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An Empirical Study and Analysis on the Implementation of the "MSF" Teaching Mode in the Context of Improving Teachers' Digital Literacy

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Abstract

In China, the digital transformation has created new demands for talent development. Enhancing teachers' digital literacy and technical skills has become an urgent priority, serving as a critical task for achieving educational modernization and building a world-class education powerhouse. The Outline of the Plan for Building a Strong Education Nation (2024-2035) explicitly states that improving teachers' information technology application capabilities should be prioritized, with regular assessments of digital literacy to enable dynamic monitoring of educators' technological proficiency. This study developed a new teaching model for the course "Computer and Computational Thinking" and analyzed the teaching model using the Flanders classroom teaching interaction analysis method. The results showed that the MOOC + SPOCs + flipped classroom teaching model effectively improved students' active participation in class, which further improved teachers' practical application ability in digital literacy. This demonstrates that digital literacy among teachers has garnered widespread attention across all levels of national governance. Currently, defining the essence of teacher digital literacy with clarity, conducting in-depth investigations into its current status, accurately identifying challenges in the improvement process, and actively exploring effective enhancement strategies have become crucial tasks in the education sector.

Keywords

Teacher Digital Literacy, Flemish Analysis, MOOC, Classroom Interaction

1. Introduction

In the current era of a deepening technological revolution and industrial transformation, the global digital transformation process is accelerating rapidly. Digital government initiatives, digital economy development, and other sectors are advancing in depth. With emerging technologies like artificial intelligence and big data being widely integrated into education, educational digitization has become a prominent focus in the field and a core direction for future educational reform. As digital technology becomes deeply embedded in teaching practices, teachers' digital literacy and skills have emerged as a global priority. Countries worldwide are actively implementing measures to cultivate educators' digital application capabilities (Zhang et al., 2025). For instance, UNESCO's 2011 Framework for Teacher Information and Communication Technology Competencies provides detailed guidelines on essential skills for effective digital-assisted instruction (Kong et al., 2025). Similarly, the International Society for Technology in Education (ISTE) released its 2017 Educator Standards, which analyze teachers' evolving roles in information-era education from multiple perspectives, clarifying professional responsibilities and competency benchmarks to promote innovative teaching through digital technologies (Deng & Zhang, 2025).

In China, digital transformation has created new demands for talent development. Enhancing teachers' digital literacy and technical skills has become an urgent priority, serving as a critical task for achieving educational modernization and building a world-class education powerhouse. The Outline of the Plan for Building a Strong Education Nation (2024-2035) explicitly states that improving teachers' information technology application capabilities requires implementing regular digital literacy assessments to enable dynamic monitoring of their proficiency (Ministry of Education of the People's Republic of China, 2025). This demonstrates that teacher digital literacy has garnered widespread attention across all levels of national governance.

In 2023, the Ministry of Education officially released the Standards for Teachers' Digital Literacy, which provides an authoritative definition: "Teachers' digital literacy refers to the awareness, capabilities, and responsibilities that teachers possess to appropriately use digital technologies to acquire, process, utilize, manage, and evaluate digital information and resources, identify, analyze, and solve educational and teaching problems, as well as optimize, innovate, and transform educational and teaching activities."

According to the Standards for Teachers' Digital Literacy, the framework of teachers' digital literacy comprises five first-level dimensions: Digital Awareness, Digital Technology Knowledge and Skills, Digital Application, Digital Social Responsibility, and Professional Development. On the basis of fully learning and understanding these contents, teachers should further apply these five aspects to practical scenarios (Fu & Chen, 2025).

Since 210, Southwest Petroleum University has been pioneering educational digitalization (Zhang et al., 2024). In online education, the university has launched over 3,000 courses, including several nationally recognized programs. In recent years, it has organized the "Mengxi" teaching competition series and initiated various educational reform projects across different themes, comprehensively enhancing faculty innovation capabilities and digital literacy through multifaceted approaches.

"Computer and Computational Thinking" stands as a pivotal course in the university's educational reform initiative, having earned multiple national and provincial awards. The MOOC + SPOCs + flipped classroom model (abbreviated as MSF) implemented in this course represents the first large-scale adoption of blended online-offline pedagogy in Guxin universities, pioneering the application of this innovative framework that has significantly boosted student performance and competition success rates. However, subsequent analysis of student feedback during practical evaluations revealed...

The main problems can be summarized as follows:

A small number of students and teachers have not fully accepted the MSF teaching mode, so it is difficult to adapt well in a short time.

