RESEARCH ARTICLE

Has the Digitization of Education Improved Students' Academic Performance?–A Meta-Analysis Based on 21 Experimental and Quasi-Experimental Studies

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Abstract

The breakthrough innovations in the application of digital technologies in education have become increasingly widespread, making educational digital transformation a focal point in the realm of education. Presently, numerous empirical studies have explored the impact of educational digital transformation on students' academic performance, yielding inconsistent findings regarding its effects on learning outcomes and capabilities in students' learning development. To this end, the article employs a meta-analysis approach to systematically review and analyze 21 experimental and quasi-experimental studies within China. The findings reveal a significantly enhanced digital transformation in enhancing students' academic performance.

Keywords: digitization of education, transformation of education through digitization, student learning, academic performance of students, meta-analysis.

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1 Introduction

With the advancement of the Fourth Industrial Revolution, the world's digital development has been continuously improved, and digitization has spread to all aspects, such as digital government, digital business models, digital education, etc. Among them, the digitization of education is entering our lives with a good forward trend under the promotion of the state. China's policy support for the digitization of education has a long history. In 2000, the Ministry of Education issued the Notice on the Implementation of the "School-to-School Communication" Project in Primary and Secondary Schools, which was the first national-level development plan in the field of education information in China [1]. In the 20 years since then, the state has successively issued a series of policies on the digitization of education. In February 2022, the "Key Points of the Work of the Ministry of Education in 2022" proposed "implementing the strategic action of education digitization" and "promoting the construction of new education infrastructure and building a national public service platform for smart education", and in October 2022, the report of the 20th National Congress of the Communist Party of China (CPC) for the first time included "promoting the digitization of education" in the report of the Party Congress [1]. As an important part of the national digital transformation strategy, education digitization is

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slowly entering schools, teaching, and classrooms. The so-called digitization of education refers to the integration of digital technology into all levels of the education field, promoting all-round innovation and reform of educational organizations to transform teaching paradigms, organizational structures, teaching processes, and evaluation methods, changing from supply-driven to demand-driven, achieving high-quality and equitable education and supporting lifelong learning, to form a good education ecology that is open, adaptable, flexible, and sustainable [2].

Nowadays, experts have a growing body of empirical research to prove that the digitization of education has significant cognitive and behavioral modifications on the transformation of students' academic performance, especially the such interventions can substantially enhance the further development of students' learning ability and learning effect. Different from traditional teaching, the digitization of education requires the seamless fusion of emerging technologies within instructional ecosystems in the teaching process, not only in the classroom but also as a tool for students' self-learning outside the classroom to supplement the content that cannot be understood in the classroom, so that self-directed knowledge construction through AI-curated micro-learning modules to supplement their learning. In the classroom, teachers use digital technology for cognitive augmentation to explain the teaching materials more vividly and help students understand the difficult knowledge points in the teaching materials. Through digital technology, teachers can data-driven learner profiling the characteristics, personalities, and needs of students, to optimize classroom teaching and meet the individual needs of students. Outside the classroom, students can consolidate knowledge points that they do not diagnose or do not diagnose through digital technology. Be able to choose the courses you are interested in according to your interests and hobbies; It can also allow students to improve the three aspects of core literacy, essential character, and key competencies. This not only promotes the rational use of educational resources but also improves the problems that exist in the academic performance of students. With the country's step-by-step advocacy of digitization of education, digitization has gradually penetrated education, schools, and classrooms, and it seems that education digitization is slowly integrating with the classroom, and the digitization of education has become a trend that cannot be ignored. The report of the 20th National Congress of the Communist Party of China pointed out that it is necessary to promote the digitization of education and build a learning society and a learning country with lifelong learning for all people. Digital transformation is a new direction for the innovation and development of global education innovation. To comprehensively promote the digitization of education, it is necessary to promote the transformation of educational concepts [3].

