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Technological Adaptation in Post-School Education: A Systematic Review of Design and Application Trends in Technology-Enhanced Learning Environments

Adaptasi Teknologi dalam Pendidikan Pascasekolah: Tinjauan Sistematis tentang Tren Desain dan Penerapan dalam Lingkungan Pembelajaran yang Ditingkatkan Teknologi

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Abstract

The growth in the use of technology with regard to learning in post-school education has shifted focus onto the psychological mechanisms behind engagement and performance of learners. Rather than just focusing on the technology, a systematic literature review which synthesizes 40, peer-reviewed, academic writings on this subject published between 2015 and 2024 examines how new technologies impact key psychological processes. Constructivist learning theory, self-determination theory and social cognitive theory framed the thematic synthesis which led to five major psychological themes. Immersive environments provide support for embodied cognition (cognitive processing through sensory input) and promote a deeper level of conceptualization of the subject(s) studied; Artificial intelligence and learning analytics provide perception of competence and self-regulation through adaptive feedback to learners; Mobile and blended instructional models facilitate autonomy and agency for learners; Intelligent Institute systems provide systemic personalization which facilitates sustained engagement by learners; and Gamification and simulation-based environments foster intrinsic motivation and collaborative efficacy. The findings indicate that tech-enhanced learning environments function as structured psychological ecosystems which affect behavioral, cognitive and social processes, related to motivation, cognitive activation and social interaction. This literature review adds to the field of educational psychology by defining the ways in which digital environments mediate learning through the motivational and cognitive pathways.

Keywords : *artificial intelligence in education, educational psychology, immersive learning, motivation, self-regulated learning.*

Abstrak

Pertumbuhan penggunaan teknologi dalam pembelajaran di pendidikan pascasekolah telah menggeser fokus ke mekanisme psikologis di balik keterlibatan dan kinerja peserta didik. Dari pada hanya berfokus pada teknologi, tinjauan literatur sistematis yang mensintesis 40 tulisan akademis yang ditinjau sejawat tentang subjek ini yang diterbitkan antara tahun 2015 dan 2024 meneliti bagaimana teknologi baru memengaruhi proses psikologis utama. Teori pembelajaran konstruktivis, teori penentuan diri, dan teori kognitif sosial menjadi kerangka sintesis tematik yang menghasilkan lima tema psikologis utama. Lingkungan imersif memberikan dukungan untuk kognisi yang terwujud (pemrosesan kognitif melalui masukan sensorik) dan mendorong tingkat konseptualisasi yang lebih dalam tentang subjek yang dipelajari; kecerdasan buatan dan analitik pembelajaran memberikan persepsi kompetensi dan pengaturan diri melalui umpan balik adaptif kepada peserta didik; model pembelajaran seluler dan campuran memfasilitasi otonomi dan agensi bagi peserta didik; sistem Institut Cerdas menyediakan personalisasi sistemik yang memfasilitasi keterlibatan berkelanjutan oleh peserta didik; dan gamifikasi dan lingkungan berbasis simulasi menumbuhkan motivasi intrinsik dan efikasi kolaboratif. Temuan menunjukkan bahwa lingkungan pembelajaran yang didukung teknologi berfungsi sebagai ekosistem psikologis terstruktur yang memengaruhi proses perilaku, kognitif, dan sosial, terkait dengan motivasi, aktivasi kognitif, dan interaksi sosial. Tinjauan literatur ini menambah bidang psikologi pendidikan dengan mendefinisikan cara-cara di mana lingkungan digital memediasi pembelajaran melalui jalur motivasi dan kognitif.

Kata Kunci : kecerdasan buatan dalam pendidikan, psikologi pendidikan, pembelajaran imersif, motivasi, pembelajaran mandiri.

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BACKGROUND

The use of digital technology in post-school education has resulted in significant changes in the way the education system operates. The presence of immersive virtual worlds, artificial intelligence (AI) led feedback systems, adaptive learning platforms, and gamified learning environments is becoming ever more prevalent in higher education and vocational training settings. Rather than serving simply as instructional aids, these technologies are also providing a structured psychological learning environment that is impacting students' motivation and cognitive engagement as well as how they engage in self-regulated learning. Recent research has shown that immersive virtual reality and augmented reality experiences have improved students' conceptualization or understanding of concepts as well as their level of engagement when learning STEM (Science, Technology, Engineering and Mathematics) content (Radianti et al. 2020; Ibáñez and Delgado-Kloos 2018). Likewise, the implementation of AI technologies in higher education are rapidly proliferating, providing adaptive recommendation systems and predictive analytics that facilitate the development of autonomy and competence amongst learners (Zawacki-Richter et al. 2019; Viberg et al. 2018).

From a psychological viewpoint, the way we learn is influenced more by a person's cognitive and motivational processes than their exposure to technology alone. According to the constructivist view of learning, we learn best when we create our own knowledge from interactions with meaningful and contextual (i.e., situated) experiences, and immersive technologies help promote this by providing us with bodily and experiential relationships that enhance our ability to process abstract information by combining it with spatial (i.e., visual, auditory) and sensory (i.e., touch, taste) experiences (Bagher et al. 2021; Acevedo et al. 2024). Therefore, self-determination theory describes how autonomy support, competence scaffolding and feedback mechanisms affect individuals' intrinsic motivation to continue learning and their persistence (i.e., how long they will keep trying to learn). AI-driven adaptive systems may help meet these psychological needs through individualized pathways to learning and instant feedback on the learner's performance (Srivastav, Kant, and Srivastava 2024; Nayak et al. 2023).

Digital environments utilize social interaction through various collaborative and modeled methods to create additional stimuli (i.e., interactivity), so they can enhance the process of self-efficacy and social learning, for example by providing opportunities to do so, and hence provide greater levels of participant engagement and more effective behaviors associated with collaborating when observing the behavior of fellow participants (Huang, Hew, and Lo 2019; Assumpção et al. 2022). The results indicate that technology-enhanced learning environments are not only a vehicle to convey new information to learners, but they are also associated with fostering intrinsic motivation and developing research skills related to intrinsic motivation, along with increased levels of perceived competence.