B. Some students have not developed good self-study habits, and they are not sufficiently prepared before the implementation of the flipped classroom. Students have no sense of learning in the new teaching mode, and they are insufficient in their ability to summarize and present problems.

C. Different students have different willpower, which leads to differences in subsequent learning, and the results of different teaching classes also vary.

D The current evaluation system, which combines online and offline assessments, remains imperfect. Online performance metrics require further refinement due to platform limitations. Offline evaluations primarily rely on group scores, failing to differentiate individual student performance. Overall, the assessment framework still lacks comprehensive and objective measures to accurately reflect students' genuine academic efforts.

2. Specific Teaching Design and Improvement Measures

As illustrated in the diagram, the MSF instructional design comprises two phases and three components: online and offline stages, as well as pre-class, in-class, and post-class phases. During the pre-class phase, students watch recommended videos or independently search for materials according to personalized learning plans based on teachers' assigned objectives (**Figure 1**). When encountering difficulties or uncertainties, they can explore solutions through discussions. Pre-class preparation serves as the foundation for in-class learning, while in-class discussions elevate and refine pre-class knowledge. The MSF teaching model fundamentally belongs to online education, where the relationalist perspective of networked learning plays a crucial role. Teachers employ problem-oriented methodologies to design diverse instructional activities, creating "knowledge pipeline" nodes for students. Guided by teachers, students progressively overcome challenges, achieving a leap from their "actual development zone" to the "zone of proximal development." The post-class phase reinforces and expands classroom learning, while in-class activities consolidate and refine post-class knowledge. Students promptly reinforce acquired knowledge through post-class sessions, with their in-class learning outcomes serving as the basis for post-class evaluation.

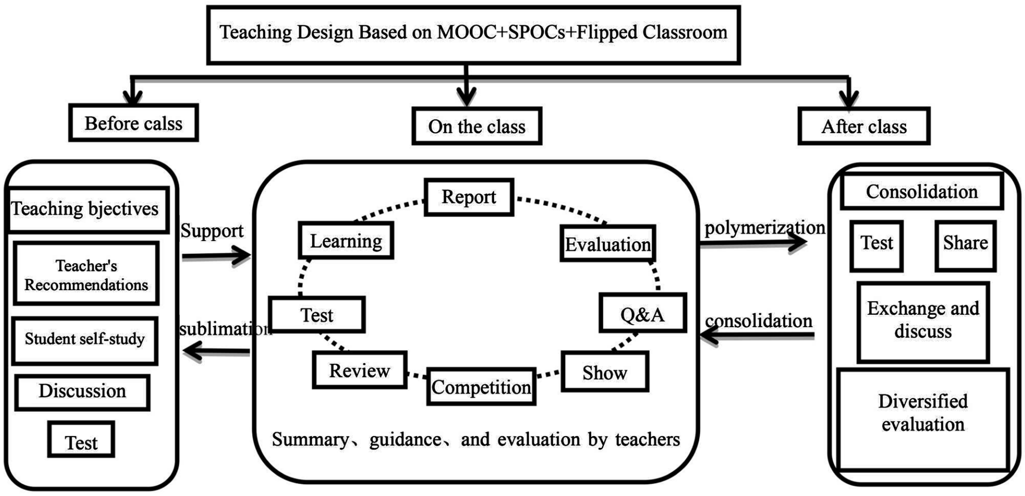

Figure 1. MSF teaching mode online and offline teaching design scheme (Zhang et al., 2024).

In view of the above concentrated problems, we put forward the following rectification plan through discussion.

Analysis of the first and second questions shows that this is a problem throughout the whole teaching process. For this, we propose a "three-stage" strategy, as shown in Figure 2.

