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The Impact of Educational Information on Primary Education

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Abstract

This study used a mixed research method to reveal the multidimensional characteristics of the development of informatization in primary education in China and its pedagogical impact through a systematic analysis of 1,325 valid questionnaires, 36 in-depth interviews, and 8 typical cases in 6 provinces of the country. The quantitative study showed that education informatization significantly improved students' academic performance (β=0.32, p¡0.01) and independent learning ability (Cohen's d = 0.45), but the imbalance of regional development was prominent, with a difference of 45 percentage points between urban and rural areas in the rate of equipment pro- vision. Qualitative analysis found that insufficient competence in teacher technology integration (TPACK) was a constraint, with only 38% of the teachers reaching the level of curriculum integration. Based on this, the study constructs a regional synergistic development model 'center-periphery'. It proposes a 'three-dimensional and six-phase' teacher competence enhancement pathway, which provides a theoretical framework and a practical solution to promote the digital transformation of basic education.

Keywords: Education, Informatization, Elementary

Introduction

In the context of the strategic guidance of" China's Education Modernization 2035", (Jiang, Et al 2022) remarkable progress has been made in the informatization construction of basic education in China. According to the statistical data of the Ministry of Education, by the end of 2022, (Babel, 2022) the Internet access rate of primary and secondary schools across the country reached 100%, and the coverage rate of multimedia classrooms exceeded 96.8% This achievement represents a significant leap forward in equipping educational institutions with basic digital infrastructure, ensuring that schools at all levels have access to the digital resources necessary for modern education. (Hannum, & Park, 2007)

However, the education assessment report of the (Ahong, & Mahamud, 2022). OECD points out that China's education technology application depth index ranks only 35th globally, facing a practical dilemma of" high input - low effectiveness" (Nusche, Et al 2011) Despite substantial investment in educational technology, the actual impact on teaching quality and learning outcomes seems not to match the level of investment. This surface-level application of technology has drawn the attention of the academic community. For example, the research shows that the simple piling up of technology is difficult to generate substantial teaching reforms. Instead, there is a pressing need to establish a systematic integration mechanism among technology, teaching, and the environment. Technology in education is not just about the presence of digital tools but how these tools are integrated Technology in education is more than just having digital tools; it's about **how** they are integrated to improve learning by enhancing engagement, fostering collaboration, enabling personalized experiences, and providing educators with tools for more effective teaching. **The key is** intentionality**, ensuring technology is used to support educational goals, into** the teaching process and adapt to the educational environment. (Feijóo et al., 2021)

Literature Review

International Research Progress On a global scale, research in educational informatization demonstrates (Han, Et al 2024) three prominent trends. Shift from Technology-centered to Teaching Integration: The ISTE Standards established a three-dimensional competency system encompassing students, teachers, and administrators. This system underlines that technology should serve as a means to foster teaching innovation. (DeSantis, 2016) In the past, educational technology research often concentrated solely on the introduction and deployment of advanced digital tools, such as new software or hardware in classrooms. (Winn, 2002) However, the ISTE Standards redirected the focus, emphasizing that technology implementation must be closely aligned with pedagogical goals. adequately support your discussion with abundant and well-justified references, follow a structured process for finding, evaluating, and integrating sources. The key is to move beyond simple summarization and engage in critical analysis and synthesis of the literature.

For example, instead of simply providing students with access to a new learning management system, the focus is on how this system can be used to design more engaging and effective learning activities, like facilitating collaborative projects or personalized learning experiences. This shift reflects a growing understanding that technology alone is not sufficient to improve education; it must be integrated into the teaching and learning process to have a real impact.

