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Research on the Pathways to Enhance Digital Literacy Skills of Teachers at Regional Applied Research Universities in the Context of Educational Digitalization

Caozheng Yan*, Ziyang Mao, Haoxuan Li, Wanling Chen, Ziqi Chen

Hubei University of Automotive Technology, Shiyan 442002, Hubei, China

caozheng3101@outlook.com

**corresponding author*

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Abstract: This study, grounded in Activity Theory, delves into the interactions and potential conflicts among various elements of digital literacy skills of teachers at regional applied research universities amid the educational digital transformation wave. Through literature review and field analysis, an indicator system for influencing factors in building digital literacy skills for these teachers is proposed. The aim is to explore new pathways for enhancing digital literacy skills of teachers at applied universities in the context of educational digitalization, providing innovative strategies and case references to address such challenges.

1. Introduction

In the 21st century, digital transformation has become the driving force behind educational innovation. National policy documents, such as "China Education Modernization 2035," explicitly call for the active promotion of educational informatization, aiming to build a networked, digitalized, personalized, and lifelong education system. With the continuous advancement of information technology, educational digitalization has not only transformed the acquisition and utilization of teaching resources but also reshaped the interaction between teachers and students. In this transformation, teachers' digital literacy is crucial, directly impacting the effective use of digital teaching resources and the improvement of teaching quality.

Particularly in regional applied research universities, the unique educational positioning and talent cultivation goals impose specific and unique requirements on teachers' digital literacy. The "Opinions of the Ministry of Education on Promoting the Connotative Development of Higher Education" emphasizes that university teachers must proactively adapt to new trends in informatized and intelligent education and enhance their information technology application

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capabilities. However, research on the digital literacy of teachers at regional applied research universities is relatively insufficient, and discussions on evaluation systems and enhancement pathways remain a novel topic in the educational field.

Facing the global trend of educational digital transformation, constructing a scientific and rational evaluation system for teachers' digital literacy, identifying and addressing the gaps in teachers' digital teaching capabilities, and effectively enhancing these capabilities through professional development and training are of significant importance for the sustainable development of higher education. This study aims to explore the evaluation standards and enhancement pathways for teachers' digital literacy at regional applied research universities in the context of educational digitalization, supporting the achievement of national education modernization goals. The research will first review the current state of research on evaluating teachers' digital literacy, analyzing existing issues and shortcomings. Through a review of existing literature, it is evident that while the importance of teachers' digital literacy is widely recognized, systematic research and practical guidance on how to evaluate and enhance this literacy, especially in specific types of university environments, are still lacking. Moreover, the unique characteristics of regional applied research universities in terms of educational positioning, talent cultivation types, and professional requirements for teachers make their digital literacy requirements and evaluation indicators incomparable to other types of universities.

Therefore, this study will investigate how to develop a diversified, data-driven evaluation indicator system for teachers' digital literacy, tailored to the characteristics of regional applied research universities. Additionally, it will propose realistic pathways for cultivating and enhancing digital literacy among teachers at these universities. Through this research, we aim to provide practical recommendations for improving digital literacy among teachers at regional applied research universities and contribute to the digital transformation of education.

2. Current Research Status and Problem Analysis of Teacher Digital Literacy Assessment

The wave of educational digitalization has propelled the evaluation of teachers' digital literacy to the forefront of educational research. Teachers' digital literacy is not only the cornerstone of their professional growth but also crucial for enhancing teaching quality and students' digital capabilities. However, the existing evaluation systems exhibit a disconnect between theory and practice. This issue is especially pronounced in the specific educational environment of regional applied research universities.

2.1 Practical Challenges and Development Needs for Teacher Digital Literacy Assessment

Numerous international organizations have established frameworks for digital literacy. Standards and dimensions for measuring digital literacy have been successfully defined by researchers through empirical studies. These frameworks have been widely applied and recognized in various fields, such as library management and teacher training, playing a crucial role in enhancing digital literacy levels.

In 2006, Polish scholar Allan Martin categorized digital literacy into three core dimensions: digital competence, which involves the basic skills in using digital tools and technologies; digital usage, which refers to how individuals integrate digital technologies into their daily lives; and digital transformation, which involves adapting to and innovating with digital technologies and applying them in new contexts [1]. In his research, Punie proposed that digital literacy indicators should include five key elements: information, communication, safety, problem-solving, and creativity. These indicators provide essential references for assessing and improving individuals'

comprehensive qualities in the digital age [2]. The specific research findings are shown in Table 1.

