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The Transformation of Digital Learning in Higher Education in the Society 5.0 Era: A Systematic Literature Review

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ABSTRACT

Purpose: This study examines the transformation of digital learning in higher education in the Society 5.0 era through a Systematic Literature Review (SLR) following the PRISMA 2020 guidelines. **Methods:** The review synthesized 34 Scopus-indexed Q1 and Q2 journal articles published between 2023 and 2025. Studies were selected through the PRISMA stages of identification, screening, eligibility, and inclusion and subsequently analyzed using thematic synthesis. All included studies met the predefined quality assessment criteria, with 20 classified as very high quality and 14 as high quality. **Findings:** The synthesis identified four major dimensions of digital learning transformation: (1) pedagogical innovation and learning experience, (2) digital learning technologies, (3) individual factors influencing digital learning adoption, and (4) institutional transformation and readiness. The reviewed studies suggest that technologies such as Artificial Intelligence (AI), adaptive learning, learning analytics, and Learning Management Systems (LMS) are frequently associated with more personalized, flexible, and data-informed learning environments, alongside higher levels of student engagement and self-regulated learning. However, the evidence also indicates persistent challenges related to digital infrastructure, unequal access to technology, limited digital competencies, and organizational readiness. **Research Implications:** The findings highlight the importance of integrating pedagogical innovation, digital technologies, individual digital competencies, and institutional readiness to support sustainable digital learning ecosystems aligned with the principles of Society 5.0. **Originality:** This study proposes an integrated conceptual framework that synthesizes pedagogical, technological, individual, and institutional dimensions into a comprehensive perspective on digital learning transformation. The review is limited to Scopus-indexed Q1 and Q2 journal articles published between 2023 and 2025, and the findings should therefore be interpreted within the scope of the available evidence.

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INTRODUCTION

The transformation of digital learning in higher education is developing massively in line with the acceleration of Artificial Intelligence (AI) technology and big data in the Society 5.0 era. However, the acceleration of digital transformation also gives rise to a new paradox in higher education, where technological innovation develops faster than pedagogical readiness, organizational culture, and digital competence of human resources. The learning model that was previously dominated by conventional approaches is now developing into technology-based learning that is more open, flexible, collaborative, and adapts to the needs of students in the digital era. The Society 5.0 era was introduced by Japan as a concept of a super-intelligent society that integrates cyberspace and physical space through the use of Artificial Intelligence (AI) in human activities (Shahidi Hamedani et al., 2024).

The transformation of the current higher education paradigm is increasingly spurred by advances in digital technology that support the implementation of flexible learning through online learning systems, blended learning, and hybrid learning. The implementation of digital transformation in the university environment is not limited to the use of technology alone, but also involves changes in organizational culture, institutional governance systems, and the

development of sustainability-oriented digital learning strategies (Gkrimpizi et al., 2024). In addition, the implementation of digital transformation also contributes to increasing learning effectiveness, academic service efficiency, and strengthening the digital ecosystem in the higher education environment (Abad-Segura et al., 2020; Zolfaghari et al., 2025). The integration of Artificial Intelligence (AI) in higher education shows a paradigm shift towards adaptive and data-driven learning from teacher-centered learning. Currently, AI has developed into a digital pedagogical system that is able to personalize students' learning experiences through adaptive learning systems, predictive analytics, and intelligent tutoring systems (Costello & Gow, 2025). The integration of digital technology also makes digital transformation an important strategy in strengthening collaborative learning, student engagement, and self-regulated learning in higher education (Akour & Alenezi, 2022).

The transformation of digital learning is also supported by the development of the concept of Education 5.0 which emphasizes the integration of technology with the development of human competencies (Mohamudally-Boolaky & Padachi, 2024). In this context, digital competencies are the main ability which includes the skills to use technology critically, creatively, collaboratively, and ethically both in the learning process and social life (Pelaez-Sanchez et al., 2024). The development of digital learning also encourages the presence of various learning innovations such as gamification, microlearning, mobile learning, immersive learning, and virtual classrooms. These innovations are considered to be able to increase learning motivation, self-regulated learning, and collaborative learning of students (Mabotha & Ngcamu, 2026)

Generation Z students tend to prefer interactive multimedia-based learning, video learning, mobile-friendly learning, and personalized learning over conventional approaches (Dolot, 2018). In global higher education, digital transformation is also closely related to sustainable education, where universities are required to build a learning ecosystem that is oriented towards sustainability, innovation, and strengthening students' digital competencies (Mohamed Hashim et al., 2022). The acceleration of digital transformation is increasingly visible after the COVID-19 pandemic with an increasing focus on AI-based learning, virtual learning environments, learning analytics, and digital competencies (Omar & Abdullahi, 2024). In addition, the implementation of AI in digital learning also has an impact on the effectiveness of learning evaluation through automatic feedback and adaptive assessment systems (Katsamakas et al., 2024). Digital learning transformation also has a significant influence on increasing student digital literacy. Students who use technology-based learning have a higher ability to access, evaluate, and use digital information critically. The success of digital transformation is greatly influenced by institutional support, leadership, digital governance, and the readiness of technological infrastructure in universities (Rodríguez-Abitia & Bribiesca-Correa, 2021). In addition, technological developments have also given birth to adaptive learning models that are able to adapt learning materials to individual student needs (Akour & Alenezi, 2022).

The rapid advancement of digital technologies has significantly accelerated the transformation of higher education, particularly following the widespread adoption of online and hybrid learning after the COVID-19 pandemic. Consequently, digital transformation has become one of the most widely discussed topics in contemporary educational research. Existing studies have explored diverse aspects of digital learning transformation, including Artificial Intelligence (AI)-assisted learning, adaptive learning systems, learning analytics, digital literacy, Learning Management Systems (LMS), and institutional digital transformation. These studies demonstrate that digital technologies have considerable potential to enhance learning flexibility, student engagement, and institutional efficiency (Akour & Alenezi, 2022; Gkrimpizi et al., 2024; Mabotha & Ngcamu, 2026). Although previous studies have contributed substantially to understanding digital transformation in higher education, most have investigated these issues from a fragmented perspective. Some studies primarily focus on technological innovation, such as Artificial Intelligence and adaptive learning (Costello & Gow, 2025; Mirata & Bergamin, 2023). While others emphasize institutional readiness, digital governance, and organizational transformation (Alenezi, 2023; Graham et al., 2023). Several studies also examine learner-related factors, including digital literacy, technology acceptance, and self-regulated learning (Lehmann et al., 2023; C. H. Liu et al., 2023; Wang et al., 2025). However, these dimensions are generally examined independently, providing only a partial understanding of digital learning transformation in higher education.

Recent review studies have similarly concentrated on specific aspects of digital transformation. For instance, one review synthesized institutional digital transformation strategies in higher education while another emphasized the implementation of Education 5.0 technologies (Mabotha & Ngcamu, 2026). Bibliometric studies have also explored research trends in sustainable digital transformation (Omar & Abdullahi, 2024). Nevertheless, these studies have not comprehensively integrated pedagogical innovation, digital learning technologies, individual readiness, and institutional transformation into a unified conceptual framework. Consequently, the complex relationships among these dimensions remain insufficiently understood, particularly within the context of the Society 5.0 era. Furthermore,

Society 5.0 introduces a broader perspective on digital transformation by emphasizing the integration of advanced technologies with human-centered values to improve social well-being and educational quality (Atay et al., 2025). Within this context, digital learning transformation should not merely be interpreted as technological adoption but rather as a multidimensional process involving pedagogical innovation, technological capability, learner readiness, and institutional capacity. Despite the increasing number of studies in this area, limited evidence has synthesized these interconnected dimensions into a comprehensive framework that explains how they collectively contribute to sustainable digital learning transformation in higher education. Existing reviews predominantly focused on one or two dimensions of digital transformation rather than explaining how these dimensions interact within an integrated higher education ecosystem in the context of Society 5.0.

To address these research gaps, this study employs a Systematic Literature Review (SLR) following the PRISMA 2020 guidelines to synthesize recent evidence from Scopus-indexed international publications. Unlike previous reviews that primarily focus on isolated dimensions of digital transformation, this study integrates pedagogical innovation and learning experience, digital learning technologies, individual factors influencing digital learning adoption, and institutional transformation and readiness into a holistic conceptual framework. By integrating these four dimensions, this study contributes to the literature by providing a more comprehensive understanding of digital learning transformation and offers evidence-based insights to support policy development and strategic planning for higher education institutions in the Society 5.0 era. Based on the identified research gaps, this study addresses the following research questions: RQ1. What are the dominant themes characterizing digital learning transformation in higher education during the Society 5.0 era? RQ2. How do pedagogical innovation, digital learning technologies, individual factors, and institutional readiness interact in supporting digital learning transformation? RQ3. What research gaps and future research directions emerge from recent international literature regarding digital learning transformation in higher education?

