examine the validation evidence for tools used to assess NTS in multidisciplinary teams in simulation-based clinical education.

Materials and Methods

For the purposes of the study, a scoping literature review was conducted to compile relevant studies. A thematic analysis was then conducted to examine and categorise the main themes.

Method of Review

The literature search was conducted in the PubMed and Web of Science databases. We used the following search terms: 'interprofessional', 'interdisciplinary', 'multiprofessional', 'multidisciplinary', 'team', 'non-technical skills', 'assessment tool', 'evaluation tool', 'medical education', 'nursing education', 'nursing student', 'medical student', 'healthcare', 'high fidelity simulation', 'patient simulation' and 'simulation training'. We combined these search terms using the Boolean operators 'OR' and 'AND', which produced the final results. The search was conducted in June 2024 and was limited to original, peer-reviewed scientific articles in English that were indexed between 1 January 2013 and 31 December 2023. These articles involved interprofessional healthcare teams composed of professionals or students from different healthcare professions (e.g. nurses, gynaecologists, respiratory therapists).

Review Results

Figure 1 shows the literature search and selection process according to the PRISMA methodology (Page et al., 2021). The initial search retrieved 138 records. Prior to screening, 31 duplicates were removed, 107 records were screened by title and abstract and 39 by full text. Finally, 10 articles were included in the detailed literature analysis.

The literature was selected on the basis of a rigorous assessment of the relevance and quality of the articles in question. The quality of the articles was assessed using critical appraisal tools developed by the Joanna Briggs Institute (JBI): the JBI Checklist for Quasi-Experimental Studies and the JBI Checklist for Cohort Studies. The articles were initially assessed by two researchers. In the event of disagreement, the third and fourth authors were consulted to resolve the differences. Each article was assigned a grade on a four-point scale: inadequate, sufficient (C), good (B) and excellent (A). Following the assessment of article quality, six studies were categorised as good quality and four as excellent quality.

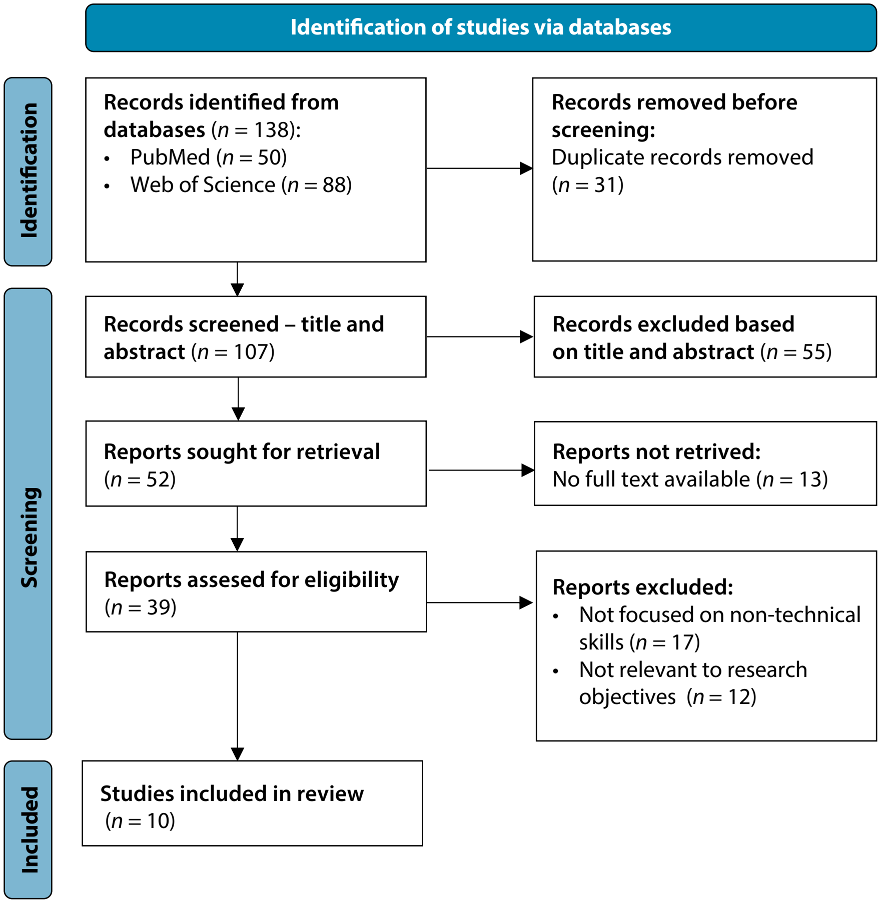

Figure 1 The Literature Search and Study Selection Process, Presented Using the PRISMA Statement Flow Diagram (Page et al., 2021).

Results

The analysis included ten studies addressing tools for the assessment of NTS in multidisciplinary teams in simulation-based clinical education. Nine studies (Alegret et al., 2023; Calhoun et al., 2014; Carpini et al., 2021; Cooper & Cant, 2014; Couto et al., 2015; Freytag et al., 2019; Phitayakorn et al., 2014; Repo et al., 2019; Zhang et al., 2015) used a single assessment tool, and one study (Briggs et al., 2015) used two different assessment tools for the assessment of teamwork NTS. Table 1 shows the primary characteristics of the studies included in the final analysis, with a focus on the objective of the research, the target population, the location where the simulation was performed, and the simulation modality involved in the study.

A total of seven different NTS assessment tools were identified in the studies. The Team Emergency Assessment Measure (TEAM) tool was used in four studies analysed, while the Non-Technical Skills for Trauma (T-NOTECHS) tool was used in two studies. Other tools were employed in a single study only. All the mentioned tools were used in a multitude of clinical scenarios, all of which focused on the management of critically ill patients, whether adults or children, in high-risk environments such as the emergency department or operating room. In these scenarios, the healthcare teams consisted primarily of physicians, particularly surgeons, paediatricians and anaesthesiologists, as well as nurses. However, some scenarios also included multidisciplinary teams consisting of respiratory therapists, paramedics, pharmacists, and students from various healthcare disciplines, reflecting the diverse and collaborative nature of real-world clinical care. The scenarios were conducted in either a simulation laboratory or a real clinical setting (in-situ simulation). The most commonly used simulation modality was the high-fidelity simulator.

Table 2 lists the NTS skills in the seven assessment tools evaluated. The most frequently assessed NTS, as determined by the frequency count, were communication ($n=6$), situation awareness ($n=5$), cooperation/teamwork ($n=5$), and leadership ($n=4$). While all tools assess three to five NTS domains, the number of items in each tool varies considerably, ranging from four items (Non-Technical Skills for Surgeons – NOTSS) to 46 items (Team Performance During Simulated Crises Instrument – TPDSCI). Each study reported validation evidence for its quantitative assessment strategy, either within the same article or by citing a related article that included this information. Seven studies used previously established NTS assessment tools, and the remaining three studies utilised newly developed or modified assessment strategies. Most of the assessment tools included had been validated in terms of scoring and generalisation. A smaller number of tools had been validated for extrapolation inference, such as factor analysis. Internal consistency was reported for four assessment tools. The reported rater agreement and internal consistency scores were all above 0.7 (acceptable), with most scores above 0.8 (good) in the case of the TEAM tool. All tools demonstrated satisfactory inter-rater reliability, as indicated by intra-class correlation or kappa coefficients. However, only two tools (Team Performance Observation Tool – TPOT and TEAM) were subjected to a test-retest reliability assessment. Factor analysis was conducted for TEAM (Freytag et al., 2019) and T-NONTECHS (Repo et al., 2019), revealing a robust construct validity in both cases. There were also other validation parameters for the included assessment strategies, such as content validity using the content validity index (CVI), unidimensional validity or face validity.