Although research on technology enhanced education has grown quickly over the past few years, a large portion of the existing knowledge base still focuses primarily on technology; for example, looking at system architecture, investigating implementation models, and most importantly looking for innovation in technology. Previous systematic literature reviews have been conducted looking for empirical literature on both immersive technologies (Radianti et al. 2020) and artificial intelligence (AI) applications (Zawacki-Richter et al. 2019). However, beyond these reviews, there are very few systematic integrative literature reviews that specifically consider how psychological mechanisms act as mediators of these relationships. Without integration, technology enhanced education could easily be viewed as having caused learning gains based solely on the sophistication of the technology itself and therefore would ignore what is happening cognitively or motivationally to support these relationships or any social modeling that exists.

In greater depth, higher education represents a unique area for studying the relationship between motivation and persistence among learners. Higher education has traditionally been characterized by three core changes: (1) increased independence from authority within the learning environment; (2) greater use of self-regulated learning strategies; (3) a movement toward professionals learning to be more competent in their work; and (4) an increased ability to take charge of your own learning because of advances in information technology (IT). For example, the ability to learn with mobile and blended learning has allowed learners more flexibility, while allowing for greater self-direction (Van Wyk 2018; Yip et al. 2020). At the institutional level, developing intelligent and adaptive systems will create a better experience for learners through customized or personalized learning path based on their data profiles (Wahid et al. 2021; Ilkou and Signer 2020). However, the psychological mechanisms that connect these types of interventions at the institutional level with the outcomes of motivation, persistence, and cognitive engagement are still only partially understood.

Despite the rapid growth of studies on technology-enhanced learning in post-school education, the theoretical basis of this field is still conceptually fragmented. While benefits in engagement and learning outcomes are commonly ascribed to immersive properties, adaptive algorithms, or gamified architectures, the underlying psychological processes are seldom consolidated. Motivation, embodied cognition, self-regulated learning, and collaborative efficacy are commonly studied in isolation, leaving a conceptual gap in understanding how these processes might interact in digitally mediated contexts.

This is a crucial point that indicates a significant gap in the field of educational psychology. It is unclear whether technology is a direct determinant of learning outcomes or whether it acts as a contextual catalyst that triggers cognitive, motivational, and regulatory processes. Furthermore, adaptive technologies seem to question the long-held assumption that self-regulation is an exclusively internal process, leaving the question of distributed regulation between the learner and the algorithmic feedback unanswered. These tensions can only be resolved through a systematic consolidation that shifts the focus of technology from a determinant of learning to an activation context for interrelated psychological processes

The objective of this comprehensive literature review was to assess how various technological advancements (those developed from 2015-2024) are impacting psychological mechanisms in post-secondary education. Rather than isolating each type of technology as an independent source of influence, the research utilized a psychological framework to understand the influence of technology based on four psychological processes (motivation, cognitive processing, self-regulation of learning and collaborative engagement) across several different categories of technologically advanced learning environments and methods (i.e., immersive technology, artificial intelligence systems, mobile and blended learning models, adaptive environment platforms, and gamification). The results of this review will assist in articulating the way digital learning ecosystems, or “Learning Ecosystems”, are affecting both the behavioral patterns of learners and the psychological behaviors and mechanisms that underlie their actions and behaviors through digital learning.

To better understand the application of these technologies, this systematic literature review (SLR) will study the ways in which technology-enhanced learning environments in post-school education have adapted to, and adopted, new technological approaches. We will follow the method of (Xiao and Watson 2019) for supervision and use the structured synthesis procedures of (Shaikh and Patil 2020). The studies we reviewed included peer-reviewed studies, published between 2015 and 2024, across post-school education and technology-enhanced learning in different forms of post-school education (e.g., universities, vocational training institutions, and adult learning). A total of 40 papers from peer-reviewed journals were reviewed.

The research questions guiding this study are:

RQ1: What impact do immersive and intelligent technologies have on learners' motivation, cognitive engagement and performance during their transition from school to higher education?

RQ2: What psychological processes mediate the effectiveness of engagement with technology enabled learning settings?

RQ3: What contextual and institutional variables act as moderators, or affect the extent to which psychological benefits from learning with these technologies occur?

The provision of technology within education as a contextual catalyst and psychological processes as the primary explanatory processes of engagement provide an integrative synthesis of the dynamics of technology mediated learning; thus, contributing to both educational psychology and the broader study of how individuals learn.

Table 1. Alignment of Review Questions with Thematic Areas

No	Review Question (RQ)	Thematic Area(s)	Description
1	RQ1: What role do immersive and intelligent technologies and their use play in supporting learner performance and engagement in post-school education contexts?	Immersive Technologies (VR/AR/MR), Simulation, Serious Games	Analyses how embodied learning, interactivity in virtual worlds, and simulation contexts support learner engagement, conceptual understanding and performance.
2	RQ2: What themes in terms of instructional design and technology use enable effective engagement with technology for learning in tertiary education settings?	Artificial Intelligence (AI), Machine Learning, Learning Analytics	Finds trends in adaptive learning, personalized feedback, data-informed decision-making and predictive modelling in higher educational contexts.
3	RQ3: What are the implications and challenges of developing and implementing technology-enhanced learning environments in varying post-school educational contexts?	IoT, Gamification, Metaverse, Digital Futures	Articulates challenges of implementation challenges, ethical challenges, and future opportunities for connected, immersive, and scalable learning ecosystems beyond schooling (i.e., out-of-school contexts).
		Mobile and Flipped Learning	Examines flexible and learner-side centered modalities, using mobile learning technologies, and flipped pedagogies within higher education and distance education.
		Smart, Adaptive Learning Systems	Articulates innovative institutional and system-wide practices such as smart campuses, intelligent content distribution, and context-aware learning systems.

RESEARCH METHODS

Search Strategy

To ensure both methodological transparency and empirical rigor, this systematic literature review (SLR) employed a formal search protocol on behalf of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). This review was conducted to locate peer-reviewed research articles, published in the field of emerging technologies in post-secondary learning environments related to system design, implementation practices and learning performance.

Scopus was chosen as the key source due to its broad coverage of emerging, high-quality, peer reviewed literature in education technology and related fields. A phased approach to keyword refinement was employed, with the aim of maximizing substantive accuracy and thematic fidelity to the goals of the research. Boolean logic and word delimiters were used to systematically limit the search parameters:

- technology → 4,910,633 results
- technology AND design → 981,577 results
- technology AND design AND application → 312,191 results
- technology AND design AND application AND performance → 88,993 results
- technology AND design AND application AND performance AND education → 2,494 results
- technology AND design AND application AND performance AND education AND "learning environments" → 197 results

Subsequent filters were applied to refine results for empirical relevance:

- Publication years: 2015–2024
- Document types: Peer-reviewed journal articles (63) and conference proceedings (40)
- Language: English only
- Discipline relevance: Education, Computer Science, Social Sciences, and Engineering

At the end-there were 40 articles that were finally selected by screening the full text of articles based on static measures, empirical depth, and matched one or more bases for the review-experiences of immersive learning (VR/AR/MR), artificial intelligence and learning analytics, mobile and flipped learning, intelligent learning systems, and pedagogical design enhanced by IoT.