Accordingly, this study aims to systematically synthesize recent international evidence on digital learning transformation in higher education by identifying dominant research themes, examining the relationships among pedagogical, technological, individual, and institutional dimensions, and proposing an integrated conceptual framework to inform future empirical research and evidence-based policy development in the Society 5.0 era.

METHOD

Research Design

This study employed a Systematic Literature Review (SLR) following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to systematically identify, evaluate, and synthesize existing evidence regarding digital learning transformation in higher education within the Society 5.0 era (Page et al., 2021). The SLR approach was selected because it enables a transparent, rigorous, and reproducible process for identifying research trends, synthesizing findings, detecting research gaps, and developing evidence-based conceptual frameworks. Compared with conventional narrative reviews, the PRISMA framework provides explicit procedures for article identification, screening, eligibility assessment, and inclusion, thereby minimizing selection bias and enhancing methodological transparency.

Data Sources and Search Strategy

The literature search was conducted exclusively in the Scopus database because it indexes high-quality international journals and provides comprehensive coverage of educational technology and digital transformation research (Page et al., 2021). The search was performed on 15 April 2026, while the screening and eligibility assessment were completed between April and May 2026. The search was limited to the TITLE-ABS-KEY field to ensure that the retrieved studies explicitly addressed the research topic. The Boolean search string applied in Scopus was as follows:

```
TITLE-ABS-KEY(
   ("digital transformation" OR "digital learning transformation")
   AND
   ("higher education" OR university OR college)
)
```

The search strategy was refined iteratively through several pilot searches to maximize the relevance of retrieved publications while minimizing irrelevant records. Reference management, article organization, and screening documentation were facilitated using the Watase UAKE application.

Eligibility Criteria
The eligibility criteria were established before the literature search to ensure consistency and transparency throughout the review process.

Inclusion Criteria
Studies were included when they satisfied all of the following criteria:
1. Published between 2023 and 2025;
2. Indexed in scopus Q1 or Q2 Journals;
3. Written in english;
4. Focused on digital learning transformation in higher education;
5. Available as complete full-text journal articles;
6. Contained sufficient methodological information and research findings relevant to the review objectives.

Exclusion Criteria
Studies were excluded when they:
1. Were conference proceedings, editorials, book chapters, review notes, or non-peer-reviewed publications;
2. Focused on primary or secondary education;
3. Were duplicate records;
4. Did not address digital learning transformation;
5. Lacked accessible full-text versions;
6. Failed to satisfy the predetermined quality assessment criteria.

Study Selection Process
The study selection followed the four stages recommended by PRISMA 2020: identification, screening, eligibility, and inclusion (Page et al., 2021). During the identification stage, 184 records were retrieved from the Scopus database. After publication-year and journal-quality filtering, 66 articles remained for title and abstract screening. Duplicate records were identified using the Watase UAKE reference management system and verified manually before screening. The screening process was independently conducted by two reviewers. Each reviewer evaluated article eligibility based on the predefined inclusion and exclusion criteria. Whenever disagreements occurred, the reviewers discussed the differences until consensus was achieved. No third reviewer was required because all disagreements were resolved through discussion. Following full-text assessment, 34 studies satisfied all eligibility criteria and were included in the final qualitative synthesis. The excluded articles did not satisfy one or more eligibility criteria, including lack of relevance to digital learning transformation, insufficient methodological reporting, inaccessibility of full texts, or failure to meet the predefined quality assessment threshold. Figure 1 presents the PRISMA 2020 flow diagram illustrating the study identification and selection process.

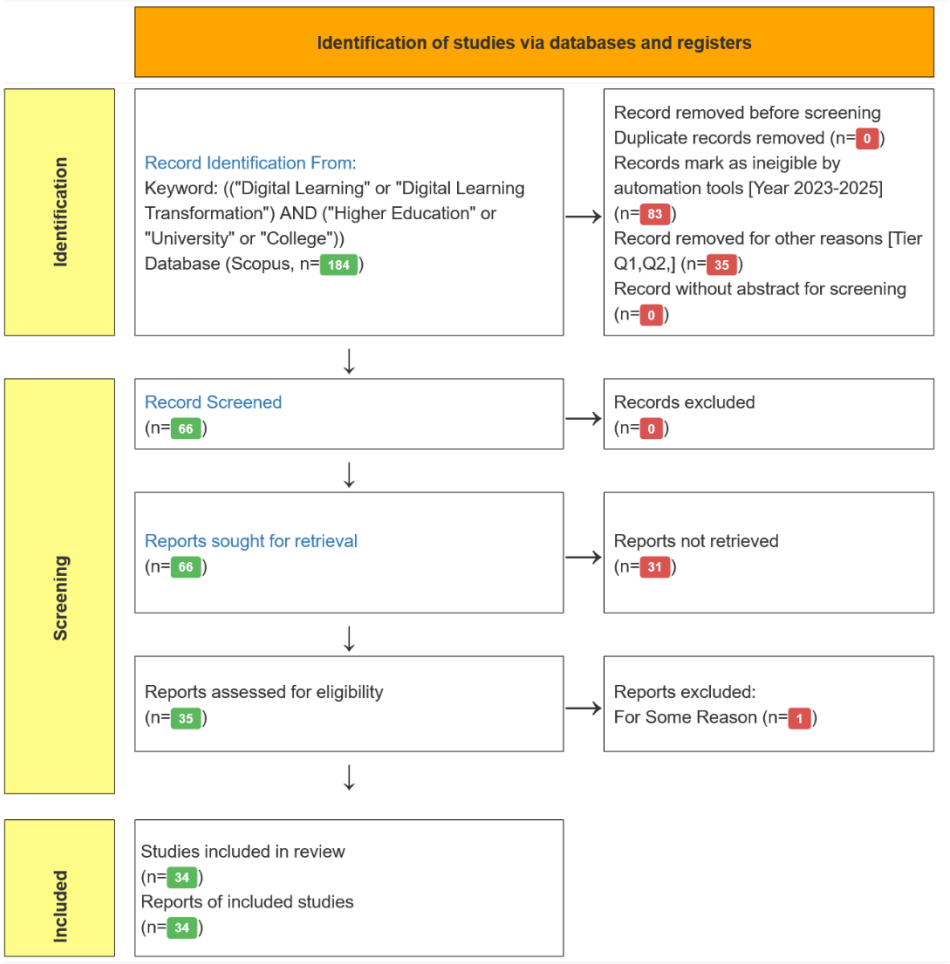


Figure 1. PRISMA 2020 flow diagram of the study selection proces

As illustrated in Figure 1, the sequential screening and eligibility procedures reduced the initial 184 records to 34 studies that satisfied all predefined inclusion and quality criteria. This systematic reduction demonstrates the application of a transparent and structured selection process before the studies entered the qualitative synthesis.

Quality Assessment

To ensure methodological rigor, each included study underwent a structured quality assessment adapted from previous systematic literature reviews. To ensure methodological rigor, each included study underwent a structured quality assessment adapted from previous systematic literature reviews. Five evaluation criteria were applied to assess the methodological and substantive quality of the eligible studies, as presented in Table 1.

Table 1. Quality Assessment Article

QA criteria	Description
QA1	Relevance to digital learning transformation in higher education
QA2	Clarity and transparency of the research methodology
QA3	Relevance of findings to the review objectives
QA4	Publication in a Scopus Q1 or Q2 journal
QA5	Adequacy of discussion and reported evidence

Collectively, the five criteria in Table 1 assessed the relevance, methodological transparency, evidentiary adequacy, and publication quality of each study. Each criterion was subsequently evaluated using the five-point quality scale presented in Table 2.

Table 2. Quality Assessment Scale

Score	Interpretation
5	Very High Quality
4	High Quality
3	Moderate Quality
2	Low Quality
1	Very Low Quality

Based on the scoring categories presented in Table 2, only studies obtaining an overall quality rating of High (4) or Very High (5) were retained for the final synthesis. This threshold was established to ensure that the synthesized evidence was derived exclusively from studies meeting the predefined methodological quality requirements. The quality assessment was independently conducted by two reviewers to improve consistency and reduce subjective bias. No study received a moderate, low, or very low quality rating; therefore, no additional studies were excluded after quality assessment.