Table 1. Research on Dimensions and Indicators of Digital Literacy

Author	Year	Dimensions/Indicators
American Library Association [3](ALA)	2011	Possess the technical and cognitive skills to discover, understand, evaluate, create, and communicate various digital information: effectively use different technologies to retrieve information, interpret results, and judge the quality of information; understand the relationship between technology, lifelong learning, personal privacy, and information management; use technology to communicate and collaborate with colleagues, family, and the public; use these skills to actively participate in civic activities and contribute to the community.
European Commission (EU)	2013	Information domain, communication domain, content creation domain, safety awareness domain, problem-solving domain.
Joint Information Systems Committee[4] (JISC)	2015	Information, data, and media literacy, digital creation, problem solving and innovation, digital communication, collaboration and participation: digital learning and development, ICT literacy, digital identity and well-being, general literacy, innovation literacy, interdisciplinary literacy.
New Media Consortium[5] (NMC)	2016	General Literacy: Innovation Literacy: Interdisciplinary Literacy

Existing Evaluation Systems Face Numerous Challenges in Practical Application.Firstly, the evaluation indicators are often overly focused on technical operational skills, neglecting the importance of information ethics, data literacy, and instructional design for teachers [6][7]. Secondly, the evaluation systems lack relevance to teaching outcomes, failing to adequately reflect the impact of teachers' digital literacy on teaching improvement and student learning effectiveness [8]. Additionally, the specific characteristics of regional applied research universities in terms of resource allocation, teaching needs, and technological development necessitate corresponding adjustments and optimizations in the evaluation systems [9][10].

To address the digital transformation of education, the evaluation systems for teachers' digital literacy need to meet new development requirements. This includes the assessment of teachers' lifelong learning abilities and the close integration of evaluation results with teachers' professional development, forming an effective feedback and improvement mechanism [11]. Constructing a scientific, reasonable, highly adaptive, and comprehensive evaluation system that covers the multidimensional structure of teachers' digital literacy is crucial for promoting teachers' professional development and enhancing teaching quality.

2.2 Unique Challenges Faced by Regional Applied Research Universities in Digital Transformation

Regional applied research universities face unique challenges during digital transformation, primarily in the following areas:

Firstly, there is an imbalance in resource allocation. These universities typically have limited resources and lack the abundant technical equipment and support teams that key universities

possess. This results in issues such as insufficient equipment and inadequate technical support for teachers in digital teaching, directly affecting their ability to enhance and apply digital literacy.

Secondly, there is a deficiency in teacher training. Teachers at regional applied research universities often bear heavy teaching workloads, leaving little time and opportunity for systematic digital literacy training. Even when training opportunities are available, the content is often not deep enough to meet teachers' practical needs.

Thirdly, student digital literacy is uneven. Students at these universities come from diverse backgrounds with varying levels of digital literacy, adding extra challenges for teachers in digital classroom teaching. Teachers not only need to improve their digital literacy but also need to consider how to effectively support the development of students' digital literacy in teaching.

2.3 Difficulties and Misconceptions in Evaluating and Enhancing Teachers' Digital Literacy at Applied Universities

For applied undergraduate universities, there are several difficulties and misconceptions in evaluating and enhancing teachers' digital literacy:

Firstly, there is an overemphasis on technical operational skills. Many evaluation systems focus mainly on teachers' technical usage abilities, neglecting other important dimensions of digital literacy such as information ethics, data management, critical thinking, and creative application. This narrow evaluation standard can lead teachers to overlook the cultivation of comprehensive literacy in actual teaching.

Secondly, there is a lack of consideration for practical application scenarios. The enhancement of teachers' digital literacy requires not only theoretical knowledge but also its application in actual teaching. However, current evaluation systems often lack integration with real teaching scenarios, failing to accurately reflect teachers' digital literacy levels in teaching.

Thirdly, there is a neglect of continuous development. Digital literacy is a dynamically evolving process that requires ongoing learning and updates. Yet, existing evaluation systems are mostly static assessments, lacking support and tracking for teachers' long-term development.

Fourthly, evaluation results do not effectively feedback into teachers' professional development. Evaluation systems should not merely be assessment tools but should also act as catalysts for enhancing teachers' professional growth. Many current evaluation systems have deficiencies in feedback and improvement mechanisms, failing to form an effective closed loop.

3 Constructing a Digital Literacy Evaluation System for Teachers in Regional Applied Research Universities in the Context of Digital Education

In the wave of digital education, regional applied research universities face the urgent task of constructing a digital literacy evaluation system for teachers. This task not only relates to the professional growth of individual teachers but also directly impacts teaching quality and students' digital learning capabilities.