Table 1 Key Information from Studies Addressing Tools to Assess Teamwork and Non–technical Skills in Simulation–based Multidisciplinary Clinical Education

Author, year/country	NTS tool	Objectives	Target population	Simulation location/ simulation modality	Medical field
(Calhoun et al., 2014)/ USA	TPDSCI	The objective was to assess team performance during simulated crises, quantifying team self–insight, and analysing session content using a video review to understand the impact of hierarchy errors on communication and team dynamics.	Paediatric Emergency Department team (physicians and nurses), a total of 5 sessions conducted.	Sim lab/HFS	Paediatric emergency
(Cooper & Cant, 2014)/ Australia and UK	TEAM	The objective was to assess the validity and reliability of the TEAM in measuring NTS in medical emergency teams.	Medical emergency teams (population sample size included 97 HCPs).	Sim lab/SP	Emergency
(Phitayakorn et al., 2014)/USA	OTAS	The study aimed to determine the feasibility of assessing OR professionals' teamwork in high–fidelity OR simulations.	The study involved five OR teams (anaesthesiology residents, general surgery residents, and OR nurses or surgical technicians).	In–situ/HFS	OR management
(Briggs et al., 2015)/ USA	NOTSS and T–NOTECHS	The study sought to investigate the deterioration of NTS over the course of simulated trauma scenarios and assess the correlation between cognitive NTS scores and critical task performance.	20 teams (surgical residents, emergency medicine residents, emergency department nurses, and emergency services assistants).	Sim lab/HFS	Emergency
(Couto et al., 2015)/ USA	TEAM	The objective was to establish baseline teamwork behaviours among paediatric emergency medicine providers during actual and simulated emergencies, and to evaluate differences in teamwork behaviours among in–situ simulations, in–centre simulations, and actual emergencies.	HCPs who work in ED (physicians, nurses, respiratory therapists, paramedics, patient care assistants, and pharmacists).	Sim lab and in–situ/ HFS	Paediatric emergency care
(Zhang et al., 2015)/ USA	TPOT	The research objectives were to decrease the subjectivity of the TPOT by establishing scenario–specific targeted behavioural markers (TBMs) and determine the psychometric properties of the TPOT with the use of TBMs.	47 students in the Doctor of Physical Therapy programme and 25 senior–level students in the Bachelor of Science in Nursing programme.	Sim lab/HFS	Emergency – trauma care

Continued on next page

Author, year/country	NTS tool	Objectives	Target population	Simulation location/ simulation modality	Medical field
(Freytag et al., 2019)/ Germany	TEAM	The objective was to compare novice and expert ratings using the TEAM in simulated emergencies to determine if raters with limited experience can provide reliable data on teamwork behaviour.	HCPs working in emergency department (physicians, psychologists).	In–situ/SP and HFS	Emergency
(Repo et al., 2019)/ Finland	T–NONTECHS	The research aimed to assess the translatability of the T–NOTECHS into a non–Anglo–Saxon language and investigate its psychometric properties for simulated multi–professional trauma team resuscitations.	193 multi–professional participants: anaesthesiologists, surgeons, paediatricians, emergency medicine residents, nurses, and nurse students.	In–situ/HFS	Emergency – trauma care
(Carpini et al., 2021)/ Australia	TEAM	The objectives were to validate the TEAM in obstetric and gynaecologic resuscitation teams through simulations, and to assess the teams' NTS and communication abilities.	Multidisciplinary teams (population sample size 452), who had undergone simulations of obstetric and gynaecologic emergencies.	Sim lab/HFS	Obstetrics and gynaecology
(Alegret et al., 2023)/ Spain	CATS	The study aimed to evaluate teamwork acquisition of NTS through clinical simulation cases by participants in a CRM polytrauma course.	12 trauma team groups (anaesthesiologist, general surgeon, traumatologist, registered nurses, nursing assistant, and stretcher bearer), totalling to 84 HCPs.	In–situ/HFS	OR management

Legend CATS – Communication and Teamwork Skills; HCPs – healthcare professionals; HFS – high–fidelity simulator; NOTSS – Non–Technical Skills for Surgeons; NTS – non–technical skills; OR – operating room; OTAS – Observational Teamwork Assessment for Surgery; Sim lab – simulation laboratory; SP – standardised patient; TEAM – Team Emergency Assessment Measure; T–NOTECHS – Trauma NOn–TECHnical Skills; TPDSCI – Team Performance During Simulated Crises Instrument; TPOT – Team Performance Observation Tool.

Table 2 Non–technical Skills Assessment Tools

NTS tool	Assessment skills	No. of items/ response scale	Article in which tool is discussed	Reliability	Validity
CATS	Four domains: situation awareness; coordination; communication; cooperation.	21 items 3–point scale	(Alegret et al., 2023)	Inter–rater (ICC 0.80)	/
NOTSS	Four domains: situation awareness; decision making; communication; teamwork.	4 items 4–point scale	(Briggs et al., 2015)	Inter–rater (k 0.83)	/

Continued on next page

NTS tool	Assessment skills	No. of items/ response scale	Article in which tool is discussed	Reliability	Validity
OTAS	Five domains: communication; cooperation/ back up behaviour; coordination; leadership; team monitoring/situation awareness.	15 items 7–point scale	(Phitayakorn et al., 2014)	Inter–rater (ICC 0.42 –0.90)	/
TEAM	Three domains: leadership; teamwork; task management.	11 items 5–point scale	(Couto et al., 2015) (original citation Cooper et al., 2010)	Internal consistency (Cronbach α – 0.89) Inter–rater (k 0.55) Test–retest (k 0.53)	Content (CVI 0.96) Concurrent
			(Freytag et al., 2019)	Inter–rater (ICC 0.66)	Construct (59% and 65% variance)
			(Cooper & Cant, 2014)	Internal consistency (Cronbach α – 0.97) Inter–rater (k 0.55)	Uni–dimensional Construct (83% variance)
			(Carpini et al., 2021)	Internal consistency (Cronbach α – 0.97) Inter–rater (ICC 0.98)	Construct (ND) Convergent
T–NOTECHS	Five domains: communication; situation awareness; cooperation; leadership; assessment/ decision–making.	5 items 5–point scale	(Repo et al., 2019)	Internal consistency (Cronbach α – 0.70) Inter–rater (ICC 0.54)	Construct (56.8% variance)
			(Briggs et al., 2015)	Inter–rater (k 0.40)	
TPDSCI	Five domains: medical knowledge; clinical skill; communication skills; professionalism; systems–based practice.	46 items 3–point scale	(Calhoun et al., 2014) (original citation Calhoun et al., 2011)	Internal consistency (Cronbach α – 0.72) Inter–rater (ICC 0.82)	/
TPOT	Five domains: team structure; leadership; situation monitoring; mutual support; communication.	25 items 5–point scale	(Zhang et al., 2015)	Internal consistency (Cronbach (α – 0.92) Test–retest (k 0.71) Inter–rater (k 0.73))	Face

Legend CATS – Communication and Teamwork Skills; CVI – content validity index; ICC – intraclass correlation; k – kappa; ND – not defined; NOTSS – Non–Technical Skills for Surgeons; NTS – non–technical skills; OTAS – Observational Teamwork Assessment for Surgery; TEAM – Team Emergency Assessment Measure; T–NOTECHS – Non–technical skills scale for trauma; TPDSCI – The Team Performance During Simulated Crises Instrument; TPOT – Team Performance Observation Tool.

Discussion

We conducted a systematic literature review to examine validation evidence for the tools used to assess NTS in multidisciplinary, simulation-based clinical education. Based on this review, we identified seven assessment tools that are suitable for evaluating NTS in simulated environments, particularly for multidisciplinary healthcare teams, as these skills are crucial for their effectiveness. Similar to technical skills, mastering NTS involves more than just acquiring knowledge or reaching a certain competency level – it requires the ongoing and accurate application of these skills in clinical practice (Garbee et al., 2021).

The tools examined in this study were designed to identify the key elements of NTS that are crucial for safe and efficient clinical care, and to evaluate these skills through simulation-based scenarios. The results of our literature review demonstrate that the seven tools we identified are mainly built around four NTS domains: communication, situation awareness, teamwork and leadership, which is also consistent with the findings of Gawronski et al. (2022). In their literature review, Garbee et al. (2021) identified two additional domains frequently categorised as NTS tools: decision making and task management, which are often included within 'leadership', 'teamwork' or 'situation awareness' (Gawronski et al., 2022). In addition, Garbee et al. (2021) show that the six NTS domains in the ten tools studied have overlaps and convergences that are consistent with recognised frameworks for teamwork in different industries. They also emphasise that the inclusion of additional tools to assess multidisciplinary teams in systematic reviews would not lead to the emergence of new related NTS domains.

The results of our review of the psychometric properties of various tools, including validity and reliability, suggest that the TEAM tool is a suitable option for assessing NTS in multidisciplinary teams in simulation-based clinical education. The TEAM tool was employed in four of the studies analysed. The tool comprises three domains (leadership, teamwork, and task management) and 11 items. The TEAM was studied in medical emergency and obstetric/gynaecologic settings (Gawronski et al., 2022). Originally designed to evaluate teamwork performance in both real and simulated emergency scenarios (Cooper et al., 2010), the tool has undergone extensive psychometric testing, including measures such as Cronbach's α, ICC, CVI, and Cohen's κ (von Wendt & Niemi-Murola, 2018). Its face validity and content validity have been reviewed by an international panel of resuscitation experts, demonstrating strong internal consistency and moderate-to-high inter-rater reliability (Cooper & Cant, 2014; Gawronski et al., 2022). However, although the tool is reliable and feasible, it lacks validation for real and simulated paediatric and clinical events (Couto et al., 2015).

Another tool that also produced positive results in terms of psychometric properties was the T-NOTECHS tool. The T-NOTECHS was developed to teach and assess the teamwork skills in multidisciplinary trauma resuscitation teams (Pires et al., 2017). The tool is divided into five domains: leadership, cooperation and resource management, communication and interaction, assessment and decision-making, and situation awareness/coping with stress (Briggs et al., 2015). The T-NOTECHS shows good construct validity and moderate internal consistency and inter-rater agreement (Repo et al., 2019). It has good sensitivity with adequate content validity, face validity and feasibility, but further evidence is needed to support its reliability in real-time settings (Stevenson et al., 2022).