Data Extraction

A standardized data extraction form was developed before analysis to ensure consistency across all included studies. The extracted information comprised:

1. author(s);
2. publication year;
3. country of study;
4. research design;
5. sample characteristics;
6. digital learning technology investigated;
7. theoretical framework;
8. principal findings; and
9. implications for digital learning transformation.

Data Analysis

The included studies were analyzed using a descriptive thematic synthesis approach. Initially, open coding was conducted to identify recurring concepts and patterns across the selected studies. Similar codes were then grouped through axial coding into broader conceptual categories, followed by selective coding to construct higher-order themes representing digital learning transformation in higher education. The coding process was independently performed by two reviewers. Any discrepancies in coding or theme classification were discussed until consensus was achieved, thereby improving the credibility and consistency of the analysis. Rather than estimating statistical effect sizes, this review aimed to synthesize qualitative evidence from diverse methodological approaches to develop a comprehensive conceptual understanding of digital learning transformation within the Society 5.0 era. The themes generated through the thematic synthesis are presented in the Results section and subsequently integrated into the conceptual framework proposed in this study.

RESULTS

Characteristics of the Included Studies

Following the PRISMA 2020 selection process, 34 studies met all inclusion criteria and were included in the final qualitative synthesis. The selected studies were published between 2023 and 2025, reflecting the increasing scholarly attention devoted to digital learning transformation in higher education during the rapid expansion of digital technologies and the emergence of the Society 5.0 paradigm.

As presented in Table 3, the largest proportion of publications appeared in 2025 (44.1%), followed by 2023 (32.4%) and 2024 (23.5%). This publication trend indicates a growing scholarly interest in digital learning transformation, particularly in response to the rapid advancement of Artificial Intelligence (AI), adaptive learning, learning analytics, and other digital technologies in higher education. The reviewed studies employed a variety of research designs. Quantitative studies constituted the largest proportion (52.9%), followed by qualitative studies (14.7%), case study or multiple case study designs (11.8%), and mixed-methods studies (8.8%). Smaller proportions consisted of systematic literature reviews (5.9%), scoping reviews (2.9%), and conceptual studies (2.9%). This methodological diversity demonstrates that digital learning transformation has been examined from multiple research perspectives, ranging from empirical investigations to qualitative inquiry, conceptual analysis, and evidence synthesis.

Such diversity provides a comprehensive understanding of digital learning transformation across different educational contexts and methodological traditions. Regarding publication quality, all selected studies were published in reputable Scopus-indexed journals, comprising 20 articles (58.8%) published in Q1 journals and 14 articles (41.2%) published in Q2 journals. This distribution indicates that the synthesized evidence was derived from high-quality international publications, thereby strengthening the credibility and reliability of the findings presented in this systematic literature review.

Table 3. Characteristics of the Included Studies

Characteristics	Frequency	Percentage (%)
Publication Year		
2023	11	32.4
2024	8	23.5
2025	15	44.1
Research Design		
Quantitative Study	18	52.9
Qualitative Study	5	14.7
Mixed-Methods Study	3	8.8
Case Study / Multiple Case Study	4	11.8
Systematic Literature Review	2	5.9
Scoping Review	1	2.9
Conceptual Study	1	2.9
Journal Quartile		
Scopus Q1	20	58.8
Scopus Q2	14	41.2

Overall, Table 3 demonstrates that the evidence base is both recent and methodologically diverse, with a clear predominance of quantitative research and publications in Q1 journals. These characteristics indicate that the synthesis draws primarily on contemporary empirical evidence published in relatively high-impact scholarly outlets.

Geographical Distribution of the Included Studies

The geographical distribution of the included studies is presented in Table 4. Most studies originated from Asia (22 studies; 64.7%), followed by Europe (8 studies; 23.5%), whereas Africa (3 Studies; 8,8%) and multi-country (1 Studies; 2,9%). This distribution demonstrates that research on digital learning transformation has been conducted across diverse higher education contexts, although the current evidence base remains concentrated in Asian countries. The inclusion of studies from multiple geographical regions enhances the contextual diversity of the synthesized evidence and supports broader interpretation of digital learning transformation practices across different higher education systems.

Table 4. Geographical Distribution of the Included Studies

Region	Frequency	Percentage (%)
Asia	22	64.7
Europe	8	23.5
Africa	3	8.8
Multi-country	1	2.9
Total	**34**	**100.0**

As summarized in Table 4, the geographical evidence base is substantially concentrated in Asia, while representation from Africa and multi-country investigations remains limited. This geographical imbalance should therefore be considered when interpreting the generalizability of the synthesized findings across global higher education systems.

Quality Assessment Results

To ensure methodological rigor, all eligible studies were evaluated using the five quality assessment criteria described in the methodology section. The assessment considered topic relevance, methodological transparency, relevance of findings, journal quality, and adequacy of reported evidence. The assessment indicated that all 34 studies satisfied the predefined inclusion threshold and were therefore retained for thematic synthesis. Overall, the selected studies demonstrated a high level of methodological quality, providing a robust evidence base for the subsequent synthesis.

Table 5. Summary of Quality Assessment Results

Quality Rating	Number of Studies	Percentage (%)
Very High Quality (Score = 5)	20	58.8
High Quality (Score = 4)	14	41.2
Total	**34**	**100.0**

Table 5 further shows that 20 studies were classified as Very High Quality and 14 as High Quality, with no included study falling within the moderate, low, or very low categories. This distribution provides a relatively strong methodological foundation for the subsequent thematic synthesis, although quality ratings should not be interpreted as eliminating heterogeneity across research designs and contexts.

Thematic Synthesis

The thematic synthesis identified four overarching themes that characterize digital learning transformation in higher education within the Society 5.0 era. These themes emerged through iterative coding and comparative analysis of the selected studies and represent the principal dimensions discussed across the reviewed literature.

The identified themes include:

1. Pedagogical Innovation and Learning Experience (12 articles)
2. Digital Learning Technologies (12 articles)
3. Individual Factors Influencing Digital Learning Adoption (11 articles)
4. Institutional Transformation and Readiness (11 articles)

Although each theme represents a distinct dimension of digital learning transformation, several studies contributed to more than one theme. This overlap indicates that digital learning transformation is a multidimensional phenomenon in which pedagogical innovation, technological advancement, learner characteristics, and institutional readiness interact to shape digital learning practices in higher education. The synthesis of findings for each theme is presented in Table 6.

Table 6. Thematic Synthesis of Research Findings on Digital Learning Transformation in Higher Education in the Society 5.0 Era

Main Themes	Number of Articles (n)	Supporting Articles	Synthesis of Findings
Pedagogical Innovation and Learning Experience	12	Yuan et al. (2025); Susanto et al. (2024); Pinto-Llorente & Izquierdo-Álvarez (2024); Al-Hail et al. (2024); Tong et al. (2025); Bitar & Davidovich (2024); Martins van Jaarsveld et al. (2025); du Plooy et al. (2024); Liu et al. (2023); Zhang & Liu (2024); Ali et al. (2025); Lo (2023)	The reviewed studies indicate that digital learning increasingly adopts student-centred pedagogical approaches, including personalised learning, adaptive learning, collaborative learning, blended learning, formative digital assessment, and self-regulated learning. These pedagogical approaches were frequently associated with higher learner engagement, learning satisfaction, motivation, critical thinking, digital competence, and more meaningful learning experiences. Their effectiveness, however, appears to depend on pedagogical design, learner readiness, and institutional support.
Digital Learning Technologies	12	Ademi & Loshkovska (2025); Langseth et al. (2023); Veseli et al. (2025); Aigbe et al. (2025); Huang et al. (2025); Zulpykhar et al. (2025); Mirata & Bergamin (2023); Martins van Jaarsveld et al. (2025); du Plooy et al. (2024); Wu & Wang (2025); Liu et al. (2025); Finkelstein & Soffer-Vital (2025)	The reviewed studies report increasing adoption of Artificial Intelligence (AI), Learning Management Systems (LMS), adaptive learning platforms, learning analytics, virtual learning environments, and digital collaboration technologies to support more flexible and data-informed learning. These technologies were commonly reported to support personalised learning, timely feedback, and instructional decision-making when integrated with appropriate pedagogical practices.
Individual Factors Influencing Digital Learning Adoption	11	Jugembayeva & Murzagaliyeva (2023); Yuan et al. (2025); Finkelstein & Soffer-Vital (2025); Susanto et al. (2024); Ahmad et al. (2023); Lehmann et al. (2023); Liu et al. (2023); Wu &	The reviewed studies suggest that successful digital learning adoption is closely associated with learners' individual readiness. Digital literacy, self-efficacy, motivation, technology acceptance, learner autonomy, and digital

Main Themes	Number of Articles (n)	Supporting Articles	Synthesis of Findings
		Wang (2025); Zhang & Liu (2024); Liu et al. (2025); Nguyen-Anh et al. (2023)	competence were frequently identified as important factors supporting participation and engagement in technology-enhanced learning. The evidence also indicates that contextual conditions such as institutional support and access to digital technologies influence these relationships.
Institutional Transformation and Readiness	11	Alenezi (2023); Graham et al. (2023); Bitar & Davidovitch (2024); Alfirević et al. (2025); Veseli et al. (2025); Langseth et al. (2023); Mirata & Bergamin (2023); Hakansson Lindqvist et al. (2024); Susanto et al. (2024); Sahni et al. (2025); Nguyen-Anh et al. (2023)	The reviewed studies highlight institutional readiness as an essential organizational condition supporting sustainable digital learning transformation. Key elements include digital leadership, governance, organizational culture, infrastructure, strategic planning, policy support, professional development, and organizational capacity building. Institutional readiness was consistently identified as enabling higher education institutions to integrate technological innovation with pedagogical development and organizational change.

