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DIGITAL LITERACY AND LEARNING ADAPTABILITY AMONG UNIVERSITY STUDENTS IN CHINA: A CONCEPTUAL REVIEW IN THE ERA OF DIGITAL EDUCATION TRANSFORMATION

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Abstract:

The rapid advancement of digital technologies has fundamentally transformed higher education, reshaping how students acquire knowledge, interact with learning resources, and engage in academic activities. As universities increasingly adopt technology-enhanced learning environments, students are expected to develop not only digital competencies but also the capacity to adapt effectively to continuous pedagogical and technological changes. Consequently, digital literacy and learning adaptability have emerged as two essential competencies for success in contemporary higher education. This conceptual paper examines the relationship between digital literacy and learning adaptability among university students in China. Drawing on the Digital Competence Framework for Citizens (DigComp 2.2), digital literacy is conceptualised as a multidimensional construct comprising five core domains: information and data literacy, digital communication and collaboration, digital content creation, digital safety, and digital problem-solving. Learning adaptability is defined as students' ability to adjust their cognitive, behavioural, emotional, motivational, and social responses to evolving learning environments and academic demands. The study employs a Narrative Literature Review (NLR) approach to synthesise and critically interpret existing literature related to both constructs. The thematic synthesis indicates that digital literacy serves as a foundational enabler of learning adaptability by enhancing students' ability to navigate digital environments, engage in self-directed learning, and respond effectively to technological and

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pedagogical changes. The review also identifies significant research gaps, particularly within the context of Chinese higher education, where empirical evidence on the relationship between digital literacy and learning adaptability remains limited. Overall, this paper contributes to the growing discourse on educational digital transformation by providing a conceptual framework that integrates digital competencies with adaptive learning capabilities. The proposed framework offers a theoretical foundation for future empirical research and highlights the importance of fostering both competencies to enhance student success and lifelong learning readiness in an increasingly digital educational landscape.

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Keyword:

Digital Literacy, Learning Adaptability, Digital Transformation, Higher Education, Digcomp 2.2, China

Introduction

The rapid advancement of digital technologies has fundamentally transformed educational systems worldwide, reshaping the ways in which knowledge is created, delivered, and acquired. In recent years, higher education institutions have increasingly integrated digital technologies into teaching and learning through learning management systems (LMS), online learning platforms, virtual collaboration tools, and artificial intelligence (AI)-enhanced educational applications (UNESCO, 2023). These developments have accelerated the shift from traditional face-to-face instruction towards more flexible, technology-enhanced learning models, including online, blended, and hybrid learning approaches.

The COVID-19 pandemic further accelerated this transformation by compelling universities worldwide to adopt digital learning systems within an unprecedentedly short period (OECD, 2023). As higher education continues to embrace digital transformation, students are expected not only to use digital technologies effectively but also to adapt to rapidly evolving learning environments characterised by continuous technological and pedagogical change. Consequently, digital literacy and learning adaptability have emerged as two fundamental competencies that underpin successful participation in digitally mediated higher education.

Digital literacy extends beyond the acquisition of basic technological skills. Rather, it encompasses a broad range of competencies, including the ability to access, evaluate, manage, and create digital information, communicate and collaborate effectively through digital technologies, ensure digital safety, and solve problems in technology-rich environments (Vuorikari et al., 2022). Students with well-developed digital literacy are better equipped to engage in self-directed learning, critically evaluate information, and utilise digital technologies to support academic achievement (Ng, 2021). These competencies have become increasingly

important as higher education places greater emphasis on independent learning, digital collaboration, and lifelong learning.

Alongside digital literacy, learning adaptability has become an equally important competency in contemporary higher education. Learning adaptability refers to students' ability to modify their cognitive, behavioural, emotional, motivational, and social responses in response to changing academic demands and learning environments (Martin et al., 2023). Students with strong adaptive capabilities are generally more resilient, flexible, and capable of responding effectively to new learning challenges, technological innovations, and evolving instructional approaches (Wang et al., 2024). In increasingly technology-enhanced educational environments, learning adaptability enables students to sustain academic engagement and perform effectively despite ongoing changes in learning contexts.

Within the Chinese higher education system, digital transformation has become a strategic national priority aligned with the country's broader digital economy agenda. Significant investments have been made to strengthen digital infrastructure, expand technology-enhanced learning, and cultivate digitally competent graduates capable of supporting national innovation and economic development (Li et al., 2022). Consequently, Chinese universities have increasingly adopted AI-supported learning systems, smart classrooms, and digital education platforms to improve teaching quality and learning outcomes. These developments have substantially altered students' learning experiences and increased the importance of both digital literacy and learning adaptability.

Despite growing scholarly interest in these two constructs, existing research has largely examined digital literacy and learning adaptability as separate areas of inquiry. Studies on digital literacy have primarily focused on digital competence development, technology adoption, and digital skills, whereas research on learning adaptability has generally emphasised self-regulated learning, academic resilience, and behavioural adjustment within changing learning environments. Consequently, limited attention has been given to understanding how digital literacy contributes to the development of learning adaptability, particularly within digitally transformed higher education settings.

This research gap is especially evident in the context of Chinese higher education, where rapid digital transformation continues to reshape teaching practices and student learning experiences. Although considerable investments have been made in educational digitalisation, empirical and conceptual evidence explaining how students' digital competencies facilitate adaptive learning remains relatively limited. A clearer understanding of this relationship is therefore needed to support both educational policy and institutional practices aimed at preparing students for increasingly complex digital learning environments.

