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Application and Innovation Research of Digital Intelligent Media Technology in Mathematics Teaching in Higher Vocational Colleges

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Abstract: *In mathematics teaching in higher vocational colleges, teachers are often accustomed to traditional teaching methods and have a low acceptance of emerging digital intelligent technologies. To this end, this study explores the application and innovation of digital intelligent media technology in higher vocational mathematics teaching, focusing on the analysis of the reform of curriculum setting, teaching model and evaluation mechanism, and verifies the effectiveness of relevant methods through experiments. First, the study points out that higher vocational mathematics courses cover basic theories and practical applications, focus on the design of practical links, and gradually shift the teaching model from teacher-centered to student-centered, emphasizing the combination of independent learning and cooperative learning. Secondly, this paper introduces the application of intelligent learning platform in mathematics teaching, and analyzes the practice of generating learning portraits through student learning data to help teachers provide personalized tutoring. The reform of the evaluation mechanism not only combines individual, group, self and other evaluations but also incorporates moral education assessment and professional quality cultivation into the evaluation system to comprehensively improve the teaching quality. The experimental results show that metaverse technology effectively enhances students' sense of participation and practical ability, and improves their mathematical application and innovative thinking abilities. The change in the role of teachers enables students to gain a deeper learning experience through interaction and cooperation. Through these innovative teaching methods, digital intelligent media technology provides new teaching experiences and learning methods for higher vocational mathematics education, laying a solid foundation for students' career development.*

Keywords: *Digital Intelligent Media Technology; Mathematics Teaching In Higher Vocational Colleges; Teaching Model; Intelligent Learning Platform; Metaverse Technology; Experimental Research*

1. Introduction

In recent years, the rise of technologies such as metaverse, virtual reality, and augmented reality has provided broad space for innovation in the field of education. These technologies can provide students with an immersive learning experience, enabling them to understand abstract mathematical concepts more intuitively and vividly, and promote active learning through interaction and exploration. This study takes mathematics courses in higher vocational colleges as the research object to explore the application effect of digital intelligent media technology in mathematics teaching. By introducing advanced educational technology and combining it with the actual teaching of mathematical analysis and probability statistics courses, the experiment explores the potential of digital technology in improving students' learning interest, enhancing classroom interaction and improving academic performance. The research results not only provide a theoretical basis for the teaching reform of higher vocational colleges but also provide practical experience for the further application and optimization of educational technology.

The article first reviews the development background and application status of digital intelligent media technology in education, and then analyzes the characteristics and challenges of mathematics teaching in higher vocational colleges. On this basis, the study focuses on how to combine digital intelligent media technology with mathematics courses and proposes specific teaching designs and implementation plans. Through experimental analysis, this study evaluates the effectiveness of the technology in improving students' learning interest, classroom interactivity, and academic performance.

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Finally, the paper summarizes the main findings of the study and puts forward suggestions for future applications and improvements.

2. Related Works

In order to provide an important perspective for in-depth exploration of various factors in mathematics education, we will combine different studies to further analyze the related issues of teacher education, technology integration and mathematics teaching. Saadati and Celis aimed to verify the validity of an instrument to measure students' motivational beliefs in mathematics, including self-efficacy, intrinsic motivation, and extrinsic motivational goal orientation, and to explore the relationship between school environment and students' motivational beliefs. The results showed that the instrument was reliable and valid, and that there were differences in students' age and school type and motivational belief levels [1]. Luzano analyzed the professional practices and standards of mathematics in higher education through a literature review, exploring historical issues, common concerns, incremental results, positive impacts, teaching advantages, significance to the academic community, and long-term impact on mathematics teachers [2]. Karim and Zoker analyzed the issues related to technology integration in mathematics education in senior secondary schools in Masingbi. Although technology-integrated teaching methods were considered to have advantages, teachers' teaching beliefs and lack of continuous professional training and curriculum expectations were the main barriers affecting their attitudes [3]. Supriyadi and Kuncoro provided a comprehensive overview of future mathematics teaching from the perspective of ChatGPT. The results showed that future mathematics teaching will integrate technology and artificial intelligence to provide personalized learning experiences, blended learning environments, and strengthen computational thinking, data literacy, and statistics [4]. Livy and Muir analyzed an open-ended questionnaire survey of 94 in-service teachers and 82 pre-service teachers and found that teachers generally faced obstacles such as lack of teaching knowledge and confidence, and time constraints, while the teaching effectiveness of children's literature and the appeal of the stories were the main promoting factors [5]. Goos et al. evaluated the impact of the Professional Diploma in Mathematics Teaching, a national professional development program for non-subject teachers in Ireland. The results showed that six years after the program was implemented, the proportion of non-subject mathematics teaching had decreased, and graduates had more opportunities to teach advanced mathematics courses [6].