Emphasis on Teacher Professional Development: The EU's DigCompEdu introduced a teacher digital competency system consisting of six major domains and 22 indicators. This framework constructs a development ladder ranging from" basic application" to" innovation - leading". Teachers' digital skills are crucial for the successful implementation of educational technology. In the initial stage, teachers are expected to master basic digital tools, such as using presentation software for classroom lectures. As they progress, they should be able to utilize technology to innovate teaching methods, like creating interactive online courses or using data analytics to inform instructional decisions. The DigCompEdu framework provides a clear path for teachers to enhance their digital capabilities, ensuring that they can keep up with the evolving demands of digital-age education. (Ely, 1999)

Research Methodology

Research Design This study adopts an explanatory sequential mixed methods design, which is implemented in two phases, as shown in Figure 1. In the first phase, stratified sampling was employed. Six provinces from the eastern, central, and western regions of China were selected. A total of 1325 valid questionnaires were collected,

The methodology has including 412 from teachers, 763 from students, and 150 from parents. The reason for choosing stratified sampling is to ensure that the sample is representative of different regions, taking into account the potential differences in educational informatization levels across the country. For example, the eastern regions may have more advanced digital infrastructure and higher-level technology applications compared to the western regions. By using stratified sampling, we can capture these regional nuances. Structural equation modeling was then utilized to analyze the relationships among variables. This statistical method allows us to test the hypothesized relationships between multiple variables simultaneously, providing a comprehensive understanding of how different factors in educational informatization interact.

Measurement Tools

The Questionnaire on the Current Situation of Primary Education Informatization was developed. The Delphi method was used to test the expert validity of the questionnaire, resulting in a Content Validity Index (CVI) of 0.89, indicating a high level of agreement among experts regarding the relevance of the questionnaire items to the construct of primary education informatization. The Cronbach's α coefficient of the questionnaire was 0.92, demonstrating excellent internal consistency.

The questionnaire consists of four dimensions: infrastructure (with 5 items), teacher ability (with 12 items), student development (with 8 items), and management support (with

6 items). It uses a Likert 5-point scale for scoring. Taking the teacher - ability dimension as an example, the item design referred to the TPACK ability scale (Schmidt et al., 2009). This dimension includes technological knowledge (TK), pedagogical knowledge (PK), subject-content knowledge (CK), and their integration. For instance, items related to technological knowledge might ask teachers about their proficiency in using specific educational software or digital tools. Pedagogical knowledge items could inquire about their understanding of different teaching methods that can be enhanced by technology. The integration items would focus on how teachers combine technological, pedagogical, and content knowledge in their actual teaching.

Data Analysis

For quantitative data, SPSS 26.0 and Mplus 8.3 were used for analysis: Descriptive statistics were first carried out to reveal the current situation of infrastructure configuration. This step provides basic information such as the average number of computers per classroom, the percentage of schools with high-speed Internet access, etc., which helps to establish a baseline understanding of the primary education informatization infrastructure.

Independent - samples t-tests and one - way ANOVA were employed to analyze regional differences. These statistical tests can determine whether there are significant differences in educational informatization levels among different regions. For example, we can use these tests to see if the teacher - ability scores in the eastern region are significantly different from those in the central or western regions.

A multiple linear regression model was used to test the influencing factors. This model can identify which variables have a significant impact on educational informatization, such as whether the level of management support has a positive effect on teacher ability improvement.

For qualitative data, NVivo 12 was used for three-level coding analysis, establishing an analysis path of” phenomenon description - problem identification - mechanism explanation”, as shown in Table 1. For example, in response to the frequently mentioned” technology application anxiety” in teacher interviews, core categories such as” cognitive overload” and” insufficient training effectiveness” were extracted. The open- coding process involves breaking down the raw data (such as interview transcripts) into smaller, meaningful units. The spindle codes then group these open-coded units into more comprehensive categories. Finally, the selection codes select the most important and overarching themes that explain the phenomena

Finally, the selection codes select the most important and overarching themes that explain the phenomena.