Against this background, this conceptual paper examines the relationship between digital literacy and learning adaptability among university students in China. Specifically, the study aims to: (a) review contemporary literature on digital literacy and learning adaptability; (b) analyse the theoretical relationship between these two constructs; and (c) identify existing research gaps and propose directions for future empirical research within the context of ongoing digital transformation in higher education.

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Literature Review

Conceptualisation of Digital Literacy

Digital literacy has evolved considerably since its early introduction into educational discourse. Initially, the concept was largely associated with the technical ability to operate computers and access digital information (Bawden, 2001). Over time, however, advances in digital technologies and the increasing complexity of digital learning environments have broadened its scope. Contemporary scholars now conceptualise digital literacy as a multidimensional construct that encompasses not only technical proficiency, but also cognitive, social, ethical, and problem-solving competencies required for effective participation in digital environments (Falloon, 2020; Van Laar et al., 2020).

In contemporary educational contexts, digital literacy is widely recognised as a fundamental competency that supports lifelong learning, employability, and active participation in an increasingly digital society. According to UNESCO (2023), digital literacy enables individuals to access, evaluate, create, and communicate information responsibly while engaging effectively in digitally mediated environments. Similarly, Ng (2021) argues that digital literacy extends beyond technological proficiency to include critical thinking, effective communication, responsible digital citizenship, and the ability to apply digital technologies meaningfully in diverse learning contexts. Collectively, these perspectives highlight that digital literacy is not merely a set of technical skills but a comprehensive capability that underpins students' academic, personal, and professional development.

Among the most influential frameworks in contemporary digital literacy research is the Digital Competence Framework for Citizens (DigComp 2.2), developed by the European Commission (Vuorikari et al., 2022). The framework conceptualises digital literacy through five interrelated competency domains that collectively enable individuals to participate effectively, confidently, and responsibly in digital environments.

1) Information and Data Literacy
   Information and data literacy refers to the ability to search for, evaluate, organise, manage, and utilise digital information effectively (Vuorikari et al., 2022). This competency enables students to critically assess the credibility and relevance of digital information, distinguish reliable sources from misinformation, and make informed academic decisions based on evidence. As digital learning environments continue to expand, the ability to evaluate information critically has become increasingly important for supporting independent and self-regulated learning. Recent empirical studies indicate that students with higher levels of information and data literacy demonstrate stronger academic resilience, enhanced self-regulated learning, and greater resistance to misinformation in AI-enhanced educational environments (Chen, 2025; Frontiers Research, 2025). Likewise, evidence from Chinese higher education institutions suggests that this competency is positively associated with academic achievement and students' capacity to manage learning effectively during ongoing digital transformation (Zhou et al., 2025).

2) Digital Communication and Collaboration
   Digital communication and collaboration encompass the competencies required to interact, communicate, and collaborate effectively through digital technologies

(Vuorikari et al., 2022). As higher education increasingly adopts online, blended, and hybrid learning models, students are expected to participate actively in virtual discussions, collaborative projects, and online learning communities. Consequently, effective digital communication has become an essential component of successful learning experiences. Previous research demonstrates that students with stronger communication and collaboration competencies tend to exhibit higher levels of engagement, teamwork, and collaborative problem-solving in technology-enhanced learning environments (Martin et al., 2023). Furthermore, recent studies conducted in China indicate that digital communication competence significantly enhances student participation and interaction in AI-supported and hybrid learning settings, thereby contributing to more meaningful learning experiences (Xie et al., 2025).

3) Digital Content Creation

Digital content creation refers to the ability to develop, modify, integrate, and share digital content using a variety of technological tools and platforms (Vuorikari et al., 2022). Beyond technical production skills, this competency encourages students to become active contributors to knowledge construction rather than passive recipients of information. Through the creation of digital artefacts, students develop creativity, critical thinking, innovation, and independent learning skills that are increasingly valued in contemporary higher education. Consistent with this perspective, Ng (2021) emphasises that active engagement in digital content creation promotes higher-order thinking and deeper learning. More recent evidence further suggests that students with well-developed digital content creation competencies demonstrate greater creativity, stronger critical thinking abilities, and higher levels of innovation within digital learning environments (Zhang et al., 2025).

4) Digital Safety

Digital safety encompasses the knowledge, skills, and attitudes required to protect personal data, maintain cybersecurity, promote digital well-being, and engage ethically in digital environments (UNESCO, 2023). As students spend increasing amounts of time learning and interacting online, awareness of digital safety has become essential for safeguarding privacy, maintaining secure digital identities, and ensuring responsible technology use. Moreover, a sound understanding of digital safety contributes to students' confidence in navigating digital environments, enabling them to participate more actively in online learning while minimising risks associated with cyber threats, privacy breaches, and unethical digital practices.

5) Digital Problem-Solving

Digital problem-solving refers to the ability to identify technological challenges, evaluate alternative solutions, and apply appropriate digital tools to address academic and practical problems effectively (Vuorikari et al., 2022). This competency requires students to think critically, adapt to emerging technologies, and respond flexibly to unfamiliar digital situations. Consequently, digital problem-solving plays an important role in supporting students' capacity to cope with the rapidly evolving technological landscape of higher education. Recent evidence indicates that this competency is strongly associated with AI readiness, adaptive learning behaviours, and students' ability to respond effectively to technology-mediated learning challenges (Rodriguez-Alvarez et al., 2026).