Today, researchers debate the question of whether digital transformation in education can improve student academic performance, and come up with different arguments: one view is that digital transformation in education has a positive effect on improving student academic performance [4], and the other view is skeptical that digital transformation in education can have a positive effect on student academic performance [5]. Due to the increasing impact of digital transformation in the field of education and the deepening of its application, the teaching and design of classrooms are inseparable from the participation of digital technology. Based on the above two perspectives, this study uses meta-analysis to analyze the relevant literature, aiming to explore the following two questions: whether the digitization of education can have a positive impact on student's academic performance, in what aspects, and by which moderating variables affect the internal mechanism of its existence?

2 Study process design

2.1 Literature search and integration

The following studies refer to the literature screening process of meta-analysis for document identification, exclusion and inclusion, as shown in Figure 1.

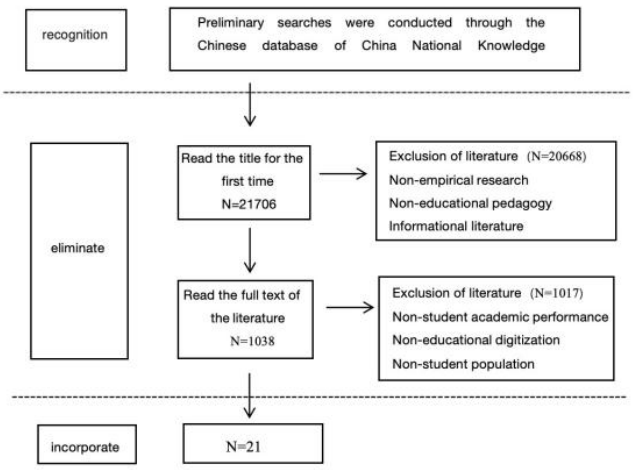

Figure 1. Flowchart of literature review process.

2.1.1 *Identify*

The research literature comes from CNKI and Web of Science, and the search in Chinese is based on keywords such as "digitization of education", "education digitization", "student academic performance" and "student learning", while in English "educational", "digital", "education digitization", "student academic performance" and "China" is searched by keywords and searched for such keywords in the title, topic or abstract. The literature was searched from January 1, 2019, to October 20, 2024, and 17,992 articles on students' academic performance and 3,714 articles on the digitization of education were retrieved, respectively, and a total of 21,706 articles were obtained. Firstly, the literature that is not empirical or experimental research in students' academic performance and digitization of education is removed, and a total of 20668 articles are excluded, and 1038 articles are preliminary available. Secondly, the combination of student academic performance and digitization of education, "education digitization", "student academic performance" and "China" was used to screen the literature, and a total of 1017 articles were excluded. Finally, 21 valid articles were identified for inclusion in this meta-analysis.

2.1.2 *Eliminate*

Literature studies that must meet the following criteria can be included in this meta-analysis study: (1) The research topic must be the relationship between digital technology and students' academic performance under the digitization of education; (2) the subject of the study must be a student; (3) It must be empirical or experimental; (4) The literature needs to have a clear data source; (5) The literature must provide data that can be calculated.

2.1.3 *Incorporate*

Finally, after the screening of the above links, 21 articles (15 Chinese literature and 6 English literature) that met the above criteria and were included in this meta-analysis study were published from 2019 to 2024.

2.2 Coding and extraction of literature features

Following established meta-analysis coding protocols [6], 21 documents that met the requirements were coded according to the characteristics of experimental sections, experimental disciplines, types of technologies used in educational digitization, and students' academic performance. Some study features were systematically extracted from the preliminary study, and the detailed coding is shown in Table 1. The results of the literature coding analysis show that the digitization of education can have a variety of impacts on students' academic performance. Therefore, based on the Compulsory Education Curriculum Plan (2022 Edition) and the core literacy evaluation framework [7], this study divides students' academic performance into two dimensions: learning ability and learning effectiveness, to analyze the impact of digitization of education on each dimension of students' academic performance. In addition, after literature coding analysis, it can be found that the impact of digitization of education on students' academic performance is not concentrated in one aspect, but on multiple aspects, such as students' critical ability [8], learning adaptation [9], information technology thinking [10], etc. Even with the help of the digitization of education, it can help promote students' in-depth learning. By drawing on the moderating variable coding framework adopted by Di et al. [11] in the study of "A meta-analysis of the impact of virtual technologies on students' spatial ability", combined with the existing literature coding information, this study identified and operated three critical moderators, learning dimensions, digital tools, and subject types as moderating variables, and tested the influence of moderating variables on the research results.