Petty et al. collected data through semi-structured interviews, diaries, and field notes, and the results showed that positive interpersonal interactions and collective collaboration promoted teachers' sense of connection, thereby improving learning outcomes [7]. Girit Yildiz et al. explored how future mathematics teachers can pay attention to, interpret, and respond to students’ mathematical misunderstandings through a professional development environment using video cases. The results showed that future teachers need to have sufficient opportunities for reflection in their professional environment in order to develop the ability to pay attention to students’ thinking [8]. Liang et al. explored the experiences of three future secondary mathematics teachers in Hong Kong, China in higher education and secondary mathematics classrooms, focusing on their identities, mathematical knowledge, and experience construction in these two environments. They found that there were significant differences in their experiences in these two contexts, which helps to deepen the understanding of the "double break in mathematics" phenomenon [9]. Wasserman et al. explored the practical significance of university mathematics for secondary school mathematics teaching, especially the challenges in secondary school mathematics teacher education [10]. Nguyen and Tran explored the impact of lesson study (LS) in designing and implementing challenging tasks on the knowledge and beliefs of Vietnamese high school mathematics teachers. The results showed that teachers developed professional content knowledge by focusing on students' mathematical performance and using students' responses to create cognitive conflicts [11]. Pinto and Koichu explored the different perspectives and experiences of Secondary to Tertiary Transition Teachers (STT) in university mathematics. The results showed that although the jump orientation was still the most common STT improvement method, university mathematics teachers' discussions on STT became more diverse and detailed [12]. The bottleneck of existing research is that there is insufficient discussion on the actual challenges teachers face in classroom teaching, the specific influencing mechanisms of motivational beliefs, and the multicultural background in the educational environment [13].

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3. Methods

3.1 Curriculum Setting and Teaching Mode Reform of Digital Media Technology in Higher Vocational Mathematics Teaching

The curriculum setting of higher vocational mathematics covers multiple levels of basic mathematical theories and applied skills. Core courses include mathematical analysis, linear algebra, probability and statistics, calculus, discrete mathematics, etc., which aim to help students master basic mathematical concepts and methods. At the same time, they also focus on applying mathematics to practical scenarios and cultivating students' ability to solve practical problems. In addition, the school also attaches importance to the design of practical links, adopting project-based teaching, internships and training to promote students to combine mathematical theory with practice and improve their practical operation capabilities. In terms of teaching mode, higher vocational mathematics education is gradually shifting to a student-centered model. Teachers are no longer just knowledge transmitters, but guides and supporters of students' learning process.

Students actively participate in it through independent learning, cooperative learning, etc., and teachers provide personalized tutoring and guidance. With the development of information technology, online teaching and hybrid teaching modes have gradually been introduced, allowing students to learn according to their own needs and pace, enhancing the flexibility and convenience of learning.

3.2 Intelligent Learning Platform Optimizes the Management and Evaluation Mechanism of Mathematics Teaching in Higher Vocational Schools

In the context of technology empowerment, the teaching team optimized the teaching activity management and learning evaluation mechanism of mathematics courses through the intelligent learning platform. The platform generates a learning profile of students by collecting data about students during their learning process, such as course attendance, study time, task completion, discussion posts, etc. Teachers use this data to evaluate students' learning progress and results in real time, conduct personalized coaching and teaching adjustments, and improve the pertinence and effectiveness of teaching.

In terms of the evaluation mechanism, the teaching team incorporates multi-dimensional evaluation elements such as individual evaluation, group evaluation, self-evaluation and other evaluation into the comprehensive evaluation system. In mathematics courses, students need to regularly demonstrate their learning outcomes, conduct self-reflection and peer evaluation. Teachers comprehensively evaluate students' learning performance and abilities through project practice and problem solving. In addition, the evaluation system of mathematics courses also combines moral education assessment with professional quality, assessing students' teamwork spirit, subject ethics and cultural values, etc., so as to achieve the dual cultivation of academic ability and comprehensive quality.