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Taken together, the literature consistently demonstrates that digital literacy has evolved from a predominantly technical skill into a comprehensive academic competency that supports students' learning, adaptability, and long-term success. Recent global and China-based studies (2024–2026) further reinforce the view that digital literacy plays a pivotal role in enhancing self-regulated learning, academic resilience, and learning performance within digitally transformed higher education environments. Consequently, developing digital literacy should be regarded as a strategic priority for higher education institutions seeking to prepare students for lifelong learning and the demands of an increasingly digital society.

Learning Adaptability

Learning adaptability has emerged as a critical competency in contemporary higher education, particularly in response to the rapid expansion of digital learning environments and ongoing educational transformation. Broadly, learning adaptability refers to an individual's capacity to modify cognitive, behavioural, emotional, motivational, and social strategies in response to changing learning conditions and academic demands (Martin et al., 2023). Within digitally transformed educational settings, this competency enables students to respond effectively to evolving instructional approaches, technological innovations, and increasingly complex learning environments. The importance of learning adaptability became particularly evident during and after the COVID-19 pandemic, when higher education institutions worldwide rapidly transitioned from conventional face-to-face instruction to online and hybrid learning models (Broadbent & Poon, 2022). This unprecedented shift exposed considerable differences in students' ability to cope with uncertainty, regulate their own learning, and utilise digital technologies effectively. As a result, learning adaptability has become widely recognised as a key determinant of academic success, resilience, and sustained engagement in technology-enhanced learning environments.

From a theoretical perspective, learning adaptability is closely associated with self-regulated learning, which emphasises learners' active role in planning, monitoring, and evaluating their own learning processes. According to Zimmerman (2021), adaptable learners are capable of regulating their learning behaviours, modifying strategies, and maintaining academic engagement despite encountering challenges and changing circumstances. Similarly, Panadero (2021) argues that learning adaptability reflects learners' ability to continuously evaluate and adjust their cognitive and behavioural responses in accordance with environmental demands. These perspectives collectively suggest that adaptability is not a fixed personal characteristic but a dynamic capability that develops through continuous interaction with changing learning contexts.

Recent empirical evidence further reinforces this perspective by demonstrating that learning adaptability plays an important mediating role between digital literacy and academic performance in AI-enhanced and hybrid learning environments (Chen et al., 2025; OECD, 2025). In the context of Chinese higher education, studies indicate that students' adaptability is increasingly influenced by the widespread adoption of AI-supported learning systems and smart education platforms, both of which require continuous cognitive and behavioural adjustment to optimise learning outcomes (Lei & Jiang, 2025). Within higher education, learning adaptability can be understood through five interrelated dimensions that collectively enable students to thrive in dynamic educational environments.

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1) Cognitive Adaptability
Cognitive adaptability refers to students' ability to modify their thinking processes, learning strategies, and problem-solving approaches when confronted with unfamiliar academic situations or changing learning demands. Students who demonstrate high levels of cognitive adaptability are able to evaluate alternative learning strategies, integrate new knowledge, and select appropriate approaches according to specific learning tasks (Martin et al., 2023). In digitally mediated learning environments, this competency becomes particularly important because learners are frequently exposed to diverse instructional formats, multimedia resources, AI-generated feedback, and technology-enhanced learning activities. Consequently, cognitively adaptable students are generally better equipped to interpret new information, respond to instructional changes, and maintain effective learning performance. Recent studies further indicate that cognitive adaptability is strongly associated with AI-assisted learning, where students are required to continuously adjust their thinking strategies in response to algorithm-driven feedback and personalised learning pathways (Zhang et al., 2025).

2) Behavioural Adaptability
Behavioural adaptability refers to students' capacity to modify their learning behaviours, study habits, and learning management strategies in response to different educational contexts. This dimension encompasses time management, learning organisation, active participation, persistence, and the ability to maintain productive learning routines despite academic challenges (Zimmerman, 2021). As responsibility for learning increasingly shifts towards students in online and hybrid learning environments, behavioural adaptability has become essential for sustaining academic performance. Evidence suggests that students who effectively regulate their learning behaviours are more likely to succeed in technology-enhanced learning environments that require greater autonomy and self-management (Broadbent & Poon, 2022). Moreover, recent findings indicate that behavioural adaptability has become increasingly important in digitally mediated education, where students must independently manage learning schedules and academic responsibilities with limited direct supervision (OECD, 2025).

3) Emotional Adaptability
Emotional adaptability refers to students' ability to regulate their emotions effectively when responding to academic stress, uncertainty, technological challenges, and changing learning conditions. Students with strong emotional adaptability are generally able to maintain emotional stability, remain optimistic, and sustain academic engagement despite experiencing learning difficulties or technological disruptions (Martin et al., 2023). This competency has become increasingly important within digital learning environments, where students may encounter feelings of isolation, anxiety, cognitive overload, or frustration arising from unfamiliar technologies and remote learning experiences. Recent empirical evidence further highlights that emotional adaptability is particularly critical in AI-enhanced learning environments, where students are required to interpret automated feedback and respond constructively to technology-mediated learning processes (Chen et al., 2025).