Table 1. Adjustment variable code table.

First-level dimensions	Secondary dimensions
Semester Term	Preschool, Elementary School, High School, University
Learning Degree	Learning Ability, Learning Effect
Types of digitization tools	Online Learning Platform, Computer, Others
Categories of Subjects	Humanities and Social Sciences, Information Technology, All Subjects, Others

3 Analysis of the results of the study

Meta-analysis refers to the review of the literature and the quantitative statistical analysis of the results of existing studies to summarize the conclusions of the research [12]. In this study, CMA 3.0 software was used to perform a meta-analysis of the data that met the requirements.

3.1 Publication bias tests

The existence of publication bias was investigated through an analysis of funnel plots of effect size distributions, as shown in Figure 2. The results showed that the symmetry of the funnel plot indicated a low publication bias in the study, which meant that the selection of samples and the reporting of results were fair. In addition, the validity and reliability of the samples were further verified by detailed observation of the distribution of effect sizes in the graph. The results of the study support the efficiency and reliability of the samples and provide a solid foundation for subsequent studies.

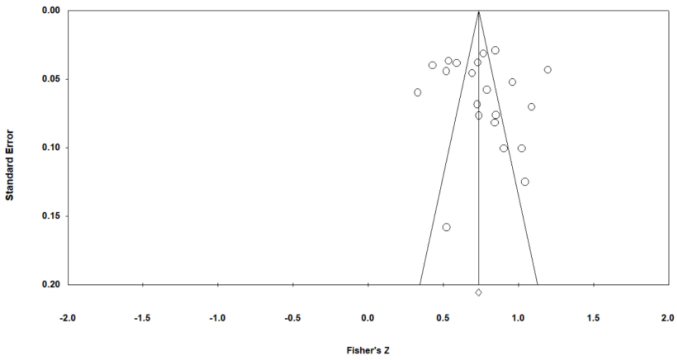

Figure 2. Funnel plot of effect size distribution.

3.2 Heterogeneity test

In this study, the heterogeneity test results of I^2 and Q values were used to select a suitable analysis model. First, the judging criterion is I^2: 0%-50% is low degree heterogeneity; I^2: 50%-75% moderate heterogeneity; I^2: 75%-100% is a high degree of heterogeneity to ensure the reliability and validity of the study results and provide a more accurate analysis basis. Secondly, through data analysis, it was found that the Q value was 370.026, the significance p-value of the Q value was less than 0.05, and the I^2 value was as high as 94.595%, exceeding the threshold of 75%. Finally, as can be seen in Figure 3, to eliminate this heterogeneity and improve the reliability of the study, a random-effects model forest plot was used to deal with the differences between samples 13-28.

3.3 Analysis of the impact of digital transformation in education on students' academic performance

3.3.1 *Analysis of the overall impact of digital transformation in education on students' academic performance*

According to Kallogjeri et al. [13] classification criteria, when the effect size is less than 0.2, it means that there is a small impact, when the effect size is between 0.2 and 0.5, it means that there is a moderate to high impact

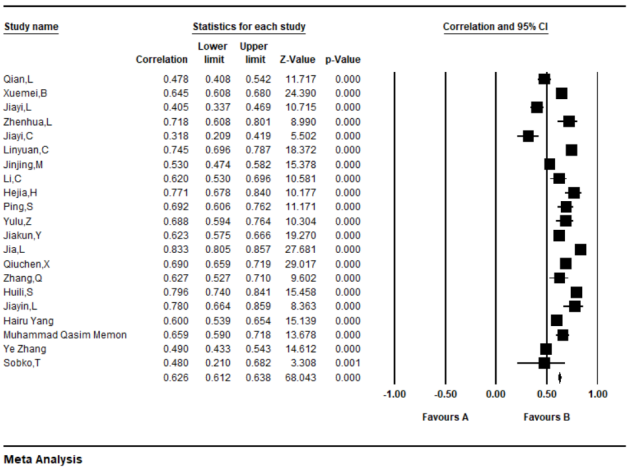

Figure 3. Random-effects model forest plots.

when the effect size is greater than or equal to 0.8, it suggests there is a high impact. The overall impact of digital transformation in education on students' academic performance is shown in Table 2, and the significant p of the impact of digital transformation on students' academic performance is less than 0.05 and the effect size is 0.644, indicating that digital transformation in education has a moderate to high degree of impact on students' academic performance.

