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DIGITAL PEDAGOGY IN MIDDLE SCHOOLS: ASSESSING THE INFLUENCE OF TECHNOLOGY ON EDUCATION IN SHANXI, CHINA

Zhang Caidong[1], Khalid Ahmed[2], Irfan Abbas[3], Ruqia Saba Ashraf[4], Ahmad Faizuddin[5], Muhammad Asad Habib[6]

[1]INTI International University, Malaysia, I24029165@student.newinti.edu.my
[2]INTI International University, Malaysia, khalid.ahmed@newinti.edu.my
[3]University of Central Punjab, Pakistan, irfanabbas.mul@gmail.com
[4]The Women University, Multan, Pakistan, rsadgk@gmail.com
[5]INTI International University, Malaysia, ahmad.faizuddin@newinti.edu.my
[6]The University of Lahore, Pakistan, asad.habib@ell.uol.edu.pk

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Corresponding Author: Khalid Ahmed (khalid.ahmed@newinti.edu.my)

ABSTRACT

This research examines how digital teaching tools enhance educational access and transform secondary education in Shanxi, China. With the rapid advancement of information technology, these tools are diversifying instructional methods, improving student engagement, and addressing systemic challenges in learning equity. This article explores the types of these tools, their current application status, and their impact on student learning outcomes, capabilities, and teaching models. Through literature analysis and case studies, it has been found that digital tools stimulate student interest, enhance autonomous learning ability, and promote the transformation of classrooms from traditional models to diverse and interactive modes. They facilitate personalized learning, enhance teacher-student interaction, and improve teaching efficiency. However, challenges such as insufficient hardware, inadequate teacher training, and the digital divide limit the development of digital education during the promotion process. To address these issues, this article recommends strengthening infrastructure construction, improving teachers' digital literacy, and reducing the digital gap. Ultimately, it aims to provide theoretical foundations and action guidelines for educational practitioners and policymakers to promote the digital transformation of secondary education, achieving comprehensive student development and continuous improvement of education quality.

KEYWORDS: Digital Teaching Tools; Educational Access; Learning Outcomes; Digital Divide; Teacher-Student Interaction.

1. INTRODUCTION

While digital tools offer significant benefits, challenges remain. Insufficient hardware and inadequate network infrastructure hinder widespread adoption, particularly in underserved areas. Many teachers lack the necessary training and support to effectively integrate these tools. The digital divide further exacerbates educational inequities, as unequal access to technology and digital literacy skills creates disparities among students. Research is urgently needed to address these challenges and maximize the effectiveness of digital tools in secondary education.

2. RESEARCH QUESTIONS

RQ1: How do digital teaching tools affect students' learning outcomes and learning abilities?

RQ2: What are the main challenges and obstacles in promoting digital teaching?

RQ3: How to optimize and improve the effectiveness of digital teaching tools?

3. SIGNIFICANCE OF STUDY

This study is of significant importance against the backdrop of the rapid development of digital education, specifically reflected in the following aspects:

Firstly, it promotes the modernization and informatization of education [1]. With the continuous advancement of digital technology, how to scientifically and reasonably integrate digital teaching tools into the classroom has become an important issue in improving educational quality. This study provided empirical evidence for education departments and schools to guide the effective integration and application of digital resources, advancing deep informatization of education.

Secondly, it enhances teaching quality and learning outcomes [2]. By systematically analyzing the application and effects of digital tools in secondary school teaching, it can help teachers optimize teaching strategies, stimulate students' interest in learning, improve academic performance and independent learning abilities, thus achieving personalized education and individual development goals.

Thirdly, it promotes teachers' professional development and enhancement of skills. The research will reveal the usage techniques and best practices of digital teaching tools, providing specialized training and practical experience for teachers, helping them master advanced teaching technologies and enhance their digital literacy. Additionally, it narrows the digital divide in education and promotes educational equity [3]. This study focuses on the inequalities in terms of equipment, network access, and skills, providing a scientific basis for the fair distribution of educational resources and contributing to achieving educational equity.