Source: Journal Analysis Results, 2026

Table 6 presents the thematic synthesis of the 34 selected studies. The analysis identified four overarching themes that collectively characterize digital learning transformation in higher education during the Society 5.0 Era: (1) pedagogical innovation and learning experience, (2) digital learning technologies, (3) individual factors influencing digital learning adoption, and (4) institutional transformation and readiness. These themes represent the major dimensions through which recent studies have examined the transformation of digital learning in higher education.

Among these themes, pedagogical innovation and learning experience emerged as the most frequently discussed dimension, appearing in 12 studies. The reviewed literature indicates an increasing shift from teacher-centred instruction toward student-centred pedagogical approaches, including personalised learning, adaptive learning, collaborative learning, blended learning, formative digital assessment, and self-regulated learning. These pedagogical approaches were frequently associated with higher learner engagement, learning satisfaction, motivation, critical thinking, digital competence, and more meaningful learning experiences. The reviewed evidence also suggests that the effectiveness of these pedagogical innovations is closely related to pedagogical design, learner readiness, and institutional support.

The second theme, digital learning technologies, was also identified in 12 studies. The reviewed literature reports increasing adoption of Artificial Intelligence (AI), Learning Management Systems (LMS), adaptive learning platforms, learning analytics, virtual learning environments, and digital collaboration technologies to support more flexible and data-informed learning. Rather than functioning as stand-alone technological solutions, these technologies were commonly reported to support personalised learning, timely feedback, and instructional decision-making when integrated with appropriate pedagogical practices.

The third theme, individual factors influencing digital learning adoption, appeared in 11 studies. This theme highlights that successful digital learning adoption is closely associated with learners' individual readiness. The reviewed studies frequently identified digital literacy, self-efficacy, motivation, technology acceptance, learner autonomy, and digital competence as important factors supporting participation and engagement in technology-enhanced learning. The evidence also indicates that contextual conditions, including institutional support and access to digital technologies, influence the relationship between individual readiness and digital learning adoption.

The fourth theme, institutional transformation and readiness, was likewise identified in 11 studies. The reviewed articles emphasize that institutional readiness represents an essential organizational condition supporting sustainable digital learning transformation. Key elements reported across the studies include digital leadership, governance, organizational culture, infrastructure, strategic planning, policy support, professional development, and organizational capacity building. Collectively, these organizational dimensions were consistently identified as enabling higher education institutions to integrate technological innovation with pedagogical development and organizational change.

Several studies contributed to more than one thematic category, indicating that digital learning transformation represents a multidimensional phenomenon. Rather than functioning independently, pedagogical innovation, digital

learning technologies, individual readiness, and institutional transformation were frequently examined as interconnected dimensions that collectively support the development of sustainable digital learning ecosystems in higher education during the Society 5.0 Era.

Development of the Conceptual Framework

The thematic synthesis presented in Table 6 served as the basis for developing the integrated conceptual framework shown in Figure 2. The framework illustrates that digital learning transformation in higher education is shaped by the interaction of four interconnected dimensions rather than by technological innovation alone. Pedagogical innovation supports meaningful learning experiences, digital learning technologies provide enabling infrastructures, individual readiness facilitates technology adoption, and institutional transformation ensures sustainable implementation. Collectively, these dimensions contribute to the development of adaptive, learner-centered, and sustainable higher education ecosystems aligned with the principles of the Society 5.0 era.

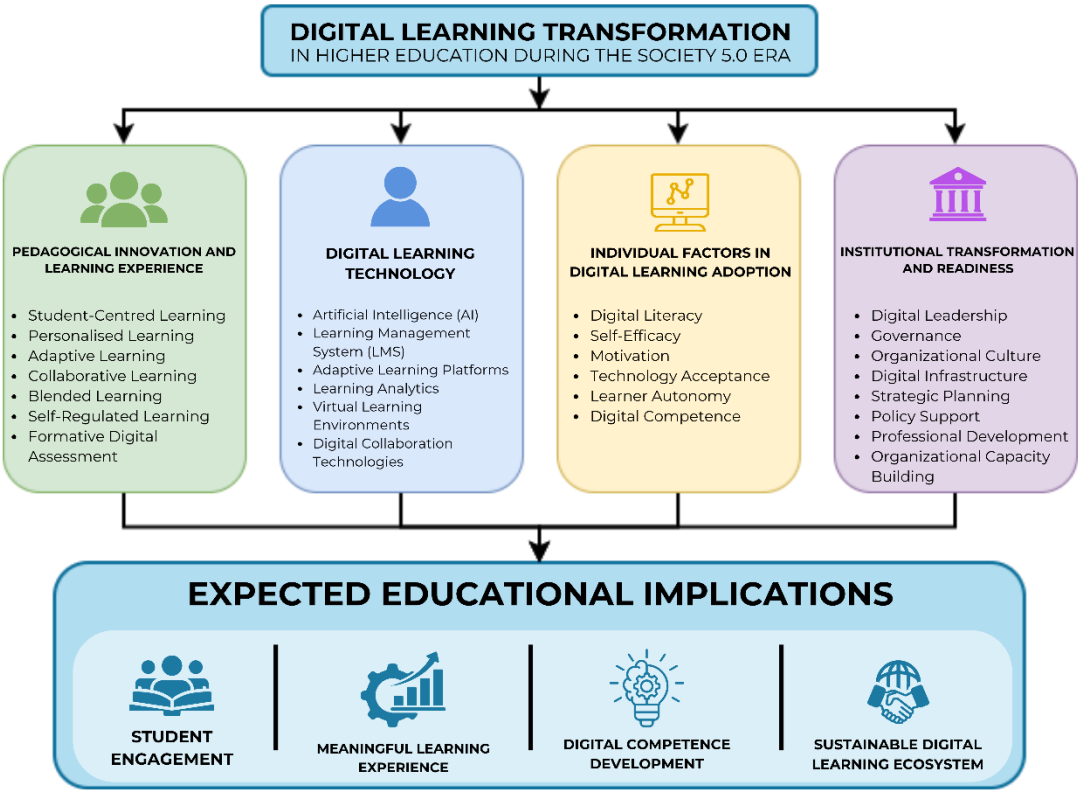


Figure 2. Integrated Conceptual Framework Developed from the Thematic Synthesis

The integrated conceptual framework presented in Figure 2 was developed through the thematic synthesis of the 34 studies included in this review. Rather than depicting causal relationships, the framework illustrates how the four dominant dimensions identified across the reviewed literature collectively characterize digital learning transformation in higher education during the Society 5.0 era. These dimensions comprise (1) pedagogical innovation and learning experience, (2) digital learning technologies, (3) individual factors influencing digital learning adoption, and (4) institutional transformation and readiness.

The framework suggests that digital learning transformation should be understood as a multidimensional process in which pedagogical, technological, individual, and institutional dimensions are closely interconnected. Pedagogical innovation emphasizes the implementation of student-centred learning approaches, including personalised learning, adaptive learning, collaborative learning, blended learning, self-regulated learning, and formative digital assessment. Digital learning technologies provide technological support through Artificial Intelligence (AI), Learning Management Systems (LMS), adaptive learning platforms, learning analytics, virtual learning environments, and digital collaboration technologies. Individual readiness encompasses learners' digital literacy, self-efficacy, motivation, technology acceptance, learner autonomy, and digital competence, while institutional readiness includes digital

leadership, governance, organizational culture, infrastructure, strategic planning, policy support, professional development, and organizational capacity building.