Other tools included in this review require further investigation to fully assess their quality before they can be recommended for use in multidisciplinary simulation training. Five NTS tools received a generally positive rating for their inter-rater reliability and internal consistency, with at least moderate quality evidence, but further testing is needed to assess their construct validity. Importantly, none of the tools in this review were deemed unsuitable for multidisciplinary simulation training, as there was no strong evidence of inadequacies in their psychometric properties.

In our literature review, we focused exclusively on tools used to assess NTS in multidisciplinary teams. Higham et al. (2019) state that it is crucial that each assessment tools be customised for the specific medical speciality and stage of training. Given the distinctive characteristics of different medical specialities, individual disciplines have sought to develop more targeted tools to assess more specific NTS. In health care, over 70 different assessment tools for NTS have been developed over the years, posing challenges for educators when selecting the most suitable one. Moreover, there is increasing recognition of the need for multidisciplinary simulation-based training to foster collaboration between healthcare professionals, as it enhances teamwork and communication as the fundamental skills for optimal patient care (Elendu et al., 2024). In order to facilitate this, it is essential to have tools that assess broader NTS that are vital for effective interprofessional collaboration.

The increasing use of digital simulation technologies, encompassing virtual reality (VR), augmented reality (AR), and artificial intelligence-driven training tools, has led to substantial advancements in the field of healthcare simulation-based education. These technologies offer an immersive and interactive learning environment, enabling multidisciplinary healthcare teams to develop and assess NTS in a controlled and reproducible manner (Lee et al., 2024). Furthermore, the accessibility of digital simulations has been enhanced by the emergence of cloud-based platforms and remote learning tools, enabling training to extend beyond traditional physical simulation centres (Chernikova et al., 2020). However, the integration of these technologies into standardised digital education frameworks remains a challenge. According to the European Framework for the Digital Competence of Educators (DigCompEdu), effective use of digital tools in education requires structured implementation, including alignment with competency-based learning outcomes and faculty training (Redecker & Punie, 2017). Ensuring that digital simulation aligns with such frameworks will support its broader adoption and enhance its impact on healthcare education.

There are several limitations to our systematic review. Firstly, our literature search was conducted using only two research databases. While these databases are comprehensive and encompass a wide range of studies, it would be unrealistic to assume that our search captured all relevant studies. Secondly, our review was purely exploratory in nature and no standardised quality assessment instrument was used for the evaluation of the measurement properties of the identified NTS tools. We would therefore recommend that future studies adopt a more rigorous methodological approach and use a validated instrument specifically designed to assess the quality of measurement tools.

Conclusion

Among the plethora of tools designed to assess NTS, the TEAM tool is a particularly noteworthy recommendation for use in multidisciplinary, simulation-based clinical education. Nevertheless, further evidence is required to support the validity and reliability of other NTS tools. Further research is required to confirm the efficacy of these tools for consistent use in multidisciplinary simulation training.

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Orodja za ocenjevanje netehničnih veščin pri izobraževanju multidisciplinarnega zdravstvenega tima na podlagi simulacij: pregled obsega literature

V zadnjih letih se vse bolj priznava pomen usposabljanja zdravstvenih delavcev na področju netehničnih veščin z uporabo učinkovitih metod za preprečevanje kliničnih napak v zdravstveni praksi. Simulacije se pogosto uporabljajo kot učna metoda za učenje netehničnih veščin (NTV) zdravstvenih delavcev. Namen pregleda je bil raziskati validiranost ocenjevalnih orodij, ki se uporabljajo za ocenjevanje NTV multidisciplinarnega tima na podlagi simulacij. Iskanje literature je potekalo v podatkovnih zbirkah PubMed in Web of Science na podlagi vnaprej določenih vključitvenih in izključitvenih kriterijev. V končno analizo je bilo vključenih deset raziskav. Identificiranih je bilo sedem različnih orodij za ocenjevanje, pri čemer sta bili večkrat uporabljena orodji za ocenjevanje TEAM (iz angl. *Team Emergency Assessment Measure*) in T-NOTECHS (iz angl. *Non-Technical Skills for Trauma*). Najpogosteje ocenjene NTV znotraj vsakega orodja so bile komunikacija, prepoznavanje situacije, timsko delo/sodelovanje in vodenje. Številna ocenjevalna orodja so validirana za ocenjevanje in posploševanje, vendar je orodij, validiranih za sklepanje na podlagi ekstrapolacije, kot je faktorska analiza, zelo malo.

Ključne besede: izobraževanje na podlagi simulacij, multidisciplinarni tim, timsko usposabljanje, orodje za ocenjevanje, netehnične veščine

Serious Digital Game-Based Learning in Nursing Education: Empowering Students for Clinical Competence

Betül Tosun
Hacettepe University, Türkiye
tosunbetul@gmail.com

Ayla Yava
Hasan Kalyoncu University, Türkiye
ayla.yava@hku.edu.tr

The evolution of technology in the era of digital transformation has significantly impacted the landscape of healthcare education, ushering in a paradigm shift in the way knowledge is imparted. This shift, accelerated by the imperative for online learning due to disruptions in traditional, in-person education caused by the COVID-19 pandemic, has compelled nursing educators to revamp existing curricula. Amidst these changes, digital educational applications, notably serious games, have gained prominence. Serious games are interactive computer applications designed with the aim of imparting specific learning objectives to players. Featuring challenging goals, engaging design, and scoring systems, serious games are believed to motivate students and aid in goal achievement. While the popularity of serious games in healthcare education is on the rise, their usage in nursing education has generally shown positive outcomes. This review aims to evaluate mobile-based serious games on the clinical competency development of undergraduate nursing students.

Keywords: healthcare education, serious games, clinical competency, nursing, nursing education.

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Introduction

In recent years, digital technologies have been rapidly developing in a way that will revolutionize the field of education. Innovations such as the internet, mobile devices and artificial intelligence are transforming teaching methodologies, student participation, learning processes, evaluation of learning and feedback methods (Ulupınar & Toygar, 2020). The accessibility of many of these technologies has caused them to become widespread in society and an indispensable part of daily life. As in every field, the effective use of digital technology has become important in the education sector. Changes in science and technology have also affected the structure of societies and have led to a rapid change towards a human profile that is inclined to use technology directly in many areas of life and whose technological skills are increasingly following technology. Especially the Z or Net Generation, born after 1997, are introduced to technological devices such as computers, tablets and smartphones when they are still babies and start using them from a very young age. The effects of using current technology instead of meeting the educational needs of this young generation with classical and traditional methods continues to be the subject of many scientific studies (Demirel, 2021).

While studies investigating the effects of technology and games on education were almost nonexistent before 1990, they have increased rapidly since the mid-2000s (Olejniczak et al., 2020). With the opportunities provided by today's technology, methods such as online courses, video education, active games, simulations and game-based learning are finding more place in education. Especially the widespread use of the Internet, developments in smartphones and mobile devices, and digital technologies have enabled the development of the concept of Digital Game-Based Learning (DGBL). DGBL leads to significant changes in the management and evaluation of education in the age of technological evolution and digital transformation (Şenyuva, 2019). The learning method expressed as serious games in Digital Based Learning (DGBL) is increasingly gaining attention in nursing education as in all fields of health sciences. Digital games are designed to improve course and subject knowledge or nursing skills, and the effectiveness of the games is evaluated.

Serious games, which can be briefly defined as 'interactive computer applications designed to achieve specific learning objectives,' have the potential to motivate students to achieve specific learning goals. In more detail, Stuckless et al. (2014, p. 146) defined a serious game as 'an interactive computer application that has a learning objective, has a high potential to entertain the practitioner and/or includes an interesting, objective and valid scoring concept and provides the user with a skill, knowledge or attitude that can be applied to the real world' (Stuckless et al., 2014). In health care professions such as nursing, where the acquisition of practical skills in addition to theoretical knowledge is mandatory; Accessing information, ensuring rapid and permanent learning and adequate practice are the most important elements in gaining professional competence/clinical competence.

In order to adapt to the changing human profile, reforms and scientific and technological enrichments in educational methods are becoming widespread in the field of nursing education. Especially the interruption of traditional face-to-face education during the COVID-19 pandemic has increased the need for online learning in nursing education, forcing educators to re-consider existing curricula and use distance education and digital teaching applications (Ali, 2020). The increase in digital education effectiveness studies conducted with serious games in the COVID-19 and post-COVID period is remarkable. Although digital games have become widespread in nursing education, it should not be forgotten that these games require serious preparation and cost in terms of preparation, monitoring and objective evaluation. In this section, serious DGBL applications in nursing education and their effectiveness in providing competence to nursing students are examined.

