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Pathways, Challenges and Strategies for Enhancing Teachers' Digital Literacy in the Context of Educational Digitalisation

Mengqi Wang

Nanning Normal University, Nanning, Guangxi, China

Abstract: ***This study examines teacher digital literacy within the context of educational digitalisation. It first establishes that educational digitalisation represents an inevitable trend, with teacher digital literacy being pivotal to the success of this transformation, thereby underscoring the study's theoretical and practical significance. The paper then defines the concept of teacher digital literacy, elaborating on its framework through five dimensions: digital awareness, digital knowledge and skills, digital application, digital social responsibility, and professional development. It then discusses practical pathways for enhancing teachers' digital literacy, including establishing tiered and categorised training models, integrating and expanding training resources, and developing shared digital teaching resources. The paper also identifies challenges such as insufficient technological application capabilities and lagging educational philosophy updates. Consequently, it proposes enhancement strategies including self-directed learning and self-improvement, improving in-school training and incentive mechanisms, regional resource sharing and collaborative development, and government policy guidance and financial support.***

Keywords: Educational digitalisation, Teacher digital literacy, Teacher professional development**.**

1. Introduction

In the contemporary era, the rapid advancement of information technology is profoundly transforming every sphere of society, with the educational domain being no exception. The digitalisation of education has become an irreversible trend. The widespread application of emerging technologies such as big data, cloud computing, and artificial intelligence within education has brought about significant transformations in the acquisition of educational resources, the presentation of teaching methods, and the models of educational management. From the advancement of national digital education strategies to the establishment of various smart education platforms, digitalisation offers new opportunities and pathways to achieve educational equity and enhance teaching quality. As the primary implementers of educational activities, teachers' digital literacy levels directly impact the effectiveness of digital transformation in education. Within the digital educational environment, teachers must not only possess traditional teaching competencies but also master digital technologies. They should be able to utilise digital resources for instruction, engage in digital communication and interaction with students, and provide effective guidance and assessment for students' digital learning. However, the current state of teachers' digital literacy is uneven, with some educators still exhibiting significant shortcomings in applying digital technologies. This, to a certain extent, constrains the deeper development of educational digitalisation.

Consequently, researching the enhancement of teachers' digital literacy within the context of educational digitalisation holds significant theoretical and practical importance. Theoretically, it contributes to enriching and refining related theoretical frameworks such as educational technology and teacher professional development. It facilitates in-depth exploration of the connotations, constituent elements, and developmental patterns of digital literacy within the educational sphere, thereby providing a theoretical foundation for subsequent research. Practically, it offers valuable reference and guidance for teacher training, educational policy formulation, and school-based teaching reforms. This empowers teachers to better adapt to the demands of educational digitalisation, enhance teaching quality, promote students' holistic development, and ultimately advance the progress of the entire educational sector.

2. Analysis of the Connotation and Dimensions of Teacher Digital Literacy

2.1 The Essence of Teacher Digital Literacy

The term "digital literacy" was first coined in the 1990s. British scholar Paul Gilster, in his publication Digital Literacy, defined it as the fundamental ability to acquire and comprehend digital information through technologies such as online searching and digital information integration, contrasting it with traditional print literacy [1]. However, the terminology surrounding digital literacy remains inconsistent across academic literature and national policy documents, encompassing concepts such as digital skills, digital competence, and digital capability. This paper treats all these concepts as falling within the scope of this research and collectively refers to them as digital literacy. Teacher digital literacy denotes the awareness, capabilities, and responsibilities that enable educators, within the context of educational digitisation, to appropriately utilise digital technologies for acquiring, processing, employing, managing, and evaluating digital information and resources. This encompasses identifying, analysing, and resolving educational challenges, as well as optimising, innovating, and transforming teaching practices. It constitutes an essential competency for educators in the digital age, reflecting not only their mastery of digital technologies but also their capacity to integrate these technologies deeply into teaching and learning. Furthermore, it embodies the comprehensive competence required to guide student development and fulfil

educational responsibilities within a digital environment.