3.1 Deepening and Applying the Concept of Digital Literacy

Teacher digital literacy is a core element in the context of digital education. It requires teachers to master not only the operational skills of digital technology but also the abilities to filter, process, and innovatively apply information. In regional applied research universities, the connotation of teacher digital literacy is even richer. It involves how teachers utilize digital means to promote local economic and social development and how they cultivate students' digital capabilities to meet the needs of future society[12].

3.2 Construction and Optimization of the Evaluation Index System

In the wave of digital education, constructing a scientific and reasonable evaluation index system for teacher digital literacy is crucial for regional applied research universities. The construction principles require the evaluation indicators to comprehensively cover all aspects of teacher digital literacy. The system must also be adaptive and forward-looking to reflect teachers' professional growth in digital teaching and their potential to adapt to future education.

Regional applied research universities are dedicated to developing an evaluation system that accurately reflects teachers' digital literacy. Vygotsky's activity theory provides a framework for deeply understanding the interaction between teachers and digital teaching. This theory posits that human consciousness and skills are formed through interaction with the objective world, which is particularly significant in the context of digital education.

The initial model of activity theory includes three basic elements: subject, object, and mediation. Mediation serves as a tool to regulate the relationship between the subject and the object. In the evaluation system for teacher digital literacy, teachers are the subject, educational goals are the object, and digital tools and resources are mediations. As the theory developed, rules, community, and division of labor were also incorporated into the model, collectively forming the structure of educational activities, as shown in Figure 1.

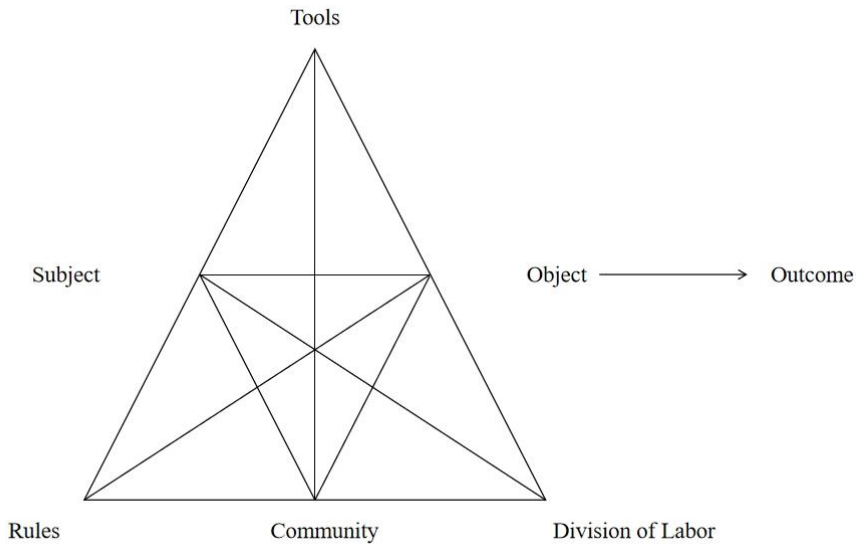

Figure 1. Engestr öm's Activity Theory Model

In regional applied research universities, the evaluation of teachers' digital literacy must not only focus on individual skill mastery but also consider how teachers function within the educational community and how they adhere to educational rules and participate in the division of labor. These factors collectively influence the development of teachers' digital literacy and their teaching innovation.The principle of contradiction emphasized by activity theory suggests that conflicts and contradictions among the elements of activity can stimulate innovation and development. When constructing an evaluation system for teachers' digital literacy, it is essential to identify and understand these contradictions. For example, conflicts between teachers' personal development needs and existing educational rules, or imbalances in resource allocation and the division of labor, must be considered.

3.3 Innovation and Implementation Strategies of the Evaluation Mechanism

The innovation of the evaluation mechanism is crucial for ensuring the effective implementation of the evaluation system. Based on activity theory, an index system of influencing factors for digital literacy education in regional applied research universities has been constructed, as shown in Table 2.