Rather than functioning independently, these four dimensions collectively describe the characteristics of successful digital learning transformation identified across the reviewed studies. The synthesis indicates that institutions integrating pedagogical innovation, appropriate digital technologies, learner readiness, and institutional capacity are more likely to establish adaptive and learner-centred digital learning environments. Accordingly, the framework proposes that the interaction among these dimensions is commonly associated with four educational implications identified in the literature, namely student engagement, meaningful learning experiences, digital competence development, and sustainable digital learning ecosystems.

Compared with previous review studies, the present synthesis offers a more comprehensive perspective by integrating dimensions that have frequently been examined separately. Previous reviews have generally focused on specific aspects of digital transformation, such as Artificial Intelligence, digital infrastructure, adaptive learning, digital literacy, institutional digitalization, or technology adoption. In contrast, this review synthesizes evidence from recent international studies into a unified conceptual framework that illustrates how pedagogical, technological, individual, and institutional dimensions collectively shape digital learning transformation within the context of Society 5.0.

The principal theoretical contribution of this study lies in proposing an integrated conceptual perspective that positions digital learning transformation as a holistic educational ecosystem rather than a technology-driven phenomenon. From a practical perspective, the framework may assist higher education institutions in designing digital transformation strategies that balance pedagogical innovation, technological development, human capability enhancement, and institutional readiness. Given that this framework is derived from qualitative thematic synthesis, it should be interpreted as a conceptual representation of patterns identified across the reviewed literature rather than as an empirically validated causal model.

DISCUSSION

Pedagogical Innovation and Learning Experience in Digital Learning Transformation

The synthesis indicates that pedagogical innovation represents the most prominent dimension of digital learning transformation in higher education. Rather than reflecting a simple shift toward technology-enhanced instruction, the reviewed studies suggest that digital transformation is fundamentally characterized by changes in pedagogical philosophy that reposition students as active participants in constructing knowledge. In this context, digital technologies primarily function as instruments that enable more flexible, collaborative, and learner-centred educational experiences rather than serving as the primary drivers of educational change. This interpretation reinforces the argument that the success of digital learning transformation depends largely on how technology is integrated into pedagogical practices instead of the sophistication of the technology itself (Lo, 2023).

Across the reviewed studies, student-centred pedagogical approaches including personalised learning, adaptive learning, collaborative learning, blended learning, and self-regulated learning were consistently reported as dominant instructional strategies within digital learning environments (Al-Hail et al., 2024; Pinto-Llorente & Izquierdo-Álvarez, 2024; Yuan et al., 2025). Several studies indicated that personalised and adaptive learning approaches provide greater flexibility by accommodating learners' diverse needs and learning preferences (Ali et al., 2025; Martins van Jaarsveld et al., 2025; Zhang & Liu, 2024). Other investigations highlighted that collaborative digital learning environments promote greater interaction between students and lecturers while encouraging knowledge sharing and active participation throughout the learning process (Bitar & Davidovich, 2024; Tong et al., 2025). In addition, self-regulated learning was frequently associated with learners' capacity to manage their own learning activities more independently in increasingly flexible educational environments (du Plooy et al., 2024; G. L. Liu et al., 2025). Collectively, these findings suggest that pedagogical innovation is increasingly oriented toward creating meaningful learning experiences rather than simply introducing new instructional technologies.

Nevertheless, the reviewed evidence also demonstrates that the effectiveness of pedagogical innovation varies across educational contexts. While most studies reported positive associations between student-centred pedagogies and learning engagement, the educational benefits were not observed uniformly across all settings. Several studies indicated that successful implementation depends on supporting conditions such as lecturers' pedagogical competence, students' digital readiness, institutional support, and the availability of appropriate technological infrastructure. These contextual differences suggest that pedagogical innovation should not be interpreted as a universally effective approach but rather as an educational strategy whose outcomes are influenced by interactions among pedagogical design, learner characteristics, and institutional capacity.

The methodological characteristics of the reviewed literature should also be considered when interpreting these findings. Most empirical studies employed quantitative cross-sectional survey designs that primarily measured students' perceptions of learning experiences, motivation, or engagement at a single point in time. Consequently, the current body of evidence provides limited understanding of how pedagogical innovation influences learning experiences over extended periods or how lecturers progressively develop pedagogical competencies for digital teaching. The relatively limited number of longitudinal, qualitative, and mixed-methods studies therefore represents an important gap that future research should address to better understand the long-term development of student-centred digital pedagogy.

Compared with previous systematic reviews, the present synthesis provides a broader interpretation of pedagogical innovation within digital learning transformation. Earlier reviews generally discussed personalised learning, technology-enhanced learning, or student engagement as separate aspects of digital education (Akour & Alenezi, 2022; Shahidi Hamedani et al., 2024). More recent reviews also highlighted the growing role of digital pedagogies but tended to examine them from technological or instructional perspectives rather than as interconnected elements within institutional digital transformation (Mabotha & Ngcamu, 2026; Omar & Abdullahi, 2024). In contrast, the present review suggests that pedagogical innovation should be understood as the central mechanism connecting digital technologies, individual learner readiness, and institutional transformation within an integrated digital learning ecosystem. This perspective extends previous literature by positioning pedagogy as the foundation through which technological innovation generates meaningful educational value.

These findings are particularly relevant within the context of Society 5.0, where educational transformation emphasizes the development of human capabilities alongside technological advancement. The widespread adoption of personalised learning, collaborative learning, self-regulated learning, and adaptive learning identified across the reviewed studies reflects the competencies expected in Society 5.0, including critical thinking, collaboration, adaptability, creativity, and lifelong learning. Accordingly, higher education institutions should prioritise strengthening lecturers' pedagogical competencies alongside investments in digital technologies. Developing innovative instructional designs, supporting continuous professional development, and fostering learner-centred educational cultures are likely to contribute to more inclusive, adaptive, and sustainable digital learning transformation consistent with the human-centred principles of Society 5.0.

Digital Learning Technology as an Enabler of Higher Education Transformation

Digital learning technologies emerged as the second major dimension of digital learning transformation, highlighting that technological innovation has become an essential component of contemporary higher education. However, the synthesized evidence suggests that the significance of digital technologies lies not merely in their adoption but in their capacity to facilitate more effective, flexible, and responsive learning environments. Across the reviewed studies, technologies such as artificial intelligence (AI), learning management systems (LMS), adaptive learning platforms, learning analytics, virtual learning environments, and digital collaboration tools were consistently discussed as complementary components that support pedagogical innovation rather than replacing existing educational practices (Zulpykhar et al., 2025). This finding reinforces the view that digital technologies primarily function as enablers of educational transformation whose value depends on their pedagogical integration (Ademi & Loshkovska, 2025; Huang et al., 2025; Veseli et al., 2025)

The reviewed studies indicate that AI-supported learning systems contribute to more personalised instructional pathways by enabling adaptive feedback and facilitating timely learning support (Wu & Wang, 2025). Likewise, learning analytics has been widely reported as an important mechanism for monitoring students' learning progress and supporting data-informed instructional decision-making (Ademi & Loshkovska, 2025).Other studies highlighted that Learning Management Systems (LMS) and digital collaboration platforms extend learning beyond conventional classrooms by facilitating communication, collaboration, and continuous interaction among learners and instructors (Bitar & Davidovich, 2024; Tong et al., 2025). In addition, virtual learning environments and adaptive learning platforms were frequently associated with more flexible and accessible learning experiences that accommodate students' diverse learning needs (Mirata & Bergamin, 2023; Zulpykhar et al., 2025). Collectively, these findings suggest that digital technologies are most effective when integrated into coherent pedagogical strategies rather than implemented as isolated technological innovations.

Despite the educational opportunities offered by these technologies, the reviewed literature also identifies several challenges that should be considered when interpreting their contribution. Several studies highlighted persistent concerns regarding unequal digital access and differences in learners' digital competencies, which may limit the effectiveness of technology-enhanced learning in certain educational contexts (Langseth et al., 2023; Veseli et al.,

2025). Other studies emphasized emerging issues related to artificial intelligence, including ethical considerations, data privacy, academic integrity, and the increasing dependence on automated learning systems (Tong et al., 2025; Wu & Wang, 2025). These findings indicate that digital learning transformation should not be interpreted simply as the replacement of conventional educational practices with technology, but rather as a continuous process of balancing technological innovation, pedagogical quality, ethical responsibility, and meaningful human interaction.