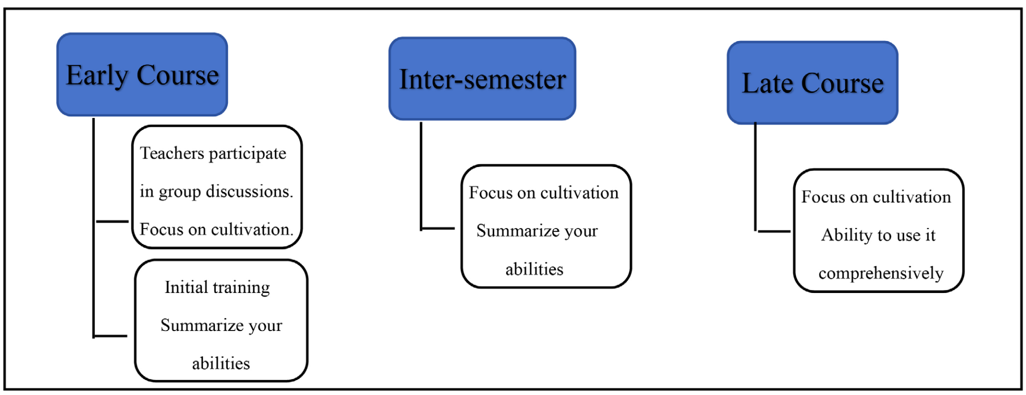

Figure 2. "Three stages" strategy.

The "Three-Stage" strategy refers to: 1. The first stage, "Early Curriculum," where students primarily struggle with failing to identify key points in given questions, and some even fail to comprehend the questions. This actually reflects students' lack of proactive exploration skills. Many students lack this self-driven awareness and immediately seek teachers' help when encountering difficulties—a habit previously praised in pre-high school education models. However, in real-world social survival, proactive exploration remains a fundamental human skill. During this transitional phase, teachers need to act as "guides." Initially, educators should invest more effort by personally participating in group discussions, providing guidance and clarification on unclear or misunderstood concepts to help students develop this habit, which is crucial for future learning. This stage focuses on cultivating summarization and knowledge application abilities, emphasizing the development of knowledge extraction skills; 2. The second stage, "Mid Curriculum," where students face challenges in integrating and summarizing knowledge. During this period, teachers' primary task is to cultivate students' ability to actively summarize and synthesize information, appropriately utilizing auxiliary tools like mind maps. Furthermore, teachers should actively foster students' intellectual curiosity by providing equal opportunities for self-expression, encouraging them to confidently showcase their abilities. 3. The "final phase" of the curriculum primarily evaluates students' ability to synthesize and apply knowledge. During this stage, educators should guide students to adopt a strategic perspective, requiring them to holistically apply acquired knowledge to solve problems. To enhance engagement, teachers can introduce a competitive element during group presentations by publicly announcing scores in real time. This approach ensures score transparency without controversy while naturally sparking healthy competition between groups—particularly when comparing two teams tackling identical discussion topics. Through this dynamic, students actively participate and monitor progress, demonstrating their role as self-driven learners.

Regarding the third question about "students' soft skills," we implement a "team leader supervision and member collaboration" approach. While developing soft skills takes time, their impact is profound once established. Since students spend most of their time interacting with peers during their school years, this collaborative model not only strengthens team cohesion but also creates mutual accountability, which drives collective growth.

Finally, as I think all teachers will face this problem, there is little differentiation in the evaluation scores between group members. For this reason, we have formed a diversified evaluation system based on outcome orientation, as shown in Figure 3 below.

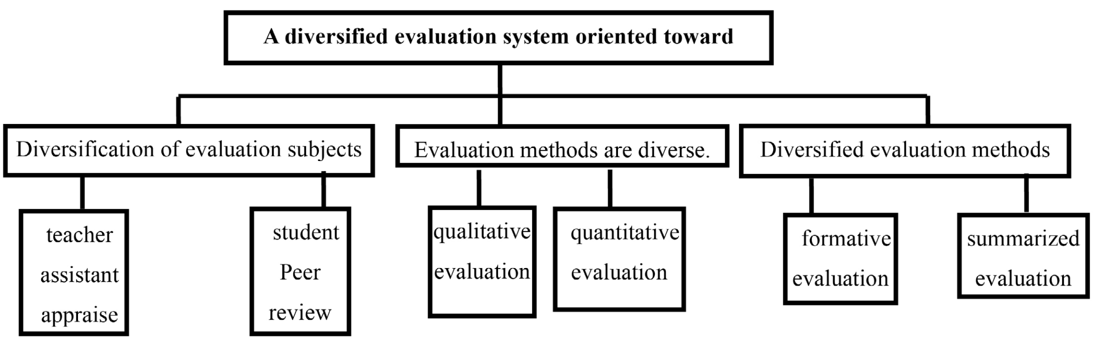

Figure 3. Achievement-oriented, diversified evaluation system.

According to the above evaluation system, the curriculum group has formulated the following specific implementation of teaching evaluation, as shown in

Figure 4 below.

