

Digital Skills in Higher Education and Post- Secondary Vocational Training: A Systematic Analysis of Pedagogical Transformation, Motivation and Engagement

Compétences Numériques dans l'Enseignement Supérieur et la Formation Professionnelle Postsecondaire : Une Analyse Systématique de la Transformation Pédagogique, de la Motivation et de l'Engagement

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Abstract

The integration of digital skills is a central requirement for higher and vocational education. This systematic review synthesises evidence of the impact of digital technologies on pedagogical processes, student motivation and learner engagement. In line with PRISMA guidelines, we analysed 49 peer-reviewed articles published between 2020 and 2024. A thematic analysis was conducted, structured around three interconnected themes: pedagogical process transformation, student motivation and learner engagement. The main findings reveal the widespread adoption of technologies such as learning management systems, gamification and immersive tools, which effectively support personalised and blended learning. However, significant challenges remain, including inequalities of access, a lack of standardisation of tools and a paucity of longitudinal research exploring the socio-emotional dimensions of digital learning. The study concludes that the success of digital transformation depends not just on technology, but on its thoughtful integration into the design of education. It highlights the crucial need for solid teacher training and institutional strategies that prioritise human factors in order to promote equitable digital learning experiences.

Keywords : Digital Transformation; Higher Education; Vocational Training; Learner engagement; Digital skills; PRISMA.

Résumé

L'intégration des compétences numériques est un impératif pour l'enseignement supérieur et la formation professionnelle. Cette revue systématique, menée selon le protocole PRISMA sur 49 articles (2020-2024), analyse l'impact des technologies sur la pédagogie, la motivation et l'engagement des apprenants. L'analyse thématique révèle une adoption croissante des plateformes d'apprentissage (LMS), de la ludification et des outils immersifs, favorisant des parcours personnalisés et hybrides. Cependant, des défis majeurs subsistent : inégalités d'accès, manque de standardisation des outils et rareté des études longitudinales sur les dimensions socio-émotionnelles. En conclusion, la réussite de la transformation numérique repose moins sur la technologie que sur son intégration réfléchie dans l'ingénierie pédagogique. L'étude souligne le besoin crucial de former les enseignants et de développer des stratégies institutionnelles centrées sur l'humain pour garantir un apprentissage numérique équitable.

Mots clés : Transformation numérique; Enseignement supérieur; Formation professionnelle; Engagement de l'apprenant; Compétences numériques; PRISMA.

Introduction

Arguably, the need for digital skills in higher and vocational education has become a central reality, driven by the demands of a globalized labor market for digital agility (Arce & Cuadros Valdivia, 2020; Mihajlović et al., 2024) and a student population already thoroughly accustomed to digital interaction (Xiao & Hew, 2024). Although this trend was well underway, the recent pandemic quite suddenly acted as a powerful stress test for educational systems worldwide (Soliman et al., 2022). In practice, the subsequent shift to remote and hybrid models was far more than a logistical challenge—it forced a fundamental re-evaluation of teaching methods. Ultimately, this period highlighted not only the potential of educational technology but also the stark gaps in institutional preparedness, underscoring the urgent need for coherent digital transformation strategies (Hasynets et al., 2024).

Naturally, against this backdrop, a variety of technological tools have become widespread. For the most part, Learning Management Systems (LMS) now serve as the foundational platforms for delivering learning content (Aulianda et al., 2023), offering flexible access, especially within blended learning models (Zervas & Stiakakis, 2024). Alongside these core systems, innovative practices like gamification are increasingly used to enhance motivation (Jayalath & Esichaikul, 2020), while immersive technologies like virtual and augmented reality (VR/AR) offer simulated, hands-on learning environments that are both interactive and engaging (Albus et al., 2021; Poupard et al., 2024). At least in theory, these technologies promise to create learning pathways that are more responsive, personalized, and efficient (Zabolotska et al., 2021).

However, a growing body of evidence now underscores a crucial point: simply deploying technology does not guarantee pedagogical success. In reality, the potential of these tools is often limited by persistent challenges, including inequitable access to digital resources (Vishnu et al., 2022), a notable skills gap among educators (Ocaña-Fernández et al., 2020), and the prohibitive costs and lack of standardization associated with advanced systems (Chiang et al., 2022; Poupard et al., 2024). Fundamentally, this points to a critical disconnect: while technology is being adopted, its influence on the core dynamics of learning remains inconsistent and under-researched. This problem is further compounded by a fragmented research landscape, where studies often focus on specific tools or outcomes in isolation. As a result, the field's understanding of how pedagogy, motivation, and engagement truly interact in these new environments remains frustratingly incomplete.

The present systematic review attempt to fill this gap by elucidating the most recent research through three main questions:

- How do digital tools modify the design, implementation, and evaluation of teaching and learning methods?
- To what extent do educational technologies influence students' interests, levels of perseverance, and autonomy in hybrid and online environments?
- In what ways do digital tools encourage active participation, collaboration and interaction among the learners?

The current review to synthesize evidence-based practices and formulate concrete recommendations. Ultimately, we seek to inform strategies that enhance pedagogical effectiveness and promote equitable access within high-quality digital learning environments.