Lastly, it enriches the theoretical system of educational technology research. It fills the empirical research gap regarding the specific application effects and existing problems of digital teaching tools, offering new research ideas and theoretical foundations to the academic community, and promoting the continuous development of the field of educational technology. In conclusion, this research not only has theoretical guidance significance but also practical promotional value, making a positive contribution to the innovation and development of value education.

4. LITERATURE REVIEW

With the rapid development of information technology, digitization has deeply integrated into our daily lives, changing the way communication, work, and even education is conducted [4]. In middle school, traditional teaching methods are gradually transitioning towards digitization and informatization. Digital teaching tools, such as multimedia courseware, interactive software, learning management systems (LMS), and artificial intelligence applications, are increasingly permeating classroom teaching [5]. These tools provide students with a richer, more intuitive, and interactive learning experience, not only meeting the diverse and personalized learning needs of the new generation of students, but also significantly improving teaching efficiency and effectiveness.

At the same time, the widespread application of digital teaching tools has posed new challenges to teaching methods and the role of teachers [6]. Teachers need to constantly adapt and learn how to effectively integrate new technologies to motivate students and improve learning outcomes. This transformation requires not only technical support, but also innovation from educators in teaching design and implementation [7].

Studying the application and impact of digital teaching tools in secondary education has important theoretical significance and practical value [8]. It can help us gain a deeper understanding of the specific manifestations of educational reform in the digital age and analyze its potential and challenges in modernizing education. By revealing the impact of

these tools on students' learning outcomes, learning abilities, and overall teaching methods, the research results can provide references and suggestions for educators and policy makers, guiding future teaching practices and decision-making.

The transformative potential of technology in education is evident across diverse sociocultural contexts. For instance, Vijayaratnam et. all in their study demonstrate how digital media (e.g., English cartoons) enhances language acquisition in preschoolers, paralleling this study's findings on engagement through digital tools [9]. Similarly, Ahmed et al. reveal how pragmatic adaptations in ESL learners intersect with technology-mediated communication [10], while Khaleel et al. underscore the role of language in shaping societal perceptions a reminder that digital pedagogy must address equity beyond access [11]. Earlier works of Ahmed et al. further highlight technology's dual capacity to empower or manipulate, reinforcing this study's call for critical digital literacy in Shanxi's classrooms [12], [13].

In addition, exploring the impact of digital teaching tools can also provide strategies for reducing educational inequality, by promoting more equitable distribution of equipment and resources, and achieving comprehensive development of education [14]. Therefore, the focus of this study is to comprehensively explore the types and application status of digital teaching tools, as well as their profound impact on the secondary education system.

4.1. Underpinning Theories

4.1.1. Educational Technology Theory
Educational technology theory is an important research field in modern educational science, emphasizing the use of various advanced technologies to optimize the teaching process and improve learning outcomes. It advocates dynamic presentation and diverse expressions of teaching content through the rational application of technology, thereby promoting deeper understanding and sustained interest among students.1. Personalized learning.2. Interactive teaching.3. Diversified development.4. Classical theoretical support.

4.1.2. Constructivism Theory

Constructivism believes that learning is a process in which students actively construct knowledge rather than passively accepting information. Students make connections between old and new knowledge, forming new cognitive structures through their own experiences and understanding. Digital teaching tools play a pivotal role in this process, providing an interactive and resourceful learning environment [15].

1. Support for independent exploration
2. Promote cooperative learning
3. Supporting Reflective Learning
4. Interaction and autonomy
5.Innovative talent training

4.1.3. Load Theory

Load theory, also known as cognitive load theory, emphasizes the impact of information presentation on learners' cognitive load during the learning process. Organizing and presenting information effectively can help reduce the cognitive load of learners, thereby improving comprehension and retention. In the design of digital instruction, load theory provides key guiding principles to ensure that information is transmitted clearly and orderly [16].