Inclusion and Exclusion Criteria

In order to achieve coherent alignment with the objectives of this SLR and theoretical relevance to post-secondary education, a rigid set of inclusion and exclusion criteria were used. The inclusion and exclusion criteria were also intended to improve transferability and analytical rigor of the review, in line with the traditions of systematic literature synthesis (Xiao and Watson 2019; Shaikh and Patil 2020).

Inclusion Criteria:

- Empirical & Theoretical Contribution: A paper must provide empirical evidence or a well-grounded conceptual framework concerned with the integration of technology in post-secondary education systems.
- Full-Text: The SLR only reviewed studies that were available in full-text to allow for a total analysis of the full study.
- Language & Date Range: The studies included in this review must be written in English and from the date range 2015-2024 to be contemporary and consistent with language.
- Research Focus: The studies had to have a focus on the design, use, and related performances of technology-enhanced educational learning environments in post-secondary contexts.
- Peer-Reviewed Source: The SLR only included peer-reviewed journal articles and conference proceedings.
- Thematic Relevance: The studies had to be classified with at least one of the following areas: immersive technologies, AI/machine learning, learning analytics, mobile/flipped learning, adaptive learning systems, gamification, or IoT in education.

Exclusion criteria:

- Articles about settings that are pre-tertiary and not directly about post-school transition or systems.
- Non-English articles and articles published outside the 2015–2024 period.
- Grey literature, dissertations, opinion briefs, and editorials.
- Articles that do not have a specific focus on the design, use, or educational performance of technology.

Table 2. Inclusion and Exclusion Criteria

No.	Review Element	Inclusion Criteria	Exclusion Criteria
1	Research Focus	Technology in post-secondary education; design, application, performance	Non-educational focus; unrelated performance domains
2	Language	English	Non-English
3	Publication Period	2015-2024	Before 2015
4	Source Type	Peer-reviewed journal articles or conference proceedings	Grey literature; abstracts only; editorials
5	Disciplinary Scope	Education, Computer Science, Social Sciences, Engineering	Law, Medicine, or unrelated technical fields
6	Selection Result	40 selected from 88 screened articles	48 excluded for relevance, clarity, or methodological limitations

This process ensured that the final corpus of articles provided an accurate and theoretically informed perspective of how technological innovations are currently being designed and enacted across educational systems and, more specifically, how they are intended to improve the learning environments and outcomes in higher education.

Prisma flow diagram summary

For systematic and transparent reporting, this review followed the Prisma 2020 guidelines. the flow diagram outlined below (table 3) shows the process of identifying, screening, eligibility, and inclusion for the selected studies.

Table 3. PRISMA Flow Diagram Summary

No	Phase	Description	Number of Records
1	Identification	Records identified through database search (Scopus) using refined keywords	197
		Additional records identified through backward/forward citation searches	5
2	Screening	Records after duplicate removal	192
		Records screened by title and abstract	126
		Records excluded (irrelevant or outside scope)	38
3	Eligibility	Full-text articles assessed for eligibility	88
		Full-text articles excluded (not meeting inclusion criteria)	48
4	Included	Studies included in final review	40

Data Extraction and Coding Procedures

In order to improve analytic transparency, a multi-stage coding process coupled with a structured data extraction process was used. The approach taken here is to extract key data points from each study's data extraction, including the publication of study, education type and corresponding technology use, pedagogical design, selected research methodology, and final results. There were two independent coders that each had undergone training in Qualitative Research/Qualitative Analytics/Qualitative Data Analysis, as well as Educational Technology, who performed the coding process. Coder A did the first round of open coding and Coder B verified each of Code A's codes or coding. If there was a disagreement in coding by the two coders, consensus meetings were held to resolve the disagreement. Cohen's Kappa was calculated in the second coding phase to ensure the reliability of the codes and was found to be 0.82, which indicates a high level of agreement between coders.

Analytical Process: From Codes to Themes

We utilized a thematic synthesis approach, following the steps described by Thomas and Harden (2008) and Braun and Clarke (2023), to examine the findings from our studies through three stages of analysis.

1. Open Codes

Each coder independently analyzed the findings sections from all studies, conducting line-by-line open coding to identify meaningful statements that described the study's outcomes in terms of learner experience, technological characteristics, instructional design, and the associated challenges.

2. Axial Coding / Categories

Next, codes were grouped by similarity and conceptual proximity into broad thematic areas and were assigned general names. The themes were based on consistent patterns identified across all studies and included:

- feedback based on adaptivity
- spatial understanding
- mechanisms of engagement
- accessibility and flexibility
- decision-making based on data
- instructor's willingness to use
- contextual constraints

3. Thematic Synthesis

Finally, the themes identified in the previous stage were grouped into higher-order themes that were informed through synthesizing the entire body of literature reviewed. Themes were created through iteratively comparing categories and checking them against raw data, and through consensus among coders. This resulted in five thematic areas that integrated knowledge from multiple studies and were not simply groupings of technological characteristics.

Ensuring Trustworthiness

To improve the quality and reliability of our synthesis, there were several specific methods employed:

- Triangulation: comparisons among findings from different studies and contexts.
- Coder Reliability: Independent coding and multiple reconciliation meetings allowed for a level of consistency in the analysis.
- Audit Trail: This includes the systematic storage of all coding files, category maps, and synthesis notes in order to provide evidence for the possibility of replicating this synthesis.
- Cross-checking with RQs: Using RQs 1 through 3, themes were always compared to the three RQs.

RESEARCH RESULTS

By completing a thematic synthesis of a total of 40 peer-reviewed publications that took place from 2015-2024, five interrelated constructs were found to explain how technology-enhanced learning environments function to effect individual learners within post-school education. After undergoing axial coding, each study was linked to one or more psychological constructs based upon the reported mechanisms functioning. Although many of the studies activated numerous cognitive, motivational, and social processes simultaneously, so that the total number of construct distributions would exceed that of the 40 studies, all 40 included studies were represented within the total construct distribution, and none were excluded from the final synthesis.