4) Motivational Adaptability
Motivational adaptability refers to students' ability to sustain learning motivation, commitment, and goal orientation despite changing educational circumstances and

learning challenges. Learners who possess high levels of motivational adaptability remain actively engaged in academic activities and continue pursuing learning goals even when confronted with setbacks or disruptions (Panadero, 2021). This competency is particularly important in self-directed and technology-enhanced learning environments, where students are expected to maintain learning motivation independently without continuous guidance from instructors. Furthermore, recent studies suggest that motivational adaptability is a significant predictor of student persistence, academic engagement, and successful learning outcomes in blended and online higher education settings undergoing digital transformation (Xie et al., 2025).

5) Social and Collaborative Adaptability

Social and collaborative adaptability refers to students' ability to adjust their interpersonal communication, teamwork, and collaborative practices across diverse learning environments. As digital technologies increasingly facilitate interaction through online learning platforms, virtual classrooms, and collaborative digital tools, students are expected to communicate effectively, participate actively, and maintain meaningful relationships with peers and instructors despite physical separation (Broadbent & Poon, 2022). Accordingly, students with stronger social adaptability are generally more capable of collaborating within multicultural and technology-mediated learning communities. Recent studies conducted in China further indicate that collaborative adaptability is significantly strengthened through AI-supported learning platforms, where interaction and teamwork are increasingly facilitated by intelligent educational technologies (Zhou et al., 2025).

Taken together, the literature demonstrates that learning adaptability is a multidimensional and dynamic capability encompassing cognitive, behavioural, emotional, motivational, and social dimensions. Rather than representing an innate personal characteristic, adaptability develops through continuous interaction with changing educational contexts and learning experiences. As higher education continues to undergo rapid digital transformation, learning adaptability has become an indispensable competency that enables students to navigate technological change, sustain academic engagement, and achieve long-term success in increasingly complex digital learning environments.

Relationship Between Digital Literacy and Learning Adaptability

Growing interest in educational digital transformation has intensified scholarly attention towards understanding how digital literacy contributes to students' learning adaptability. Although these two constructs have frequently been investigated independently, an increasing body of literature suggests that they are conceptually and empirically interconnected. In digitally transformed higher education, digital literacy provides the foundational competencies that enable students to respond effectively to changing learning environments, while learning adaptability reflects their capacity to regulate and adjust their learning processes in response to evolving academic and technological demands (Ng, 2021; Zhao & Watterston, 2021).

From a theoretical perspective, the relationship between digital literacy and learning adaptability can be explained through the complementary roles of digital competence and self-regulated learning. The Digital Competence Framework for Citizens (DigComp 2.2) proposes that digitally competent individuals are able to access information, communicate effectively, solve problems, and use digital technologies responsibly to achieve personal, academic, and

professional goals (Vuorikari et al., 2022). These competencies closely align with the characteristics of adaptable learners, who continuously regulate their cognitive, behavioural, emotional, and motivational processes in response to changing learning contexts. Accordingly, students with stronger digital competencies are generally better positioned to navigate technological change, manage learning challenges, and sustain academic engagement within technology-enhanced learning environments.

Empirical evidence consistently supports this theoretical perspective. Van Laar et al. (2020), for example, reported that students possessing higher levels of digital competence demonstrated stronger self-regulated learning, critical thinking, and problem-solving abilities, all of which contribute significantly to adaptive learning behaviours. Similarly, Ng (2021) argues that digital literacy enhances students' confidence in using digital technologies, thereby increasing their willingness to explore new learning opportunities, experiment with innovative learning strategies, and engage more actively in independent learning. Collectively, these findings indicate that digital literacy extends beyond technological proficiency by fostering the competencies required for effective adaptation in contemporary educational environments.

More recent studies have further strengthened this relationship within the context of AI-enhanced and hybrid learning environments. Emerging evidence suggests that digital literacy significantly predicts students' learning adaptability through the development of self-regulated learning, cognitive flexibility, and technology-mediated problem-solving skills (Chen et al., 2025; Frontiers Research Group, 2025). Likewise, studies conducted in Chinese higher education institutions indicate that students with stronger digital competencies demonstrate greater adaptability when engaging with smart learning platforms and AI-assisted educational systems, both of which require continuous adjustment of learning strategies and behaviours (Zhou et al., 2025; Xie et al., 2025). These findings highlight the increasingly important role of digital literacy in supporting students' successful participation in digitally transformed higher education.

A closer examination of the DigComp 2.2 framework further illustrates how each dimension of digital literacy contributes to different aspects of learning adaptability. Information and data literacy strengthens cognitive adaptability by enabling students to evaluate digital resources critically, identify credible information, and modify learning strategies in response to changing academic requirements. As learners become more proficient in locating and interpreting relevant information, they are better equipped to make informed decisions and regulate their own learning processes. Similarly, digital communication and collaboration contribute to behavioural and social adaptability by facilitating meaningful interaction within virtual learning communities, collaborative projects, and online discussions. Through these experiences, students develop the interpersonal and collaborative competencies required to participate effectively across diverse digital learning environments. These competencies are particularly valuable in contemporary higher education, where collaboration increasingly occurs through technology-mediated platforms.