Contextual variation also appears to shape the implementation of digital learning technologies across higher education systems. The predominance of studies conducted in Asia suggests that much of the current evidence reflects institutions that are rapidly integrating AI, adaptive learning technologies, and digital learning platforms into teaching and learning processes. By contrast, studies undertaken in European and multi-country contexts more frequently discussed digital governance, institutional innovation, and the long-term sustainability of digital learning ecosystems. Although comparatively few studies originated from African higher education institutions, the available evidence consistently highlighted infrastructure availability and institutional readiness as continuing challenges for technology implementation. These differences suggest that the educational value of digital technologies is closely related to institutional capacity, policy priorities, and broader socio-economic conditions rather than technological availability alone.

The present review also extends previous systematic reviews on digital transformation in higher education. Earlier reviews primarily examined digital transformation through the perspectives of technology adoption and digital infrastructure (Alenezi, 2023; Shahidi Hamedani et al., 2024). More recent reviews further emphasized the growing role of artificial intelligence, learning analytics, and emerging educational technologies in higher education (Mabotha & Ngcamu, 2026). In contrast, the present synthesis suggests that digital technologies should be understood as one component within a broader digital learning ecosystem. By integrating evidence from 34 recent studies, this review demonstrates that the educational contribution of digital technologies is closely associated with their interaction with pedagogical innovation, learner readiness, and institutional transformation. This perspective broadens previous understandings by emphasizing the interdependence between technological, pedagogical, individual, and organizational dimensions of digital learning transformation.

These findings are particularly relevant within the context of Society 5.0, where digital technologies are expected to enhance human capabilities rather than replace human roles in education. From this perspective, artificial intelligence, learning analytics, adaptive learning systems, and digital collaboration platforms should be viewed as instruments that strengthen human-centred learning rather than as autonomous educational solutions. Accordingly, higher education institutions should prioritise the responsible integration of digital technologies through appropriate governance, lecturer professional development, ethical guidelines for AI implementation, and institutional policies that ensure equitable access and meaningful learning experiences. Such an approach is expected to support the development of digital learning ecosystems that are technologically advanced while remaining consistent with the human-centred principles of Society 5.0.

Individual Factors in Digital Learning Adoption

The synthesis indicates that digital learning transformation extends beyond technological and pedagogical innovation by highlighting the importance of individual readiness as a fundamental factor associated with successful digital learning adoption. Across the reviewed studies, individual characteristics such as digital literacy, self-directed learning, learning motivation, self-efficacy, technology acceptance, and digital competence consistently emerged as important factors supporting students' and lecturers' engagement in technology-enhanced learning environments. These findings suggest that digital transformation is ultimately a human-centred process in which technological innovation can only generate meaningful educational value when individuals possess the competencies and confidence required to utilise digital technologies effectively (Finkelstein & Soffer-Vital, 2025; Jugembayeva & Murzagaliyeva, 2023).

The reviewed studies consistently indicate that digital competence and self-regulated learning play an important role in helping learners adapt to technology-enhanced learning environments. Students with stronger digital competencies were generally reported to engage more actively in digital learning activities and to utilise learning resources more effectively (Nguyen-Anh et al., 2023). Similarly, studies focusing on self-regulated learning emphasized that learner autonomy supports more effective participation in flexible and technology-mediated learning environments. Beyond digital competence, motivation and technology acceptance also emerged as recurring themes in the reviewed literature. Several studies reported that students with higher learning motivation and stronger acceptance of educational technologies were more willing to participate in digital learning and demonstrated greater engagement throughout the learning process .Other studies highlighted that positive learning experiences are

strengthened when digital technologies are perceived as useful, accessible, and supportive of students' learning needs (Lehmann et al., 2023).

Nevertheless, the reviewed evidence also reveals considerable variation in how individual factors are associated with digital learning adoption. While most studies reported positive relationships between digital competence, motivation, and learning engagement, several studies suggested that these relationships are shaped by contextual conditions, including previous digital experience, socio-economic background, institutional support, and access to digital technologies. Consequently, digital learning transformation should not be interpreted as producing uniform outcomes across all learners, since differences in digital literacy, self-efficacy, and learning readiness may lead to unequal opportunities for participation in technology-enhanced learning.

The methodological characteristics of the reviewed studies also influence the interpretation of these findings. Most investigations employed quantitative cross-sectional survey designs that primarily measured perceptions, attitudes, motivation, or technology acceptance at a single point in time. Consequently, the current body of evidence provides limited understanding of how learners' digital competence and self-regulated learning evolve throughout their academic experiences or how institutional interventions contribute to long-term competency development. The relatively small number of longitudinal and mixed-methods studies therefore represents an important gap that future research should address.

Compared with previous systematic reviews, the present synthesis offers a more integrated perspective on individual readiness within digital learning transformation. Earlier reviews generally examined digital competence, technology acceptance, and learner engagement as separate constructs related to digital education (Akour & Alenezi, 2022; Omar & Abdullahi, 2024). More recent reviews also acknowledged the importance of digital competence but primarily discussed it within broader institutional or technological perspectives (Mabotha & Ngcamu, 2026; Shahidi Hamedani et al., 2024). In contrast, the present review suggests that these individual characteristics should be understood as interconnected dimensions that collectively bridge pedagogical innovation, digital technologies, and institutional transformation. This integrated perspective represents one of the conceptual contributions of the present review.

These findings are particularly relevant within the context of Society 5.0, where technological advancement is intended to enhance human capabilities rather than replace them. The emphasis on digital literacy, self-directed learning, adaptability, critical thinking, and lifelong learning identified across the reviewed studies reflects the competencies required for individuals to participate effectively in increasingly digital societies. Accordingly, higher education institutions should invest not only in digital infrastructure but also in systematic initiatives that strengthen students' and lecturers' digital competencies through continuous professional development, digital literacy programmes, and learner support services. Such efforts are likely to contribute to more inclusive, equitable, and sustainable digital learning transformation consistent with the human-centred principles of Society 5.0.

Transformation and Institutional Readiness

The synthesis demonstrates that institutional transformation and organizational readiness constitute the enabling foundation of sustainable digital learning transformation in higher education. While technological innovation, pedagogical redesign, and individual readiness are essential components of digital learning, the reviewed studies consistently indicate that their successful implementation depends on institutional capacity to establish supportive policies, strategic leadership, digital infrastructure, organizational culture, and continuous professional development. This finding suggests that digital learning transformation should be understood as an institutional change process rather than as a collection of isolated technological initiatives. Consequently, higher education institutions play a central role in coordinating technological, pedagogical, and human dimensions to create sustainable digital learning ecosystems.

The reviewed studies indicate that institutional readiness extends well beyond the provision of digital infrastructure (Langseth et al., 2023; Sahni et al., 2025). Several studies emphasized that effective digital transformation requires strong institutional governance, strategic leadership, and long-term policy commitment to support digital learning initiatives (Alenezi, 2023; Bitar & Davidovitch, 2024). Other studies highlighted the importance of curriculum redesign, quality assurance mechanisms, and lecturer professional development to ensure that technological innovation is effectively integrated into teaching and learning practices (Langseth et al., 2023; Mirata & Bergamin, 2023; Veseli et al., 2025). In addition, institutional support for educational innovation, including organizational collaboration and continuous capacity building, was frequently identified as an important factor in sustaining digital learning transformation (Yuan et al., 2025). Collectively, these findings suggest that institutions capable of aligning technological resources with organizational strategies are more likely to establish adaptive and sustainable digital learning environments.

Nevertheless, the reviewed evidence also indicates considerable contextual variation in institutional transformation. Studies conducted in technologically advanced higher education systems generally focused on strengthening institutional innovation, digital governance, and the long-term sustainability of digital ecosystems. By contrast, studies undertaken in developing contexts more frequently highlighted challenges related to digital infrastructure, financial resources, institutional capacity, and human resource development. These differences indicate that institutional readiness is shaped not only by technological availability but also by policy priorities, organizational culture, leadership commitment, and broader socio-economic conditions. Therefore, institutional transformation should be interpreted as a context-dependent process rather than as a universal model applicable across all higher education systems.

The methodological characteristics of the reviewed literature also influence the interpretation of institutional transformation. Most studies evaluated institutional readiness through quantitative cross-sectional surveys that captured the perceptions of lecturers, students, or institutional stakeholders at a single point in time. Consequently, the current body of evidence provides limited understanding of how institutional digital transformation evolves over time or how organizational strategies influence long-term educational outcomes. The relatively limited number of longitudinal and mixed-methods studies therefore represents an important research gap that future investigations should address.