3.3.2 *Analysis of the impact of digitization of education on students' academic performance*

To understand the impact of digital transformation in education on students' academic performance, this study analyzes two basic points of students' academic performance. As shown in Table 3, it can be seen that the significance p of learning ability is less than 0.05 and the effect size is 0.617, which shows that the digitization of education has a moderate yet circumscribed impact degree of impact on the development of students' learning ability. The significance p of the learning effect was less than 0.05 and the effect size was 0.651, indicating that the digitization of education had a small-to-moderate impact on the development of students' learning effect. These findings collectively suggest the impact of digital transformation in education on all dimensions of students' academic performance has a moderate yet circumscribed impact degree.

3.4 mechanism analysis

To systematically investigate and understand the determinants influencing students' academic performance in the context of education digitization, the following three moderating variables were incorporated as moderators.

Table 2. The overall impact of digital transformation in education on student academic performance.

Model	K-Value	Effect size	95%confidence interval		Two-tailed test		Heterogeneity test			
			lower limit	upper limit	Z-Value	p-Value	Cochran's Q statistic	degrees of freedom	p-Value	I squared statistic
Random effect model	21	0.644	0.585	0.696	15.865	0.000	370.026	20	0.000	94.595

Table 3. The influence of educational digitization on various dimensions of students' academic performance.

Dimension	K-Value	Effect size	95%confidence interval		Two-tailed test	
			lower limit	upper limit	Z-Value	p-Value
Learning Ability	14	0.617	0.535	0.687	11.517	0.000
Learning Effect	7	0.651	0.577	0.715	12.763	0.000

3.4.1 *The impact of digital transformation in education on students' academic performance at different school levels*

The mechanism analysis was carried out with different school periods as moderating variables to identify the channels of digitization of education affecting students' academic performance, as shown in Table 4. The significance p of the preschool stage was less than 0.05 and the effect size was 0.718, indicating that the significance p of the preschool stage was less than 0.05 and the effect size was 0.623, indicating that the significance p of the preschool stage was less than 0.05 and the effect size was 0.618, indicating that the significance p of the high school stage was less than 0.05 and the effect size was 0.645, indicating that the environmental environment of digitization of education had a moderate yet circumscribed impacter degree of impact on the academic performance of high school students, and the significance p of the university stage was less than 0.05 and the effect size was 0.629, indicating that the environment of digital transformation in education has a moderate yet circumscribed impact degree of impact on the academic performance of college students. Therefore, the following data can be used to illustrate that in the context of the digitization of education, there is a moderate impact on the academic performance of students at each grade level.

3.4.2 *The impact of different digital tools in education on students' academic performance*

Different educational digital tools were used as moderating variables to analyze the mechanism and identify the channels of digitization of education affecting students' academic performance, as shown in Table 5. The analysis revealed the significance p of the online learning platform is less than 0.05 and the effect size is 0.653, indicating that the online learning platform has an upper-moderate impact on student's academic performance in the context of education digital transformation, the significance p of computer is less than 0.05 and the effect size is 0.597, indicating that the impact of computer on student's academic performance is lower than moderate in the context of education digital transformation, and the significance p of other digital technologies is less than 0.05 and the effect size is 0.629, indicating that other digital technologies have a moderate yet circumscribed impacter impact on student's academic performance in the context of education digital transformation. Therefore, according to the following data, it can be shown that in the context of digitization of education, the types of digital tools in education have a moderate impact on students' academic performance.

3.4.3 *The impact of digital transformation in education on student academic performance across different subject areas*

Different subject areas were used as moderators to analyze the mechanism and identify the channels of digitization of education affecting students' academic performance, as shown in Table 6. It can be seen that the significance p of all disciplines is less than 0.05 and the effect size is 0.639, indicating that the environment of education digitization has a moderate yet circumscribed impacter degree of impact on students' learning in all disciplines, the significance p of humanities and social sciences is

Table 4. The impact of the term on students' academic performance.