3.3 Characteristics and Innovation of Reform

3.3.1 New learning environment and experience

Through the application of metaverse technology, a virtual three-dimensional mathematics learning environment is created, where students can explore mathematical concepts and applications and solve problems through mathematical modeling and simulation in the virtual world. The interaction of virtual characters and participation in virtual projects enable students to have an immersive learning experience, enhancing the fun and immersion of learning.

3.3.2 Personalized learning and independent exploration

The Metaverse digital intelligent teaching model provides students with personalized learning paths and resources. Especially in mathematics learning, students can choose learning content and progress according to their own foundation and interests. Teachers encourage students to explore independently, raise questions and try to solve them, and cultivate their innovative thinking and mathematical modeling skills.

3.3.3 Practice-oriented learning

Through the Metaverse digital intelligent teaching model, students can participate in actual mathematical modeling, data analysis and other projects, and apply the mathematical knowledge they

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have learned to solve practical problems. This project-driven learning method not only improves students' hands-on ability but also enhances their professional qualities in solving complex problems, laying the foundation for their future career development.

3.3.4 Teacher role transformation

Under the Metaverse digital intelligent teaching model, the teacher's role changes from a traditional lecturer to a guide and learning supporter. Teachers use tools and resources in the Metaverse to design learning activities, organize students to interact and collaborate, encourage students to actively participate, and improve students' mathematical thinking and problem-solving abilities. Through these innovative teaching methods and models, digital intelligent media technology has brought new teaching experiences and learning methods to higher vocational mathematics teaching, which helps to improve students' mathematical application ability, innovative thinking and comprehensive quality, and lay a solid foundation for their future careers.

4. Results and Discussion

4.1 Experimental Objectives

This experiment aims to verify the effectiveness of digital intelligent media technology (including metaverse technology and intelligent learning platform) in improving the quality of higher vocational mathematics education. Specifically, the experiments will evaluate the impact of these technologies on student engagement, learning outcomes, problem-solving skills, and creative thinking in mathematics.

4.2 Hypothesis

(1) Hypothesis 1(H1): The application of metaverse technology can significantly enhance students' participation and engagement in mathematics learning.

(2) Hypothesis 2 (H2): Students who use intelligent learning platforms for personalized learning have better academic performance and understanding of mathematical concepts than students who use traditional teaching methods.

(3) Hypothesis 3 (H3): Using project-based learning and practical problem solving in a virtual environment can significantly improve students' ability to apply mathematical theories to practical problems.

(4) Hypothesis 4 (H4): The combination of personalized learning and collaborative learning in a metaverse environment can enhance students' innovation and critical thinking abilities in mathematics.

4.3 Participants

The sample is 20 students of vocational college mathematics courses; experimental group: 10 students use the teaching model based on digital intelligent media technology (including metaverse technology and intelligent learning platform); control group: 10 students use the traditional face-to-face teaching model without using advanced technology.

4.4 Experimental Design

The experiment will be conducted in two courses, "Mathematical Analysis" and "Probability and Statistics", with the same course content to ensure the fairness of the experiment. Students in the experimental group used the Metaverse platform to conduct virtual mathematical modeling, simulation and exploration, participated in interactive learning, and used the intelligent learning platform for personalized learning and real-time feedback. The control group adopted the traditional teaching method, with teachers imparting knowledge through classroom lectures and homework.

4.5 Learning Assessment

4.5.1 Participation

Students' learning enthusiasm is assessed through multi-dimensional data such as class participation, online discussions, and homework completion.