1. Methodology

1.1. PRISMA protocol

This systematic review was carried-out in full adherence with the PRISMA (preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021) making it a highly transparent and replicable process. Guidelines such as these are necessary to ensure transparency, reproducibility, and reliability of findings with the results from this review outlining multiple individual phases regarding their implementation:

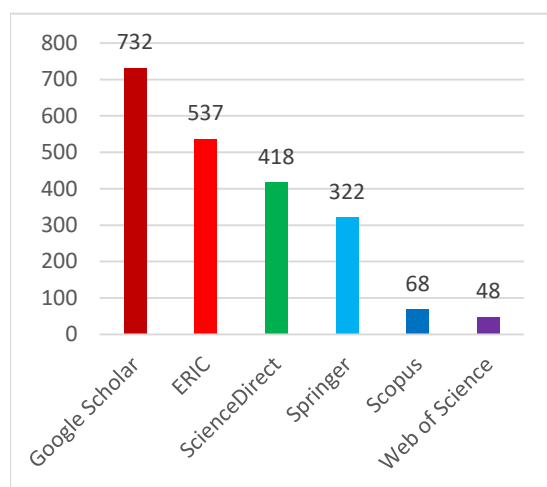
- **Identification:** An initial search was conducted in the aforementioned databases to compile a corpus of potential studies. To avoid repetitive references, all duplicates were removed with the aid of a deduplication step to guarantee the uniqueness of the sources for further analysis.
- **Filtering:** Titles, and abstracts of the selected studies were reviewed independently to exclude irrelevant studies that did not meet the eligibility criteria or while not within the objective of this study. This particular phase lead to a significant decrease in the number of studies within the corpus, now targeting only relevant research.
- **Eligibility assessment:** A detailed review of the full texts of preselected studies was performed to confirm compliance with those eligibility criteria already defined in the protocol. This step was taken in order to make sure of two key matters that the chosen studies meet both methodological and thematic criteria.
- **Final inclusion:** Studies that met all previous criteria were included in this step and scrutinized further to provide a more heterogeneous and generalizable body of studies, which was used to answer research questions.

1.2. Research sources and strategies

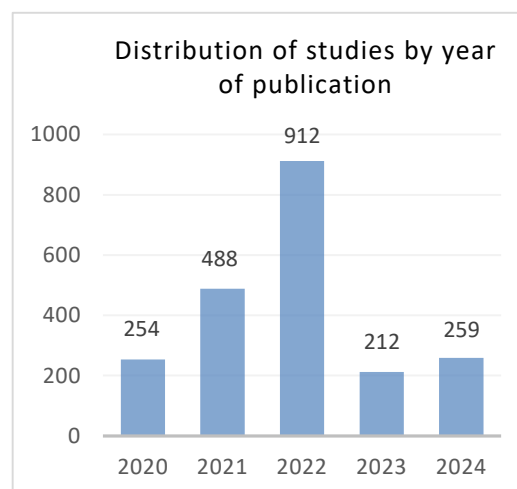
The literature search was conducted by consulting a set of academic databases recognized for their richness and multidisciplinary diversity. To cover the full 2020-2024 publication window, final searches were performed in March 2025 across several major academic databases: Google scholar, Eric, ScienceDirect, Springer, Scopus, and web of science. This multi-database strategy following PRISMA guidelines and is an established best practices for enhancing search comprehensiveness and minimizing the risk of selection bias (Page et al., 2021).

To maximize the scope of our research, we used keywords and Boolean search operators. The keywords, which were meticulously selected to reflect the central themes of the study, pertained to digital skills, higher education, vocational training, student motivation and learner engagement. Examples of such phenomena include: The following subjects will be covered in this study: “Digital skills in higher education”, “Blended learning and engagement”, “Gamification and student motivation”, “VR/AR in vocational training” and “E-learning platforms and cognitive outcomes”. The use of the keywords in combination with Boolean operators sharpens the search and makes sure that the documents obtained are in close conformity with the objectives of the study (Farias-Gaytan et al., 2023). To improve the search and target the most relevant articles, Boolean operators (AND, OR) were applied, making logical combinations of different keywords and the identification of the documents that best matched the criteria (Aulianda et al., 2023). This approach led to increased speed and reliability in the process of selecting studies.

Figure 1 presents the distribution of the included studies by publication source, while **Figure 1 bis**, illustrates the annual publication trend.

Figure N°1: Distribution of studies by database

Source: Authors

Figure N°1 bis: Distribution of studies by year of publication

Source: Authors

1.3. Inclusion and exclusion criteria

To ensure the relevance and quality of the literature, the selection of studies was governed by a rigorous protocol of inclusion and exclusion. This methodology, adhering to established research principles, is outlined below:

1.3.1. Inclusion criteria:

- **Publication period:** To capture the most current research in a rapidly evolving field, our selection was restricted to studies published between 2020 and 2024, ensuring the analysis reflects the latest advancements in digital technologies and pedagogical practices (Hasynets et al., 2024; Soliman et al., 2022; Xu et al., 2022).
- **Type of documents:** To ensure methodological rigor, the selection prioritized peer-reviewed articles from academic journals, while excluding grey literature such as conference proceedings, technical reports, and editorials. This emphasis on peer-reviewed literature is a standard practice to guarantee the validity and transparency of the synthesized evidence (Page et al., 2021).
- **Language:** To ensure broad accessibility and a comprehensive international research scope, the selection of studies was limited to articles published in English and French.
- **Main theme:** A significant body of literature has emerged to address the impact of digital skills in higher education and post-secondary vocational training, areas that are directly linked to our three research themes (TPP, ME and EA).

- **Methodology:** To ensure the robustness of our analysis, our selection focused exclusively on empirical studies and systematic reviews that demonstrated rigorous methodologies. We excluded articles that lacked a clearly defined research design or presented findings that were not usable for synthesis.
- **Accessibility:** To facilitate a comprehensive analysis, full-text access to the studies in question was imperative.

It should be noted that while the analysed corpus was restricted to articles published between 2020 and 2024, seminal theories and foundational studies published prior to this period are referenced in the introduction and discussion. These earlier works are included not as part of the systematic analysis, but to establish the theoretical framework and provide necessary context for the findings.