2.2 Five Dimensions of Teacher Digital Literacy

Referencing the Ministry of Education's published standard "Teacher Digital Literacy", the framework for teacher digital literacy may be defined across five interconnected dimensions: digital awareness, digital technology knowledge and skills, digital application, digital social responsibility, and professional development. These dimensions mutually influence one another, collectively forming the overarching structure of teacher digital literacy [2].

2.2.1 Digital Awareness

As the foundational dimension of teacher digital literacy, digital awareness refers to educators' acute perception and profound understanding of the widespread application of digital technologies in education. It provides the ideological foundation and directional guidance for teachers to conduct educational activities in the digital age. Educators possessing strong digital awareness proactively monitor developments in digital technologies, keenly identify their potential applications in teaching and learning, and demonstrate willingness to integrate these technologies into their pedagogical practice, thereby serving as a driving force for instructional innovation.

2.2.2 Digital Technology Knowledge and Skills

Only by possessing solid digital technology knowledge and skills can teachers effectively apply digital tools in teaching practice, achieving deep integration between technology and education. Proficiency in operating online teaching platforms enables teachers to seamlessly conduct virtual instruction during pandemics, ensuring uninterrupted curriculum progression. Mastery of multimedia processing technologies empowers educators to create visually compelling teaching materials, enriching content presentation and enhancing instructional engagement. Understanding the functionalities and application scenarios of AI teaching assistants allows teachers to leverage intelligent teaching processes—such as automated assignment marking and personalised learning recommendations—thereby elevating teaching efficiency and quality.

2.2.3 Digital Application

Digital application constitutes the core practical dimension of teachers' digital literacy, reflecting their capacity to translate digital knowledge and skills into tangible pedagogical actions. This permeates the entire educational process—from instructional design and delivery to assessment and collaborative teaching—directly influencing teaching effectiveness and optimising student learning experiences.

During instructional design, educators utilise digital tools for learner profiling. Through online surveys and learning analytics platforms, they gather student data to precisely identify learning starting points, interests, and learning styles. This enables the formulation of more personalised, targeted teaching objectives and plans, aligning content and activities with students' actual needs to enhance precision and effectiveness.

During implementation, educators employ diverse digital pedagogical approaches such as flipped classrooms and blended learning. By fully leveraging digital technology's advantages, they transcend temporal and spatial constraints to create more autonomous and flexible learning environments, thereby stimulating students' motivation and initiative. Teachers may utilise online platforms to distribute pre-class preparation tasks and learning resources, facilitating independent study prior to lessons. During class sessions, teachers organise group discussions and project-based activities, guiding students to apply acquired knowledge to real-world problem-solving, thereby cultivating innovative thinking and practical skills.

Regarding academic assessment, teachers utilise learning management systems and online testing platforms to implement diversified, formative evaluations of both the learning process and outcomes. By analysing student behaviour data from online learning platforms—such as study duration, discussion participation, assignment submissions, and test scores—teachers gain comprehensive, objective insights into learning attitudes, processes, and outcomes. This enables timely identification of challenges faced by students, allowing for targeted feedback and guidance to drive learning improvement and development.

Furthermore, the role of digital applications in education extends to enabling teachers to advance collaborative educational practices through digital technology. This strengthens communication and cooperation with parents, peers, and societal educational resources, collectively supporting students' holistic development. For instance, educators can establish robust communication channels with parents through online platforms, promptly sharing academic progress and jointly exploring educational strategies. Active participation in virtual professional development activities enables teachers to exchange pedagogical insights and resources with peers, collaboratively seeking solutions to teaching challenges and elevating overall educational standards.