While the degree of overlap is indicative of how interconnected digital learning ecosystems can be since immersive, adaptive, and collaborative features are frequently activated at the same time.

Table 4. Integrated Bibliometric and Descriptive Profile of Reviewed Studies (n = 40)

Dimension	Category	Frequency (n)	Percentage (%)	Dominant Characteristics	Comparative Insight
Publication Year	2015–2017	4	10%	Early adoption of VR/AR	Early exploratory and experimental focus
	2018–2019	8	20%	Growth of AR & analytics	Start data-driven learning integration
	2020–2021	12	30%	Expansion during digital shift	Influenced by global digital acceleration
	2022–2024	16	40%	Dominance of AI & adaptive systems	Shifting to an intelligent learning ecosystem
Research Method	Quantitative	18	45%	Performance measurement, statistical testing	Dominant in the evaluation of technology effectiveness
	Qualitative	12	30%	Experience, perception, cognition	Deeper explanation of psychological mechanisms
	Mixed Methods	10	25%	Integrated analysis	Combining the strengths of two approaches
Technology Type	AI & Adaptive Systems	12	30%	Personalized learning, feedback systems	Focus on self-regulation & competence
	VR/AR/MR	10	25%	Immersive environments	Dominant in embodied cognition
	Gamification	7	17.5%	Game-based engagement	Focus on intrinsic motivation
	Mobile/Blended	6	15%	Flexible learning	Supporting autonomy
	IoT/Smart Systems	5	12.5%	Institutional integration	Focus on system-level alignment
Citation Impact	Very High	5	12.5%	Foundational SLR studies	Becoming the main reference in the field
	High	10	25%	Widely cited empirical studies	Strengthening empirical validity
	Medium	15	37.5%	Emerging research	Moderate contribution
	Low	10	25%	Recent publications	Low citations due to time factors
Productive Authors	(Zawacki-Richter et al. 2019)	3	—	AI in Education	Dominant in conceptual studies of AI
	(Viberg et al. 2018)	2	—	Learning Analytics	Focus on data-driven learning
	(Radianti et al. 2020)	2	—	Immersive Learning	Focus on VR/AR
	(Huang, Hew, and Lo 2019)	2	—	Gamification	Focus on engagement
	(Wahid et al. 2021)	2	—	Smart Systems	Focus on institutional systems

The integrated bibliometric analysis shows how technology-enhanced learning research developed during the last ten years. The first research studies used immersive technological systems which included virtual and augmented reality to investigate how students became engaged with their learning activities. The most recent research studies show that there has been a major trend shift towards using artificial intelligence together with adaptive systems because educational institutions now recognize the value of personalized learning through data analysis.

The research shows that quantitative research methods have become the dominant approach because researchers focus on assessing learning outcomes together with technological performance. The research uses qualitative and mixed-method approaches to discover psychological processes which drive motivation and cognition and self-regulated learning.

The main technological area of research focuses on artificial intelligence and adaptive systems which show a shift from experience-based learning towards intelligent learning ecosystems. The two technologies of immersive technologies and gamification together with mobile learning create different results through their effects on cognitive processing and student motivation and independence. The analysis of IoT and smart systems shows institutional-level operations while showing that staying connected with the complete system leads to better student engagement results.

The analysis of citations shows that foundational systematic reviews still impact the field while current research studies contribute to developing new research fields through their emerging patterns. The research field developed a structured framework which shows that authors tend to specialize in particular technological domains according to their recurring presence in the field.

The research results show that technology-enhanced learning consists of multiple components which activate different psychological mechanisms through various technological systems. The bibliometric and descriptive characteristics of the reviewed studies are shown in Table 4 but it does not provide complete information about the psychological processes that explain how technology affects learning. The researchers performed a thematic synthesis to find common patterns which appeared in multiple studies. The analysis resulted in five interrelated psychological constructs that explain technology-enhanced learning as a multidimensional system.

Embodied Cognition and Conceptual Processing

Various studies have revealed that learning about concepts in immersive environments, such as virtual reality, augmented reality, and mixed reality helps improve how we conceptualize those particular things and the manner in which we understand them (i.e., experience-based and spatially [visually] reasoning). Overall, research indicates that there are multiple benefits from the use of immersive environments, including: improved cognitive integration, transfer of knowledge and the use of applied problem solving skills, especially in STEM and design areas (Radianti et al. 2020; Ibáñez and Delgado-Kloos 2018; Acevedo et al. 2024; Bagher et al. 2021; Azzam, Breidi, and Soudah 2023; Bharathi and Tucker 2015; Safari Bazargani, Sadeghi-Niaraki, and Choi 2021; Ogunseiju et al. 2022; Crolla et al. 2024; de Ravé et al. 2016; Nunes et al. 2024).

In all of these areas, immersive environments allow learners to manipulate abstract (theoretical) representations using a dynamic medium of presentation that involves sensorimotor engagement, which in turn will facilitate higher-order conceptual processing (thinking about concepts).

Motivation, Autonomy, and Perceived Competence

Several studies on adaptive systems, gamified learning systems and flexible instructional delivery methods illustrate that intrinsic motivation increases when students feel that they are making progress at their own pace and receive structured support for achieving competence (Zawacki-Richter et al. 2019; Srivastav, Kant, and Srivastava 2024; I. Nayak et al. 2023; Viberg et al. 2018; Huang, Hew, and Lo 2019; Costa-Tebar, Gallud, and Lozano 2023; Van Wyk 2018; Yip et al. 2020; Chen and Kao 2019; Lee, Chern, and Azmir 2023; Mohamed-Amar and Mohamed Amar 2024; Ayaz 2023; Konstantinidis et al. 2017; Fedele, Punzi, and Tramacere 2024).

Gamified formats supported the mastery approach to learning while using mobile and blended learning formats increased learner engagement through increased access to the content and self-direction in their participation. Fulfillment of psychological needs was an important mediating variable that connected the technology design and continued involvement with the learning process

Self-Regulated Learning and Adaptive Feedback

According to the research mentioned, when teachers use AI technology to provide feedback to students in an adaptive learning environment (Gupta, Garg, and Kumar 2022; Udupi, Sharma, and Jha 2016; Viberg et al. 2018; I. Nayak et al. 2023; Srivastav, Kant, and Srivastava 2024; Konstantinidis et al. 2017) to improve their use of self-regulated learning strategies, they not only enhance learner motivation, but they also provide students with problem-solving assistance throughout the learning process while developing their understanding of self-regulated learning through adaptive learning systems (Zhou and Wang 2024; Fedele, Punzi, and Tramacere 2024; García et al. 2016; Ilkou and Signer 2020; Wahid et al. 2021).