1.3.2. Exclusion criteria

- **Publication period:** In order to consider only the most recent studies in this field, articles published before 2020 were excluded from the analysis.
- **Type of documents:** In order to favour peer-reviewed sources, conference abstracts, editorials and non-academic reports were excluded from the study.
- **Language:** It is important to note that publications in languages other than English or French were not considered due to accessibility concerns.
- **Theme:** Studies that did not explicitly address digital skills in higher education or vocational training were excluded from the analysis. In the course of the analysis, studies which did not relate directly to the thematic areas under investigation were excluded.
- **Population:** Studies focusing on children under the age of 12 or on older adults outside the educational context were excluded from the analysis.
- **Methodology:** It is important to note that studies which exhibited significant methodological limitations or produced unusable results were excluded from the analysis.

Table 1 provides a concise overview of the inclusion and exclusion criteria employed in this review, thus facilitating a clear understanding of the parameters that guided the selection of studies.

Table N°1 : Summary of inclusion and exclusion criteria

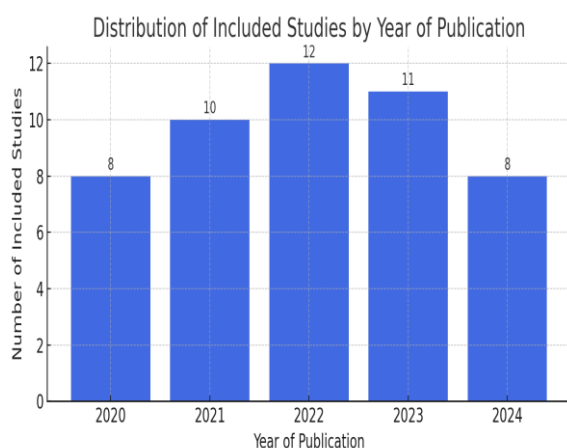
Inclusion criteria	Exclusion criteria
Publication period: Articles published between 2020 and 2024.	Publication period: Articles published before 2020 or after 2024.
Language: Articles published in English or French.	Language: Publications in languages other than English or French.
Type of documents: Peer-reviewed scholarly articles.	Type of documents: Conference abstracts, editorials, or non-academic reports
Main topic: Studies focusing on the impact of digital competencies in higher education and vocational training.	Out-of-scope topics: Studies not addressing the impact of digital competencies in education.
Methodology: Studies based on empirical data or rigorous analysis.	Methodology: Articles lacking a clear methodology or with unusable results.
Accessibility: Full-text articles available.	Target Population: Studies focusing on children under 12 or elderly adults outside an educational context.

Source : Authors

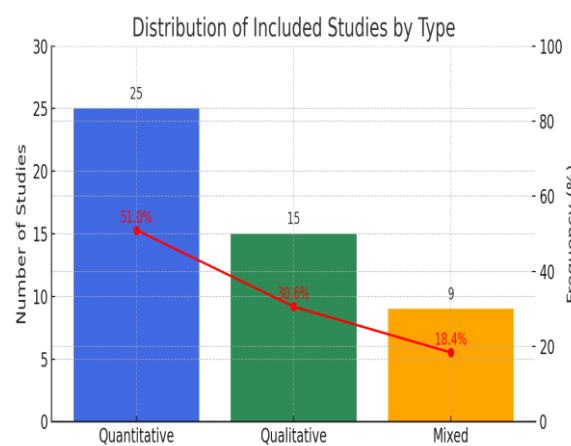
1.4. Selection process

The study selection process strictly adhered to the steps recommended by the PRISMA model, ensuring the transparency and systematic nature of the approach adopted.

The distribution of the included studies by year of publication is illustrated in **Figure 2**, thereby providing a visual representation of the evolution of research in the field. A notable increase in publications from 2020 onwards is indicative of the growing interest in this topic. **Figure 3** provides a more comprehensive overview of this distribution, differentiating between the various study types over time.