1. Core Perspective.
2.Digital Instruction.
3.Optimize the learning experience.
4.Guiding Practice.

4.2. Theoretical Framework of the Study

Constructivist Learning Theory: Jean Piaget proposed his theory of cognitive development in the mid-20th century, which provided a foundation for constructivism. Lev Vygotsky's ideas on social constructivism were developed in the 1930s. The theories of Piaget and Vygotsky together laid the foundation for constructivist educational practices. Emphasizes students' autonomous exploration, collaborative learning, and active knowledge construction. Digital tools such as virtual experiments and interactive platforms can stimulate students' initiative in learning, supporting deep understanding and the cultivation of innovative abilities [17].

5. RESEARCH METHODOLOGY

This section outlines the overall methodological framework of this study, including the research design concept, implementation scenarios, subject selection criteria, data collection tools, and analysis methods. This study employs a quantitative design to derive comprehensive and in-depth conclusions. The research design utilizes a combination of survey methods, mainly collecting large sample quantitative data through surveys, which evaluate teachers' and students' usage, attitudes, and learning outcomes of digital teaching tools. This multidimensional approach compensates for the limitations of a single method and enhances the richness and scientific

validity of the conclusions.

The research settings are selected from various middle schools in Shanxi Province, covering urban and rural areas as well as different subjects and grades, to reflect the applicability and effectiveness of digital tools in various teaching environments, providing practical guidance for promotion. The focus of the research subjects is on middle school students and frontline teachers: students are concerned with changes in learning interest and academic performance, while teachers focus on tool application strategies, encountered issues, and professional development needs. Data analysis carried out by using SPSS software, conducting descriptive analysis, correlation testing, and regression analysis on the questionnaire data to evaluate the effectiveness of digital teaching tools.

5.1. Research Design

A quantitative design was used in this study. The quantitative component includes the distribution of questionnaires to collect relevant data on student and teacher use, attitudes, and learning outcomes related to digital teaching tools;

Table 1: Questions About the Survey Questionnaire.

Question 1: What is your gender?	1.Male 2. Female
Question 2: Does your teacher encourage the use of digital teaching tools for independent learning?	1.Yes 2. No
Question 3: Do you often use digital teaching tools (such as tablets and online learning platforms) for learning?	1.Yes 2. No
Question 4: Is your secondary school located in the city or the countryside?	1.Urban 2. Rural
Question 5: How do digital teaching tools affect your interest in learning?	1.Greatly increased 2.Slightly increased 3.No change 4.Slightly decreased 5.Greatly decreased
Question 6: What impact do you think digital teaching tools have on your learning outcomes?	1.Improved learning effectiveness 2.No significant changes 3.Reduced learning effectiveness
Question 7: Which do you think promotes your ability to learn independently more, digital teaching tools or traditional classroom teaching?	1.Digital teaching tools 2.Traditional classroom teaching 3. Combination of both 4.No difference
Question 8: What are the main difficulties you encounter when using digital teaching tools?	1.Technical issues (such as software malfunctions, unstable network) 2.Self-management (such as difficulty concentrating, poor self-discipline) 3. Lack of resources (such as insufficient equipment, materials) 4.Others (please specify)
Question 9: What types of digital teaching tools have been most helpful for your learning?	1.Online course platforms (such as Coursera, Xuetang Online) 2.Teaching video platforms (such as Bilibili Education Channel, YouTube Education Channel) 3.E-learning applications (such as Baicizhan, Duolingo) 4. Learning management systems (such as Moodle, Blackboard) 5. Collaboration tools (such as Google Classroom, Padlet) 6. Quiz and exam preparation applications (such as Quizlet, YuanTiku)
Question 10: What impact do you think the use of digital teaching tools has on the education of middle school students in Shanxi?	Open-ended question

5.2. Research Setting

The research primarily took place in secondary schools in Shanxi Province, covering both urban and rural areas to ensure the representativeness of the sample. The selected schools have already introduced digital teaching tools and have some experience in their practical application, which facilitates the analysis of their actual effects. In addition, the research was conducted in the middle of the semester to avoid the fluctuations caused by new applications at the beginning of the semester.