As a result of their design, adaptive learning technologies do not remove control and autonomy from learners but act as scaffolds for regulation so that learners can develop more effective self-regulatory strategies in all types of learning environments.

Social Learning and Collaborative Efficacy

Learning with simulations, using the internet of things to support learning activities and working on gamified collaborative platforms enhanced the social learning process (Assumpção et al. 2022; Teizer et al. 2020; Kunovic, Filipovic, and Krzic 2024; Costa et al. 2021; Huang, Hew, and Lo 2019; Lee, Chern, and Azmir 2023; Yang et al. 2023; Ayaz 2023; Mohamed-Amar and Mohamed Amar 2024).

The use of peer modeling, shared feedback loops, and cooperative task structures resulted in increased levels of both individual and collective self-efficacy. As such, collaborating through technology was an important driver of socially situated cognition and problem-solving in an applied context.

Psychological Readiness and Sustained Engagement at the System Level

Multiple studies have highlighted the significance of having systemic alignment if sustainability of engagement in smart campus infrastructure, adaptive institutional systems, and context-aware platforms is to be achieved (Wahid et al. 2021; Ilkou and Signer 2020; García et al. 2016; Hu and Li 2024; Watanabe 2016; Viberg et al. 2018; Zhou and Wang 2024; Fedele, Punzi, and Tramacere 2024).

As shown by the above-mentioned findings, factors such as institutional readiness, digital competence, and infrastructural coherence influence the level of persistence and regulatory stability a person has for long-term motivation. While instructional design and system-level conditions shape people's engagement with a given system, there are many other factors that contribute to how those systems perform.

Integrative Interpretation

Notwithstanding the fact that the five psychological themes have been presented for analytical clarity as separate constructs, they were actually meaningfully connected to one another. In fact, the same technological learning environment has been researched in numerous studies at the same time regarding cognitive processing, motivation regulating, and social interaction. The reason that the cumulative distribution of the different constructs exceeds 40 is due to the overlap of multidimensional constructs from the total number of constructs synthesized based upon 40 unique studies.

Technology-enhanced learning environments represent an integrated psychological system in which learners' immersion of interaction, adaptive feedback, motivational scaffolding, collaborative modelling and alignment with institutional structure affect their level of engagement and performance as a learner.

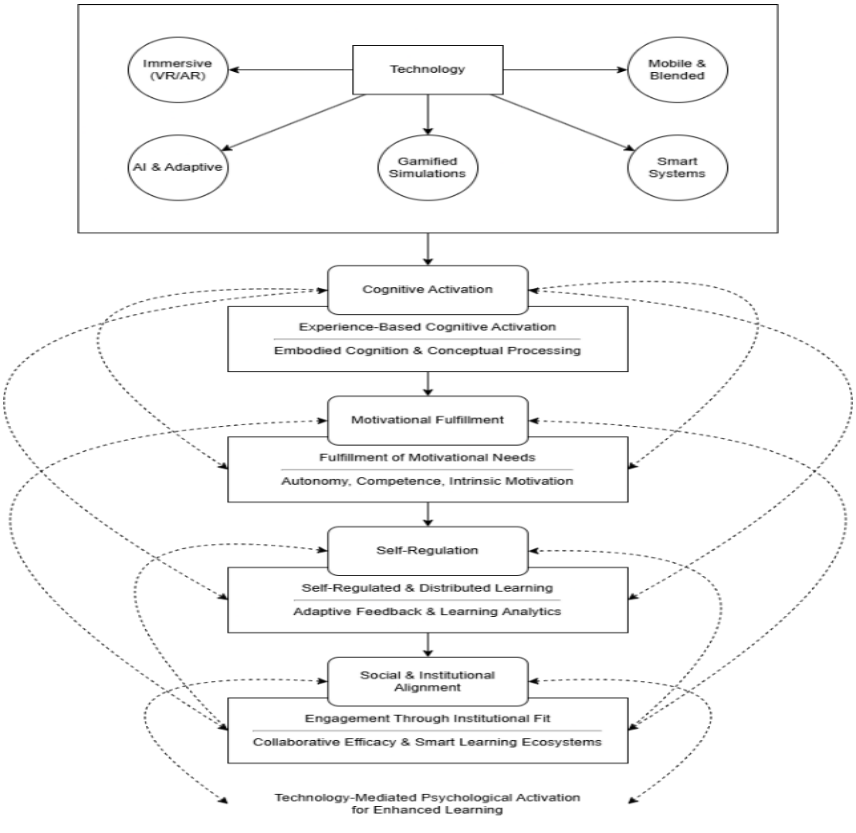

Fig 1. Integrative Contribution and Proposed Model

The proposed model demonstrates that technological systems function as activation layers which proceed to activate multiple cognitive processes that are interconnected within educational environments. The use of technological elements like immersive systems and artificial intelligence and adaptive platforms activate cognitive processes through interaction with real-life experiences which leads to better learning of concepts and building of knowledge (Radianti et al. 2020; Ibáñez and Delgado-Kloos 2018). The process of cognitive activation enables learners to meet their motivational needs because it provides them with both autonomy and the ability to demonstrate their competence which drives their intrinsic motivation to study in digital environments (Viberg et al. 2018); (Zawacki-Richter et al. 2019).

Moreover, motivation increases the ability of learners to become self-directed and able to evaluate their learning and adjust their methods of learning using adaptive feedback and learning analytics (Gupta, Garg, and Kumar 2022; Nayak et al. 2023). Also, the model illustrates the collaborative use of technology as the social interaction between peers using different methods of technology allows for more opportunity to learn collectively and solve problems together (Huang, Hew, and Lo 2019; Assumpção et al. 2022). Long-term learning can be achieved through collaborative experiences across multiple contexts when the person and place are aligned, along with appropriate institutional resources and infrastructure (Wahid et al. 2021; Ilkou and Signer 2020).

This model is not a linear structure; it instead is representative of the interdependent and reciprocal connections between the cognitive, motivational, regulatory, and social aspects of learning in conjunction with using technology as an influencing element in relationship to learning outcomes.