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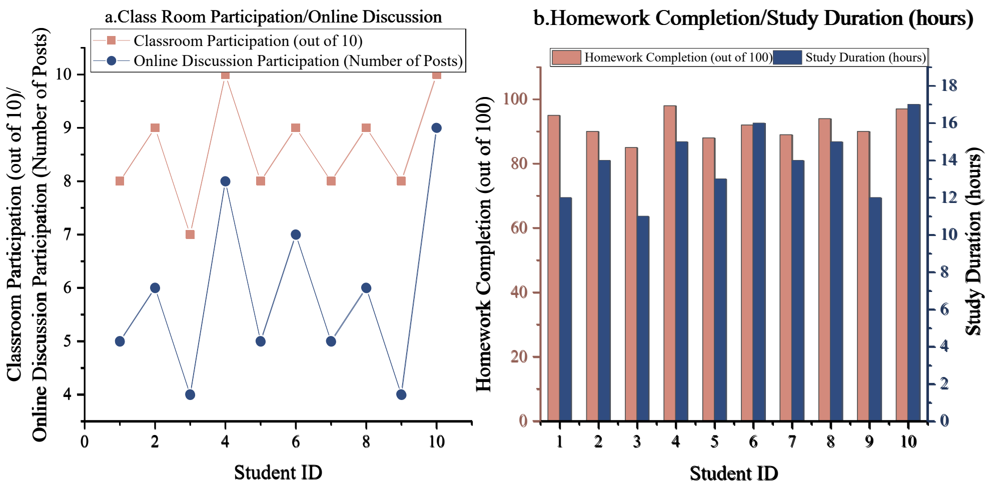

Figure 1. Evaluation of participation in the experimental group

In terms of class participation, most students participate well in class. Students No. 004 and No. 010 score full marks of 10, respectively, showing extremely high participation. The class participation of other students generally remain between 8 and 9 points, indicating that they are all actively involved in discussions and interactions in class. However, the class participation of student No. 003 is relatively low, only 7 points, which may have affected his overall learning performance (as shown in Figure 1a). In terms of online discussion participation, students in the experimental group are also more active. Students No. 004 and No. 010 speak 8 and 9 times in the discussion respectively, making them the two most active students, reflecting their high level of commitment to learning. Most students speak between 4 and 7 times, showing a good willingness to learn and communicate. It is worth noting that student No. 003 speaks only 4 times, which is relatively low and may be related to his low class participation, as shown in Figure 1b.

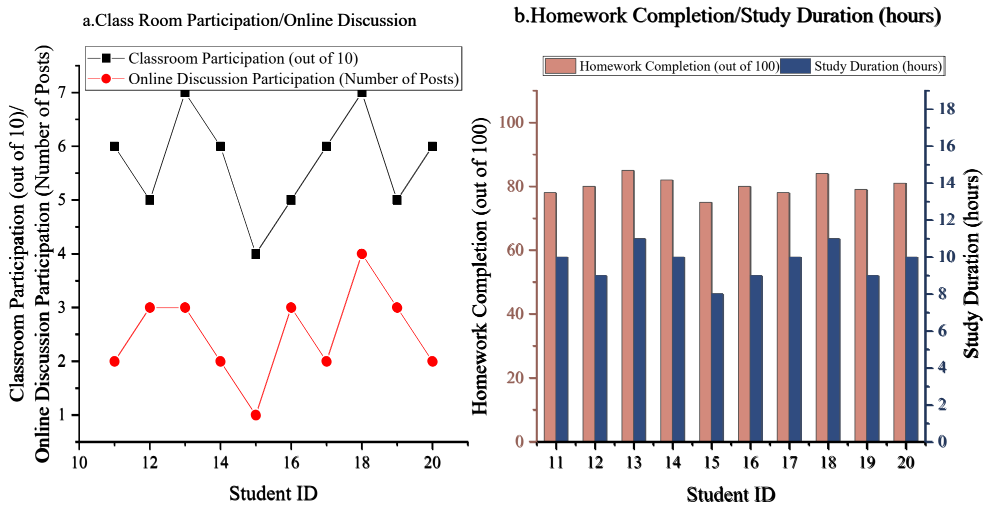

Figure 2. Evaluation of participation in the control group

In the experimental data of the control group, students' learning enthusiasm is generally stable, but there are certain differences. In terms of class participation, most students' class participation is maintained at around 6 points. Student No. 14 and No. 20 have a class participation rate of 6 points, while No. 13 and No. 18 have relatively high class participation rates of 7 points respectively. These students show a strong willingness to participate in class, while other students have lower levels of participation. The class participation score of No. 15 is only 4 points, which may affect their learning outcomes. In terms of participation in online discussions, students participate relatively less. Students No. 18 and No. 13 speak more times, 4 times and 3 times, respectively. Most other students speak 2 to 3 times. No. 15 speaks the least, only 1 time, as shown in Figure 2a. Overall, students' participation in online discussions is low, and they may not pay enough attention to interaction, which affects the depth and breadth of learning. In terms of homework completion, the experimental group students generally have higher scores, while there are some differences in the control group. Student No. 18 scores a high

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score of 84 points, while No. 15 scores the lowest, only 75 points, indicating that there are certain differences in the completion of homework among students in the control group, as shown in Figure 2b.