5.3. Population And Sampling

The research subjects are middle school teachers and students in Shanxi who are using digital teaching tools. A stratified random sampling method was used to ensure that samples cover different grades, subjects, and regions. The questionnaire sample consists of 90 students and 30 teachers.

5.4. Research Instruments

Purpose: To measure students' and teachers' usage, attitudes, and effectiveness evaluations of digital teaching tools.

The questionnaire is divided into several sections, including: Background Information: To collect basic information from participants, such as gender, system usage experience, frequency of use, etc. Frequency of Tool Usage: To evaluate the frequency of using multimedia presentations, LMS, AI applications, etc., through a five-point Likert scale. Learning Effect and Interest: To investigate students' self-evaluation of the impact of digital tools on learning effectiveness and interest. Teacher Feedback: To collect teachers' views on the effectiveness of digital tools in teaching.

Implementation: Self-administered, distributed and collected by research team members at schools to ensure the authenticity and completeness of the data.

5.5. Pilot Text

Before officially conducting the questionnaire survey, a pilot study was carried out to test the feasibility and effectiveness of the research tools. The objective of this pilot was to assess the comprehensibility of the questionnaire, the rationality of the questions, thereby ensuring the smooth progress of each stage during the formal research.

Pilot School Selection: A representative middle school in Shanxi Province was selected, which possesses both urban and rural characteristics, conforming to the basic traits of the research subjects, in order to identify potential issues in advance.

Sample selection: A total of 10 enrolled students and 2 teachers with rich teaching experience were selected as pilot subjects. These participants are representatives of the school and can provide genuine feedback.

Questionnaire testing: Students were asked to fill out a questionnaire to observe their understanding difficulties, record the time taken to complete it and any points of confusion, and collect student feedback on the questionnaire content.

Results and Adjustments: Analyze questions in the questionnaire that are difficult to understand or may cause ambiguity, adjusting the wording to improve accuracy and conciseness. After testing, confirm that the questionnaire's length is appropriate, the content is relevant ensuring that the tools are user-friendly and practical.

5.6. Demographic And Social Characteristics

A total of 90 middle school students in Shanxi Province, China were investigated in this study. 120 valid questionnaires were retrieved, with an effective recovery rate of 100%. Among them, there were 58 male cases, accounting for 48.30%, and 62 female cases, accounting for 51.7%. Geographical distribution is relatively even, with 60 cases in urban areas and 60 cases in rural areas. In terms of teachers' attitudes towards the use of digital teaching tools, 84 cases, accounting for 70.00%, actively encouraged it, while the remaining 30% of students believed that teachers did not encourage the use of digital teaching tools. Among them, 72 students frequently use digital teaching tools in their daily studies, accounting for approximately 60.00%, while the remaining 40.00% believe they do not frequently use digital teaching tools in their daily studies.

In this study, the proportions of male and female students in the sample were close, with a gender ratio of approximately 1:1. There are 60 students each from urban and rural areas, with an even geographical distribution. This balanced sample structure reduces the interference of variables such as gender and region on the results, making subsequent analyses on digital teaching tools more representative. Teachers' "active encouragement" of the use of digital teaching tools, combined with students' usage (60% frequently use and 40% infrequently use), can be inferred that teachers' attitudes may be an important factor influencing students' use of digital teaching tools. Teachers who actively encourage students may promote their use through classroom guidance, task assignment and other means, while those who do not encourage students may indirectly reduce the frequency of students' use due to unfamiliarity with the tools or concerns about distraction. Although 60% of students "frequently use" digital teaching tools, indicating that these tools have gained some popularity among middle school students, there are still 40% of students who do not frequently use them. This proportion suggests that the penetration of digital teaching tools among middle school students in Shanxi has not yet been fully covered.

Table 2: Frequency Distribution of Demographic Data (N=120).