DISCUSSION

This literate search demonstrates that technology-enhanced learning environments can’t just be thought of as tools for learning, but rather as interconnected mental systems in which things like technology act as stimulants to enable learners to engage in cognitive learning, motivation, regulation and social processes. The 40 studies reviewed found very clearly that the technological sophistication (the level of technology) of an environment is not the only factor that determines what you learn, but influences how you interact with that environment through psychological mediation mechanisms (Radianti et al. 2020; Zawacki-Richter et al. 2019; Viberg et al. 2018). As a result of this review, the primary finding has been that we see technology as providing context for activating learners, opposed to determining what you can learn. The focus of the study has changed from examining the attributes of technology to understanding the mechanisms that the learner uses to learn with technology.

Immersive technologies such as VR and AR are capable of making learning more effective through showed cognition, a concept where one gains knowledge by physically interacting with digital environments. Learning is not passive. It happens when learners interact with the content at the very place it happens, as constructivist theory explains (Bagher et al. 2021). Studies reveal that learners in immersive environments understand spatial concepts, perform better problem-solving, and have a clearer grasp of abstract STEM topics - Especially when they are capable of manipulating the objects in real-time (P Acevedo et al. 2024). That is because the brain is attuned to movement, touch, and other sensory inputs. Making the experience memorable. The big thing is these gadgets physically engage us which make us understand even the most difficult aspects of the subjects.

Thing is, motivation shows up as a big player in tech-driven learning. Self-determination theory backs this up - students feel more at its core motivated when digital tools give them choice and let them feel capable, thanks to adaptive feedback and custom paths (Viberg et al. 2018; Srivastav, Kant, and Srivastava 2024). AI and learning analytics translate those needs into action by providing live updates and customized progress, which help learners to achieve mastery (Zawacki-Richter et al. 2019; Nayak et al. 2023). The result? Motivation isn't baked in from the start. It's built through how the system talks to the learner, forming a shared rhythm of engagement.

The changes in self-regulated learning within digital settings show even more how traditionally learning paradigms are being changed. Classical theories saw self-regulation as an inner process but the pieces of evidence that is summarized in this review points to the concept of distributed regulation, where the learners have the dynamic interaction with algorithmic feedback systems that facilitate the support of monitoring, evaluation, and strategic adjustment (Gupta, Garg, and Kumar 2022; Nayak et al. 2023). Learning analytics and predictive models serve as external scaffolds, through which they heighten learners' metacognitive awareness and decision-making skills. This, in fact, helps to extend the notion of self-regulation/guidance crypto beyond the player, psychic self (Viberg et al. 2018). Therefore, this review denotes as a main theme the result in the change of the concept of self-regulated learning as a distributed process between human cognition and intelligent systems.

Social interaction is not merely an element one can overlook in tech-driven learning, but a fundamental mechanism through which individuals develop. In addition to cognitive and regulatory processes, technology-enhanced learning ecosystems may find social interactions as a highly important aspect. Collaborative platforms, simulations, and gamified environments not only facilitate social learning by peer modeling, shared feedback, and collective problem-solving, but also align with the basic principles of social cognitive theory (Kunovic, Filipovic, and Krzic 2024). Learners see what others do, copy it, adjust it, inside connected systems. This helps both individuals and groups feel more capable (Huang, Hew, and Lo 2019). The result? Digital spaces stretch social thinking into online and out-of-sync settings. Collective confidence ends up shaping how well people learn.

On a macro scale, the sustainability of engaging in technology-enhanced learning is also determined by the institutional level factors such as the readiness of infrastructure, the level of integration of systems, and the digital competence of users. Smart campus projects and the adaptive institutional systems that continue to operate in the ways of providing a well-ordered environment that matches the technological, or digital, capabilities of the users (learners) with their needs to safely back and support long-term engagement and persistence (Wahid et al. 2021; Ilkou and Signer 2020). This is very much in line with the ecological perspective in educational psychology, which views an individual as being in continuous and dynamic interaction with his/her environment and that this interaction shapes the behavior of the individual as well as his/her learning outcome. Therefore, this paper highlights institutional alignment not only as an outcome variable but also as a variable that can significantly change/shift the effectiveness of those psychological processes mediated by technology.

Taken together, these results very well support the idea of technology being the psychological activation context whereby the different layers of learning processes are integrated into one another. The main result that we have reached after doing this systematic review is the creation of a Technology-Mediated Psychological Activation framework which shows learning to be the consequence of passage of a number of cognitive motivational regulatory, and social mechanisms that are triggered/exposed in a digital environment. With this comprehensive viewpoint, we are taking a step forward from the old researches by depicting technology not as a sole factor that leads to the performance but as a facilitating environment in which different modes of cognition (e.g. embodied cognition), motivation (e.g. intrinsic motivation), and learning (e.g. self-regulated learning, collaborative efficacy, and institutional alignment) are brought into play (Radianti et al. 2020; Zawacki-Richter et al. 2019).

CONCLUSION

In this review, 40 empirical studies on technology, enhanced post, school education were analyzed, and it was found that such education is more than just a digital instructional shift. Technology, based systems serve as environmental stimuli that trigger cognitively activating experiences through the senses. Students thus learn through direct involvement and interaction, which in turn, leads to increased motivation and the fulfillment of needs such as perceived competence and autonomy. As a result, self, regulated learning behaviors are established.

Moreover, the development of regulatory skills is demonstrated when individuals working together collaborate efficiently by sharing their problem, solving strategies through technology, enhanced communication. Engagement, of course, can only be maintained if the institutional fit is there, that is, when the infrastructure and the organizational readiness are aligned with the psychological activation processes. The innovative Technology, Mediated Psychological Activation Model accounts for the gradual but connected components.

This study leads us from educational psychology to a more mechanistic understanding of learning in digitally mediated ecosystems by resituating technology as an activating environment that supports cognitive, motivational, regulatory, and social processes. Further, by providing a tool for understanding students' engagement in technology, based environments from a psychological perspective, this research contributes to the progress of technology, supported education.

It is recommended that future studies test the proposed model in different institutional settings and investigate how psychological activation, digitally assisted, affects people's developmental trajectories over time.

REFERENCES

Acevedo, P, A J Magana, B Benes, and C Mousas. 2024. “A Systematic Review of Immersive Virtual Reality in STEM Education: Advantages and Disadvantages on Learning and User Experience.” *IEEE Access* 12: 189359–86. https://doi.org/10.1109/ACCESS.2024.3489233.

Acevedo, Pedro, Alejandra J Magana, Yoselyn Walsh, Hector Will, Bedrich Benes, and Christos Mousas. 2024. “Embodied immersive virtual reality to enhance the conceptual understanding of charged particles: A qualitative study.” *Computers & Education: X Reality* 5: 100075. https://doi.org/10.1016/j.cexr.2024.100075.