Beyond interpersonal interaction, digital content creation promotes behavioural adaptability by encouraging students to become active participants in knowledge construction. The process of designing, modifying, and sharing digital artefacts requires learners to exercise creativity, critical thinking, and independent decision-making, all of which strengthen their ability to respond flexibly to new academic challenges (Falloon, 2020). Consequently, students who regularly engage in digital content creation are more likely to demonstrate adaptive learning

behaviours across different educational contexts. In addition, digital safety contributes primarily to emotional adaptability. Students who understand cybersecurity principles, privacy protection, digital well-being, and ethical technology use generally experience greater confidence when participating in online learning environments. This confidence reduces anxiety associated with technology use and enables learners to engage more actively with digital platforms while managing potential technological risks responsibly.

Perhaps the most direct relationship exists between digital problem-solving and learning adaptability. Digital problem-solving requires students to identify challenges, evaluate alternative solutions, and implement appropriate digital strategies in response to unfamiliar situations. These processes closely mirror the adaptive behaviours expected of successful learners, particularly within AI-enhanced educational environments where continuous adjustment is required. Recent evidence further confirms that digital problem-solving competence is strongly associated with cognitive adaptability and students' readiness to respond effectively to dynamic learning pathways generated by intelligent educational systems (Rodriguez-Alvarez et al., 2026). Despite growing theoretical and empirical support for the relationship between digital literacy and learning adaptability, several important research gaps remain. Most existing studies have focused primarily on digital competence development, technology acceptance, or technology adoption, with comparatively limited attention given to the mechanisms through which digital literacy influences students' adaptive learning capacities. Consequently, the multidimensional relationship between these constructs remains insufficiently understood.

This limitation is particularly evident within Chinese higher education, where rapid digital transformation continues to reshape teaching practices, learning environments, and student experiences. Although universities have invested substantially in AI-supported learning systems, smart classrooms, and digital education initiatives, relatively little empirical research has examined how students' digital competencies facilitate adaptive learning in these increasingly complex educational contexts (OECD, 2025; Li et al., 2025). Addressing this gap is essential for strengthening both theoretical understanding and practical implementation of digital transformation strategies within higher education. Taken together, the reviewed literature consistently positions digital literacy as a foundational antecedent of learning adaptability. Rather than functioning as independent constructs, digital literacy and learning adaptability appear to operate in a complementary and mutually reinforcing manner, enabling students to navigate technological change, regulate their learning effectively, and respond successfully to evolving educational demands. Accordingly, examining the relationship between these constructs provides an important theoretical basis for understanding student learning within digitally transformed higher education and establishes a strong foundation for the conceptual framework proposed in the following section.

Proposed Conceptual Framework

Building upon the preceding literature review, this study proposes a conceptual framework that positions digital literacy as a key antecedent of learning adaptability among university students in China. The framework is developed on the premise that students' ability to adapt successfully to digitally transformed learning environments is strongly influenced by the extent of their digital competencies. As higher education increasingly integrates digital technologies into teaching and learning, students are expected not only to acquire digital knowledge and skills

but also to apply these competencies in responding effectively to evolving academic demands and technological innovations.

The proposed framework is primarily grounded in the Digital Competence Framework for Citizens (DigComp 2.2), which conceptualises digital literacy as a multidimensional construct comprising five interrelated competency domains: information and data literacy, digital communication and collaboration, digital content creation, digital safety, and digital problem-solving (Vuorikari et al., 2022). Collectively, these competencies provide a comprehensive foundation for understanding how students interact with digital technologies and participate effectively in contemporary higher education environments.

Beyond the DigComp 2.2 framework, the proposed conceptual model is further supported by Self-Regulated Learning (SRL) Theory (Zimmerman, 2002) and Constructivist Learning Theory. Self-Regulated Learning Theory explains how learners actively regulate their cognitive, behavioural, and motivational processes through planning, monitoring, and evaluating their learning activities in order to achieve academic goals. Meanwhile, Constructivist Learning Theory emphasises that knowledge is actively constructed through learners' interactions with their learning environment, digital resources, and social experiences. Together, these theoretical perspectives provide a robust foundation for explaining how digital literacy facilitates the development of learning adaptability within technology-enhanced educational contexts.

More specifically, each dimension of digital literacy is expected to contribute to different aspects of learning adaptability. Information and data literacy is anticipated to strengthen cognitive adaptability by enabling students to locate, evaluate, and synthesise digital information critically before making informed academic decisions. Students possessing this competency are therefore more capable of adjusting their learning strategies in response to changing educational requirements and increasingly complex information environments. Similarly, digital communication and collaboration are expected to enhance social and behavioural adaptability by supporting effective interaction, teamwork, and knowledge sharing within virtual learning communities. Through active participation in digitally mediated collaborative activities, students develop communication skills and collaborative practices that enable them to adapt more effectively to diverse instructional settings and technology-supported learning experiences.

Furthermore, digital content creation contributes to behavioural adaptability by encouraging learners to become active participants in knowledge construction rather than passive consumers of information. By designing, modifying, and sharing digital content, students strengthen their creativity, critical thinking, independent learning, and problem-solving abilities, all of which support more adaptive learning behaviours in dynamic educational environments (Falloon, 2020). Equally important, digital safety contributes to emotional adaptability by enhancing students' confidence in navigating digital learning environments securely and responsibly. Knowledge of cybersecurity, digital ethics, privacy protection, and digital well-being enables learners to minimise technological risks while maintaining positive attitudes towards online learning. Consequently, students are more likely to participate confidently in technology-enhanced educational activities despite encountering unfamiliar digital platforms or emerging technologies.