Figure N°2: Distribution of included studies by year of publication

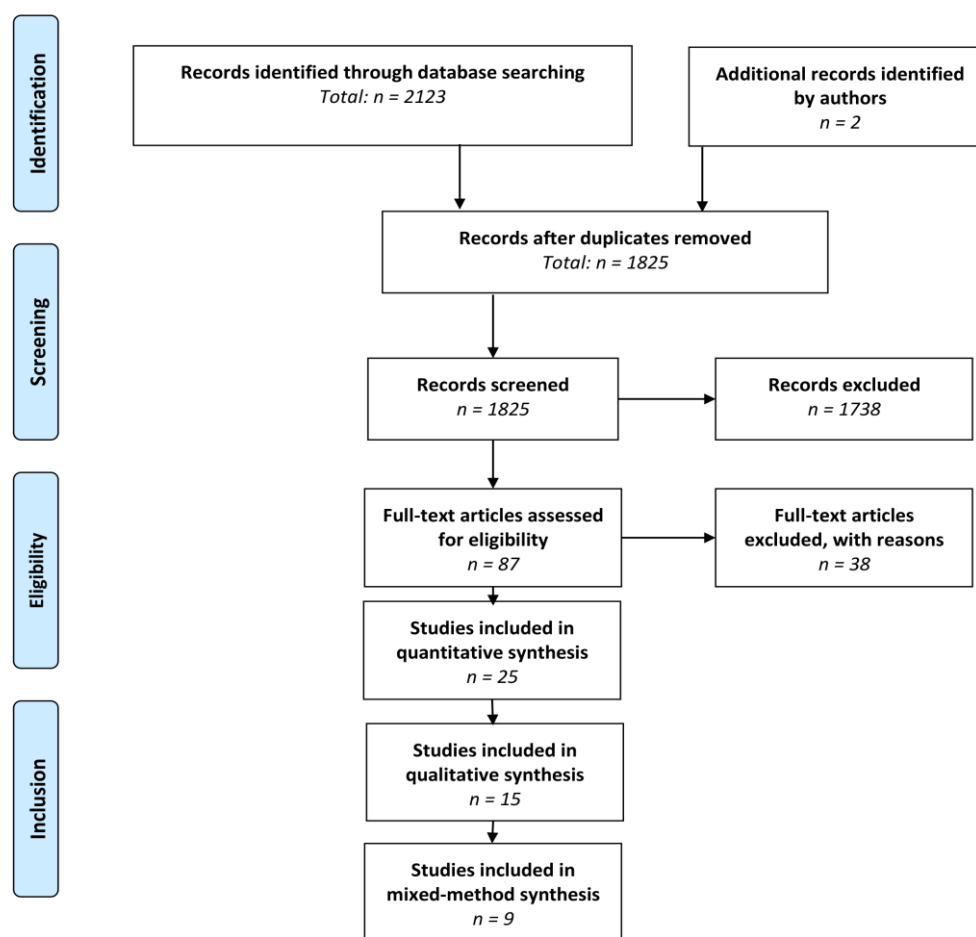
Source: Authors

Figure N°3: Distribution of included studies by type

Source: Authors

The study selection process is detailed in the PRISMA flow diagram (**Figure 4**), which outlines each stage from initial identification to the final inclusion of studies for analysis.

Figure N°4: PRISMA diagram



Source: Authors

1.5. Data extraction and analysis

Data were extracted from each study using a structured coding sheet and analyzed thematically across three dimensions: Transformation of the Pedagogical Process (TPP), Student Motivation (SM), and Learner Engagement (LE). Concurrently, each study's methodological quality was rigorously appraised based on the clarity of its objectives, the validity of its instruments, and the relevance of its sample.

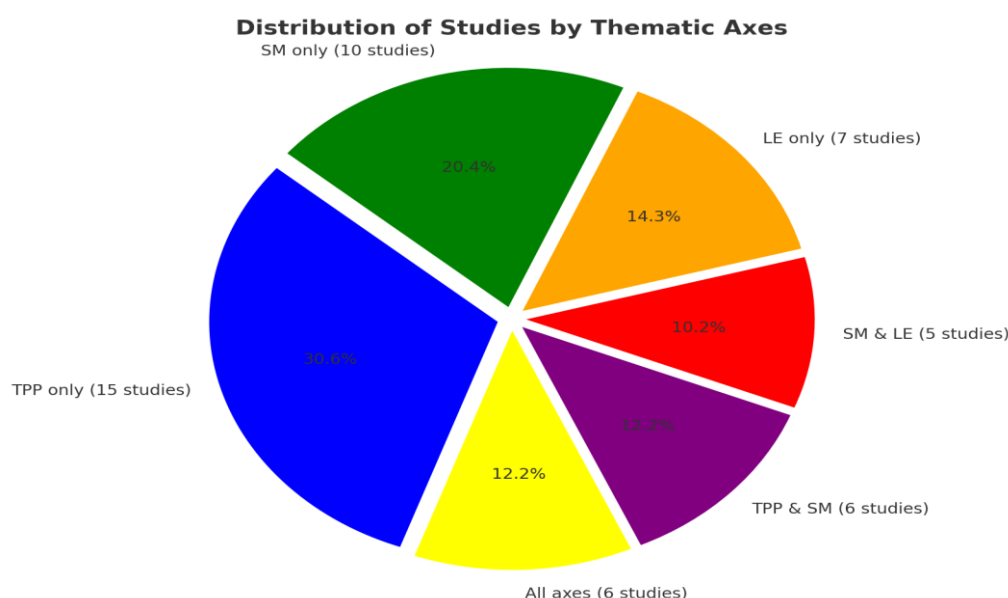
Our coding framework was designed to capture three core elements from each paper: study context, digital tool descriptions, and reported impacts. We evaluated these impacts against our key variables—pedagogical practice (TPP), student motivation (SM), and learner engagement

(LE). A thematic synthesis of the findings concluded our analysis. In parallel, we documented each study's methodological limitations and its authors' recommendations for future inquiry.

2. Results

Our analysis of the 49 articles revealed three central themes: TPP, SM and LE. **Figure 5** illustrates the distribution of the literature across these key areas.

Figure N°5: Distribution of studies by thematic axes



Source : Authors

2.1. Transformation of Pedagogical Process (TPP)

2.1.1. Adoption of digital technologies

A significant trend in pedagogical modernization is the integration of digital technologies, beginning with the foundational layer of online learning platforms. Systems like Moodle, Google Classroom, and Microsoft Teams are now commonplace for managing coursework and facilitating student-teacher communication (El-Sabagh, 2021; Xu et al., 2022; Aulianda et al., 2023). A more recent wave of innovation involves immersive technologies, where augmented reality (AR) and virtual reality (VR) are being applied to construct authentic training environments, a development particularly prominent in technical domains (Chiang et al., 2022; Poupard et al., 2024). The capacity of these tools to simulate professional contexts and deliver interactive experiences is prompting a fundamental shift in practice, guiding the teacher's role away from direct instruction and towards the facilitation of learning.