Table 2. Index System of Influencing Factors for Digital Literacy Education in Regional Applied Research Universities

Relationship Dimension	Code	Influencing Factors	Reference Sources
Subject Dimension	F1	University Policy	Doni A et al.[13] , K.Tuamsuk et al. [14], Roma et al.[15]
	F2	Teaching Management	K.Tuamsuk et al. [14]
	F3	Teacher Literacy	Ling Zhiqiang[16], Roma et al.[15]
Object Dimension	F4	Digital Awareness	Zheng Yunxiang[17], Roma et al.[15]
	F5	Digital Natives	List A et al.[18] , Song Shijie et al.[19]
Tool (Mediation) Dimension	F6	ICT Infrastructure	Ma Teng et al.[20] , K.Tuamsuk et al.[14]
	F7	Digital Resources	Roma et al.[15] , Zhang Jing et al.[21]
	F8	Cultural Environment	Zhang Mingming[22], Luo Yi et al.[23]
Community Dimension	F9	Institutional Cooperation	Zhang Jing et al.[21], Ling Zhiqiang et al.[16]
Division of Labor Dimension	F10	Diverse Education	Kong Qiongjie et al.[24] , Zhang Jing et al.[21]
Rules Dimension	F11	Supervision Mechanism	Han Shidong,[25] K.Tuamsuk et al.[14]
	F12	Evaluation System	Zhu Hongyan et al.[26]

3.3.1 Subject Dimension

The subject dimension focuses on the leading role of universities and teachers in digital literacy education. Comprehensive policy frameworks should be established by universities, including faculty training, technological investments, and the allocation of teaching resources to promote the development of teachers' digital skills. Teachers, as implementers of education, are crucial to the formation of students' digital literacy through their technical proficiency, innovative teaching methods, and digital service capabilities. Key factors in the subject dimension include: university policy framework (F1), teachers' technical proficiency (F2), and teaching innovation ability (F3).

3.3.2 Object Dimension

The object dimension focuses on teachers themselves as recipients of digital literacy education. Teachers' digital awareness, values towards information technology, application attitudes, personal interests, and cognitive levels are core elements that influence the development of their digital literacy. As digital natives, teachers must consistently enhance their deep understanding of technology and critical thinking skills. Key factors in the object dimension include: teachers' digital awareness (F4) and attitudes towards the value and application of technology (F5).

3.3.3 Tool/Mediation Dimension

The tool/mediation dimension involves the material and cultural environment necessary for teachers' digital literacy education. This includes ICT infrastructure, the richness of digital resources, and the construction of campus culture and network ecology. A supportive teaching environment provides teachers with the necessary tools and platforms to practice and enhance their digital skills. Key factors in the tool/mediation dimension include: completeness of ICT infrastructure (F6), richness and accessibility of digital resources (F7), and the teaching culture and network ecological environment (F8).

3.3.4 Community and Division of Labor Dimension

The community and division of labor dimension emphasize the importance of multi-party participation and collaboration in the educational process. Universities should establish cooperative relationships with educational management departments, industries, and enterprises to jointly promote the enhancement of teachers' digital literacy. By deepening the division of labor, a diversified educational model can be formed to more effectively meet the professional development needs of teachers. Key factors in the community and division of labor dimension include: inter-institutional cooperation networks (F9) and diversification and innovation in educational models (F10).

3.3.5 Rules Dimension

The rules dimension focuses on the norms and constraints within educational activities to ensure the orderly conduct of digital literacy education for teachers. Effective supervision mechanisms and evaluation systems should be established by universities to monitor and assess the development of teachers' digital literacy. These rules pertain not only to the organization and implementation of teaching activities but also to the guidance and regulation of students' online behavior. Key factors in the rules dimension include: supervision mechanisms for teaching activities (F11) and digital literacy evaluation and feedback systems (F12).

4. Pathways to Enhance Digital Literacy Skills of Teachers at Regional Applied Research Universities in the Context of Educational Digitalization

4.1 Policy Formulation and Faculty Training: Building the Foundation for Digital Skills Enhancement

Amid the wave of educational digitalization, regional applied research universities must prioritize the enhancement of teachers' digital literacy as a strategic focus. Consequently, universities should formulate a series of forward-looking policies that establish digital skills as a core component of teachers' professional development. These policies should encompass recruitment, training, evaluation, and promotion, ensuring that digital literacy becomes an integral part of teachers' career planning.

Faculty training is crucial for enhancing teachers' digital skills. Targeted training programs should be designed and implemented by universities, covering topics such as the use of online teaching platforms, the creation and management of digital content, and modern educational technologies like data analysis. These training sessions should go beyond technical operations, focusing on innovative pedagogy and optimizing teaching strategies to help teachers seamlessly integrate digital technologies into their teaching practices. Additionally, universities should

encourage teachers to participate in academic exchanges and workshops domestically and internationally. Through observation, discussions, and collaboration, teachers can continuously absorb and apply advanced digital education concepts and practices. This not only helps teachers update their knowledge structures but also stimulates innovative thinking, driving the reform of teaching methods.