Advances in Digital Technologies

Digitalization and the internet environment, computer and game technologies, the prolifer ation of smartphones and tablets have also affected the education and training sector and have provided significant changes in the creation of a new and digital learning environment. In addition, tools such as online courses, digital classrooms, e-learning platforms have undergone a rapid transformation and are recommended for use by both public authorities (such as Ministries of National Education) and public and private educational institutions for student-teachers (Şenyuva, 2019). Various digital game applications have been developed and started to be used in formal education areas (Tschopp & Rach, 2019). All these efforts have made it possible for education to reach wider audiences.

Digital technologies play a critical role in increasing student engagement and making learning experiences interactive, both in improving and enriching communication skills. Game-based learning and virtual reality (VR) applications are innovative methods that encourage students' active learning (Güngör et al., 2024). These methods help students understand abstract concepts by providing experiential learning opportunities (Kirkley & Kirkley, 2005). The use of artificial intelligence (AI) technologies, which have started to have a significant impact within the scope of DGBL, also enables personalized learning experiences. AI-supported games can guide the structuring of educational processes and offer learning paths adapted to individual needs by analyzing student performance. Thus, it is possible to provide educational materials customized according to students' strengths and weaknesses (Şenyuva, 2019; Luckin et al., 2016).

International organizations, associations, local nursing organizations and nursing departments related to nursing education recommend the optimum use of technology in education to train nurses suitable for the ever-changing technology and human profile in the health field. The International Council of Nurses (ICN), the European Nurses Council, the American Nurses Credentialing Center (ANCC) and national and local Nursing Associations emphasize that evidence-based patient care and adaptation of current technologies in nursing education are the most important factors in increasing nursing competence (Şenyuva, 2019).

Development of Serious Digital Games

Serious games are applications designed and operated in the digital field that are adapted to any level of education for any discipline or field of science, and that have specific educational goals and learning objectives. Although some digital games were developed for educational purposes with the widespread use of computer games towards the end of the last century, they began to be used in formal education much later. The concept of 'serious games', which was first comprehensively addressed and published in a book by C. C. Abt (1987), discussed the basis of learning through games in education, its conceptual framework, and the impact of games on education and other sectors. In his book, Abt emphasizes that 'games are considered serious games if their primary purpose is not entertainment and if they have a clearly stated and carefully planned educational purpose' and that the game activity must be prepared at a level appropriate to the age and educational capabilities of the students. In addition, for a game to be recognized as a serious game, it is necessary that it has measurable learning objectives and that there is a prior definition of how these objectives will be measured (Abt, 1987, pp. 7–11).

Serious games have continued to grow and spread in scientific and academic research and in the gaming industry for the last twenty years in parallel with the pace of development in digital technologies. Serious digital games have especially attracted the attention of health educators. Video games have begun to be used as an effective method for developing cognitive and practical skills of students in the health field (Gee, 2003). Today, it is expected that the use of mobile-based serious games to develop the clinical competencies of nursing students will become widespread and the concept of DGBL will become an important part of nursing curricula.

Serious games developed for educational purposes do not contain completely fictional and imaginary elements and have scenarios meticulously prepared by professionals in this field. These scenarios must be inspired by real environments. At the same time, the scenario must be created in a way that will carry the entertainment feature of the games. When compared to practical trainings with high-fidelity simulators frequently used in nursing education, the most important difference between serious digital games and serious games is that a serious game also includes the entertainment factor.

Thus, in trainings carried out with serious games, while simultaneously addressing the visual, auditory, sensory and psychomotor areas of the students, it is also aimed for the student to have fun using the decision-making mechanism in the game. Moreover, in a serious game, students find opportunities to improve their performance as measured by the scoring mechanism and can also self-assess their progress (Lu & Lien, 2020). This situation, unlike training with traditional simulators, offers the student the opportunity not only to reach the predetermined goal but also to benefit from the entertainment element (Blakely et al., 2009).

Effects of COVID-19 Pandemic on Nursing Education

The COVID-19 pandemic has caused major changes in all areas of education. Almost all levels of schools and universities had to stop face-to-face education and then immediately switched to distance education methods. The interruption of formal education forced nursing schools to rapidly develop and effectively use distance education strategies (Min et al., 2022). Thus, in addition to the increase in distance education applications in nursing education, educator and student experiences regarding the use of this technology in education have also begun to develop. During the COVID-19 period, distance education, online live or video-trainings were used effectively in nursing education, and the internet and digital tools were used at this stage of education (Baker et al. 2020). Innovative technologies, especially mobile applications, virtual reality (VR) and augmented reality (AR), have begun to be used to improve students' clinical skills in nursing education and research has begun to be conducted in this field (Güngör et al., 2024).

The effectiveness of DGBL applications in developing nursing skills has recently become the subject of many nursing studies. For example, Chang et al. (2021) study showed that DGBL tools are an effective alternative in the skill training of nursing students, most students stated that serious game-based learning positively affected their learning during the pandemic process, and increased their communication skills and motivation (Chang et al., 2021). It is seen that serious games play an important role in terms of skill development and psychological strengthening, as well as cognitive and knowledge development. This situation has created an alternative way for the pandemic to physically limit nursing education, and has supported educators and students to make maximum use of technology in this process and contribute to the educational processes. However, although the benefits of distance education tools and digital technologies in nursing education are seen, it is also stated that evaluating the impact of these technologies, especially in terms of clinical competence in nursing, may be premature and further studies are needed (Agu et al., 2021).

Clinical Competence and Learning Objectives in Nursing

Nursing is a care profession that provides health care using professional nursing knowledge and skills to protect, improve and regain the health of individuals. Nurses play a role in every step of the health system. Nurses have a critical role in protecting and improving the health of sick and healthy individuals. In this context, clinical competence in nursing refers to the ability of nurses to effectively care for patients with their professional skills and knowledge. There should be a curriculum and teaching method based on learning objectives to gain clinical competence in nursing. In order for nursing students to correctly and competently apply the nursing knowledge and skills they receive during their education after graduation, clinical competence should be compatible with learning objectives and measurable (Benner, 2001).

Learning objectives in nursing education are determined in a way that will enable students to gain these abilities (Perry et al., 2014). Learning objectives in nursing education aim to provide students with certain knowledge, skills, and attitudes. These objectives play a fundamental role in structuring educational programs and developing curricula. Learning objectives are generally determined in line with accreditation standards and professional standards (American Association of Colleges of Nursing, 2021). The determined learning objectives provide students with practical experience in nursing practice while also supporting them in providing high-quality service in patient care.

Competency-based education is essential for learners to gain basic competencies in their professional fields and thus to be entitled to take professional responsibilities as a member of a professional profession. In competency-based education, students are at the center of the learning environment and are tried to reach outcome-based goals. In health professions such as nursing, the curriculum, classroom and laboratory environment and practices should be continued by utilizing developing educational technologies in a way that encourages students to learn at a level appropriate for the responsibilities they need to acquire. Advances in learning environments and technologies, understanding developing student learning styles and preferences, and transitioning to outcome-oriented education and assessment are accepted as signs of the transition to competency-based education. Competency-based education designed in this way creates permanent learning and professional attitudes because it establishes connections between knowledge and practices (American Association of Colleges of Nursing, 2021).

In addition to classical and traditional teaching methods, active learning methods such as in-class games, methods, laboratory applications, simulations, role-play are used to continue competency-based education in nursing. It is aimed that all health professions students receive education in a way that will enable them to develop their knowledge and skills optimally and to perform error-free applications before they come into contact with patients in real practice environments (Dieckmann et al., 2009).

Digital game-based learning methods, especially mobile-based serious games, have been increasingly used in clinical competence development in recent years. It is a fact that the COVID-19 pandemic has accelerated the transition to educational methods that require technology installation and knowledge, such as mobile applications, serious games, and distance learning. The technologies adapted in nursing education during this process can be considered an indicator of how the future impact of digital technologies in education may take shape (Baker et al., 2020).

The Effect of Digital Serious Games on the Development of Nursing Competencies

- Engagement and Learning Outcomes: Digital game-based learning can facilitate students' learning motivation and achievement of course learning objectives.
- Simulation and Skill Development: It has been determined that serious games, especially those using technologies such as virtual reality (VR) and augmented reality (AR), have a significant effect on the skill development of nursing students. Güngör et al. (2024) reported that VR-based serious games play an important role in the development of specific nursing skills such as surgical gloving practices.
- Critical Thinking Skill Improvement: Perhaps the most important effect of digital serious games is the development of students' critical thinking skills. The development of critical thinking skills plays an important role in using quality and scientific evidence-based practices in nursing practices. A meta-analysis study published on this subject has shown that digital games are effective in developing critical thinking skills of nursing students (Chen et al., 2021). This result can be considered as an indication that serious games can encourage critical and analytical thinking skills.