2.2.4 Digital Social Responsibility

Digital social responsibility constitutes a crucial dimension of teachers' digital literacy, emphasising ethical conduct and behavioural standards in digital activities, alongside their responsibility for cultivating students' digital literacy and safeguarding their digital security [3]. With the widespread adoption of digital technologies, students face numerous risks and challenges in the digital environment, such as cyberbullying, information leaks, and the dissemination of harmful content. As guides for students' development, teachers bear the responsibility to steer pupils towards sound digital values, cultivate their awareness of digital safety and online ethical standards, and ensure their healthy and secure growth within the digital realm.

Teachers may employ methods such as themed class meetings and specialised lectures to impart cybersecurity knowledge, including safeguarding personal privacy, recognising online scams, and preventing internet addiction. They should guide

pupils to critically evaluate online information, avoiding blind acceptance or dissemination of unverified content. Educate pupils to adhere to online ethical standards, respect others' intellectual property rights, and refrain from online plagiarism or intellectual theft; encourage active participation in digital public welfare initiatives, using digital technology to disseminate positive values, thereby cultivating social responsibility and civic awareness.

2.2.5 Professional Development

Digital literacy has become an essential competency for every citizen in the digital society. Focusing on the educational sphere, the digital transformation of education relies on individuals possessing digital literacy, particularly educators equipped with the capability structure necessary to adapt to the evolving digital society [4]. Professional development serves as the sustained driving force for teachers' digital literacy, reflecting their awareness and actions to continually enhance their professional standards and pedagogical capabilities in the digital age. In other words, the digital transformation of education necessitates that teachers possess a corresponding capability structure. The rapid advancement of digital technologies provides teachers with abundant resources and accessible pathways for professional development. Educators should fully leverage these resources and avenues to continually update their pedagogical philosophies, enhance their digital literacy and professional competencies, thereby achieving their own professional growth and development.

These five dimensions are intrinsically interconnected, forming an organic whole. The awakening of digital awareness prompts teachers to proactively acquire digital knowledge and skills, while the enhancement of these competencies provides a solid foundation for digital application. The practice of digital application requires teachers to focus on fulfilling digital social responsibilities. Simultaneously, through the process of digital application and fulfilling these responsibilities, teachers continually identify their own professional development needs. This, in turn, drives further enhancement of digital literacy through professional development, thereby advancing the quality of teaching and learning and their own career progression. Together, these factors promote the continuous improvement of teachers' digital literacy and the digital transformation of education and teaching.

3. Practical Pathways for Enhancing Teachers' Digital Literacy

3.1 Establishing a Tiered and Categorised Training Model

Given variations in teachers' years of service and digital technology foundations, establishing a tiered and categorised training model is imperative. For newly recruited teachers, who typically possess enthusiasm for educational work but may lack proficiency in digital technology applications, training should prioritise foundational skills. This includes basic computer operating system operations, proficient use of common office software (such as Word, Excel, PowerPoint), and methods for operating teaching equipment (such as multimedia projectors and interactive whiteboards). This facilitates rapid adaptation to digital teaching environments and mastery of essential instructional tools. Established teachers with considerable experience possess substantial pedagogical expertise but may require further development in the deep integration of digital technology with teaching. For them, training should emphasise innovative applications of digital teaching methods, such as designing and implementing flipped classrooms and blended learning models; utilising digital technology for precision teaching by collecting and analysing student learning data through learning management systems and online assessment platforms to provide targeted guidance and evaluation; and employing emerging technologies like virtual reality (VR) and augmented reality (AR) to create immersive teaching scenarios that enhance learning outcomes.

3.2 Integration and Expansion of Training Resources

To deliver high-quality teacher training, it is necessary to integrate diverse training resources and establish a comprehensive, multi-tiered training resource system. Develop smart teacher training classrooms. Leveraging technologies such as the Internet of Things, sensor technology, and artificial intelligence, construct smart training classrooms that integrate intelligent hardware devices, smart teaching software systems, AI-powered classroom teaching analysis systems, and intelligent teaching assistants to support teachers' routine practical training. Regarding online resources, fully leverage renowned domestic and international university and educational institution platforms such as Coursera, EdX, and China MOOC. These platforms host extensive courses on educational technology and digital literacy, spanning fundamental theoretical knowledge to practical application skills. Teachers may independently select courses according to their needs and schedules, enabling personalised learning pathways.