The present synthesis also extends previous systematic reviews on digital transformation in higher education. Earlier reviews primarily examined institutional readiness from the perspectives of digital infrastructure and technology adoption (Akour & Alenezi, 2022; Omar & Abdullahi, 2024). More recent reviews expanded this perspective by discussing organizational digitalisation and institutional preparedness for emerging educational technologies (Mabotha & Ngcamu, 2026; Shahidi Hamedani et al., 2024). In contrast, the present review suggests that institutional readiness should not be understood as an isolated organizational characteristic but rather as the mechanism that connects pedagogical innovation, digital technologies, and individual capabilities within an integrated digital learning ecosystem. This perspective broadens previous understandings by emphasizing that sustainable digital transformation depends on the alignment of institutional strategy with pedagogical development, technological innovation, and human capacity building rather than on technological investment alone.

These findings have important implications for higher education in the context of Society 5.0, where institutions are expected to balance technological advancement with human-centred educational values. Rather than focusing exclusively on expanding digital infrastructure, universities should establish institutional ecosystems that promote pedagogical innovation, strengthen lecturers' and students' digital competencies, ensure the ethical and responsible use of emerging technologies, and support continuous organizational learning. Accordingly, institutional transformation should be regarded as a long-term strategic commitment integrating governance, educational quality, technological innovation, and human development. Such an approach is expected to support sustainable digital learning transformation while ensuring that technological progress remains aligned with the broader educational goals of Society 5.0.

CONCLUSION

The present systematic literature review indicates that digital learning transformation in higher education during the Society 5.0 era is best understood as a multidimensional process involving the interaction of pedagogical innovation, digital learning technologies, individual readiness, and institutional transformation. Rather than representing a technology-driven initiative, the synthesized evidence suggests that successful digital learning transformation is commonly associated with the alignment of these four dimensions in creating adaptive, learner-centred, and sustainable digital learning environments. This review contributes to the existing literature by proposing an integrated conceptual framework that positions pedagogical, technological, individual, and institutional dimensions as interconnected components of digital learning transformation. Unlike previous reviews that primarily examined specific aspects of digital transformation, this synthesis provides a more holistic understanding of how these dimensions collectively shape digital learning in higher education. From a practical perspective, the findings suggest that higher education institutions should complement investments in digital technologies with strategies that strengthen pedagogical innovation, digital competency development, institutional governance, and organizational readiness to support sustainable digital transformation aligned with the human-centred principles of Society 5.0.

This review is limited to Scopus-indexed Q1 and Q2 journal articles published between 2023 and 2025. Consequently, the synthesized evidence reflects the characteristics of recent high-quality international publications and may not fully represent studies indexed in other databases or published in different periods. Furthermore, because this study employed a qualitative systematic literature review, the identified relationships among the four dimensions

should be interpreted as patterns emerging from the literature rather than as empirically verified causal relationships. Future research is encouraged to validate the proposed conceptual framework through empirical investigations using longitudinal, mixed-methods, or cross-national research designs. Such studies would provide stronger evidence regarding how pedagogical innovation, digital technologies, individual readiness, and institutional transformation interact in supporting sustainable digital learning transformation across diverse higher education contexts.

REFERENCE

Abad-Segura, E., González-Zamar, M.-D., Infante-Moro, J. C., & Ruipérez García, G. (2020). Sustainable management of digital transformation in higher education: Global research trends. *Sustainability, 12*(5), 2107. https://doi.org/10.3390/su12052107

Ademi, N., & Loshkovska, S. (2025). Gender impact on performance in adaptive learning settings: Insights from a four-year university study. *Education Sciences, 15*(6), 771. https://doi.org/10.3390/educsci15060771

Ahmad, R., Mehmood, S. T., & Ijaz, S. (2023). Digital literacy competencies: A study of distance learners of higher education regulatory authority Khyber Pakhtunkhwa. *Pakistan Journal of Distance and Online Learning, 9*(1), 82–96. https://doi.org/10.30971/pjdol.v9i1.1396

Aigbe, F., Aigbavboa, C., Ayobiojo, L., & Imoisili, P. E. (2025). Adaptive learning for inclusivity, sustainable development, and societal impact: A case study of community engagement at the University of Johannesburg. *Sustainability, 17*(11), 4861. https://doi.org/10.3390/su17114861

Akour, M., & Alenezi, M. (2022). Higher education future in the era of digital transformation. *Education Sciences, 12*(11), 784. https://doi.org/10.3390/educsci12110784

Alenezi, M. (2023). Digital learning and digital institution in higher education. *Education Sciences, 13*(1), 88. https://doi.org/10.3390/educsci13010088

Alfirević, A. M., Vasilj, D., Vasić, D., & Alfirević, N. (2025). Digital maturity of academic teaching and learning, digital culture and transformation: Empirical evidence and implications for higher education in Bosnia and Herzegovina and Croatia. *Information, 16*(12), 1084. https://doi.org/10.3390/info16121084

Al-Hail, M., Zguir, M. F., & Koç, M. (2024). Exploring digital learning opportunities and challenges in higher education institutes: Stakeholder analysis on the use of social media for effective sustainability of learning–teaching–assessment in a university setting in Qatar. *Sustainability, 16*(15), 6413. https://doi.org/10.3390/su16156413

Ali, S. M., Yunus, K., Alshaikhi, T., & Aliia, A. M. (2025). The use of digital learning in the EFL classroom and its effect on self-perceived knowledge, learning, and English use at the University of Tabuk. *E-Learning and Digital Media, 22*(1), 67–85. https://doi.org/10.1177/20427530241229125

Atay, S., Müftüoğlu, C. T., Gülmez, N., & Şahin, M. (2025). Society 5.0 and human-centered technology: Redefining talent management in the digital age. *Sustainable Futures, 9*, 100733. https://doi.org/10.1016/j.sftr.2025.100733

Bitar, N., & Davidovich, N. (2024). Navigating new norms: Lecturers' insights on digital learning integration in higher education—A case of Israel. *Education Sciences, 14*(8), 816. https://doi.org/10.3390/educsci14080816

Bitar, N., & Davidovitch, N. (2024). Cultural adaptation of digital learning tools in Israeli higher education: A case study of lecturer perceptions and practices. *TechTrends, 68*(6), 1152–1165. https://doi.org/10.1007/s11528-024-01007-3

Costello, E., & Gow, S. (2025). Authoritarian EdTech. *Dialogues on Digital Society, 1*(3), 302–306. https://doi.org/10.1177/29768640251377165

Dolot, A. (2018). The characteristics of Generation Z. *E-Mentor*, (74), 44–50. https://doi.org/10.15219/em74.1351

du Plooy, E., Casteleijn, D., & Franzsen, D. (2024). Personalized adaptive learning in higher education: A scoping review of key characteristics and impact on academic performance and engagement. *Heliyon, 10*(21), e39630. https://doi.org/10.1016/j.heliyon.2024.e39630

Finkelstein, I., & Soffer-Vital, S. (2025). Cultural empathy in AI-supported collaborative learning: Advancing inclusive digital learning in higher education. *Education Sciences, 15*(10), 1305. https://doi.org/10.3390/educsci15101305

Gkrimpizi, T., Peristeras, V., & Magnisalis, I. (2024). Defining the meaning and scope of digital transformation in higher education institutions. *Administrative Sciences, 14*(3), 48. https://doi.org/10.3390/admsci14030048

Graham, C. R., Danaa, G., Purevsuren, T., Martínez, A., Spricigo, C. B., Camilotti, B. M., & Batsukh, T. (2023). Digital learning transformation in higher education: International cases of university efforts to evaluate and improve blended teaching readiness. *Education Sciences*. https://doi.org/10.3390/educsci13111143

Hakansson Lindqvist, M., Mozelius, P., Jaldemark, J., & Cleveland Innes, M. (2024). Higher education transformation towards lifelong learning in a digital era: Scoping literature review. *International Journal of Lifelong Education, 43*(1), 24–38. https://doi.org/10.1080/02601370.2023.2279047

Huang, Z., Huang, J., & Han, Z. (2025). Online environmental gamification and university students' pro-environmental organizational citizenship behaviour: Evidence for a dual motivational mechanism. *Sustainability, 17*(24), 11038. https://doi.org/10.3390/su172411038

Jugembayeva, B., & Murzagaliyeva, A. (2023). Physics students' innovation readiness for digital learning within the University 4.0 model: Essential scientific and pedagogical elements that cause the educational format to evolve in the context of advanced technology trends. *Sustainability, 15*(1), 233. https://doi.org/10.3390/su15010233