- Collaborative Learning Experience: Serious games can be developed in a design that encourages group work and team collaboration according to learning objectives. This offers students the opportunity to work as a group, develop teamwork, leadership and communication skills (Chen et al., 2021).
- Assessment and Feedback: Serious games that are suitable for a sufficient infrastructure and well-designed have the ability to provide real-time feedback to students and teachers to monitor and evaluate learning processes.
- Collaboration with Health Care Professionals: Serious games that involve other professionals in the health care team allow nurses to develop their skills in working with other health professionals. Chang et al. (2021) found that serious games encouraged nursing students to interact with other health disciplines.

Advantages of Serious Game-Based Learning

Serious digital game-based learning method creates an e-learning resource that provides nursing students with the opportunity to practice clinical reasoning and decision-making skills in a realistic environment without harming patients, by having fun, and with its participatory and feedback-based structure (Thangavelu et al., 2022).

Increasing Motivation

The interaction provided by games also leads to significant development in students' cognitive development. Game-based learning increases students' motivation and makes learning processes more interactive (Özdemir & Dinç, 2022). The feedback and interaction provided increase students' participation in the learning process. Thanks to the interactive feedback they receive instantly during games, it becomes easier for them to make quick decisions, which increases their motivation and self-confidence. Serious games allow students to gain hands-on experience by simulating clinical scenarios. Thus, they can help students reinforce their nursing knowledge (Ordu & Çalışkan, 2021). and support the development of clinical decision-making skills. Chang et al. (2021) stated that serious games also contribute to students' achievement of learning goals.

Participation in Education and the Development of Problem Solving Skills

Studies examining the effects of serious games have examined the effects of games on not only the achievement of learning objectives but also on the cognitive development of students and other dynamics of the educational process. These games provide students with the opportunity to put their theoretical knowledge into practice, develop their problem-solving skills, and simulate clinical situations, thus increasing their cognitive abilities such as systematic and quick thinking and making correct decisions in different clinical situations/problems (Stuckless et al., 2014). In particular, it is known that in education through serious games, student participation in the lesson increases significantly and the retention of information obtained at the end of the games is significantly higher compared to other teaching methods. The features of the games require students to analyze complex situations in scenarios quickly and accurately, make the right decisions and think about the outcomes when they encounter them; these are important competencies required in nursing practice (Lee et al., 2024).

Increase in Clinical Competence with Realistic Clinical Scenarios

The scenarios developed in DGBL applications can simulate real situations/cases that nurses may encounter in the hospital. It is stated that nursing students who participate in this training method increase their clinical reasoning and decision-making skills compared to traditional methods. In addition, such an experience can also provide deep and permanent learning and the development of nursing competencies.

Flexible Learning Environment and Team Collaboration

Many serious games are designed to encourage cooperation and the team concept among players. The training process carried out with serious games also allows students to increase their communication skills, get to know the team, and cooperation. In addition, the fact that the players are peers and that a learning environment and opportunities are provided at the same speed allows students to benefit from the learning environment to the maximum (Chang et al. 2021).

Measurement and Evaluation

Serious games allow for the evaluation of pre-structured goals and rapid feedback can be given. Various models can be used in the evaluation of learning. For example, Bloom's taxonomy can be used to assess learning objectives and learning outcomes (Krathwohl, 2002).

- 1.0: To Remember:
  - 1.1. To Recognize, 1.2. To Recall

- 2.0: To Understand:
  - 2.1. To Interpret, 2.2. Sample, 2.3. Classify, 2.4. Summarize, 2.5. To Infer, 2.6. To Compare, 2.7. To Explain
- 3.0: Apply:
  - 3.1. Implement, 3.2. Use
- 4.0: Analyze:
  - 4.1. Segregate, 4.2 Organize, 4.3 Attribute
- 5.0 Evaluate:
  - 5.1 To Check, 5.2 To Criticize
- 6.0 Create:
  - 6.1 Create, 6.2 Plan, 6.3 Produce

Using a taxonomy like the one above, feedback can be given to students with an objective and universal evaluation method. This allows educators to see the development and weaknesses of the students and can also highlight areas that need development (Yurdabakan, 2012).

Serious Digital Game Preparation Steps and Evaluation Methods

Studies show that serious digital games have the potential to be used in nursing education to improve knowledge, skills, and core clinical competencies. By simulating real-life scenarios, developing critical thinking and collaboration skills, effective evaluation methods, and flexible learning environments, serious games can be used as an effective method to improve the quality of healthcare for future nurses. Incorporating serious digital games into nursing education involves serious preparation processes, planning in line with learning objectives, and developing objective evaluation tools and feedback mechanisms. The following summarizes the steps involved in designing a serious digital game for use in nursing education (Fleming, 2008; Kalelioğlu & Gülbahar, 2014):

- *Defining Learning Objectives:* Clearly articulate the specific skills, knowledge, and competencies that the game will address. This could include clinical skills, critical thinking, teamwork, and decision-making.
- *Identify Target Audience:* Understand the demographic of your nursing students, including their level of education (undergraduate vs. graduate), prior gaming experience, and learning preferences.
- *Select Appropriate Games:* Choose or design games that align with the

learning objectives. Look for evidence-based games that have been validated in nursing education or similar fields.
- *Integrate Curriculum:* Ensure that the game fits seamlessly into the existing curriculum. Consider how it complements other learning activities, such as lectures, simulations, or clinical practice.
- *Develop a Teaching Plan:* Create a detailed plan for how the game will be introduced, played, and debriefed. Include time for instruction on the game mechanics and objectives.
- *Facilitate Technical Preparation:* Ensure that all necessary technology and resources are available, including devices, internet access, and any software or applications required.
- *Train Educators:* Provide training for educators on how to facilitate the game, manage student engagement, and guide discussions post-gameplay.
- *Plan for Feedback:* Design a structured debriefing session to reinforce learning, allow students to reflect on their experiences, and discuss how the game relates to real-world nursing practice.

Suggested Assessment Methods for Serious Digital Games in Nursing Education

- *Formative Assessment:* Informal assessments can be used during the game, such as observing student participation, teamwork, and decision making. Provide quizzes or analysis questions immediately after the game to gauge understanding.
- *Peer Assessment:* Encourage students to provide feedback on each other's performance, especially in team-based scenarios. This can encourage collaboration and critical evaluation.
- *Self-Assessment:* Use surveys to allow students to assess their own learning and performance in the game. Provide feedback focused on skills developed and areas for improvement.
- *Performance Measures:* Use in-game metrics such as completion rates, scores, or time spent completing tasks to measure student performance.
- *Pre- and Post-Tests:* Conduct assessments before and after the game to measure knowledge gains, changes in attitudes, or skill acquisition related to nursing competencies.
- *Critical Incident Reports:* Encourage students to describe a significant moment or challenge they encountered in the game and how they

overcame it. This helps assess critical thinking and the transfer of knowledge into practice (Kalelioğlu & Gülbahar, 2014).

- *Give Qualitative Feedback:* Collect qualitative data through post-game interviews or focus groups to gain insight into students' experiences and perceptions of the learning process (Scherer et al., 2016).
- *Portfolio Assessments:* Encourage students to create portfolios documenting their learning experiences, including their thoughts about the game, the skills they developed, and how they put what they learned into practice.

Barriers and Limitations for Creating and Implementing DGBL in Nursing Education

It is seen that creating a learning environment with serious game method has the potential to contribute to the field of nursing education. There are also some limitations in the adoption of game-based learning. Lack of technological infrastructure, digital literacy levels of instructors and social factors affecting student motivation may be among these obstacles. Some students may not find the content presentation and educational benefits of the game effective enough, and students' access to technology should be considered as a factor that increases these difficulties. In addition, most of the studies have design deficiencies, most require a high budget, and learning in small groups limits their generalizability and application to large masses.

Developing serious games with well-defined learning objectives, well-defined skill contents, a solid theoretical basis and conceptual framework requires serious time, work and technological competence. Another important issue is that the development of these games requires long-term work with experts in scientific fields other than nursing disciplines, such as computer and software engineering, and a technical infrastructure and the ability to use this technology. These aspects include challenging features for nursing educators.

Implications for Nursing Education

The development of serious games allows nursing education curricula to be updated according to current conditions and to enrich students' clinical experiences. The inclusion of these games in the educational process allows students to practice as much as necessary to develop their knowledge and skills without harming the patient before applying them in real-life settings, and helps students develop active learning skills while gaining important competencies such as communication and teamwork (Chang et al., 2021). When integrating serious games into their curricula, nursing educators should pay attention to how the game connects to its educational objectives. The selection of games should be considered in accordance with educational objectives and the appropriateness of the content of the games should be evaluated.

Conclusion

Serious digital game-based learning stands out as an important tool in improving students' clinical competence in nursing education. The COVID-19 process has accelerated the integration of these methods and emphasized their importance in education. Although nursing education is built on a strong scientific foundation, the effective use of digital technologies provides students with more effective learning experiences. In the future, more research and innovation are needed to cope with the challenges encountered and to fully utilize the potential of game-based learning.