3.3 Development and Sharing of Digital Teaching Resources

Teachers' active participation in developing and sharing digital teaching resources not only enhances their own digital literacy but also promotes equitable development of educational resources. Digital course resources should not only support teachers in delivering digital curriculum instruction but also offer a wide range of online elective courses for students' personalised learning. Institutions should establish mechanisms for jointly building and sharing course resources to avoid redundant and low-level development. Existing high-quality resources can be appropriately adapted and incorporated into resource repositories [7].

4. Challenges Faced in Enhancing Teachers' Digital Literacy

4.1 Insufficient Technical Application Skills

Some teachers demonstrate limited familiarity with the functionalities of online teaching platforms when conducting live lectures. They may struggle with basic operations such as muting, activating interactive panels, or screen sharing, leading to disorderly classrooms, excessive noise, and

students' inability to focus on learning content. When using courseware creation software, they often fail to proficiently utilise features like animation effects and hyperlinks, resulting in monotonous and rigid courseware that fails to capture students' attention or stimulate their interest in learning. These issues not only reflect shortcomings in teachers' software operation skills but also highlight the urgency of enhancing their digital technology application capabilities. Moreover, teachers' psychological attitudes towards digital technology directly influence the formation and development of their digital literacy [8]. With the rapid advancement of technology, the education sector continually witnesses the emergence of novel technologies such as blockchain, virtual reality (VR), and augmented reality (AR), presenting fresh opportunities and transformative potential for teaching and learning. However, many educators lag behind in adopting these new technologies, lacking sufficient understanding and practical experience. Regarding virtual reality and augmented reality technologies, while these can create immersive learning experiences for students, rendering abstract knowledge more intuitive and vivid, their application in classroom teaching remains severely limited. This is due to teachers' unfamiliarity with these technologies and insufficient investment by schools in relevant equipment and resources. Consequently, students cannot fully benefit from the high-quality learning experiences these technologies offer, and teachers struggle to leverage them to innovate teaching methods and models, thereby enhancing teaching quality.

4.2 Lagging Renewal of Educational Philosophy

Amidst the wave of educational digitisation, some teachers remain constrained by traditional pedagogical mindsets. They over-rely on conventional lecture-based methods, overlooking the advantages of digital technology in stimulating student interest and fostering independent learning abilities. In certain classrooms, teachers persist as mere knowledge disseminators, with lessons dominated by teacher-led explanations. Students remain passive recipients of information, resulting in a stifled classroom atmosphere and low learning motivation. Take secondary school history lessons as an example: when explaining historical events, some teachers merely recite textbook content verbatim, rarely employing digital tools (such as historical documentaries or virtual historical reenactments) to enrich teaching content and allow students to more vividly experience historical contexts and events. This traditional teaching approach struggles to meet students' diverse learning needs, hinders their deep understanding and mastery of knowledge, and fails to cultivate critical thinking and innovative abilities. It runs counter to the student-centred philosophy of educational digitalisation, which advocates developing students' comprehensive competencies.

4.3 Misconceptions Regarding the Value of Digital Literacy Education

Some educators harbour misconceptions about the value of digital literacy education, viewing digital technology merely as an auxiliary teaching tool for presenting courseware or assigning homework. They fail to fully recognise the importance of digital literacy for students' holistic development. They fail to realise that digital literacy not only enhances knowledge acquisition but also cultivates students' abilities to filter, analyse, and synthesise information, alongside fostering communication, collaboration, and innovation skills within digital environments. Therefore, in the face of complex and evolving "intelligent + education" environments, it is essential to establish a digital diagnostic mechanism that meets teachers' instructional and research needs, thereby transforming perceptions of their role and value. Opinions and ideas should be gathered through questionnaires and interviews, with corresponding intervention and evaluation mechanisms put in place [9]. Schools should pay close attention to teachers' digital diagnostic reports and monitor the entire diagnostic process to ensure its practical effectiveness, making adjustments and optimisations based on evaluation outcomes.