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Finally, digital problem-solving is expected to exert the strongest direct influence on overall learning adaptability. This competency requires students to identify technological challenges, evaluate alternative solutions, and implement appropriate digital strategies when confronted with unfamiliar learning situations. Such processes closely resemble the adaptive behaviours required for successful learning within AI-enhanced and digitally transformed educational environments, where learners must continuously adjust their approaches in response to changing technologies and instructional practices. In addition to these direct relationships, the proposed framework recognises educational digital transformation as the broader contextual environment within which digital literacy and learning adaptability interact. The widespread integration of artificial intelligence, smart learning platforms, learning analytics, and other digital technologies has fundamentally reshaped higher education, creating increasingly complex and technology-mediated learning environments. Consequently, students are required to continuously modify their cognitive, behavioural, emotional, and social responses in order to remain academically engaged and achieve successful learning outcomes (OECD, 2023; UNESCO, 2023).

Taken together, the proposed conceptual framework suggests that digital literacy influences learning adaptability through multiple and interconnected pathways rather than through a single linear relationship. Digital competencies enable students to regulate their learning processes, interact effectively with digital technologies, and respond adaptively to evolving educational contexts. By integrating DigComp 2.2 with Self-Regulated Learning Theory and Constructivist Learning Theory, the framework provides a comprehensive theoretical explanation of how digital literacy supports adaptive learning within digitally transformed higher education. Accordingly, it offers a solid conceptual foundation for future empirical studies examining the relationship between digital literacy and learning adaptability among university students in China. Figure 1 illustrates the proposed conceptual framework of the relationship between digital literacy and learning adaptability among university students in China.

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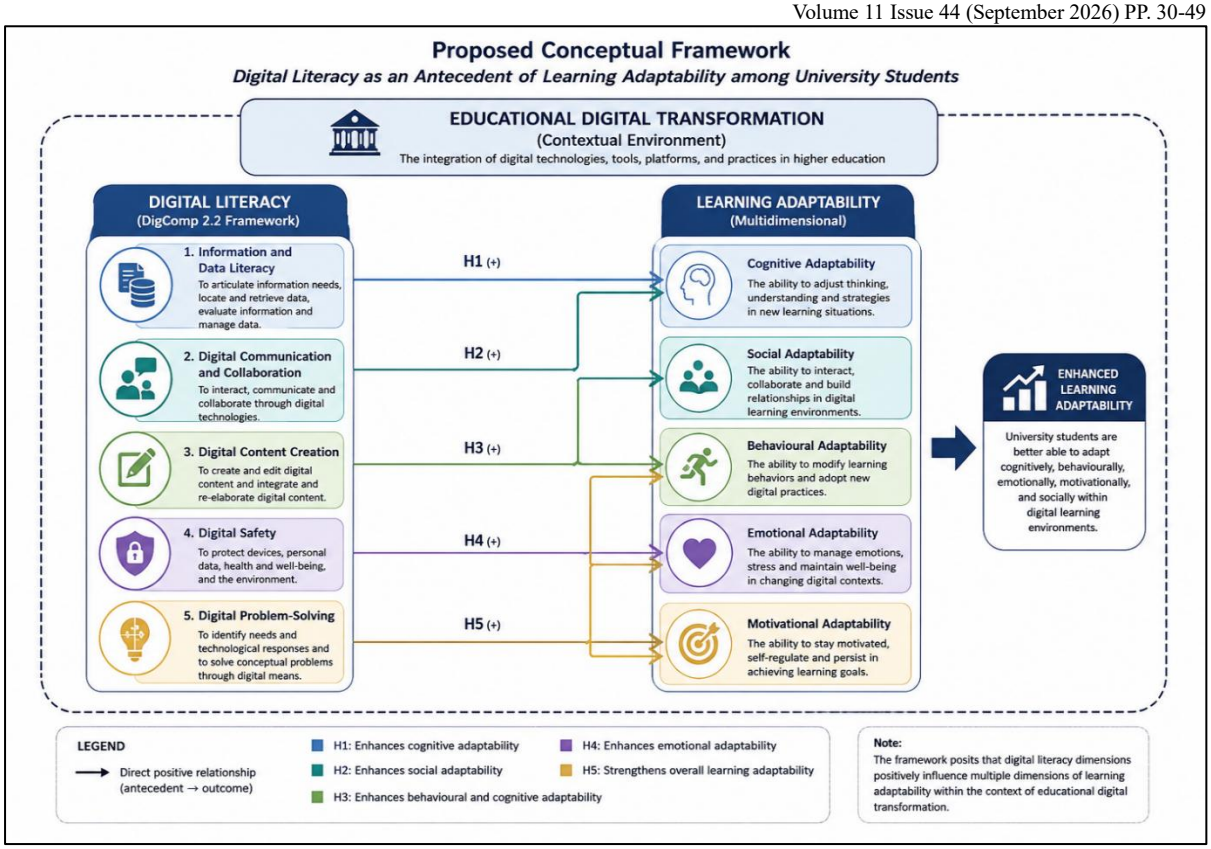