By carefully preparing and assessing the use of serious digital games in nursing education, educators can create an engaging and effective learning environment that enhances the educational experience and better prepares students for their future roles as healthcare professionals. Continuous evaluation and iteration of these methods will ensure that they remain relevant and effective.

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Resno digitalno učenje na podlagi iger v izobraževanju zdravstvenih delavcev: opolnomočenje študentov za klinično kompetenco

Razvoj tehnologije v obdobju digitalne transformacije je pomembno vplival na izobraževanje na področju zdravstvene nege, saj je povzročil premik v načinih posredovanja znanja. Ta premik, ki ga je dodatno pospešila potreba po spletnem učenju zaradi motenj v tradicionalnem, neposrednem izobraževanju med pandemijo covida-19, je izobraževalce v zdravstveni negi prisilil k preoblikovanju obstoječih učnih načrtov. V sklopu teh sprememb so digitalne izobraževalne aplikacije, zlasti resne igre, pridobile na pomembnosti. Resne igre so interaktivne računalniške igre, zasnovane z namenom posredovanja specifičnih učnih ciljev. Z vključevanjem zahtevnih ciljev, privlačne zasnove in sistemov točkovanja naj bi resne igre motivirale študente ter jim pomagale pri doseganju ciljev. Priljubljenost resnih izobraževalnih iger v izobraževanju na področju zdravstvene nege narašča, njihova uporaba na tem področju pa že izkazuje pozitivne rezultate. V pričujočem preglednem članku bomo predstavili vpliv mobilnih resnih izobraževalnih iger na razvoj kliničnih kompetenc pri dodiplomskih študentih zdravstvene nege.

Ključne besede: izobraževanje v zdravstvu, resne igre, profesionalne kompetence, zdravstvena nega, izobraževanje v zdravstveni negi

Digital Narrative Photography as a Method to Improve Empathy in Health Sciences

Juan M. Leyva
Universitat Autònoma de Barcelona, Spain
Juanmanuel.leyva@uab.cat

This chapter explores narrative photography in health sciences education, highlighting its effectiveness in addressing the often-overlooked psychosocial needs of patients. Traditionally focused on immediate biological outcomes, healthcare has neglected the importance of empathy and reflective practice. Narrative photography, inspired by Photovoice and reflective practice, involves capturing and reflecting on patients' real-life narratives through visual and written means. Students create self-made photographs or drawings, articulate their interpretations through short reflective narratives, and engage in group discussions to foster deeper empathy and reflection. Originally dependent on face-to-face interaction, narrative photography has been adapted to hybrid formats with digital tools, enhancing accessibility and cost-effectiveness. This chapter examines the origins, methodologies, technological advancements, and real-world applications of narrative photography, along with variations developed by the author. It also provides recommendations for assessing learning outcomes, evidence of effectiveness, and evaluations of student and faculty satisfaction.

Keywords: art-based methods, narrative photography, teaching innovation, active learning, hybrid learning.

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Introduction

What is Narrative Photography?

Narrative photography is an arts-based educational approach, that combines visual storytelling with reflective thinking. This innovative method involves students in creating and analyzing photographs to express and explore personal or observed experiences and emotions emphasizing learning through reflection on experiences (Leyva-Moral et al., 2022). The narrative photography intervention is grounded in the theories of reflective thinking and Photovoice methods. Reflective thinking, as articulated by Donald Schön (1983, 1987), emphasizes the importance of reflecting on experiences as a key component of professional learning and development. Photovoice, developed by Caroline Wang (1999) and Caroline Wang and Mary Ann Burris (1997), is a participatory method that empowers individuals to capture their community's strengths and challenges through photography, aiming to promote social change.

Narrative photography has become a valuable teaching tool, especially in health sciences and nursing education in the last few years. In health sciences education, narrative photography is particularly effective in cultivating empathy, enhancing reflective thinking, and fostering a deeper understanding of patients' experiences (Dodd et al., 2022; Jih et al., 2023; Kolaiti, 2009; Leyva-Moral et al., 2021, 2022). This method follows a structured process that integrates visual and reflective elements to enrich the learning experience. Overall, the structured process of narrative photography in health sciences education not only improves students' observational and reflective abilities but also strengthens their empathetic engagement with patients, making it a valuable pedagogical tool (Rieger et al., 2016).

Later in this chapter, specific details on the implementation of the narrative photography method will be provided. To provide a succinct overview, the process initiates with students engaging in the *Feeling the Narratives* activity (Hall & Powell, 2011; Timpani et al., 2022). This preliminary step encourages students to observe and interpret the nuanced aspects of patient care, extending their understanding beyond clinical symptoms to encompass the human experience. This is achieved through the reading of real narratives or the viewing of real story videos. The materials selected by faculty include personal accounts available on the internet, podcasts, blogs, or verbatims from qualitative studies. Subsequently, students are tasked with *Creating Narrative Photographs*. Working either individually or in small groups, as determined by the instructor, students must produce up to three images that encapsulate their feelings and the meaning of what they have learned. No specific format is required for these photographs. The only guidelines are that the images must be original, creative, sensitive, integrative, and explanatory of the theoretical concepts discussed. Following the creation of these visual narratives, students move on to *Reflective Narratives* (Dunn, 2024; Smith et al., 2015). In this phase, students write short reflective essays or commentaries that elucidate the emotions, thoughts, and meanings behind their images. This reflective writing fosters deep introspection and critical thinking, as students articulate their observations and insights. It also helps students to connect emotionally with the patients' experiences, enhancing their ability to empathize and respond compassionately. Finally, these visual and written narratives are brought into *Group Discussions*. During these sessions, students share their narratives with peers in small or medium-sized groups moderated by experienced active-learning methods faculty. This collaborative environment promotes a rich exchange of perspectives and reflections, allowing students to gain deeper insights and broaden their understanding. Through discussion and feedback, they refine their interpretive skills and develop a more comprehensive view of patient care.

Why using Narrative Photography?

The primary advantage of narrative photography is its ability to enhance empathy (Leyva-Moral et al., 2021, 2022). By visualizing and reflecting on patients' experiences, students develop a better understanding and empathy for their patients' psychosocial needs. This method helps students to see beyond the clinical symptoms and engage with the human aspects of patient care.

Reflective practice is another critical benefit of the method. To create meaningful images students must critically reflect on their own experiences and those of others, improving their reflective thinking skills. This practice is crucial for health professionals who must continuously learn from their experiences to provide better care. Engaging in discussions about their narratives with peers sharpens students' ability to articulate complex emotions and experiences. This process not only enhances their communication skills but also creates a supportive learning environment where students benefit from each other's perspectives and insights.

Recent advancements in digital technology have enabled the adaptation of narrative photography to hybrid formats. These innovations have made the method more accessible and cost-effective, providing digital tools for creating and sharing visual narratives and facilitating remote collaboration (Abdulrahaman et al., 2020; Smeda et al., 2014). This integration of technology ensures that narrative photography can be effectively utilized in contemporary educational environments, accommodating the needs of 21st-century students and faculty.

Narrative Photography and Empathy

Empathy is a fundamental element of nursing care that leads to better patient outcomes (Engbers, 2020). Empathic competence includes identifying patient distress, understanding patient perspectives, and expressing this understanding (Stepien & Baernstein, 2006). Innovative pedagogical approaches, such as narrative photography, have proven effective in educating nursing students about empathy and humanised care. There is a significant gap between the skills learned at university and the demands of employers (Hayter & Parker, 2019; Moore & Morton, 2015; Pang et al., 2018). Despite this, university teaching remains heavily based on traditional methodologies like lectures (Lai et al., 2018; Pelger & Nilsson, 2017; Rasool & Chaudhry, 2012).

Active methodologies that emphasise learning, creativity, and motivation are necessary to bridge this gap (Betihavas et al., 2016; Calimeris & Sauer, 2015). Research shows that health science curricula incorporating visual arts help develop clinical observation skills (Mukunda et al., 2019). However, few human science-based educational interventions have included reflective and artistic methods (Bas-Sarmiento et al., 2017, 2020). For instance, Leyva et al. (2021) found that using photographs in the classroom helped Spanish nursing students understand the effects of HIV on individuals. Similarly, Photovoice has been found to help develop empathy, reduce stigma, and encourage nondiscriminatory treatment of patients with HIV/AIDS (Dermatoto et al., 2016).

Studies on narrative photography as a teaching method for nursing students have reported high levels of satisfaction and empathy. Leyva-Moral et al. (2022) highlighted that narrative photography is associated with enhanced empathy and student satisfaction, demonstrating the effectiveness of innovative and active strategies in nursing education. The use of narratives and images through books, autobiographical accounts, and other visual arts has helped nursing students develop critical and creative thinking, empathy, and meaningful interpretations (Stone & Levett-Jones, 2014).