4.4 Inadequate Support and Safeguard Systems

At the institutional level, insufficient and ageing digital equipment remains prevalent, severely hindering the enhancement of teachers' digital literacy. Many institutions possess limited multimedia classrooms, failing to meet teachers' daily instructional needs and imposing time and space constraints on digital teaching delivery. Some schools operate computers with low specifications and sluggish performance, frequently experiencing lag, crashes, or system freezes when running complex teaching software or handling large digital resources, thereby disrupting teaching flow and efficiency. Limited training funding constitutes another significant challenge. Insufficient funding for teacher training means educators have fewer opportunities to participate in high-quality courses and activities. Some institutions cannot afford to invite specialist educational technology experts for in-school training, nor can they support teachers attending external academic conferences, workshops, or other professional development events. Consequently, teachers struggle to access the latest digital education concepts, technologies, and methodologies, leading to slow knowledge renewal and hindering effective improvement in digital literacy. Inadequate incentive mechanisms similarly dampen teachers' motivation to enhance digital literacy. Schools lack clear assessment criteria and reward systems for teachers' digital literacy development, leaving educators with insufficient motivation and reward expectations when investing time and effort into learning digital technologies and implementing digital teaching practices. In areas such as professional title evaluations and performance appraisals, achievements related to digital literacy receive limited recognition. Teachers' efforts in developing digital teaching resources, constructing online courses, and innovating teaching applications often fail to gain commensurate acknowledgement, which to some extent dampens their enthusiasm and initiative for enhancing digital literacy.

4.5 Regional Disparities in Educational Informatisation

Regional disparities in educational informatisation development present another challenge for enhancing teachers' digital literacy. A pronounced digital divide exists between urban and rural areas. Urban schools generally possess more robust digital infrastructure, featuring high-bandwidth, stable networks that facilitate seamless online teaching and learning environments for both staff and

pupils. Conversely, rural schools often grapple with inadequate network coverage, slow internet speeds, and unstable connections. These challenges significantly impede rural teachers' access to digital teaching resources and their ability to conduct online teaching activities, severely constraining the development of their digital literacy and the implementation of digital teaching practices. Schools across different regions also exhibit substantial disparities in accessing digital resources and technical support. Institutions in economically developed areas typically gain greater access to high-quality digital teaching materials, such as supplementary digital textbooks, extensive online course libraries, and specialised subject-specific teaching software. They also benefit from timely support and maintenance by professional technical teams, ensuring the smooth operation of digital teaching equipment and platforms. Schools in economically underdeveloped regions, however, face relative scarcity of digital resources with limited access channels. They lack professional technicians for equipment maintenance and technical guidance, making it difficult for teachers to resolve issues promptly when using digital technologies. This impedes teachers' application and exploration of digital technologies, thereby hindering the improvement of their digital literacy. Such regional imbalances result in significant disparities in teachers' digital literacy development across different areas, undermining the realisation of educational equity and the overall advancement of educational digitalisation.

5. Strategies for Enhancing Teachers' Digital Literacy

5.1 Self-directed Learning and Personal Development

Teachers should embrace the concept of lifelong learning and proactively enhance their digital literacy. Developing personal digital literacy improvement plans is crucial. Teachers must not only master various educational technologies—including online teaching platforms, interactive software, virtual reality devices, and artificial intelligence tools—but also comprehend their underlying principles, functions, and internal mechanisms. This ensures alignment between teaching objectives, student needs, and instructional tools [10]. For instance, educators could set monthly learning targets such as mastering a new teaching application—like Geometer's Sketchpad for mathematics instruction or the Baici Zhan app for English teaching. To achieve this, teachers may allocate specific weekly time slots for online coursework, such as utilising relevant modules on platforms like China MOOC, to deepen their understanding of the software's functionalities and operational techniques. Concurrently, monthly participation in technical exchange events organised by educational technology institutions or schools allows for peer-to-peer sharing of experiences and insights, acquiring additional application techniques and practical case studies. This approach continuously enriches their digital knowledge and skill reserves, progressively elevating their digital literacy.