Figure 1: Proposed Conceptual Framework: Digital Literacy as an Antecedent of Learning Adaptability among University Students in the Context of Educational Digital Transformation

Discussion

The findings from the literature indicate that digital literacy is no longer merely a technical competency but rather a multidimensional capability that supports successful participation in contemporary educational environments. The expansion of digital technologies within higher education has significantly increased the importance of digital competencies as key determinants of students' learning experiences, engagement, and academic outcomes. Recent research further reinforces that digital literacy has become a core academic survival skill in AI-integrated and digitally enhanced higher education systems, where students are required to continuously interact with complex digital ecosystems (Chen, 2025; Yuan, Yu, & Liu, 2025). One significant finding emerging from the literature is that digital literacy contributes substantially to self-directed learning. Students possessing stronger digital competencies are generally more capable of identifying learning needs, accessing relevant resources, monitoring learning progress, and evaluating academic performance (Ng, 2021). These capabilities align closely with the characteristics of adaptable learners described by Zimmerman (2021) and Panadero (2021). This reflects the principles of self-regulated learning, where learners actively plan, monitor, and adjust their cognitive and behavioural strategies to achieve academic goals. Recent empirical studies also confirm that digital literacy is significantly associated with online self-regulated learning and academic achievement, where learning adaptation and self-regulation act as key mediating mechanisms (Chen, 2025; Supratman et al., 2025).

The literature also suggests that digital literacy strengthens students' resilience when confronted with educational challenges. Students who can effectively navigate digital technologies experience fewer difficulties adapting to new learning platforms, instructional approaches, and assessment methods. Consequently, digital literacy serves as an enabling factor that reduces barriers to learning adaptation. Recent empirical findings indicate that self-regulated learning strategies and digital competence significantly enhance students' ability to adapt within AI-supported and technology-rich learning environments (Liu, Xiao, & Li, 2025; Yang et al., 2025). Moreover, digital literacy supports lifelong learning by encouraging continuous engagement with emerging technologies and information resources. In an era characterized by rapid technological advancement, adaptability and continuous learning have become essential competencies for academic and professional success (Ng, 2021). This is increasingly relevant in digital higher education contexts where technological change occurs at a rapid and continuous pace, requiring students to constantly update their skills and learning strategies. Recent integrative studies highlight that AI literacy and self-regulated learning are increasingly interconnected, forming an integrated competency framework that supports lifelong learning in higher education (Gu & Ericson, 2025; Shi, Liu, & Hu, 2025).

The findings further highlight the importance of integrating digital literacy development into higher education curricula. Universities should move beyond isolated technology training and adopt comprehensive approaches that embed digital competencies across academic disciplines. Such strategies would not only improve students' digital literacy but also enhance their adaptive learning capacities. Recent studies indicate that structured integration of AI literacy, multimodal literacy, and self-regulated learning within curriculum design significantly improves students' digital competence and academic performance compared to standalone ICT instruction (Zhao, An, & Liu, 2025; Mejeh, Sarbach, & Hascher, 2024). The Chinese higher education sector is particularly well-positioned to benefit from such initiatives due to ongoing investments in educational digital transformation. However, the success of these initiatives depends largely on students' ability to utilize digital technologies effectively and adapt to evolving educational environments. In this context, recent studies suggest that the integration of AI-based learning systems in China has increased both the demand for and the importance of student adaptability, particularly in managing autonomous and technology-mediated learning processes (Chen, 2025; Long et al., 2025).

Implications

Theoretical Implications

This paper contributes to the growing body of knowledge on digital transformation in higher education by integrating two important constructs digital literacy and learning adaptability within a single conceptual framework. Although both concepts have been widely discussed in educational research, they have frequently been examined independently, resulting in limited understanding of their interrelationship, particularly in the context of Chinese higher education. The findings support the argument that digital literacy should not be viewed solely as a technological competency but rather as a multidimensional construct that influences broader educational outcomes. Consistent with DigComp 2.2 (Vuorikari et al., 2022), digital literacy encompasses cognitive, social, ethical, and problem-solving dimensions that contribute directly to students' adaptive learning capabilities.

The present review also extends self-regulated learning theory by highlighting the role of digital competencies in supporting students' capacity to manage learning processes effectively within technology-enhanced environments. Previous studies have emphasized motivational and cognitive factors as determinants of learning adaptability (Zimmerman, 2021; Panadero, 2021). However, recent empirical evidence further suggests that digital competence is a significant predictor of self-regulated learning behaviour in technology-rich and AI-supported learning environments (Broadbent & Poon, 2022; Chen, 2025). Furthermore, this study contributes to educational digital transformation literature by proposing a conceptual mechanism through which digital literacy influences students' ability to adapt to technological and pedagogical changes. The proposed framework may serve as a theoretical foundation for future empirical studies examining causal relationships between digital competencies and adaptive learning outcomes.

From a broader perspective, the study reinforces the notion that digital transformation in education should be understood as a human-centred process rather than merely a technological initiative. The effectiveness of digital transformation depends not only on technological infrastructure but also on students' capacities to engage with, adapt to, and benefit from digital learning environments.