Implementing Hybrid Narrative Photography

The implementation of a hybrid format of narrative photography in university settings can be regarded as an innovative approach to teaching and learning, particularly in nursing education. The uniqueness of this innovation lies in its integration of traditional face-to-face classes with the use of digital technologies to promote student creativity, sensitivity, engagement, and deepen understanding of complex healthcare concepts. The successful implementation of Narrative Photography methodology in hybrid format necessitates careful planning and execution. This process entails several fundamental steps to ensure effectiveness and engagement from both teaching staff and students. In this introduction, we will explore the key elements required to execute this innovative methodology.

Concept Clarification and Assessment: An introductory session must be conducted to clarify the concepts to be addressed and the evaluation method, directed at both teaching staff and students.

Table 1 example of evaluation rubric

	Fail	Pass	Good	Excellent
Use of theoretical concepts	The student does not use or demonstrate understanding of relevant theoretical concepts	The student uses some theoretical concepts appropriately, but application is inconsistent or shows partial understanding	The student applies most relevant theoretical concepts clearly and appropriately, demonstrating good understanding	he student consistently and accurately applies all relevant theoretical concepts, demonstrating comprehensive understanding
Integration of theoretical content covered in class	Does not integrate theoretical content covered in class into the narrative photography. The work shows no evidence of applying classroom concepts	Demonstrates partial integration of theoretical content covered in class in the narrative photography. Some classroom concepts are applied, but connections may be superficial or inconsistent	Demonstrates good integration of theoretical content covered in class in the narrative photography. Most relevant classroom concepts are applied effectively and show clear connections to the work	Demonstrates excellent integration of theoretical content covered in class in the narrative photography. All relevant classroom concepts are applied comprehensively, showing deep understanding and seamless incorporation into the work
Creativity and originality	Shows little to no creativity in the narrative photography. Ideas presented are conventional, predictable, or cliché. No evidence of original or innovative thinking	Demonstrates some creativity in the narrative photography. While there are elements of originality, the work could be more innovative or unique in its approach	Exhibits considerable creativity in the narrative photography. The work demonstrates clear originality and innovative thinking in most aspects	Displays outstanding creativity in the narrative photography. The work is highly original throughout, showcasing innovative thinking and unique perspectives that go beyond expectations
Sensitivity in Emotional Capture and Message Conveyance	Demonstrates minimal or no sensitivity in the narrative photography. Fails to capture emotions effectively or convey meaningful messages. The work lacks emotional depth or empathetic understanding	Shows some sensitivity in the narrative photography. Captures basic emotions and conveys simple messages, but may lack nuance or depth in emotional representation	Exhibits considerable sensitivity in the narrative photography. Effectively captures a range of emotions and conveys clear, meaningful messages. The work demonstrates a good understanding of emotional nuances	Displays exceptional sensitivity in the narrative photography. Masterfully captures complex emotions and conveys profound messages. The work shows a deep, empathetic understanding of the subject matter, evoking strong emotional responses
Reflexivity and Critical Analysis	Shows minimal or no reflexivity in the narrative photography. The work is largely descriptive, lacking critical analysis or self–reflection. No evidence of considering multiple perspectives or questioning assumptions	Demonstrates some reflexivity in the narrative photography. There are attempts at critical analysis, but these could be more in–depth. The work shows basic self–reflection but may not fully explore implications or alternative viewpoints	Exhibits considerable reflexivity in the narrative photography. The work demonstrates clear critical analysis, showing thoughtful self–reflection and exploration of multiple perspectives. Assumptions are questioned and implications are considered	Displays deep reflexivity in the narrative photography. The work showcases sophisticated critical analysis, demonstrating insightful self–reflection, thorough examination of multiple perspectives, and challenging of assumptions. Implications are fully explored, and the work shows a transformative understanding of the subject matter
Group discussion participation	Rarely participates in group discussions. When participation occurs, questions or answers are often irrelevant, off–topic, or lack coherence. Shows little engagement with the subject matter.	Demonstrates partial participation in group discussions. Contributions include some relevant questions or answers, but they may be superficial or show limited understanding of the topic. Minimal reference to theoretical concepts or evidence.	Shows active and informed participation in group discussions. Regularly contributes relevant questions and responses that demonstrate clear understanding of the topic. Some comments are supported by theoretical concepts or evidence from the literature	Demonstrates leadership in group discussions by actively participating and encouraging others' involvement. Consistently poses insightful questions and provides thoughtful answers that are highly relevant to the topic. All contributions are well–informed by theoretical concepts and evidence from the literature

- *Creation of the Virtual Campus*: A virtual campus was established to provide all necessary instructions, evaluation tools, and a space for students to submit their assignments.
- *Facilitation of Experiential Materials*: Students received experiential materials, including real-life stories, podcasts, videos from various platforms such as TikTok and Instagram, as well as short films or series scenes. Additionally, verbatims from published qualitative studies were included.
- *Creation of Images and Reflective Narratives*: In groups of 3–4, students created original images representing the concepts studied. These images were accompanied by reflective narratives, where students expressed their emotions and reflected on their impact on nursing practice. A deadline of 7 days was set for submitting images and narratives on the virtual campus.
- *Discussion Seminar and Evaluation*: Seven days later, a synchronic virtual seminar was held where each subgroup presented their creations. A group discussion space was opened to share reflections and emotions, and works were evaluated using a specific rubric (see Table 1). A patient expert's participation enriched the discussion.
- *Selection of Best Images and Dissemination*: Through voting by students and faculty, the best images from each topic were selected. These images were exhibited through a photographic exhibition (physical and virtual) to educate and sensitize the community and future generations of nurses. Additionally, dissemination through written reports, books, pamphlets, or short videos, always with student participation, was encouraged.

In 2019, the Nursing Department of the Faculty of Medicine at the Universitat Autònoma de Barcelona (UAB) initiated a targeted educational program exclusively tailored for nursing students, with a primary focus on fostering the humanization of care towards individuals living with HIV. This specialized curriculum delved into three overarching thematic areas, meticulously designed to provide comprehensive insights into the complexities of caring for individuals affected by HIV/AIDS. These areas encompassed: a) the emotional journey of receiving an HIV diagnosis, b) the profound impact of societal stigma and discrimination faced by those with HIV, and c) the multifaceted aspects surrounding antiretroviral medication management and the lifelong management of chronicity. The instructional format comprised a series of three face-to-face seminars, each spanning two hours, strategically complemented by curated reading materials and educational videos accessible

Figure 1 & 2 Photography Exhibition 'Feeling and Creating to Care' at UAB After Using Narrative Photography Method.

online. Additionally, to extend the reach of awareness and understanding beyond the participating students, the program culminated in a thoughtfully curated exhibition displayed in the faculty corridors. This exhibition served as a poignant testament to the shared commitment towards advocating for compassion and inclusivity in healthcare practice among both students and faculty members alike.

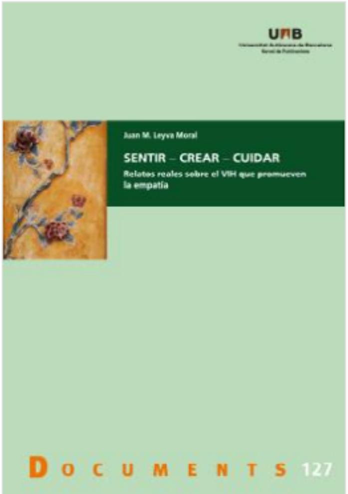

Figure 3 Book Cover 'Feel–Create–Care: Real HIV Stories That Promote Empathy'. More info here https://publicacions.uab.cat/llibres/sentir-crear-cuidar

In 2020, the Nursing Department of the Faculty of Medicine at the Autonomous University of Barcelona conducted an online training for health science students to enhance empathy and humanize care for people with HIV. This initiative comprised six two-hour seminars, followed by a closing seminar. Unlike traditional dynamics, exercises were individual, and image and reflection presentations were all done online via Teams and Moodle. At each session, a patient expert shared their experiences, enriching discussions. Topics covered included receiving a HIV diagnosis, facing stigma and discrimination, experiencing professional care, managing antiretroviral medication, and dealing with risk. The activity culminated in writing and publishing a book aimed at sensitizing the community and healthcare professionals about caring for people with HIV (see Figure 3). This example illustrates how Narrative Photography methodology can be used to promote reflection, understanding, and awareness in health-related topics.

In 2022, a comprehensive hybrid training program was introduced for students pursuing studies in health sciences, with a central focus on gender-based violence prevention, employing the innovative approach of narrative photography. The curriculum delved into multifaceted aspects, covering a spectrum of topics essential to understanding and addressing gender-based violence. Among these themes were explorations into the complexities of masculinities and femininities, elucidation of the concept of gender-based violence, categorization of various forms of gender-based violence, identification of key indicators signalling instances of such violence, examination of the cyclic nature of violence, and an analysis of the far-reaching consequenc-

Figure 4 Photography Exhibition 'Reflections on Gender–Based Violence From Creativity and Narrative Photography' at UAB After Using Narrative Photography Method

es it entails. Distinguishing this initiative was the integration of expertise from a seasoned medical anthropologist specializing in gender-based violence, whose contributions elevated the discourse within seminars, fostering critical engagement and deep reflection grounded in the realities of societal dynamics and the imperative of social change.