2.1.2. Educational transformation through personalisation

The strategic integration of digital technologies is fundamentally reshaping higher education pedagogy by enhancing both the quality and personalisation of learning (Alenezi, 2023). For instance, tailoring educational pathways to students' individual knowledge levels not only transforms teaching practices but also improves learning outcomes (Fariani et al., 2023). Similarly, adaptive environments designed around specific learning styles can boost student engagement, reduce cognitive load, and simultaneously optimize instructors' time (Li et al., 2021). This principle extends to immersive technologies; studies show that incorporating simple visual cues within virtual reality environments helps students structure information more effectively, leading to a better grasp of the subject matter (Albus et al., 2021). Furthermore, adding elements of gamification and competition to digital platforms has proven to significantly improve students' language skills across reading, writing, and listening domains (Arce & Cuadros Valdivia, 2020; Li et al., 2024).

2.1.3. Blended learning and flexibility

Blended learning, which integrates face-to-face and online instruction, has become a prevalent model, valued for the flexibility it offers both students and institutions. Such approaches allow students to work at their own pace, access content on demand, and engage with a variety of learning materials (Zervas et al., 2024). Artificial intelligence further enhances this personalization, enabling educational content to be tailored to individual learner profiles (Fariani et al., 2023). However, the success of these strategies hinges on the quality of the instructional design and the proficiency of educators in integrating digital technology. This dependence on effective design and skilled implementation is critical for the efficacy of hybrid models (Allmann & Blank, 2021). As Allmann and Blanck (2021) argue, digital skills are not monolithic but a complex set of abilities—including sequential mastery, task management, and knowledge abstraction—which in turn requires that pedagogical approaches be adapted to foster these specific competencies.

2.1.4. Transformation of roles

The integration of digital technology fundamentally alters the teacher's role, recasting educators as facilitators and mentors within the learning process. This shift requires them to leverage technology to foster greater interaction and personalization. Consequently, adopting a more student-centered pedagogy becomes essential, enabling teachers to use digital tools to tailor their instructional methods (Petersen et al., 2022). This pedagogical evolution, however, underscores the critical need for targeted teacher training to ensure they can effectively adopt

and integrate these tools into their practice (Zabolotska et al., 2021). To this end, professional development must focus on three core areas: mastering active teaching methodologies, designing engaging digital activities, and developing technical proficiency with the tools themselves.

2.1.5. Digital skills and educational transformation

While most students at public universities demonstrate fundamental digital competencies, they often struggle with more advanced technological applications. This gap underscores the need for greater technological integration within the curriculum to drive educational transformation (Nalaila & Elia, 2024). Similarly, public sector workers report a critical need for training in digital skills—particularly in data management, cybersecurity, and communication systems—to support this shift (Lopes et al., 2023). On a practical level, e-learning platforms incorporating interactive tools like virtual simulators and tutorial videos have proven effective for personalizing vocational training. The success of these tools, however, hinges on instructor proficiency, as trainers with advanced digital competencies are more likely to leverage the collaborative features of an LMS (Budiarto et al., 2024).

2.1.6. Limitations

The widespread adoption of immersive technologies like AR and VR continues to be hindered in developing nations, largely due to the prohibitive cost of infrastructure (Alenezi, 2023). The substantial investment required often necessitates a pragmatic balance with more established teaching methods rather than a complete overhaul. This challenge is further compounded by a lack of standardization across digital tools—an issue noted in several studies—which complicates the comparison of outcomes across different platforms. Consequently, further research is needed to explore the impact of digital technologies not only on practical skill acquisition but also on the affective dimensions of learning. A truly holistic approach to digital transformation in education must therefore extend beyond purely technical considerations to encompass these critical human and social factors (Van Laar et al., 2020).

2.2. Student motivation

2.2.1. Gamification

Studies confirm that adding gamification elements to learning platforms can stimulate students' motivation. These elements include badges, ranking and rewards. This makes learning more interactive and engaging. As a result, it can boost both intrinsic motivation (Arce & Cuadros Valdivia, 2020; Xiao & Hew, 2024). While this approach has proven effective across various

educational contexts, particularly in language learning, its success hinges on careful implementation tailored to student preferences, learning objectives, and institutional culture. This underscores the importance of selecting appropriate gamification elements for the specific context and learners, a point emphasized by Sailer et al. (2017) and operationalized by Jayalath and Esichaikul (2021) through their ARCS model. The potential impact is significant, as demonstrated by Arce and Cuadros Valdivia (2020), who found that 82.76% of students reported higher motivation in second language learning when using a gamified digital platform. Reinforcing this point, a recent study by Li et al. (2024) confirms that digital educational games can boost student motivation by strengthening their engagement with the learning process.

2.2.2. Autonomy and choice

The opportunity for students to personalize their learning paths, select their activities, and progress at their own pace is a powerful driver of motivation. This approach directly fosters a sense of autonomy and empowerment, which Li and An (2023) identify as essential factors for sustaining both motivation and a sense of efficacy. Therefore, granting learners meaningful agency in managing their educational journey is fundamental to cultivating lasting engagement.

2.2.3. Impact of digital literacy

A strong foundation in digital skills appears to be a significant factor in student motivation within online learning environments (Pham & Nguyen, 2022). When students feel confident in their ability to use digital tools, they tend to show greater engagement in learning activities and demonstrate more perseverance when encountering challenges. It is therefore crucial that this digital literacy is cultivated early in their academic journey and continually reinforced throughout their training.

2.2.4. Limitations

While gamified tools have seen considerable adoption in higher education, their application within vocational training remains a notably under-researched area. The existing literature further complicates this picture by underscoring the intricate interplay of student emotions and motivation, which points to the necessity of personalizing pedagogical strategies (Lopes et al., 2023). Compounding these gaps, there is a discernible scarcity of research exploring teacher motivation, particularly concerning their willingness and capacity to integrate digital technologies into their professional practices. For a holistic understanding, it is necessary to explore the factors that influence both learner and teacher motivation. The significance of incorporating emotional and social dimensions, which have been demonstrated to be

instrumental in the motivation to learn, is frequently disregarded in contemporary studies (Van Laar et al., 2020).