Practical Implications

The findings have important implications for higher education institutions seeking to strengthen students' readiness for digitally transformed learning environments. First, universities should integrate digital literacy development systematically across academic programmes rather than limiting digital skills training to technology-related disciplines. Given the increasingly digital nature of contemporary learning environments, all students require competencies related to information management, digital communication, content creation, digital safety, and problem-solving. Second, curriculum designers should embed authentic digital learning experiences into teaching and learning activities. Project-based learning, collaborative online assignments, digital portfolio development, and technology-enhanced problem-solving activities can provide meaningful opportunities for students to develop both digital literacy and learning adaptability simultaneously (Ng, 2021; Redecker, 2017).

Third, academic staff should receive professional development opportunities that enable them to design adaptive learning environments. Research indicates that teaching approaches emphasizing flexibility, collaboration, and learner autonomy contribute significantly to students' adaptive capacities (Broadbent & Poon, 2022). Therefore, educators should move beyond content delivery models and adopt pedagogical approaches that encourage self-directed learning and critical engagement with digital technologies. Fourth, universities should establish support systems that facilitate students' transition into digitally mediated learning environments. Such support may include digital literacy workshops, online learning support centres, peer mentoring programmes, and technical assistance services. These initiatives can reduce barriers associated with technology adoption and strengthen students' confidence in digital learning contexts.

Finally, assessment practices should be aligned with the competencies required in digitally transformed education. Traditional examinations may not adequately capture students' abilities to collaborate, solve problems, create digital content, and adapt to changing learning environments. Alternative assessment approaches such as project-based assessment, digital

portfolios, reflective journals, and collaborative assignments may provide more comprehensive evaluations of students' competencies (Redecker, 2017; Chen, 2025).

Policy Implications

At the policy level, the findings highlight the importance of recognizing digital literacy as a strategic competency that supports national educational and economic development goals. In China, educational digital transformation has become a central component of national modernization strategies (Li et al., 2022). Significant investments have been directed towards expanding digital infrastructure, enhancing technology integration, and promoting digital innovation within higher education institutions. However, the success of these initiatives depends largely on students' abilities to utilize digital technologies effectively and adapt to rapidly changing educational environments. Policymakers should therefore consider digital literacy development as a fundamental component of higher education quality enhancement. National frameworks for higher education should incorporate digital literacy competencies as key graduate attributes, ensuring that students acquire the knowledge and skills necessary to participate successfully in digital society. Additionally, policy initiatives should address issues related to digital equity and accessibility. Despite substantial progress in digital infrastructure development, disparities in access to technology and digital learning opportunities continue to exist among students from different socio-economic backgrounds (van Dijk, 2020; Tan & Lu, 2023).

Educational policies should therefore promote equitable access to digital resources, high-speed internet connectivity, and technology-enhanced learning opportunities. Particular attention should be given to students from disadvantaged backgrounds who may face greater challenges in developing digital competencies. Furthermore, policymakers should encourage collaboration among universities, industry partners, and technology providers to ensure that digital literacy initiatives remain relevant to emerging technological developments and labour market demands. Such collaborations can facilitate the development of future-ready graduates capable of adapting to rapidly evolving professional environments. Ultimately, educational digital transformation should be accompanied by comprehensive human capacity development strategies that strengthen students' digital literacy and adaptive learning capabilities. Without such efforts, investments in technological infrastructure alone may be insufficient to achieve desired educational outcomes.

Conclusion

The rapid advancement of digital technologies has transformed higher education globally, creating new opportunities and challenges for students, educators, and institutions. As universities continue to embrace digital transformation initiatives, the development of competencies that support effective participation in digital learning environments has become increasingly important. This paper examined the conceptual relationship between digital literacy and learning adaptability among university students in China. Through a comprehensive review of contemporary literature, the study highlighted the multidimensional nature of digital literacy and its potential role in enhancing students' adaptive learning capacities. Drawing upon DigComp 2.2 (Vuorikari et al., 2022), digital literacy was conceptualized through five competency domains: information and data literacy, digital communication and collaboration, digital content creation, digital safety, and digital problem-solving. These competencies collectively enable students to engage effectively with digital

technologies, manage information critically, collaborate within virtual environments, and solve complex problems. Learning adaptability was conceptualized as students' ability to adjust cognitive, behavioural, emotional, motivational, and social processes in response to changing educational circumstances. The literature reviewed suggests that students possessing stronger digital competencies are generally better equipped to adapt to technology-enhanced learning environments, engage in self-directed learning, and respond effectively to technological and pedagogical changes.

The review also identified several important research gaps. Despite increasing scholarly interest in digital literacy and learning adaptability, empirical studies examining their relationship remain limited, particularly within the context of Chinese higher education. Existing research has tended to focus on digital competence development, technology adoption, or adaptive learning independently rather than exploring the interconnections among these constructs. The findings suggest that digital literacy should be regarded as a critical enabler of learning adaptability within digitally transformed educational environments. Consequently, efforts to strengthen students' adaptive capacities should be accompanied by comprehensive initiatives aimed at developing digital competencies across multiple dimensions. Future research should empirically test the proposed conceptual framework using quantitative and mixed-method approaches. Particular attention should be given to examining the influence of individual digital literacy dimensions on various aspects of learning adaptability. Such investigations would provide valuable insights into how digital competencies contribute to educational success within contemporary higher education systems. In conclusion, digital literacy and learning adaptability represent two interrelated competencies that are essential for student success in the twenty-first century. Strengthening these competencies will be crucial for supporting educational digital transformation and preparing future graduates for lifelong learning and participation in an increasingly digital society.

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