Class	Option	Frequency	Proportion （%）
Gender	male	58	48.30
	female	62	51.70
Urban or Rural	urban	60	50.00
	rural	60	50.00

Teachers are encouraged to use digital teaching tools	yes	84	70.00
	deny	36	30.00
Use digital teaching tools regularly	yes	72	60.00
	deny	48	40.00

6. DATA ANALYSIS

6.1. The Impact of Using Digital Teaching Tools on Learning Outcomes

The study on the impact of digital teaching tools on learning outcomes shows that the average overall score of students is 2.00, indicating that from the perspective of the group level, students' evaluation of the learning outcomes of digital teaching tools tends to be "moderately low". This means that the majority of students believe that the positive effect of the tools on learning has not yet reached a "significant" or "strong" level, and the overall effect is in the range of "average" or even "weak". Moreover, the overall students' views on the impact of digital tools vary greatly (standard deviation 0.85), which suggests that the influence of digital tools is not uniform but highly dependent on factors such as individual experience, specific usage scenarios, tool types, teacher guidance methods, and students' own characteristics (such as learning styles and digital literacy). The gap between the "teacher encouragement rate (70%)" and the "student usage rate (60%)" mentioned in the previous analysis, as well as the experience differences among the 40% of the "infrequently used" student group, are very likely to be the important reasons for this large standard deviation.

Table 3: The Impact of Digital Teaching Tools on Learning Outcomes (N=120).

class	least value	crest value	mean	standard deviations	Interpretation
Impact effect	1.00	4.00	2.0000	0.85	Low Impact

6.2. Multi-Dimensional Comparison of the Impact of Using Digital Teaching Tools on Learning Outcomes

A multi-dimensional comparison of the impact of digital teaching tools on learning outcomes was conducted. There was no significant difference in the gender dimension ($t=0.27$, $p>0.05$) and the regional dimension ($t=0.45$, $p>0.05$), and the overall evaluations were similar, indicating that there was no statistically significant difference in the evaluation of the effects of digital teaching tools by gender and region.

Table 4: Multi-Dimensional Impact of Digital Teaching Tools on Learning Outcomes (N=120).

Domain	clauses and subclauses	Mean ± standard deviation	Standard error mean	F	t
Gender	male	1.62±0.86	0.11	2.32	0.27
	female	1.58±0.76	0.10		
The middle school I attended	urban	1.63±0.82	0.11	0.39	0.45
	rural	1.57±0.79	0.10		
The effect of digital teaching tools on learning outcomes	yes	1.42±0.73	0.08	0.26	0.61
	deny	2.03±0.81	0.14		

6.3. Research Status Frequency Statistics

In this study, a total of 69 students, accounting for 57.5% (34.2%+23.3%), believed that digital teaching tools "significantly enhanced" or "slightly enhanced" learning interest, which exceeded half. This indicates that the positive effect of tools on learning interest is more obvious. Sixty percent of the students believe that the tools "improve the learning effect". 57.5% of the students believe that digital teaching tools are "more capable of promoting autonomous learning ability" than traditional classrooms, which is much higher than the proportion of those choosing "traditional classrooms" (19.2%) or "no difference" (10.0%), indicating that the advantages of tools in empowering autonomy (such as independently choosing learning content and pace) have been perceived by the majority of students. The proportion of "test and exam preparation applications" is 87.5%, reflecting the strong demand of middle school students for "test-taking assistance" tools. These tools directly serve to improve grades through functions such as doing practice questions and organizing wrong answers and have the strongest perceived practicality.

The prominent issues in this study are presented as "resource scarcity" and "technical problems". The proportion of "resource scarcity" is the highest (92.5%), almost covering all students, indicating that

the accessibility of hardware/resources is the primary bottleneck restricting the use of tools. "Technical issues" reflect the insufficient stability and ease of use of the tool.