4.5.2 Academic performance

In this study, this paper analyzes the application effect of digital intelligent media technology in higher vocational mathematics teaching by comparing the performance of the experimental group and the control group in the midterm exam and the final exam. The following are the specific analysis results:

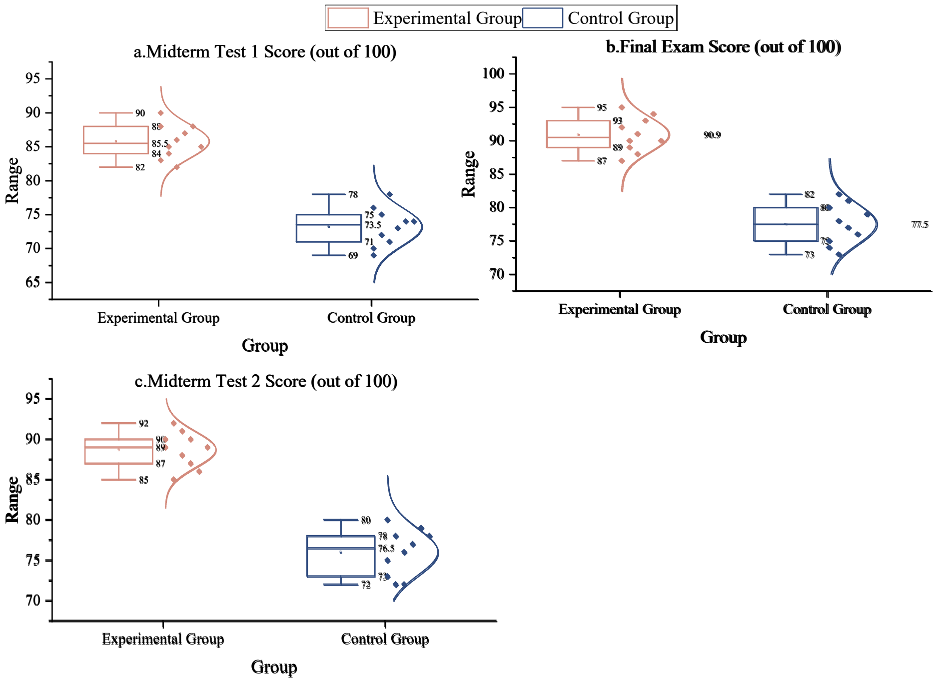

Figure 3. Academic performance assessment

In the midterm exam 1 score analysis, the median score of the experimental group is 85 points, showing a relatively high overall level. The score box ranges from 82 to 88, indicating that most students' scores are concentrated in this range, while the whisker range extends from 82 to 90, showing the wide distribution of scores. The median score of the control group is 73.5 points, which is lower than that of the experimental group, indicating that the overall performance of students declines without the assistance of digital intelligent media technology (as shown in Figure 3a). The median score of the experimental group in the final exam is 90.9 points, significantly higher than that of the control group, showing the significant effect of digital intelligent media technology in improving students' final exam scores. The box range of the scores is from 87 to 95, showing a high concentration of scores, while the whiskers range from 87 to 95, indicating a wide distribution of scores. The median score of the control group is 80 points, which is higher than that of the midterm exam, but still lower than that of the experimental group. The box range of the score ranges from 73 to 82 points, showing that the score distribution is relatively concentrated, and the whisker range extends from 73 to 82 points, indicating that the overall distribution of the scores is relatively compact (as shown in Figure 3b). In the midterm exam 2, the median score of the experimental group is 89 points, showing a sustained high level of performance. The median score of the control group is 76.5 points, which is lower than that of the experimental group, indicating that the overall performance of students declines without the assistance of digital intelligent media technology. The box range of the scores is from 72 to 80, indicating that the scores are more concentrated, and the whisker range extends from 72 to 80, indicating that the overall distribution of scores is more compact (as shown in Figure 3c).