The seminars, complemented by thought-provoking readings and online video resources, provided a rich platform for students to grapple with nuanced concepts and ethical considerations. The culmination of the program was marked by the creation of a captivating photographic exhibition (Figure 4), meticulously curated to encapsulate the multifaceted dimensions of gender-based violence. This exhibition, conceived as a travelling showcase, traversed various educational and healthcare institutions, serving as a catalyst for awareness and dialogue. Furthermore, recognizing the importance of extending the reach of this critical discourse beyond physical boundaries, a dynamic virtual tour of the exhibition was meticulously crafted (visit the virtual tour here https://my.matterport.com/show/?m=8apG1r6p4A1). This digital iteration was disseminated widely, reaching influential stakeholders including political leaders, healthcare administrators, educators, NGOs, community organizations, students, and beyond, fostering broader societal

Figure 5 Book Cover '*Reflections on Gender–Based Violence from Creativity and Narrative Photography*'. More info here https://www.bellaterra.coop/es/libros/reflexiones-sobre-las-violencias-de-genero-desde-la-creatividad-reflexiones-sobre-las-violencias-de

engagement and advocacy for meaningful change. Finally, a digital book including academic content related to gender-based violence was written and illustrated with the pictures created by students (Figure 5).

Digital blackboards such as Miro® or Padlet® are an effective and inspiring space for students to share and disseminate information. International students attending the UAB Summer School course called 'Culture, Society and Health' are a case in point. Students shared their creations using one of these sources, following clear indications from faculty. These digital blackboards were invaluable for the group presentations, as images and texts were easily accessible and could be shown with ease. They also provided inspiration for students by allowing them to view their peers' creations. This encouraged healthy competition within the class, as the system allows participants to vote on others' creations, give likes, and engage in other social media-like actions (see example at Figure 6).

Teachers' Experience with Narrative Photography

The implementation of narrative photography in a hybrid format or with the utilisation of technology as an instructional method has elicited a diverse range of responses from educators, with the majority expressing positive and enthusiastic attitudes. Upon initial introduction to the concept, many teachers reported a combination of curiosity and apprehension. The novelty of the approach prompted interest, albeit accompanied by some initial trepidation regarding the ability to comprehend and utilise it effectively. As one educator noted, 'I was very curious, although the fact that it was a new methodology

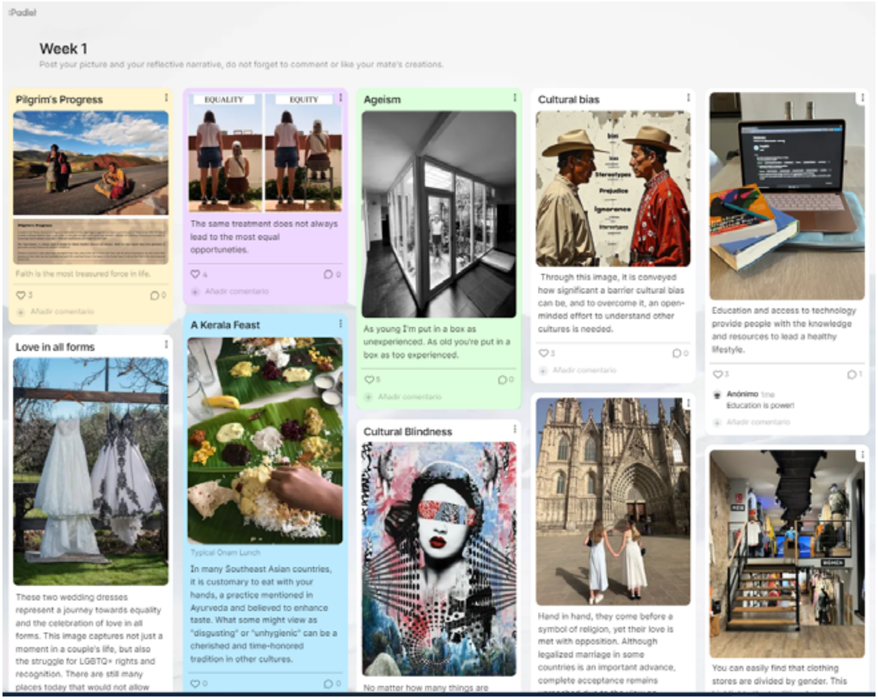

Figure 6 Padlet Screenshot

for me also made me a bit nervous at the beginning, or afraid of not knowing how to 'use' or understand it'.

From a pedagogical standpoint, narrative photography has been met with considerable approval. Educators commended its capacity to stimulate students' imaginative and creative faculties, emphasising its profound emotional impact. The method was described as innovative, with the capacity to promote proactive learning and facilitate the integration of complex concepts. It was also commended for its straightforwardness in terms of both explanation and evaluation, despite the inherent subjectivity involved. One participating teacher articulated this sentiment: 'A two thumbs up activity to be able to work on theoretical aspects in the seminars with a more reflective and critical view. The students, surprisingly, get involved and enjoy the activity. It brings out their most creative side, and with it they work, debate and question concepts that cannot be done with other activities or methodologies. And the best thing is that the debate and reflection does not stay in the group itself but has an impact on the rest of the class and the teacher'.

The impact of the activity extended beyond the classroom for numerous educators. Some respondents indicated that they had adopted a 'narrative photographic perspective' in their daily lives, employing a lens that seeks to capture meaningful moments and concepts. Others observed an enhanced tolerance for diversity and a commitment to ongoing enhancement in this domain. Teachers particularly appreciated the flexibility of the method and the absence of restrictive guidelines, which permitted a wide range of possibilities in representation. The educators valued the debates and reflections generated by the students' work, especially when these led to challenging preconceptions and addressed societal issues. However, some challenges were noted. There was discomfort when presentations failed to generate substantive discussions, and some difficulty in aligning certain rubric items with the nature of the activity, particularly for first-year students. As one teacher expressed, 'It makes me uncomfortable when one group presents their photographs, and the others just applaud and nod. I like it when thought-provoking discussions are generated, but not all photographs or themes achieve this equally. I love learning from the students'.

Overall, narrative photography has been embraced as an innovative and impactful pedagogical tool, fostering critical thinking, creativity, and deeper engagement with theoretical concepts among students.

Conclusions

The integration of narrative photography and digital technologies in nursing education represents a significant advancement in pedagogical approaches within health sciences. This innovative methodology has demonstrated considerable efficacy in enhancing students' empathetic understanding, reflective capabilities, and critical thinking skills. The hybrid implementation, facilitated by digital platforms, has proven particularly valuable in contemporary educational settings, enabling greater flexibility and accessibility. The process of creating, analysing, and discussing visual narratives encourages a profound emotional and intellectual connection with patient experiences and psychosocial aspects of care. However, successful implementation requires careful planning, adequate technological infrastructure, and ongoing support for both educators and students.

As nursing education evolves, the role of innovative approaches like narrative photography is likely to grow. Future research should focus on longitudinal studies to assess long-term impacts on nursing practice and patient outcomes, and explore integration with emerging technologies. In conclusion, the hybrid implementation of narrative photography represents a promising direction for nursing education, aligning with the profession's emphasis on holistic, patient-centred care. By fostering empathy, reflection, and critical thinking through creative and technologically-enhanced means, this approach has the potential to produce well-rounded, emotionally intelligent nursing professionals, ultimately contributing to improved patient care outcomes.

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Digitalna narativna fotografija kot metoda za izboljšanje empatije v zdravstvenih vedah

Pripovedna fotografija igra ključno vlogo v izobraževanju zdravstvenih ved, še posebej pri naslavljanju spregledanih psihosocialnih potreb pacientov. Ta metoda, ki izhaja iz načel Fotovoicea in refleksivne prakse, študentom omogoča, da s pomočjo fotografij ali risb zajamejo resnične zgodbe pacientov in jih interpretirajo skozi refleksivne pripovedi. Skupinske razprave nato spodbujajo globoko razmišljanje in empatijo. Zgodovinsko je bila pripovedna fotografija odvisna od osebnega stika, vendar se je skozi čas prilagodila uporabi digitalnih orodij, kar je olajšalo dostop do nje in uporabo. V poglavju so predstavljene izvorne metode in aplikacije pripovedne fotografije, vključno s tehnološkimi inovacijami in praktično uporabo le-te. Predstavljeni so tudi avtorjeve lastne prilagoditve metode, priporočila za vrednotenje učnih izidov, dokazi o učinkovitosti ter ocene zadovoljstva študentov in predavateljev.

Ključne besede: umetniške metode, pripovedna fotografija, inovacije pri poučevanju, aktivno učenje, hibridno učenje