Table 5: Comparison Of Differences in the Impact of Digital Teaching Tools on Learning Outcomes (N=120).

domain	clauses and subclauses	frequency	percentage
Digital teaching tools affect learning interest	enhance greatly	41	34.20
	Slightly more	28	23.30
	unchanged	23	19.20
	Slightly lower	18	15.00
	greatly decrease	10	8.30
The influence of digital teaching tools on learning effect	Improved learning effect	72	60.00
	There was no significant change	24	20.00
	Reduced learning effectiveness	24	20.00
Which is more conducive to autonomous learning ability, digital teaching tools or traditional classroom teaching?	Digital teaching tools	69	57.50
	Traditional classroom teaching	23	19.20
	The two go together	16	13.30
	as broad as long	12	10.00
Main difficulties encountered in the use of digital teaching tools	Technical issues (such as software failures, network instability)	87	72.50
	Self-management (e.g. difficulty concentrating, poor self-discipline)	80	66.70
	Lack of resources (e.g. lack of equipment, materials)	111	92.50
	Other (please specify)	7	5.80
The type of digital teaching tool that helps most with learning	Online course platforms (such as Coursera, Xuetang Online)	53	44.20
	Teaching video platform (such as Bilibili education channel, YouTube education channel)	73	60.80
	E-learning apps (such as Baiduizi and Duolingo)	52	43.30
	Learning management systems (e.g. Moodle, Blackboard)	72	60.00
	Collaborative tools (e.g. Google Classroom, Padlet)	39	32.50
	Test and exam preparation apps (such as Quizlet, Yuan Tiku)	105	87.50

6.4. Univariate Analysis of the Impact on the Learning Outcomes of Digital Teaching Tools

This study analyzed the differential effects of different factors on the "learning outcomes of digital teaching tools" (classified into three categories: "improved", "no significant change", and "decreased") from multiple dimensions such as gender, region, teacher encouragement, and tool type through chi-square test (χ^2) and t-test.

Teacher encouragement, the promotion method of autonomous learning ability, and different types of digital tools showed statistically significant differences in learning outcomes ($p < 0.001$), whereas other factors showed no significant differences ($p > 0.05$).

Among the students who received teacher encouragement, 72.6% believed it "improved learning outcomes", while only 30.6% of those who did not receive encouragement thought it "improved". This indicates that the guidance and support of teachers are crucial for the effectiveness of digital teaching tools, which may enhance the effectiveness by boosting students' confidence and standardizing the usage methods, etc. Among the ways to promote autonomous learning ability, 76.8% of the students who believe that "digital teaching tools can better promote autonomous learning" think that "they can improve learning outcomes". Among the students who believe that "traditional classrooms are more effective", only 30.4% think it has "improved", indicating that the enabling effect of digital teaching tools on autonomous learning ability is strongly positively correlated with learning outcomes: students who recognize the value of their autonomous learning are more likely to feel the improvement in outcomes. Among different types of tools, 62.9% of the mid-term tests and exam preparation applications believe that "improving effectiveness" is a highly recognized tool. The proportions of teaching video platforms and learning management systems that "improve effectiveness" are 61.6% and 61.1% respectively, and the effects are relatively stable. The proportion of online course

platforms and e-learning applications that "improve effectiveness" is approximately 54% to 61%, which is slightly less effective. The "specificity" of the tools (such as test tools directly serving the learning goals) may be the key factor influencing the outcome. The higher the match between the functions and the learning needs, the more significant the effect will be.

Table 6: Univariate Analysis of the Impact of Digital Teaching Tools on Learning Outcomes (N=120).