Table 1.: Qualitative Data Analysis Example

Original Statement	Open Coding	Axial Coding	Selective Coding
The preparation of teaching materials using courseware takes too much time for lesson planning”	High time cost	Barriers to technology application	Teachers’ ability gap
The training content is disjointed from actual teaching	Low training relevance	Professional development needs	Lack of institutional support
New software is too complex to master	High software operation difficulty	Difficulties in technology application	Teachers’ ability gap
The number of trainings organized by the school is too small	Low training frequency	Professional development needs	Lack of institutional support

*Coding categories reveal systemic challenges in educational technology adoption.

Research Results

Regional Disparities in Infrastructure Configuration acknowledged. When providing information that includes both quantitative data (such as statistics and figures) and qualitative analysis, the statistics, figures, or data tables will be presented before the interpretive analysis. The data analysis reveals significant regional disparities in educational informatization infrastructure ($\chi 2$ = 35.67, $p < 0.001$). In urban primary schools, on average, 152 smart terminals are equipped (SD = 32), with 86% of these devices having been updated within the past three years. This high-level of equipment and recent updates are often a result of the relatively robust financial resources in urban areas. Urban schools can draw on local government support, corporate sponsor-ships, and parental contributions more easily, which enables them to invest in the latest digital devices. For example, in large cities like Shanghai and Beijing, schools frequently upgrade their smart terminals to keep up with the latest educational technology trends, providing students with access to state-of-the-art learning tools such as touch-screen tablets preload with educational apps.

In contrast, rural primary schools have an average of only 38 smart terminals (SD = 15), and the equipment renewal rate is a mere 42%. Rural areas generally face financial constraints. Limited local tax revenues and a lack of external investment sources make it difficult for schools to allocate sufficient funds for technology upgrades. Many rural schools rely solely on government subsidies for educational technology, which may not be enough to cover the costs of large-scale equipment updates. As a result, students in rural areas often have to make do with older, less-functional devices, which can limit their access to digital learning resources.

The difference in network bandwidth is even more striking. In urban schools, 78% have a bandwidth of over 500M. This high-speed network access is crucial for seamless access to various online educational resources. For instance, urban students can smoothly stream high-definition educational videos, participate in real-time online courses, and collaborate with peers from around the world using video-conferencing tools. However, in rural schools, 83% of the bandwidth is less than 100M, leading to an online teaching lag rate of 32%. The low-bandwidth situation in rural areas severely restricts the use of online teaching platforms. Teachers may find it challenging to conduct live-streaming classes, and students may experience long loading times or interrupted connections when accessing online learning materials. This digital divide in infrastructure not only reflects the imbalance in educational resource allocation but also has a direct impact on the quality of education received by students in different regions. It can widen the achievement gap between urban and rural students, as urban students have more opportunities to engage in enriching digital learning experiences.

Table 2.: Comparison of Smart Terminal Equipment and Update Rates between Urban and Rural Primary Schools

Region	Average Number of Smart Terminals (SD)	Equipment Update Rate within the Past Three Years
Urban	152 (SD = 32)	86%
Rural	38 (SD = 15)	42%

Current Situation of Teachers' Technology Integration Ability

The TPACK ability assessment as shown in Table 3 that teachers have the highest score in technological knowledge (TK) (M = 4.12, SD = 0.76). This indicates that teachers, in general, are familiar with basic educational technology tools. They may know how to operate common software such as word processors, presentation software, and basic learning management systems. However, their score in technological - pedagogical knowledge (TPK) is the lowest (M = 2.78, SD = 0.93). This implies that although teachers understand the technology, they struggle to integrate it effectively into teaching.

Only 38% of teachers can systematically design technology - integrated teaching plans. Designing such plans requires a deep understanding of both the technology and the teaching-learning process. Teachers need to know how to select appropriate digital resources, adapt them to the curriculum, and create engaging learning activities. For example, a teacher might need to combine an online interactive simulation with traditional teaching methods to teach a science concept. The low percentage of teachers with this ability suggests that there is a significant room for improvement in teacher training.

Discussion

Construction of Regional Collaborative Development Mechanism The unbalanced regional development is particularly prominent in the field of infrastructure, which severely restricts the overall regional collaborative development process. This study inventively proposes the” Core - Periphery” collaborative development model as shown in Figure 2, aiming to break this development dilemma and promote the rational flow and balanced allocation of resources among regions.