Assumpção, Raphael M, Pedro R Chaves, Luiz C Ferreira, Paulo Cardieri, Omar C Branquinho, and Fabiano Fruett. 2022. “Advancing engineering education: Using the three-phase methodology to teach IoT.” *Computer Applications in Engineering Education* 30 (5): 1547–60. https://doi.org/https://doi.org/10.1002/cae.22543.

Ayaz, Barış. 2023. “Observation and Improvement of Mobile-Assisted Learning of Students with Visual Impairment: An Action-Research Study.” *Egitim ve Bilim* 48 (214): 17–39. https://doi.org/https://doi.org/10.15390/EB.2023.11626.

Azzam, Israa, Farid Breidi, and Peter Soudah. 2023. “Virtual Reality: A Learning Tool for Promoting Learners’ Engagement in Engineering Technology.” In . ASEE Conferences.

Bagher, Mahda M, Pejman Sajjadi, Jan Oliver Wallgrün, Peter C La Femina, and Alexander Klippel. 2021. “Move the object or move the user: the role of interaction techniques on embodied learning in VR." *Frontiers in Virtual Reality* 2: 695312. https://doi.org/10.3389/frvir.2021.695312.

Bharathi, Ajay Karthic B Gopinath, and Conrad S Tucker. 2015. "Investigating the impact of interactive immersive virtual reality environments in enhancing task performance in online engineering design activities." In *International Design Engineering Technical Conferences and Computers and Information in Engineering Conference*, 57106:V003T04A004. American Society of Mechanical Engineers. https://doi.org/https://doi.org/10.1115/DETC2015-47388.

Braun, Virginia, and Victoria Clarke. 2023. "Toward good practice in thematic analysis: Avoiding common problems and be (com) ing a knowing researcher." *International journal of transgender health* 24 (1): 1–6. https://doi.org/10.1080/26895269.2022.2129597.

Chen, Q, and T-C Kao. 2019. "Applying the flipped classroom instructional model to rural online tutoring program in upper elementary mathematics." *Contemporary Educational Research Quarterly* 27 (2): 1–37. https://doi.org/https://doi.org/10.6151/CERQ.201906_27(2).0001.

Costa-Tebar, Felipe, Jose A Gallud, and Maria Dolores Lozano. 2023. "Definition and Implementation of a Gamification Model for Virtual Teaching Environments." In *Proceedings of the XXIII International Conference on Human Computer Interaction*, 1–8. https://doi.org/https://doi.org/10.1145/3612783.3612800

Costa, Maria Cristina, Paulo Santos, João Manuel Patrício, and António Manso. 2021. "An interactive information system that supports an augmented reality game in the context of game-based learning." *Multimodal Technologies and Interaction* 5 (12): 82. https://doi.org/https://doi.org/10.3390/mti5120082.

Crolla, Kristof, Jingwen Song, Andreea Bunica, and Abdullah Tahir Sheikh. 2024. "Integrating extended reality in architectural design studio teaching and reviews: Implementing a participatory action research framework." *Buildings* 14 (6): 1865. https://doi.org/10.3390/buildings14061865.

Fedele, Andrea, Clara Punzi, and Stefano Tramacere. 2024. "The ALTAI checklist as a tool to assess ethical and legal implications for a trustworthy AI development in education." *Computer Law & Security Review* 53: 105986. https://doi.org/https://doi.org/10.1016/j.clsr.2024.105986.

García, Alejandro Montes, Natalia Stash, Marc Fabri, Paul De Bra, George H L Fletcher, and Mykola Pechenizkiy. 2016. "WiBAF into a CMS: Personalization in learning environments made easy." In *CEUR Workshop Proceedings*. Vol. 1618.

Gupta, Anika, Deepak Garg, and Parteek Kumar. 2022. "Mining sequential learning trajectories with hidden Markov models for early prediction of at-risk students in e-learning environments." *IEEE Transactions on Learning Technologies* 15 (6): 783–97. https://doi.org/https://doi.org/10.1109/TLT.2022.3197486.

Hu, Xingli, and Jiangtao Li. 2024. "Research on the integrated solution of physical education based on smart campus." *Advances in Physiology Education* 48 (2): 378–84. https://doi.org/https://doi.org/10.1152/advan.00006.2024.

Huang, Biyun, Khe Foon Hew, and Chung Kwan Lo. 2019. "Investigating the effects of gamification-enhanced flipped learning on undergraduate students' behavioral and cognitive engagement." *Interactive Learning Environments* 27 (8): 1106–26. https://doi.org/10.1080/10494820.2018.1495653.

Ibáñez, María-Blanca, and Carlos Delgado-Kloos. 2018. "Augmented reality for STEM learning: A systematic review." *Computers & Education* 123: 109–23. https://doi.org/10.1016/j.compedu.2018.05.002.

Ilkou, Eleni, and Beat Signer. 2020. "A Technology-enhanced Smart Learning Environment based on the Combination of Knowledge Graphs and Learning Paths." In *CSEDU (2)*, 461–68. https://doi.org/https://doi.org/10.5220/0009575104610468.

Konstantinidis, Stathis Th, Aaron Fecowycz, Kirstie Coolin, Heather Wharrad, George Konstantinidis, and Panagiotis D Bamidis. 2017. "A proposed learner activity taxonomy and a framework for analysing learner engagement versus performance using big educational data." In *2017 IEEE 30th International Symposium on Computer-Based Medical Systems (CBMS)*, 429–34. IEEE. https://doi.org/https://doi.org/10.1109/CBMS.2017.160.

Kunovic, Ivan, Ivan Filipovic, and A Sovic Krzic. 2024. "Teaching Robotics Concepts with Besiege: A Game-Based Approach for Developing Design and Problem-Solving Skills." In *2024 47th MIPRO ICT and Electronics Convention (MIPRO)*, 672–77. IEEE. https://doi.org/https://doi.org/10.1109/MIPRO60963.2024.10569275.

Lee, Cheng Ean, Huei Huei Chern, and Dzafran Adris Azmir. 2023. "WhatsApp use in a higher education learning environment: Perspective of students of a malaysian private university on academic performance and team effectiveness." *Education Sciences* 13 (3): 244. https://doi.org/https://doi.org/10.3390/educsci130302

44.
Mohamed-Amar, Horía, and Rachida Mohamed Amar. 2024. "Flipped classroom and collaborative work as an inclusive strategy in higher education." https://doi.org/https://doi.org/10.24857/RGSA.V18N8-075.