class	option	distribution			χ^2	t
		Improve learning effectiveness	There was no significant change	Reduce learning effectiveness		
sex	man	36（62.10%）	8（13.80%）	14（24.10%）	3.20	0.20
	woman	36（58.10%）	16（25.80%）	10（16.10%）		
region	city	35（58.30%）	12（20.00%）	13（21.70%）	0.22	0.90
	village	37（61.70%）	12（20.00%）	11（18.30%）		
Teachers encourage	yes	61（72.60%）	11（13.10%）	12（14.30%）	18.68	0.00
	deny	11（30.60%）	13（36.10%）	12（33.30%）		
Digital teaching tools affect learning interest	enhance greatly	26（63.40%）	9（22.00%）	6（14.60%）	11.14	0.19
	Slightly more	22（78.60%）	3（10.70%）	3（10.70%）		
	unchanged	13（56.50%）	4（17.40%）	6（26.10%）		
	Slightly lower	8（44.40%）	5（27.80%）	5（27.80%）		
	greatly decrease	3（30.00%）	3（30.00%）	4（40.00%）		
Use digital teaching tools regularly	yes	43（59.70%）	13（18.10%）	16（22.20%）	0.79	0.68
	deny	29（60.40%）	11（22.90%）	8（16.70%）		
Which is more conducive to autonomous learning ability, digital teaching tools or traditional classroom teaching?	Digital teaching tools	53（76.80%）	8（11.60%）	8（11.60%）	22.18	0.00
	Traditional classroom teaching	7（30.40%）	8（34.80%）	8（34.80%）		
	The two go together	8（50.00%）	5（31.30%）	3（18.80%）		
	as broad as long	4（33.30%）	3（25.00%）	5（41.70%）		
Main difficulties encountered in the use of digital teaching tools	Technical issues (such as software failures, network instability)	53（60.00%）	16（20.00%）	18（20.00%）	2.50	0.29
	Self-management (e.g. difficulty concentrating, poor self-discipline)	47（58.80%）	19（23.80%）	14（17.50%）		
	Lack of resources (e.g. lack of equipment, materials)	66（59.50%）	23（20.70%）	22（19.80%）		
	Other (please specify)	3（42.90%）	2（28.60%）	2（28.60%）		
The digital teaching tool that helps you learn the most	Online course platforms (such as Coursera, Xuetang Online)	29（54.70%）	15（28.30%）	9（17.00%）	12.19	0.00
	Teaching video platform (such as Bilibili education channel, YouTube education channel)	45（61.60%）	9（12.30%）	19（26.00%）		
	E-learning apps (such as Baiduizi and Duolingo)	32（61.50%）	13（25.00%）	7（13.50%）		
	Learning management systems (e.g. Moodle, Blackboard)	44（61.10%）	13（18.10%）	15（20.80%）		
	Collaborative tools (such as Google Classroom, Padlet)	20（51.30%）	13（33.30%）	6（15.40%）		
	Test and exam preparation apps (such as Quizlet, Yuan Tiku)	66（62.90%）	16（15.20%）	23（21.90%）		

7. CONCLUSION

This study focuses on the core issue of "the impact of using digital teaching tools on education for middle school students in Shanxi, China" and systematically analyzes the current situation, influencing factors, and existing challenges of digital tool applications. Through questionnaires it was found that digital teaching tools significantly enhance students' learning interest, promote autonomous learning, and improve learning outcomes, while also revealing constraints such as insufficient equipment, lack of teacher training, and the digital divide.

The research indicates that the application of digital technology in Shanxi middle schools has a

high penetration rate, especially in urban areas, where the richness of digital teaching resources has greatly improved teaching effectiveness. However, regional disparities and uneven resources remain significant obstacles to the digitalization of education. The frequent use of digital tools by teachers reflects their recognition of teaching reform, while also emphasizing the importance of ongoing training and infrastructure upgrades.

Although digital teaching tools bring many benefits, their promotion and application still require improvements in various aspects. Strengthening hardware investment, improving training mechanisms, and narrowing the digital divide will be key to promoting the sustainable development of digital education in the future. Future research should focus on the long-term impacts of these tools and their personalized applications to better achieve the deep integration of technology and teaching.

In summary, digital teaching tools have brought new opportunities to secondary education in Shanxi but also present many challenges. Only by continuously improving infrastructure, enhancing teacher quality, and promoting equitable accessibility can we achieve fairness and high-quality development in education, thereby advancing the modernization of China's education system.

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