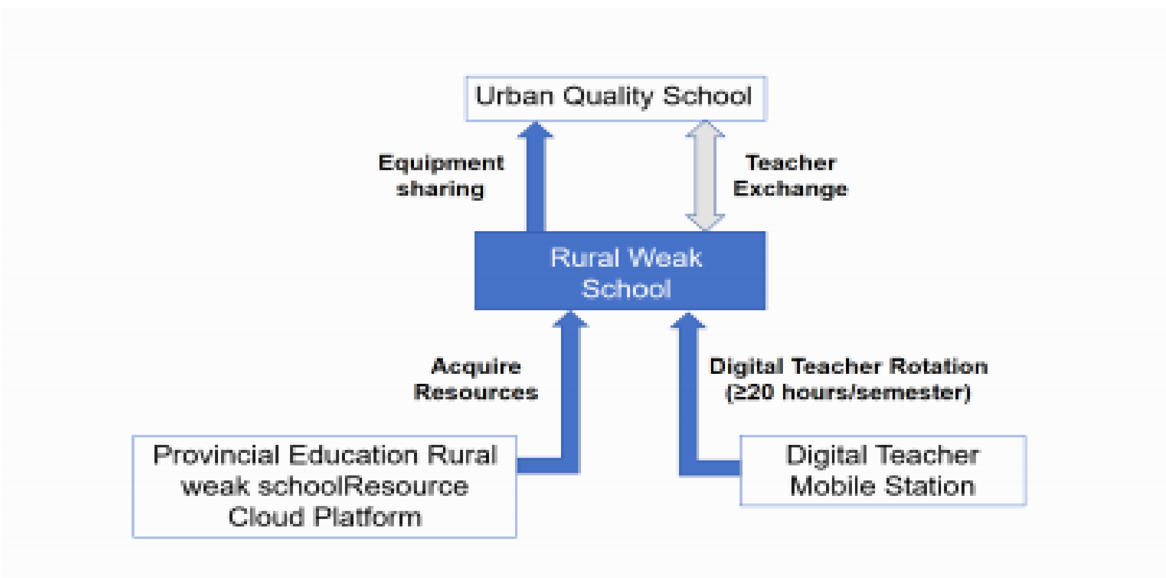

Figure 2.: “Core - Periphery” collaborative development model

This model outlines three practical implementation paths. Firstly, a ”1+N” inter-school alliance is established. Taking high-quality urban schools as the core, each high-quality urban school drives 3 - 5 weak rural schools to form a close-knit cooperation community. Through equipment sharing, weak rural schools can obtain advanced teaching equipment, making up for the shortage of hardware facilities. Teacher exchanges pro- vide rural teachers with opportunities to learn advanced teaching experiences and methods, promoting the renewal of educational concepts, and realizing the effective flow of educational resources within the region, thus narrowing the urban-rural education gap.

Conclusions and Recommendations

The Promotion of Academic Performance by Educational Informatization and Its Moderating Factors This study indicates that educational informatization plays a significant positive role in improving students' academic performance. By introducing diverse digital educational resources, such as online courses and virtual laboratories, it provides students with a more abundant and personalized learning experience, thus powerfully promoting academic progress. However, this promoting effect is not absolute and fixed. It is significantly moderated by the quality of resources and teachers' capabilities. High-quality educational resources, in terms of the accuracy, richness of content, and diversity of presentation forms, can more effectively attract students' attention and stimulate their learning interest, thereby better facilitating academic advancement. Meanwhile, as the key guides in the teaching process, teachers' information technology application capabilities and their ability to control the integration of teaching content and technology also play a decisive role in the effect of educational informatization on improving academic performance. If teachers can skillfully use various information-based teaching tools and ingeniously integrate them into daily teaching, the promoting effect of educational informatization on academic performance will be greatly enhanced.

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