2.3. Learner engagement

2.3.1. Immersive digital environments and interactions

Immersive technologies (VR/AR) enable the creation of more interactive, engaging and realistic learning environments, particularly in technical and vocational training (Poupard et al., 2024; Ravichandran & Mahapatra, 2023). Immersion, by placing the learner in a simulated environment, allows them to better project themselves into professional situations and acquire practical skills (Chiang et al., 2022). Collaborative platforms (Slack, Discord) facilitate exchange and communication between students. These tools help develop active participation, collaboration and communication, and improve geographical and cultural backgrounds (Organ et al., 2023). Immersive technologies can create inclusive learning environments by simulating complex work situations. Furthermore, as shown in the study by Albus et al. (2021), the integration of visual cues in a VR environment allows for better structuring of information thereby improving learner engagement.

2.3.2. Teacher support

Teacher involvement in students' acquisition of digital skills and in the design of stimulating educational activities is essential to fostering learner engagement and a sense of competence (Timotheou et al., 2022). Teacher support, their ability to provide appropriate feedback, and their presence in learning communities are important factors in student engagement. Active teacher presence on platforms, regular and individualised feedback, and personalised support are essential to sustaining student engagement online and ensuring their success. The role of the teacher must evolve towards that of a facilitator and learning coach.

2.3.3. Digital literacy

Students who are proficient in digital tools are more likely to be engaged in online academic activities (Pham & Nguyen, 2022). In other words, good digital literacy enables learners to participate more easily and actively in digital environments. Digital literacy is an essential prerequisite for active participation in digital environments. This digital literacy must be developed from the beginning of studies and reinforced throughout the course of training.

2.3.4. Limitations

Access to immersive technologies is uneven, particularly in low-resource institutions. Standardisation of tools is poor, making it difficult to compare results. There is little research on the psychological impacts of immersive tools, and there are methodological gaps in the

assessment of engagement in hybrid environments. Further studies are needed to better understand the long-term effects of immersive tools on engagement and learning.

3. Discussion

Ultimately, this study underscores a central tension: while digital technology offers transformative potential, its effective integration into higher education and vocational training remains a complex and multifaceted challenge.

3.1. Integrative summary of results

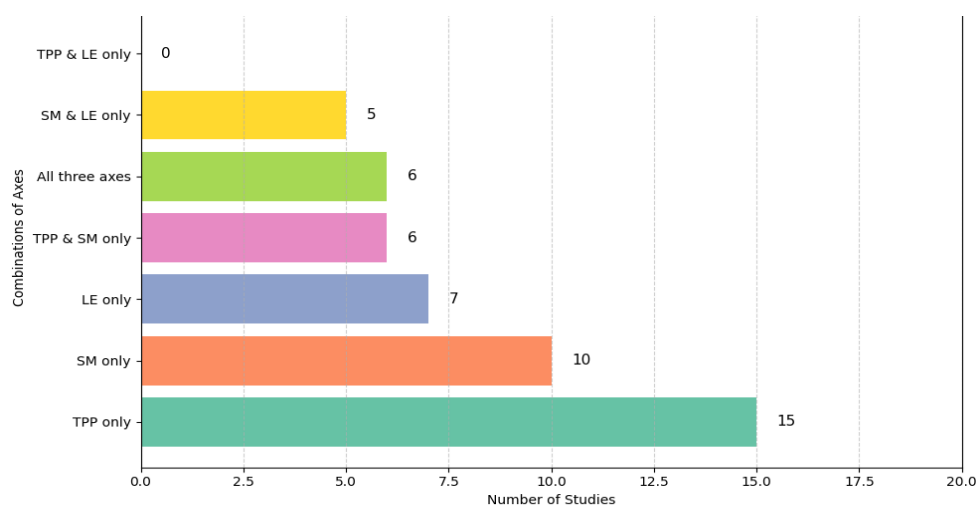
This review underscores a crucial paradigm: the value of digital technologies is realized not through the tools themselves, but through their deliberate integration into sound pedagogical frameworks. The literature consistently demonstrates that successful implementation is contingent upon key pedagogical elements, including learner flexibility (Zervas & Stiakakis, 2024), opportunities for autonomy and collaboration (Li et al., 2023), and robust teacher support (Timotheou et al., 2022). This is particularly evident in the adoption of learning management systems, where perceived convenience and an intuitive interface are paramount for driving engagement (Bansah & Agyei, 2022). In essence, the research converges toward a clear conclusion: when platforms effectively combine interactivity with adaptivity, they foster a personalized experience that enhances student satisfaction and significantly lowers dropout rates (Budiarto et al., 2024; El-Sabagh, 2021).

Teachers' competence in content creation and personalised feedback is crucial: perceived incompetence can reduce engagement, whereas effective practice can increase. Similarly, personalised learning has been shown to increase satisfaction and motivation (Fariani et al., 2023). There is an urgent need for digital skills training in various sectors (Lopes et al., 2023) and universities, where students have mastered the basics but struggle with advanced applications (Nalaila & Elia, 2024). Furthermore, augmented reality seems more capable of optimising cognitive load than virtual reality, but data on their motivational impact remains inconclusive (Poupard et al., 2024).

The development of digital skills among future teachers is essential (Rahimi & Mosalli, 2024), and students' own self-organisation skills positively influence their acceptance of technologies (Scheel et al., 2022). Integrating educational games and gamification improves motivation and skills (Arce & Cuadros Valdivia, 2020; Li et al., 2024), while adaptive e-learning environments reduce academic stress (Li et al., 2021). Finally, students' attitudes towards technology are predictors of their performance (Rodafinos et al., 2024).