Nayak, Ipsita, Sonam Bansal, Priya Kale, Shalini Tonpe, C Santhosh Kumar, and Ravi Rastogi. 2023. "Application of RNN-ET-Based Digital Education Using Speech Interactions." In *2023 International Conference on Self Sustainable Artificial Intelligence Systems (ICSSAS)*, 80–85. IEEE. https://doi.org/https://doi.org/10.1109/ICSSAS57918.2023.10331628.

Nunes, Miguel, Telmo Adão, Somayeh Shahrabadi, António Capela, Diana Carneiro, Pedro Branco, Luís Magalhães, Raul Morais, and Emanuel Peres. 2024. "ARPocketLab—A Mobile Augmented Reality System for Pedagogic Applications." *Computers* 13 (6): 148. https://doi.org/10.3390/computers13060148.

Ogunseiju, Omobolanle R, Nihar Gonsalves, Abiola A Akanmu, Diana Bairaktarova, Doug A Bowman, and Farrokh Jazizadeh. 2022. "Mixed reality environment for learning sensing technology applications in Construction: A usability study." *Advanced Engineering Informatics* 53: 101637. https://doi.org/10.1016/j.aei.2022.101637.

Radianti, Jaziar, Tim A Majchrzak, Jennifer Fromm, and Isabell Wohlgenannt. 2020. "A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda." *Computers & education* 147: 103778. https://doi.org/10.1016/j.compedu.2019.103778.

Ravé, E Gutiérrez de, Francisco J Jiménez-Hornero, Ana B Ariza-Villaverde, and J Taguas-Ruiz. 2016. "DiedricAR: a mobile augmented reality system designed for the ubiquitous descriptive geometry learning." *Multimedia Tools and Applications* 75: 9641–63. https://doi.org/10.1007/s11042-016-3384-4.

Safari Bazargani, Jalal, Abolghasem Sadeghi-Niaraki, and Soo-Mi Choi. 2021. "Design, implementation, and evaluation of an immersive virtual reality-based educational game for learning topology relations at schools: A case study." *Sustainability* 13 (23): 13066. https://doi.org/https://doi.org/10.3390/su132313066.

Shaikh, Junaid R, and Matsyagandha Patil. 2020. "Qualitative tests for preliminary phytochemical screening: An overview." *International journal of chemical studies* 8 (2): 603–8. https://doi.org/https://doi.org/10.22271/chemi.2020.v8.i2i.8834.

Srivastav, G, S Kant, and D Srivastava. 2024. "Design of an AI-driven feedback and decision analysis in online learning with google BERT." *International Journal of Intelligent Systems and Applications in Engineering* 12 (10s): 629.

Teizer, Jochen, Olga Golovina, Stephan Embers, and Mario Wolf. 2020. "A serious gaming approach to integrate BIM, IoT, and lean construction in construction education." In *Construction Research Congress 2020*, 21–30. American Society of Civil Engineers Reston, VA.

Thomas, James, and Angela Harden. 2008. "Methods for the thematic synthesis of qualitative research in systematic reviews." *BMC medical research methodology* 8 (1): 45. https://doi.org/10.1186/1471-2288-8-45.

Udupi, Prakash Kumar, Nisha Sharma, and S K Jha. 2016. "Educational data mining and big data framework for e-learning environment." In *2016 5th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions)(ICRITO)*, 258–61. IEEE. https://doi.org/https://doi.org/10.1109/ICRITO.2016.7784961.

Viberg, Olga, Mathias Hatakka, Olof Bälter, and Anna Mavroudi. 2018. "The current landscape of learning analytics in higher education." *Computers in human behavior* 89: 98–110. https://doi.org/10.1016/j.chb.2018.07.027.

Wahid, Abdul, Seny Luhriyani, Jumadi Mabe Parenreng, and Muh Irfan Nur. 2021. "Smart campus framework: a solution for new normal education system." In *2021 IEEE 5th International Conference on Information Technology, Information Systems and Electrical Engineering (ICITISEE)*, 266–71. IEEE. https://doi.org/https://doi.org/10.1109/ICITISEE53823.2021.9655952.

Watanabe, Toyohide. 2016. "A framework of information technology supported intelligent learning environment." In *Proceedings of the 10th International Conference on Ubiquitous Information Management and Communication*, 1–8. https://doi.org/https://doi.org/10.1145/2857546.2857549.

Wyk, Micheal M Van. 2018. "Economics student teachers' views on the usefulness of a flipped classroom pedagogical approach for an open distance eLearning environment." *The International Journal of Information and Learning Technology* 35 (4): 255–65. https://doi.org/https://doi.org/10.1108/IJILT-07-2017-0068.

Xiao, Yu, and Maria Watson. 2019. "Guidance on conducting a systematic literature review." *Journal of planning education and research* 39 (1): 93–112. https://doi.org/https://doi.org/10.1177/0739456X17723971.

Yang, Hairu, Yanru Shao, Xinye Bai, Mingyue Ma, Yuqi Liu, and Sidan Liu. 2023. "The design and application of flipped classroom teaching model based on blended learning: A case study of junior high school information technology course." In *Proceedings of the 2023 14th International Conference on E-Education, E-Business, E-Management and E-Learning*, 6–13. https://doi.org/https://doi.org/10.1145/3588243.358827

2.

Yip, Karen Hiu Tung, Patrick Lo, Kevin K W Ho, and Dickson K W Chiu. 2020. "Adoption of mobile library apps as learning tools in higher education: a tale between Hong Kong and Japan." *Online Information Review* 45 (2): 389–405. https://doi.org/https://doi.org/10.1108/OIR-07-2020-0287.

Zawacki-Richter, Olaf, Victoria I Marín, Melissa Bond, and Franziska Gouverneur. 2019. "Systematic review of research on artificial intelligence applications in higher education–where are the educators?" *International journal of educational technology in higher education* 16 (1): 1–27. https://doi.org/10.1186/s41239-019-0171-0.

Zhou, Weihua, and Nan Wang. 2024. "Intelligent Analysis Algorithm of Online Collaborative Learning Behavior of Chinese-Foreign Cooperative Students Combining Deep Learning and Transfer Learning." In *2024 International Conference on Telecommunications and Power Electronics (TELEPE)*, 32–36. IEEE. https://doi.org/https://doi.org/10.1109/TELEPE64216.2024.00012.