Semester Term	K-Value	Effect size	95%confidence interval		Two-tailed test	
			lower limit	upper limit	Z-Value	p-Value
Preschool	1	0.718	0.608	0.801	0.899	0.000
Elementary School	3	0.623	0.290	0.822	3.313	0.001
High School	1	0.645	0.608	0.680	24.390	0.000
University	16	0.629	0.561	0.689	13.628	0.000

Table 5. The Impact of Digital Tools on Students' Academic Performance.

Types of digitization tools	K-Value	Effect size	95%confidence interval		Two-tailed test	
			lower limit	upper limit	Z-Value	p-Value
Online Learning Platform	10	0.653	0.599	0.731	10.192	0.000
Computer	5	0.597	0.453	0.711	6.725	0.000
Others	6	0.629	0.589	0.667	22.463	0.000

less than 0.05 and the effect size is 0.5, indicating that the environment of education digitization has a moderate yet circumscribed impacter degree of impact on students' learning in humanities and social sciences, the significance p of information technology is less than 0.05 and the effect size is 0.705, indicating that the environment of education digitization has a moderate to upper degree of impact on students' learning of information technology disciplines, and the significance p of other disciplines is less than 0.05 and an effect size of 0.632, indicating that the environment of education digitization has a moderate yet circumscribed impact degree of impact on students' learning in other subjects. Therefore, the following data can be used to illustrate that in the context of digitization of education, the digitization of education has a moderate impact on students' learning subject areas.

4 Conclusions and discussions

4.1 The digitization of education has a lower-to-moderate impact on student's academic performance

The results of the study showed that the pooled effect size of the impact of digital transformation in education on students' academic performance was 0.644, indicating that it had a moderate yet circumscribed impact on students' academic performance. It can be said that the digitization of education has a moderate yet circumscribed impact degree of impact on students' learning ability and learning effect. This result explains that students' learning ability, may be because the digitization of education provides students with a more vivid picture sense and rich learning resources than traditional teaching, which helps to arouse students' enthusiasm and desire for learning, to better and targeted the development of students' learning ability to a certain extent. For the learning effect of students, This phenomenon may be attributed to the digitization of education in the classroom, teachers use certain interesting means to attract students' attention, so that students' interest can stay in the classroom, and better let students concentrate and better absorb classroom knowledge. Before and after class, students can also check and fill in the gaps through digital technology tools according to the problems existing in class, to form a whole of their knowledge and better serve their learning. However, the allure of digitization in education still exists for students, and teachers and parents suggest pay attention to whether it is used in learning when students use technology for learning.

4.2 The internal mechanism of digital transformation in education affecting students' learning performance

Based on the above data, this paper can conclude that the degree of influence of the moderator variables on students' internal mechanisms on academic performance is slightly different, and the reasons are

Table 6. The impact of subject areas on student academic performance.

Categories of Subjects	K-Value	Effect size	95%confidence interval		Two-tailed test	
			lower limit	upper limit	Z-Value	p-Value
Humanities and Social Sciences	12	0.639	0.551	0.713	10.808	0.000
Information Technology	4	0.581	0.416	0.708	5.897	0.000
All Subjects	2	0.705	0.557	0.809	6.916	0.000
Others	3	0.632	0.514	0.726	8.309	0.000

as follows:

From the perspective of different stages of education manifests distinct stage-specific characteristics. The main functions and tasks of preschool education are: to implement comprehensive education for young children, prepare for young children to enter primary school, and lay a solid foundation for young children's lifelong development [14]. As the product of the integration and unity of form, sound, color, knowledge, emotion, and intention, digitally-mediated instruction intuitively, concretely, vividly, and vividly displays cognitive objects under the guidance of reasonable teaching design, which facilitates children's multi-sensory and multi-channel interactions with external stimuli, establishes a wide range of connections between the brain and external information, and can also maximize the non-intellectual factors in children [15]. In primary classrooms, the integration of digital technologies fosters more frequent and substantive teacher–student interactions, thereby enhancing differentiated instruction that supports each pupil's individual development and enabling the implementation of value-added assessments during instruction [16]. For high school students, digitization of education can further optimize the allocation of educational resources, and students can share high-level teacher resources and high-quality learning resources through the Internet [17]. Better promote high school students to supplement their studies before and after class. For students at the university stage, the knowledge-based cultivation goal is no longer adapting to the digital age, and digital technology has triggered a new "knowledge explosion". It has become possible to create knowledge by human-machine collaboration, and a large amount of "dark knowledge" has even emerged [18]. Because the digital environment has affected the talent demand in the employment market, college students also need to learn digital knowledge to acquire digital competencies competencies.

Judging from the different types of digital tools for education, the impact of digital tools used in the context of digital transformation on students' academic performance has a moderate and lower-level impact. For online learning platforms, the blended learning model driven by online open courses has brought significant help to students' exposure to high-quality course resources, improved their independent learning and knowledge reconstruction abilities, and is an important innovation in cultivating students' learning methods and enhancing knowledge-driven drive [19]. The use of this type of online learning platform meets students' learning needs; for the use of computers, the use of computers can help students cultivate their digital thinking, better use it to supplement their trinity framework abilities, and enhance integration into the digital environment. The application of new-generation information technology not only provides a strong impetus for the innovative development of digital resources in higher education but also lays a solid foundation for building a better, efficient, and equitable education system [20].

From the perspective of different experimental disciplines, the impact on different disciplines students learn in the context of digitization of education varies significantly across disciplinary domains. The subject of information technology is itself a discipline generated by the integration of education and digitization. In actual work and life, solving practical problems often requires the use of information technology. In the process of solving problems, students learn relevant information technology knowledge, complete relevant operations, and establish awareness of using information

technology. More importantly, they will cultivate core subject literacy throughout the process [21]. For disciplines like humanities and social sciences, such as Chinese, digital technology has greatly expanded the time and space of learning, broken through the traditional limitations of time and space, and learning reflects ubiquity and immediacy [22]. It further promoted the improvement of Chinese language subjects to students' academic performance.

5 Research recommendations

According to the above research conclusions, this study develops a comprehensive analytical framework on the dual challenges in practical implementation and theoretical advancement of digital transformation in education through four strategic pillars: educational research, teaching strategies, multi-stakeholder collaboration, and educator competency development:

5.1 Carry out empirical research in-depth to promote the implementation of theory into practice

Through critical examination of methodological limitations that arise during data collection in this study, recommends implementing more mixed-methods longitudinal studies from the following aspects: developmental continuum approach of the academic stages of the research population, implementing comprehensive cohort studies spanning from early childhood development(ages3-5) through post-secondary education(age22+).Investigate the longitudinal effects the digitization of education has an impact on young children's academic performance and what aspects affect preschool children. Provide more basis for whether people at different stages of education will affect students' academic performance due to the digitization of education, to better integrate the digitization of education into teaching and promote students' development.Demographic diversity, children from resource-constrained communities and neurodiverse learners can also be included in the empirical research, and the digital learning level of students' education in resource-constrained communities is conducted in-depth research, laying a solid foundation for students in resource-constrained communities to obtain the same opportunities and resources as students in developed areas to cultivate abilities and improve literacy [23]. Allow students in resource-constrained communities to enjoy the same digital resources as students in developed areas, thereby promoting the digitization of education in resource-constrained communities. Children in special education are the most special among the educational groups. The construction of an information environment is the basis for carrying out information teaching, compensating defects for special students, and developing potential. The resource optimization metrics determine the quality of applications of information technologies in special education [24]. Therefore, the digitization of education necessitates focused investigation and studied, and a certain degree of teaching changes suggest be made based on its particularity. This move aims to expand the scope of research subjects and better understand the impact of digital transformation in education on the academic performance of various groups. The third is to deeply explore the learning pathways of students. From the perspective of students' learning development, it can be more conducive to teachers conducting targeted digital teaching based on students' paths to promote students' progress and give full play to the value of digital education and entertainment.