<table>
<tr><td colspan="10">Computer and Computational Thinking 100</td></tr>
<tr><td colspan="4">Operational practice 40%</td><td colspan="6">Computational thinking 60%</td></tr>
<tr><td colspan="3">Average score 30%</td><td rowspan="2">Midterm exam score: 70%</td><td colspan="3">Online results 40%</td><td colspan="3">Offline performance 60%</td></tr>
<tr><td>Attendance 50%</td><td>Operational practice video viewing 20%</td><td>Examination system assignment score: 30%</td><td>MOOC video viewing 50%</td><td>Online homework accounts for 30%.</td><td>Online discussion score: 20%</td><td>Discussing documents accounts for 30% of the score.</td><td>Discussion participation accounts for 30% of the score.</td><td>Final exam score: 40%</td></tr>
</table>

Figure 4. Specific content of diversified and multi-level teaching evaluation.

This teaching initiative adopts a diversified evaluation approach under the outcome-oriented framework, primarily manifested in three aspects: 1. Diversified Evaluation Subjects: The assessment process no longer relies solely on teachers, with peer evaluations incorporated into the system. This better embodies student-centered principles, as peer reviews significantly boost learning motivation. 2. Diversified Evaluation Methods: The evaluation approach now extends beyond midterm and final exam scores to emphasize students' performance during the learning process and their creative outputs, including discussions presented and presentations made. 3. Diversified Evaluation Approaches: A combination of formative and summative assessments is employed, providing students with ample opportunities to showcase their capabilities.

In addition, we give more power to the group leader in the actual application process because the group leader has a longer participation time than the teacher in the whole learning process of the group, and let the group leader participate in the offline group members' evaluation, which can ensure the objectivity and fairness of the evaluation.

When students are found plagiarizing assignments, teachers immediately deduct their discussion scores and publicly announce the names anonymously to serve as a deterrent. For those who merely complete assignments perfunctorily, we publicly disclose their group's lowest scores during class discussions and provide improvement opportunities. Students who demonstrate proper rectification in final assignments will have their individual grades unaffected, while those failing to make corrections will face grade deductions. This approach cultivates collective responsibility awareness through the concept of "collective honor," enhancing students' accountability towards both themselves and their groups.

3. Rectification Effect and Conclusion

The most widely used method for classroom interaction analysis is the Flanders Interaction Analysis System (FIA). This system analyzes teacher-student interactions in classroom recordings through three main components: 1) A coding system (i.e., scale) that describes interactive behaviors; 2) Standardized criteria for observing and recording coded data; 3) A transfer matrix for displaying data and conducting analyses to achieve research objectives. Over time, the FIA has been developed into a practical software application (Xu et al., 2025). The improved FIA coding scale we use is shown in **Table 1** below.

Table 1. Improved Flemish coding scale.

First dimension	Second dimension	Encoding	Behavioral content	Description of behavioral norms
Education teacher language speech	indirect influence	1	Teachers embrace emotion	Accept or clarify the student in a calm tone.
		2	Encourage praise and compliments.	Praise, commendation, and encouragement
		3	Teachers accept advice	Modify or expand the student's statement.
		4	The teacher asked open questions.	There is no single answer.
	Direct influence	5	Teachers ask closed questions.	A question with a definite and unique answer
		6	professor	Elaborate on a concept or phenomenon.
		7	instruct	Order or instruct a student to do so.
		8	criticize	Denying or blaming students
Student language		9	Students respond passively	Teachers designated
		10	Students respond reactively	Take the initiative to express opinions or respond to teachers.
		11	Students take the initiative to ask questions.	Take the initiative to ask about your doubts.
		12	Students discuss with peers.	Share your opinions with others.
Reticent		13	Ineffective silence or confusion	Students are distracted, looking down, or making noise.
		14	Good silencing	Think or take notes, practice.
Technology		15	Teachers take the initiative.	Teachers take the initiative to use the Internet and multimedia tools.
		16	Students take the initiative.	Teachers take the initiative to use the Internet and multimedia tools.

With the help of the improved scale, the average data of the three teachers were analyzed to form the migration matrix, as shown in **Figure 5**.

The cells in the diagonal (top-left to bottom-right) of the table are called "steady-state cells," indicating that a behavior has persisted for over three seconds. For example, the numbers in the 3-3 steady-state cell represent teachers continuously revising or expanding students' ideas. The 11-11 steady-state cell shows active participation from classmates during student presentations, while the 16-16 steady-state cell indicates that students consistently used media tools to support their presentations throughout this period.