To understand the interdependence of the different thematic areas, **Figure 6** shows how the

Figure N°6: Overlaps between thematic axes



Source: Authors

The analysis is furthered by **Table 2**, which summarises the trends, gaps, shortcomings and recommended tools for each thematic area of the study. This provides an overview of the main findings and their implications.

Table N°2: Summary of results by thematic axis

Thematic axis	Trends	Gaps	Research gaps	Recommended tools
Transformation of pedagogical process (TPP)	Blended learning, AR/VR, personalization (AI)	Limited adoption of immersive technologies in developing countries. Unequal access to digital tools.	Lack of studies on the impact of digital tools on practical learning. Scarcity of longitudinal data	Moodle, Oculus VR, Google Classroom, Vuforia, ZapWorks
Student motivation (SM)	Gamification, collaborative digital assessments, digital literacy	Uneven adoption of gamified tools in vocational training. Unequal access to digital resources and skills.	Few studies on optimizing gamification for different types of learners. Lack of research on long-term emotional impact. Limited focus on teacher motivation	Kahoot, Quizizz, PeerGrade, Google Meet, Padlet

Learner engagement (LE)	Immersive technologies, teacher support, digital literacy	Uneven adoption of immersive tools depending on institutions and students' digital skills. Lack of tool standardization	Limited studies on long-term psychological effects of immersive environments. Lack of in-depth analysis of emotional and cognitive mechanisms. Methodological gaps.	
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Source: Authors

3.2. Critical analysis

3.2.1. Interpretation of trends

The analysis shows a clear increase in the adoption of digital technologies in education, particularly learning management systems, gamification, and immersive tools. These technologies, however, are not a silver bullet for enhancing teaching quality. Their effectiveness hinges on thoughtful integration, tailored to specific academic disciplines, learning objectives, and diverse student backgrounds. Gamification, for instance, demands a nuanced approach, given its complex and sometimes contradictory effects on both intrinsic and extrinsic motivation (Sailer et al., 2017). Among these tools, blended learning and collaborative platforms seem especially promising for creating dynamic and effective learning environments. Ultimately, the lack of a single, universally applicable solution underscores the need for tailored strategies grounded in empirical data and thoughtful pedagogical reflection. This means the integration of any digital tool must be guided by the identified needs and expectations of both students and educators.

3.2.2. Explanation of discrepancies

Our analysis suggests that the variability in findings across the included studies stems from three factors: methodological heterogeneity, contextual diversity, and differences among student populations. The presence or absence of a control group, study duration, and assessment tools significantly influence the interpretation of conclusions. Similarly, it is essential to distinguish between quantitative, qualitative, or mixed- methods studies and their instruments for measuring the impact of digital technologies. Second, the diversity of studied contexts – universities, professional schools, developed and developing countries- affects the adoption and effectiveness of digital tools. Available resources, familiarity with technologies, and

pedagogical cultures also modulate this impact on learning. Finally, differences among student populations significantly influence outcomes. Educational level, familiarity with digital tools, learning profiles, and personal preferences explain the varied responses to digital pedagogical approaches. For instance, students with strong digital competencies are more likely to benefit from online learning (Pham & Nguyen, 2022), while others may demonstrate resistance to digital approaches (Scheel et al., 2022).

3.2.3. Literature gaps

Studies have confirmed that the digital transformation of higher education and vocational training has progressed rapidly in recent years, with numerous research works highlighting new approaches and practices. However, there remain areas that deserve to be emphasized, notably:

3.2.3.1. Lack of longitudinal data

Research evaluating the long-term impact of digital interventions and environments on students is still insufficient. In particular, there is a lack of concrete evidence regarding the sustainability of acquired skills and their influence on learners' professional development. Most studies adopt a short-term perspective, and it is therefore necessary to develop works that explore the longer-term consequences of these interventions on learners' trajectories. Longitudinal studies are essential to establish the influence of acquired digital skills on their employability.

3.2.3.2. Under-exploration of emotional aspects

The psycho-affective aspects of online or hybrid learning remain insufficiently studied, particularly concerning their impact on social isolation, psychological well-being, and sense of belonging. However, studies have shown that emotions, whether positive or negative, have a significant effect on motivation and learning outcomes (Poupard et al., 2024). It is therefore essential to explore this dimension in order to design systems that are both engaging and respectful of the human dimension of learning.

3.2.3.3. Limited focus on practical skills

Studies evaluating the impact of digital tools on the acquisition of practical skills and non-cognitive skills (such as collaboration, communication, or problem-solving) are still too few. The evaluation of these practical and non-cognitive skills in a digital environment requires specific methods and the establishment of adapted skill frameworks. In fact, the majority of studies primarily focus on the impact of tools on academic performance or the acquisition of theoretical knowledge.

3.2.3.4. Role of teachers

Scientific literature shows a lack of research on the role of the teacher as a facilitator and animator in digital environments. Although teachers are called upon to become key players in the transformation, their role and needs in this digital transition process remain largely unexplored (Zabolotska et al., 2021). Future research should therefore focus on how teachers appropriate digital tools, how they perceive their new role as facilitators, and their specific needs in terms of training and support.

3.3. Theoretical positioning and contribution

This systematic review distinguishes itself from previous works by its integrative approach, examining the dynamic interconnections between the transformation of pedagogical process, student motivation and learner engagement. Where many studies focus on only one of these dimensions, our synthesis highlights their systemic interdependence.

This contribution can be interpreted through several complementary theoretical frameworks that, when combined, offer a multi-faceted lens for understanding the complexities of digital integration.