5.2 Starting from subject teaching strategies, promote the development of students' various learning results

According to the conclusions of the impact of different experimental disciplines on students' academic performance, disciplinary-specific competency development. For example, in this study, the subject of information technology promotes the development of students' computational thinking, the subject of humanities and social sciences promotes the development of students' collaborationist competencies, other subjects promote the strengthening of students' language ability, and all subjects promote the development of students' deep learning. This study suggests that teachers can start from the perspective of interdisciplinary integration when teaching, not only focusing on teaching more than just teaching the knowledge of this subject in their classroom but also interspersing the knowledge of other subjects in teaching. Of course, it does not mean that superficial juxtaposition of disciplinary content is to teach students interdisciplinary subjects. The goal of interdisciplinary learning is to break through the knowledge separation caused by subject teaching to cultivate students' interdisciplinary literacy - integrating two or more subject fields, connecting new knowledge with existing knowledge and experience, and then connecting the real issues of community life and even global society, and promoting learners'

basic and practical understanding of learning topics [25]. Therefore, interdisciplinary knowledge suggest be systematically integrated and taught by teachers and principles of relevance and moderation. Enable students to learn knowledge from different subjects in one subject and cultivate transferable learning skills and multidimensional thinking abilities, to better promote the development of students' core competencies.

5.3 Promote the further improvement of home-school cooperation and create a digital learning environment for students

According to the conclusion of the impact of different types of educational technologies on students' academic performance, this study recommends promoting cooperation between home and school to promote the better integration of digitization into schools and families. Specifically, this paper can start from the following two aspects: From the school level, school administrators suggest prioritize collaboration with teachers to carry out curriculum modules that combine digital technology with classroom teaching, so that teachers can systematic understanding of digitization and have a certain technology-enhanced learning environment for teaching. Compared with traditional teaching, interactive digital learning spaces will enhance instructional effectiveness, allowing students to maintain cognitive engagement in the classroom and develop a certain multi-modal content delivery. This will help students to better concentrate in the classroom, thereby enhance academic performance and developmental outcomes. From a familial perspective, from the perspective of family, families suggest give students a certain amount of digital learning space, but they can tailor their approaches according to household resources. Parents suggest fulfill their supervisory role when using digital technology at home so that students can use electronic products correctly to supplement their learning. Therefore, the cooperation between home and school aims to better create a digital learning environment and promote the facilitate personalized learning pathways through targeted interventions of students' learning in a targeted manner.

5.4 Strengthen teachers' digital capabilities and promote the effectiveness of students' thinking development

According to the conclusions of the impact of the development of different experimental stages and learning dimensions, the findings indicate the necessity of strengthening teachers' digital awareness, digital application, digital technical competencies, and promoting the effectiveness of students' learning development levels. This three-phase implementation framework comprises:

Significant emphasis should be placed on developing teachers' digital competencies awareness. The "Teacher digital competencies" standard provides direction guidance and tool support for teachers to improve digital competencies, which helps to establish teacher leadership in digital pedagogy transformation [26]. Whether it is a school or a society, educational institutions must institutionalize competency development through teachers' digital competencies, and strive to improve teachers' digital competencies capabilities to cultivate digitally proficient educators through tiered professional development programs that conform to the pedagogical integration of digital tools of education.

Attach great importance to the digital competencies of teachers and the digital competencies of teachers. In the context of the digitization of education, the following measures suggest be taken to promote the improvement of teachers' digital capabilities:

At the school level, schools suggest carry out more digital-related training so that teachers can use this to strengthen their digital application capabilities and systematically address existing gaps. At the teacher level, establish peer learning communities. Teachers suggest also actively communicate with students so that digital teaching can enter the classroom and promote students' academic performance development. It is recommended also implement teaching research and activities based on digital applications based on real application scenarios, continuously demonstrate evidence-based growth of teachers' digital competencies, and use points to lead the whole to form new mechanisms, new scenarios, and new models that are conducive to the development of teachers' digital competencies [26].

Data Availability Statement

Data will be made available on request.

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Conflicts of Interest

The author declares no conflicts of interest.

Ethical Approval and Consent to Participate

Not applicable.

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