The closed loop formed by the four cells 3-3, 3-12, 12-3, and 12-12 shows that teachers induce students to actively speak by accepting or adopting students' opinions, which represents the degree of innovative questioning. The data in **Figure 5** also show that the setting of innovative questions by teachers can be further strengthened.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	合计
1	3	10	32	4	2					3		1					55
2	5	18	40	5	1					8		6	1	2	4	12	102
3	5	23	30	17	2				1	20	10			2	7	11	128
4	10	8	3	0						5	4						30
5	2	6	1			4						1				2	16
6	1	1	1		1					20	4				9	5	42
7	1	2		1							1						5
8																	0
9	2									2							4
10	10	8	11	1	5		3			36	10	2	1	7	2	25	121
11	2	6	2		3	10				12	15	10		10	20	9	99
12	6	4									16			6		16	48
13				1							1					1	3
14	2	5									13	3		2	5	7	37
15		1		1		2					10	8		4	6	29	61
16	6	10	8		2	26	2		3	15	15	17	1	4	8	31	148
合计	55	102	128	30	16	42	5	0	4	121	99	48	3	37	61	148	900

Figure 5. Migration matrix formed by the average data of three teachers in the improved MSF teaching model.

In view of the whole classroom teacher-student interaction, we can combine the following data table and elaborate on the following aspects (SEE Table 2):

Table 2. Statistics of classroom interaction behavior ratios.

Variable	Rate of verbal communication (%)
Teacher language ratio	42
Student-to-language ratio	30.3
Depression rate	4
The ratio of students thinking about problems in silence	90
The percentage of open-ended questions asked	65
The percentage of open-ended questions asked	35
Technology utilization rate	23

(1) Classroom atmosphere

The intersection area of rows 1 - 5 and columns 1 - 5 in the matrix represents the positive integration grid. A high frequency of records in this region indicates a harmonious emotional atmosphere between teachers and students. Table 1 shows that classroom interactions were predominantly teacher-led, with encouragement, timely feedback on student shortcomings, and extended explanations of knowledge points. The intersection area of rows 6 - 8 and columns 6 - 8 constitutes the deficiency grid. The table reveals minimal instances of teacher directives or student reprimands during lessons. Notably, the positive integration grid accounted for 37% of total records, while the deficiency grid recorded zero occurrences, demonstrating a relatively harmonious emotional dynamic between teachers and students in this class.

(2) Classroom structure

In this class, the teacher's language ratio (1 - 8 columns/total) was 42%, and the students' language ratio (9 - 12 columns/total) was 30.3%. It can be seen that the teacher's guidance and the affirmation, modification, and expansion of students' opinions accounted for a larger proportion, which reflects the irreplaceable role of teachers in the MSF teaching mode.

The disengagement rate (13 - 14th row occurrences/total occurrences) was 4%, with 90% of these instances occurring during student-led group discussions, exercises, or critical thinking activities that aligned with teacher expectations, indicating high instructional engagement throughout the class. Open-ended questions posed by teachers were approximately twice as frequent as closed-ended ones, demonstrating educators' emphasis on developing students' divergent thinking skills.

The student-led speaking ratio (10-11th column count / 9-12th column count) stands at 87%, indicating that students actively participate in classroom discussions. However, this figure actually reflects a proportion higher than 87%, as it includes both teacher-responsive responses and peer interactions. This demonstrates that students maintain a dominant role in classroom dynamics.

(3) Teacher bias

The ratio of direct to indirect teaching in this classroom (6th-8th column occurrences/1st-5th column occurrences) stands at 10%, indicating that teachers' traditional lecture-based and directive approaches are gradually fading from the classroom. The positive-to-negative influence ratio (2nd column occurrence/7th-8th column occurrences) reaches 200%, demonstrating educators' emphasis on positive influences such as encouragement and praise toward students.

(4) Technology application

The application rate of students' technology accounts for 16%, which shows that students are good at applying technology to practice. This also reflects the auxiliary role of practical courses to theoretical courses.

In order to further analyze the effect of rectification, we use CT for the classroom in 2015 and GT for the flipped classroom in 2016. After processing, we obtain the following data analysis chart shown in **Table 3**.

Table 3. Processing results of the Flemish classroom interaction coding system.