At the core of our framework lies Self-Determination Theory (SDT) (Ryan & Deci, 2000), which provides a powerful analytical lever to understand motivation. SDT posits that intrinsic motivation (SM) is fostered when pedagogical environments support three basic psychological needs: autonomy, competence, and relatedness. Our findings align with this, showing that pedagogical innovations (TPP) such as personalized learning paths and collaborative platforms directly support these needs, thereby fostering deeper engagement (LE).

However, the effectiveness of such environments is not guaranteed. This is where Cognitive Load Theory (CLT) (Sweller, 1988; Sweller et al., 2019) offers a critical counterpoint. CLT explains how the design of intuitive digital tools and environments (TPP) is a necessary condition to minimize extraneous cognitive load—the mental effort wasted on navigating a complex interface or deciphering unclear instructions. By reducing this "bad" cognitive load, attentional resources are freed up for deep processing and learning, which is a prerequisite for sustained engagement (LE). This creates a crucial theoretical tension: while a feature-rich digital tool might offer more autonomy (satisfying SDT), its complexity could simultaneously induce a high cognitive load (violating CLT principles), ultimately hindering learning. This review navigates this very debate, suggesting that successful digital integration lies in finding an optimal balance between motivational affordances and cognitive ergonomics.

Finally, to understand how these learning experiences scale and connect beyond the individual, Connectivism Theory (Siemens, 2013) provides a relevant framework. It conceptualizes learning as a process of network formation. In this view, well-orchestrated digital environments (TPP) are those that foster the creation of knowledge networks—connecting learners to content, to experts, and to each other. This perspective effectively links the three dimensions of our analysis in a dynamic of connected learning, where pedagogical design (TPP) enables networked interactions that sustain both motivation (SM) and engagement (LE).

By weaving together these three theoretical threads - socio-psychological (SDT), cognitive (CLT), and socio-technical (Connectivism) - this review offers a more holistic and critical interpretation of the evidence. It moves beyond a simple description of tools and effects to explain the underlying mechanisms and inherent tensions that govern the success of digital transformation in education.

3.4. Strengths and limitations of the review

This systematic review possesses several strengths that bolster the credibility of its findings. Its primary strength lies in the rigorous and transparent methodology, adhering strictly to the PRISMA guidelines (Page et al., 2021), which ensures the review is replicable and minimizes selection bias. Furthermore, its contemporary focus on literature published between 2020 and 2024 provides a timely snapshot of a rapidly evolving field, capturing the significant shifts that occurred during and after the global pandemic. Finally, the synthesis of evidence from a diverse set of international, peer-reviewed studies allows for a comprehensive and nuanced understanding of the central themes.

However, the findings must be interpreted in light of several limitations. First, as with any systematic review, our results are susceptible to publication bias, the tendency for studies with statistically significant or positive results to be published more frequently. While our critical analysis sought to maintain a balanced perspective, this inherent bias in the available literature may overstate the positive effects of digital interventions. Second, our reliance on major international databases, while ensuring a high standard of peer-reviewed content, carries a risk of overlooking emergent or local studies from the Global South not indexed in these platforms. This is compounded by the third limitation: the exclusion of non-English and non-French literature, which may have omitted relevant perspectives from other linguistic and cultural contexts.

Fourth, the literature itself presents limitations that this review inherits. The notable absence of longitudinal analyses makes it difficult to assess the durable impact of these technologies on

long-term skill retention and employability. The review also confirms a relative under-exploration of the socio-emotional dimensions of digital learning and the well-being of both learners and educators. Finally, while the importance of the teacher is frequently mentioned, few studies delve deeply into their evolving role as facilitators and the specific support they require to navigate this complex transformation. These identified gaps do not invalidate our findings, but rather frame them, providing a clear and urgent agenda for future research.

Conclusion

This systematic review of 49 peer-reviewed articles (2020-2024) synthesized the evidence on the integration of digital skills in higher and vocational education to understand its impact on pedagogy, motivation, and engagement. The analysis reveals one main conclusion: the effectiveness of digital technologies is less a question of tools than of strategic, contextual and pedagogically sound integration. These results corroborate studies emphasising that success depends on the conditions of implementation and the suitability of the technology to the needs of learners. Success is based on fundamental pillars, including the personalisation of learning pathways, the essential strengthening of teachers' digital skills and the implementation of active strategies- to support student motivation and engagement. Approaches such as gamification and adaptive environments show particular promise, although significant technical barriers continue to hinder the engagement of some students (Vishnu et al., 2022).

The implications of this synthesis are threefold. First, institutions must invest in continuing education for teachers, going beyond simple technical mastery to encompass digital instructional design. Second, a holistic approach to digital literacy development is imperative, both for learners and trainers. Third, technological design must be user-centred to promote adoption and effectiveness. The limitations of this review should be acknowledged, including the possible heterogeneity of the contexts and methodologies of the included studies, as well as a possible publication bias favouring positive results. The analysis period (2020-2024), although relevant to the post-pandemic era, limits the scope of conclusions about longer-term trends.

Consequently, future research should prioritize addressing the significant gaps identified herein. There is a clear and urgent need for longitudinal studies to assess the long-term impact of these technologies, not only on academic performance but also on the acquisition of sustainable professional skills and the construction of learner identity. Furthermore, particular attention should be paid to the emotional and social dynamics of online learning, an area that remains critically under-explored. Future inquiries must also delve deeper into the evolving role of teachers as facilitators in these new ecosystems, moving beyond their technical proficiency

to understand their pedagogical needs. Finally also to present a wider range of research which is more global in nature studies should look at different contexts especially in Africa and Latin America. In the end the digital transformation of education has to present an inclusive approach which goes past just the adoption of technology to that which brings out true value in education via large scale and regular collaboration between researchers and practice.

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