5.2 Enhancing In-School Training and Incentive Mechanisms

Schools should establish a regularised in-school training system, periodically organising teachers to participate in digital literacy training courses and workshops. For instance, schedule one centralised training session monthly, each focusing on a specific digital technology theme such as advanced applications of online teaching platforms or innovative uses of educational apps. Invite educational technology specialists or experienced teachers to deliver instruction and share expertise. Concurrently, conduct weekly online learning exchange activities via the institution's internal network learning platform to share the latest digital education updates, teaching case studies, and technical techniques, thereby fostering mutual learning and exchange among teaching staff.

5.3 Regional Resource Sharing and Collaborative Development

Currently, the educational sector faces significant imbalances and inadequacies in the allocation of digital resources. Notable disparities exist in resource distribution between urban and rural areas, across different regions, and among individual schools. In underdeveloped regions and schools with relatively weaker foundations, the provision of digital educational resources is markedly insufficient, struggling to meet actual teaching demands [11]. Implementing urban-rural teacher pairing initiatives for digital literacy support also constitutes an effective measure. In an educational poverty alleviation project in a certain province, key urban schools formed partnerships with remote rural schools. Each urban school selected several core teachers with high digital literacy to pair one-to-one with rural teachers. Mentor teachers regularly visited rural schools to provide on-site guidance, assisting rural colleagues in resolving practical challenges encountered in digital teaching, such as software operation difficulties and instructional platform usage techniques. Concurrently, through online communication platforms, they offered remote guidance and support to rural teachers at any time, sharing teaching resources and insights on digital technology applications. This approach accelerated the enhancement of rural teachers' digital literacy, gradually narrowing the digital competence gap between urban and rural educators and promoting balanced regional educational development.

5.4 Government Policy Guidance and Financial Support

Governments should play a pivotal role in guiding and supporting the enhancement of teachers' digital literacy. This involves implementing specialised policies and increasing financial investment to provide robust safeguards for this development. For instance, a municipal government issued the Implementation Opinions on Enhancing Teachers' Digital Literacy, explicitly incorporating digital literacy into the teacher professional development assessment system. It requires schools at all levels to formulate digital literacy enhancement plans and conduct regular assessments, linking outcomes to professional title evaluations and commendations to incentivise teachers to proactively improve their digital capabilities.

6. Conclusion

Although this study has explored pathways, challenges, and

strategies for enhancing teacher digital literacy within the context of educational digitisation in considerable depth, the research domain remains expansive, with numerous avenues warranting further investigation. The divergence and convergence of teacher digital literacy across diverse cultural contexts also presents a challenging and innovative research direction. As globalisation advances and educational exchanges intensify, educational cultures across nations and regions increasingly influence and learn from one another. Future research may focus on the characteristics, developmental patterns, and opportunities and challenges faced by teachers' digital literacy in diverse cultural contexts. It could explore how to promote the exchange and integration of teachers' digital literacy within multicultural settings, thereby advancing the collaborative development of global educational digitalisation. For instance, comparative studies could examine teachers' acceptance levels, application methods, and value perceptions of digital technologies across cultural traditions, analysing the mechanisms through which cultural factors influence the development of teachers' digital literacy. Concurrently, research could explore how to draw upon successful experiences and advanced practices in enhancing teachers' digital literacy from other countries and regions during cross-cultural exchanges. By integrating local cultural characteristics, this would facilitate the exploration of pathways and strategies tailored to domestic teachers, thereby promoting mutual learning and shared prosperity in educational cultures.

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