Variable	Contract write	Computational formula	CT1	GT1	CT2	GT2	CT3	GT3	2023 Classroom Summary	2024 Classroom Summary
Teacher language ratio (%)	R1	[XW1 + XW2 + … XW7]/Total	53.4	40.0	35.2	39.0	40.9	47.0	43.5	42
Student language ratio (%)	R2	[XW8 + W9]/Total	18.0	23.9	25	35.0	37	32.0	28	30.3
Effective silence rate (%)	R3	[XW13 + XW14 + XW15]/Total	26.9	33	37.8	26.2	20.0	19.0	23.4	25.7
Ineffective silence ratio (%)	R4	[XW16]/Total	0.1	0.0	0.2	0.0	0.1	0.1	0.13	0.0

Continued

Teacher behavior ratio (%)	R5	[XW1 + XW2 + … XW8 + XW15]/Total	60.5	52.0	40.0	47.3	46.8	40.8	49.8	46.7
Student behavior ratio (%)	R6	[XW9 + XW10 + XW11…XW14]/Total	40.0	43.3	59.8	60.3	52.3	50.0	50.9	51.2

American psychologist Carl Rogers' research revealed that in traditional classrooms, teachers' verbal input far outweighs students'. American educator David Baleycke's data-driven analysis using extensive statistical modeling confirmed this disparity: during standard classroom interactions, teachers' speech accounts for 68% of total communication, while student contributions make up 20%, resulting in a striking 3.4:1 ratio. Through Baleycke's data analysis model and processing of classroom-collected data, we have reached the following conclusions:

A. As can be seen from the data in the table, the teacher's language ratio in the improved MSF teaching mode in 2024 decreased compared with that in 2023, indicating that teachers transferred more classroom discourse power to students as a whole and paid more attention to student-centered teaching.

B. The improved MSF teaching model achieved an effective teacher-student language ratio of approximately 1.4:1, a reduction from the 2015 level of 1.7:1. This indicates that instructors are now more focused on guiding students to develop skills in knowledge summarization, synthesis, and practical application. Data from R2 also demonstrate that the post-reform student effective language ratio has shown significant improvement, reflecting positive educational outcomes. 2. The improved MSF teaching model achieved an effective teacher-student language ratio of approximately 1.4:1, a reduction from the 2015 level of 1.7:1. This indicates that instructors are now more focused on guiding students to develop skills in knowledge summarization, synthesis, and practical application. Data from R2 also demonstrate that the post-reform student language ratio has shown significant improvement, reflecting positive educational outcomes.

C. The values in the table show that the R3 value in 2016 is higher than that in 2015, indicating that students can think more effectively in class. The values of R5 and R6 indicate that a larger proportion of students dominate the classroom, while teachers' behavior is reduced.

In addition, through the overall operation and implementation of the MSF teaching model, data comparison shows that in the MSF teaching model in 2023 and 2024, compared with the traditional model dominated by teachers' in-class lectures and supplemented by students' online learning, students' final exam scores increased by 4.8 points and 5.6 points respectively, and the proportion of students with excellent grades rose by 8.2% and 18.3% respectively. This indicates that the MSF-based teaching model has met students' diversified and personalized needs to a certain extent and improved their learning engagement.

4. Implementation of the MSF Teaching Model

Change in Awareness and Attitude: Teachers generally recognize the importance of digital technology in teaching, and their willingness to proactively seek digital technology support for teaching has been significantly enhanced. Surveys show that after the implementation of the MSF model, 85% of teachers stated that they would take the initiative to pay attention to updates of digital teaching tools, and 70% of teachers believed that digital technology is a key factor in improving teaching quality, representing a significant increase compared with the period before implementation.

Significant Improvement in Skills: Teachers have made remarkable progress in digital skills such as the use of teaching software and data processing and analysis. For example, 90% of teachers can proficiently use Wenjuanxing (a professional online questionnaire platform) to design teaching feedback questionnaires, and 75% of teachers can use Excel for basic data statistical analysis and to create data visualization charts to provide data support for teaching decision-making.

Optimization of Teaching Application: Teachers have deeply integrated digital technology into all aspects of teaching, resulting in more flexible and diverse teaching methods and improved teaching outcomes. Classroom interaction has been enhanced, and teaching content has become more targeted. After adjustments based on multi-source feedback, students' mastery of knowledge has been significantly improved.

Accelerated Professional Development: Teachers' enthusiasm for participating in digital teaching research has increased. After the implementation of the MSF model, the number of papers related to digital teaching published by teachers in the school has increased by 30%, and the number of teaching reform projects they participated in has increased by 25%, indicating a continuous improvement in teachers' professional capabilities.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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