Moreover, universities should establish incentive mechanisms to encourage teachers to explore and experiment in the field of digital teaching. Initiatives such as teaching competitions and project funding can stimulate teachers' enthusiasm and creativity. These measures will create a continuous learning and growth environment for teachers, propelling progress in digital education.

4.2 Resource Allocation and Environmental Optimization: Establishing a Digital Teaching Practice Platform

In advancing educational digitalization, regional applied research universities need to meticulously design resource allocation and teaching environments to establish a platform that promotes teachers' digital literacy. Investments in modernizing ICT infrastructure are essential to ensure high-speed and stable network connectivity, providing teachers and students with convenient access to digital resources. This involves updating hardware and continuously iterating software platforms to cater to the teaching needs of various disciplines.

A comprehensive digital resource repository should be constructed by universities, serving not only as a repository of teaching materials but also as a community for knowledge sharing and innovation. The resource repository should be user-friendly, allowing teachers to quickly retrieve and apply resources according to their teaching plans. It should also encourage them to share their teaching innovations, forming a dynamically growing ecosystem of educational resources. Furthermore, a positive campus network culture should be fostered by organizing digital teaching seminars, workshops, and competitions to stimulate teachers' enthusiasm and teaching method innovation. A feedback loop mechanism should be established to allow teachers and students to provide insights on digital teaching practices, continually improving the teaching environment.

Ensuring information security is paramount; thus, universities should develop clear guidelines for the use of digital resources and security strategies to protect data privacy. A safe and open teaching environment will enable teachers to freely experiment with and practice new digital teaching methods.

4.3 Quality Monitoring and Continuous Improvement: Establishing a Supervision System for Digital Literacy

The success of educational digitalization hinges on constructing a comprehensive quality monitoring and evaluation system, encompassing not only teachers' digital skills but also the continuous innovation of teaching methods and the ongoing enhancement of teaching quality. Universities should develop a detailed digital literacy evaluation system capable of thoroughly assessing teachers' capabilities in digital teaching, including technical application, instructional design, student interaction, and teaching outcomes.

Regular evaluations help teachers identify their strengths and weaknesses in digital teaching and provide personalized development recommendations. Through these evaluations, teachers can promptly adjust their teaching strategies to better adapt to the digital teaching environment and meet student learning needs. Additionally, universities should establish an open feedback mechanism, encouraging the active participation of teachers, students, and other educators in the evaluation of teaching quality. This multi-angle, multi-dimensional feedback provides universities with comprehensive teaching quality information, helping them to review and improve teaching practices from various perspectives.

The application of feedback results should be taken seriously, translating the collected information into concrete measures for teaching improvement, which may include adjusting course content, improving teaching methods, and updating teaching resources. Continuous improvement driven by feedback ensures the sustained enhancement of teaching quality.

This evaluation-driven process of teaching improvement will facilitate teachers' professional growth in digital teaching, enhance their proficiency with digital teaching tools, and increase the interactivity and attractiveness of teaching. Through constant self-reflection and practical improvement, teachers' digital literacy skills will be substantively enhanced, laying a solid foundation for the success of educational digitalization.

5. Conclusion

As the wave of educational digitalization surges forward, the role of the teaching community becomes increasingly prominent. Teachers are not only the drivers of educational reform but also the practitioners of educational innovation. Within the context of digitalization, teachers are no longer merely transmitters of knowledge; they have become guides and facilitators in the cultivation of students' digital capabilities. This shift in roles requires teachers to possess up-to-date digital skills to adapt to the profound changes in the educational environment.

This paper analyzed the necessity of constructing a diversified, data-driven evaluation index system for teachers' digital literacy. The establishment of this system aims to comprehensively assess teachers' digital skills and reflect their performance in teaching innovation, lifelong learning, and information ethics awareness. Especially for applied undergraduate universities, considering their unique educational positioning, types of talent cultivation, and professional requirements for teachers, the formulation of evaluation index systems must align closely with these characteristics to provide practical paths for cultivating and enhancing teachers' digital literacy.

Universities play a critical role in this process. They need to promote the enhancement of teachers' digital literacy through systematic training, encouragement of practical application, establishment of exchange platforms, and improvement of incentive mechanisms. Additionally, universities should keep pace with the development trends in educational technology, actively exploring new teaching models and methods to cultivate innovative talents capable of adapting to and leading a digital society.

The enhancement of teachers' digital literacy is a long-term and complex process requiring the joint efforts and collaboration of universities, teachers, students, and educational management departments. This research aims to provide references and guidance for improving the digital literacy skills of teachers at regional applied research universities to collectively advance the process of educational digitalization. The ultimate goal is to cultivate digital talents for the new era and paint a brighter future for education.

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