4.5.3 Innovation and application capabilities

The experiment assesses students' innovative thinking and practical application ability through mathematical modeling, practical problem-solving projects and group cooperation tasks.

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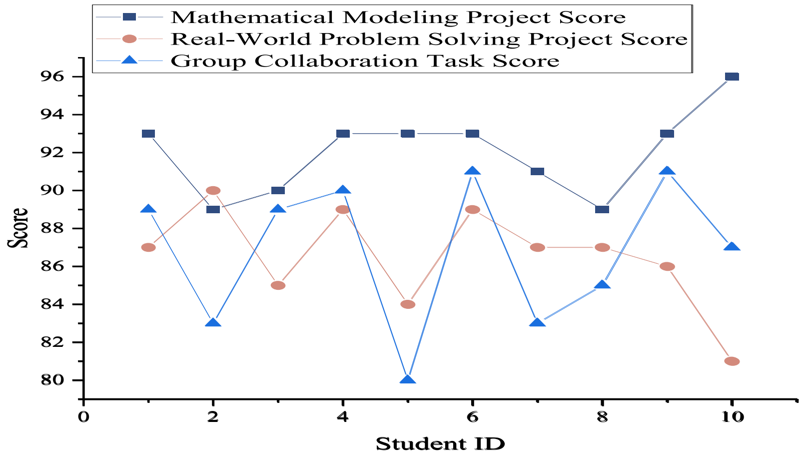

Figure 4. Evaluation of innovation and application capabilities of the experimental group (full score: 100)

In the innovation and application ability assessment data of the experimental group in Figure 4, students generally perform well in mathematical modeling, practical problem-solving projects and group cooperation tasks. Most students achieve close to full marks in these projects, demonstrating strong innovative thinking and practical application capabilities. Specifically, student number 010 performs the best in all tasks, with a score of 96 in the mathematical modeling project, 81 in the practical problem-solving project, and 87 in the group cooperation task, with an overall excellent performance.

Table 1. Evaluation of innovation and application ability of the control group (full score: 100)

Student ID	Mathematical Modeling Project Score	Real-World Problem Solving Project Score	Group Collaboration Task Score
011	73	78	81
012	70	73	81
013	73	60	90
014	76	70	70
015	90	60	72
016	67	70	71
017	67	71	73
018	79	67	70
019	75	73	76
020	72	76	74

Students generally score lower in mathematical modeling, practical problem-solving projects, and group collaboration tasks. Although most students are still able to complete various tasks, their overall performance is relatively stable and varied greatly compared to the experimental group. Specifically, student No. 015 scores 90 points in the mathematical modeling project, which is the most outstanding performance, but his scores in the practical problem-solving project (60 points) and the group cooperation task (72 points) are lower, showing his shortcomings in some aspects. The scores of other students are generally lower, especially in the practical problem solving project, where the scores are concentrated between 60 and 70. For example, student No. 013 and No. 016 score 60 and 67 points respectively in the practical problem solving project, which is much lower than the performance of the experimental group (as shown in Table 1).

5. Conclusion

This study explores the application and innovation of digital intelligent media technology in vocational mathematics education, focusing on curriculum design, teaching model and evaluation mechanism to improve teaching effectiveness and student participation. The study emphasizes the shift from a teacher-centered to a student-centered teaching model, and emphasizes the integration of autonomous learning and collaborative learning methods. In addition, the study also explores the role of intelligent learning platforms and metaverse technology in creating immersive and interactive learning experiences, thereby promoting better participation and innovation in mathematics education.

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The main results of the experiment encouraged a deeper learning experience and problem-solving ability. Digital intelligent media technology provides new educational opportunities for vocational students, and it is shown that the use of metaverse technology significantly improves students' participation and practical ability. The transformation of teachers' roles to facilitators can prepare them for their future career development. The experimental sample of this study is limited to 20 students of vocational mathematics courses, and the sample distribution is relatively concentrated, which may not fully represent the student population of all vocational colleges. Therefore, the universality and generalizability of the research results have certain limitations. In the future, the sample size can be expanded and the participation of students from different regions and backgrounds can be increased to verify the wide applicability of the results.

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