Katsamakas, E., Pavlov, O. V., & Saklad, R. (2024). Artificial intelligence and the transformation of higher education institutions: A systems approach. *Sustainability, 16*(14), 6118. https://doi.org/10.3390/su16146118

Langseth, I., Jacobsen, D. Y., & Haugsbakken, H. (2023). The role of support units in digital transformation: How institutional entrepreneurs build capacity for online learning in higher education. *Technology, Knowledge and Learning, 28*(4), 1745–1782. https://doi.org/10.1007/s10758-022-09620-y

Lehmann, T., Blumschein, P., & Seel, N. M. (2023). Accept it or forget it: Mandatory digital learning and technology acceptance in higher education. *Journal of Computers in Education, 10*(4), 797–817. https://doi.org/10.1007/s40692-022-00244-w

Liu, C. H., Horng, J. S., Chou, S. F., Yu, T. Y., Lee, M. T., & Lapuz, M. C. B. (2023). Digital capability, digital learning, and sustainable behaviour among university students in Taiwan: A comparison design of integrated mediation-moderation models. *International Journal of Management Education, 21*(3), 100835. https://doi.org/10.1016/j.ijme.2023.100835

Liu, G. L., Zou, M. M., Soyoof, A., & Chiu, M. M. (2025). Untangling the relationship between AI-mediated informal digital learning of English (AI-IDLE), foreign language enjoyment and the ideal L2 self: Evidence from Chinese university EFL students. *European Journal of Education, 60*(1). https://doi.org/10.1111/ejed.12846

Lo, N. P. (2023). Digital learning and the ESL online classroom in higher education: Teachers' perspectives. *Asian-Pacific Journal of Second and Foreign Language Education, 8*(1), 24. https://doi.org/10.1186/s40862-023-00198-1

Mabotha, P. A. P., & Ngcamu, B. S. (2026). Digital transformation in the higher education sector: A systematic literature review. *Administrative Sciences, 16*(1), 1. https://doi.org/10.3390/admsci16010001

Martins van Jaarsveld, G., Wong, J., Baars, M., Specht, M., & Paas, F. (2025). Enhancing goal attainment in higher education with a scripted conversational agent: Effects of monitoring and reflection support in digital learning. *Computers and Education, 239*, 105441. https://doi.org/10.1016/j.compedu.2025.105441

Mirata, V., & Bergamin, P. (2023). Role of organisational readiness and stakeholder acceptance: An implementation framework of adaptive learning for higher education. *Educational Technology Research and Development, 71*(4), 1567–1593. https://doi.org/10.1007/s11423-023-10248-7

Mohamed Hashim, M. A., Tlemsani, I., & Duncan Matthews, R. (2022). A sustainable university: Digital transformation and beyond. *Education and Information Technologies, 27*(7), 8961–8996. https://doi.org/10.1007/s10639-022-10968-y

Mohamudally-Boolaky, A., & Padachi, K. (2024). Leveraging technology for math education: A systematic literature review. *Creative Education, 15*(8), 1692–1704. https://doi.org/10.4236/ce.2024.158102

Nguyen-Anh, T., Nguyen, A. T., Tran-Phuong, C., & Nguyen-Thi-Phuong, A. (2023). Digital transformation in higher education from online learning perspective: A comparative study of Singapore and Vietnam. *Policy Futures in Education, 21*(4), 335–354. https://doi.org/10.1177/14782103221124181

Omar, A. M., & Abdullahi, M. O. (2024). A bibliometric analysis of sustainable digital transformation in developing countries' higher education. *Frontiers in Education, 9*, 1441644. https://doi.org/10.3389/feduc.2024.1441644

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., Stewart, L. A., Thomas, J., Tricco, A. C., Welch, V. A., Whiting, P., & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, n71. https://doi.org/10.1136/bmj.n71

Pelaez-Sanchez, I. C., Glasserman-Morales, L. D., & Rocha-Feregrino, G. (2024). Exploring digital competencies in higher education: Design and validation of instruments for the era of Industry 5.0. *Frontiers in Education, 9*, 1415800. https://doi.org/10.3389/feduc.2024.1415800

Pinto-Llorente, A. M., & Izquierdo-Álvarez, V. (2024). Digital learning ecosystem to enhance formative assessment in second language acquisition in higher education. *Sustainability, 16*(11), 4687. https://doi.org/10.3390/su16114687

Rodríguez-Abitia, G., & Bribiesca-Correa, G. (2021). Assessing digital transformation in universities. *Future Internet, 13*(2), 52. https://doi.org/10.3390/fi13020052

Sahni, S., Verma, S., & Kaurav, R. P. S. (2025). Understanding digital transformation challenges for online learning and teaching in higher education institutions: A review and research framework. *Benchmarking: An International Journal, 32*(5), 1487–1521. https://doi.org/10.1108/BIJ-04-2022-0245

Shahidi Hamedani, S., Aslam, S., Mundher Oraibi, B. A., Wah, Y. B., & Shahidi Hamedani, S. (2024). Transitioning towards tomorrow's workforce: Education 5.0 in the landscape of Society 5.0: A systematic literature review. *Education Sciences, 14*(10), 1041. https://doi.org/10.3390/educsci14101041

Susanto, H., Setiana, D., Besar, N., Najib Ali, M., Susanto, A. K. S., Seruddin, R., & Ibrahim, F. (2024). Leveraging technology enhancement: The well-being emotional intelligence, security keys to the university students' readiness in digital learning ecosystem. *Sustainability, 16*(9), 3765. https://doi.org/10.3390/su16093765

Tong, L., Niu, Y., Xuan, Z., Jin, S., Wang, Y., & Xiao, Q. (2025). Nursing students' experiences of digital learning in Chinese higher education institutions: A descriptive qualitative study. *Nurse Education Today, 144*, 106454. https://doi.org/10.1016/j.nedt.2024.106454

Veseli, A., Hasanaj, P., & Bajraktari, A. (2025). Perceptions of organizational change readiness for sustainable digital transformation: Insights from learning management system projects in higher education institutions. *Sustainability, 17*(2), 619. https://doi.org/10.3390/su17020619

Wang, K., Cui, W., & Yuan, X. (2025). Artificial intelligence in higher education: The impact of need satisfaction on artificial intelligence literacy mediated by self-regulated learning strategies. *Behavioral Sciences, 15*(2), 165. https://doi.org/10.3390/bs15020165

Wu, H., & Wang, Y. (2025). Disclosing Chinese college students' flow experience in GenAI-assisted informal digital learning of English: A self-determination theory perspective. *Learning and Motivation, 90*, 102134. https://doi.org/10.1016/j.lmot.2025.102134

Yuan, N., Yu, Q., & Liu, W. (2025). The impact of digital literacy on learning outcomes among college students: The mediating effect of digital atmosphere, self-efficacy for digital technology and digital learning. *Frontiers in Education, 10*, 1641687. https://doi.org/10.3389/feduc.2025.1641687

Zhang, Y., & Liu, G. (2024). Revisiting informal digital learning of English (IDLE): A structural equation modeling approach in a university EFL context. *Computer Assisted Language Learning, 37*(7), 1904–1936. https://doi.org/10.1080/09588221.2022.2134424

Zolfaghari, Z., Karimian, Z., Zarifsanaiey, N., & Farahmandi, A. Y. (2025). Navigating challenges in medical English learning: Leveraging technology and gamification for interactive education – A qualitative study. *BMC Medical Education, 25*(1), 1045. https://doi.org/10.1186/s12909-025-07511-1

Zulpykhar, Z., Kariyeva, K., Sadvakassova, A., Zhilmagambetova, R., & Nariman, S. (2025). Assessing the effectiveness of personalized adaptive learning in teaching mathematics at the college level. *International Journal of Engineering Pedagogy, 15*(4), 4–22. https://doi.org/10.3991/ijep.v15i4.52797

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AUTHOR CONTRIBUTION STATEMENT

PR contributes to concept formulation, research design, data collection and analysis, and manuscript preparation. The MA and PS play a role in reviewing the scientific substance, refining the content of the article, and approving the final version of the manuscript for publication.

AI DISCLOSURE STATEMENT

The author uses ChatGPT (OpenAI) as a tool for language editing and improving the readability of manuscripts. All ideas, research designs, data analysis, interpretation of results, and conclusions are the work of the author and have been independently verified. The author is solely responsible for the content, accuracy, and integrity of this manuscript.

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