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The Effect of Teaching a Mathematics Teaching Theory Course Based on Deep Learning to Enhance Mathematics Teaching Competency for Student Teachers at Zhoukou Normal University

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Abstract

Background and aim: With the development and progress of the times, China's basic education has higher and higher requirements for teachers' competency. As a normal university that trains basic education teachers, the traditional teaching model can no longer meet the requirements of training high-quality student teachers. The aims of this study were: 1) to compare student teachers' mathematics teaching competency after learning through Mathematics Teaching Theory course based on Deep learning with the criterion of 70 percent, and 2) to assess the student teachers' satisfaction toward Mathematics Teaching Theory course based on Deep learning.

Methodology: The study involved 120 student teachers at Zhoukou Normal University, with a sample of 30 third-year student teachers from one class of Zhoukou Normal University in China through cluster random sampling. The research instruments were lesson plans, a mathematics teaching competency observation form, and a student teachers' satisfaction questionnaire. Experimental design is the one-group posttest design. Data were collected and analyzed by means, standard deviation, t-test for one sample, and t-test for dependent samples.

Results: After studying the Mathematics Teaching Theory course based on Deep learning, student teachers' mathematics teaching competency was higher than the determined criterion of 70% at the .05 statistical significance level; Additionally, student teachers' satisfaction was at a high level.

Conclusion: The development of a Mathematics Teaching Theory course based on Deep learning has a significant effect on enhancing mathematics teaching competency for student teachers. Furthermore, student teachers were satisfied with their learning of this course.

Keywords: Mathematics teaching theory course; Deep learning; Mathematics teaching competency; Student teachers' satisfaction

Introduction

The 2018 National Education Conference was held in Beijing, China. State leader Xi Jinping inspected the school many times and personally presided over many important meetings such as a symposium for teachers. Subsequently, "China's Education Modernization 2035", "Opinions on Comprehensively Deepening the Reform of the Construction of Teachers in the New Era", "Opinions on Deepening Education and Teaching Reforms Comprehensively Improve the Quality of Compulsory Education", "the Ministry of Education's comprehensive improvement of the reform of undergraduate education and teaching reform Opinions of talent training "," New Era Basic Education Strong Division Program "," Mathematics Mathematics Curriculum Standards (2022 Edition) " and other documents have been released one after another. This indicates that China's education has entered a new stage of modernization.

In 2022, the Ministry of Education issued the "Compulsory Education Curriculum Planning and Curriculum Standards", which will be implemented in September of the same year. The new version of the "Compulsory Education Mathematics Curriculum Standards" clarifies the unique educational value of mathematics, further refines the core competencies of students that the mathematics curriculum should cultivate, designs structured learning content, and points out teaching activities that promote student development. It points out the direction for promoting a new round of curriculum reform from knowledge-based to subject-based education. (Guo, 2022)

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Mathematics Teaching Theory is a course to cultivate the mathematics teaching competency of student teachers. However, at Zhoukou Normal University, the textbook for this course used by student teachers is still an old version that focuses on theoretical learning and has less content on cultivating student teachers' mathematics teaching competency. In classroom teaching, student teachers have few opportunities to practice. Students generally believe that the combination of theoretical knowledge and practice is low, and some content is out of touch with primary and secondary school mathematics classrooms, and cannot keep up with the pace of basic education reform and development. At the same time, student teachers have less time to participate in skill training, which leads to the inability of student teachers to apply the theoretical knowledge they have learned to practical teaching. (Yang, 2015)

In the teaching of the current course, a book-centered approach is still used, in which theoretical knowledge is taught and then put into practice by the students. The instructional strategy is based on the teacher's lectures, and the instructional strategy is single, which fails to mobilize students' enthusiasm and initiative, and the teaching effect is poor, and it cannot effectively improve teachers' mathematical teaching competency. Meanwhile, in terms of using modern teaching resources, teachers are unable to make effective use of digital technology, such as online learning platforms, online resources and simulation software, and other teaching resources, which limits students' access to a variety of learning materials and interactive learning opportunities. (Duan, 2019)

Based on the problems faced by the course of Mathematics Teaching Theory, and according to the objectives and requirements of teacher education professional training mode, the course of Mathematics Teaching Theory needs to be reformed in all aspects from the course concept, course objectives, course content, teaching strategies, teaching tools, and evaluation.

"Deep learning," also known as deep neural learning in English. Words such as "Deep learning" and "Deeper learning" are commonly used in English literature. It is a concept opposite to "Surface Learning". Deep learning is widely used in machine learning and education fields. Deep learning in the field of education was first proposed by American scholars Martion and Saijs in 1976. They believed that deep learning is a learning method adopted by learners in a certain period or a specific task. Beattie et al (1997) believe that the deep learning method means that students learn for understanding, which is mainly reflected in the critical understanding of the learning content, emphasizing the connection with previous knowledge and experience, and focusing on evidence of logical relationships and conclusions.

A (2014) believes that deep learning is a high-order thinking learning process in which students actively understand, construct, transfer, and apply knowledge around challenging learning topics. Driven by problem tasks, students establish connections between old and new knowledge, use existing knowledge and experience to solve new problems in complex situations, master subject knowledge in depth, grasp the essence of the subject, achieve knowledge integration, and develop abilities in the process of understanding, application, and innovation. Get promoted.

You (2020) believes that deep learning can improve teachers' teaching capabilities from three aspects: teaching design, teaching implementation, and teaching evaluation. First of all, deep learning emphasizes understanding students' subject cognition, including their learning attitudes, existing knowledge and skills, learning difficulties, etc. This can help student teachers better grasp the key points and difficulties of teaching, and design teaching content and methods in a targeted manner. Secondly, teachers create real teaching situations and organize students to carry out group cooperative learning for collaborative inquiry, discussion, and sharing, so that students can learn and apply knowledge to practical problems. This helps student teachers better understand the practical application value of knowledge and improve their teaching abilities. Finally, deep learning advocates a timely and effective feedback mechanism. Teachers can understand students' learning situations and needs by observing students' classroom performance, homework, tests, etc., and adjust teaching content and methods promptly to

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improve teaching effects. In short, deep learning reconstructs the traditional teaching structure, allowing student teachers to pass basic content such as micro videos before class, and complete the high-order thinking learning process of knowledge construction, transfer, and application in class, thereby improving the teaching competency of student teachers the goal of.

Based on the above results, the research questions about the effect of teaching a Mathematics Teaching Theory course based on Deep learning to enhance mathematics teaching competency are as follows:

1. Are student teachers' mathematics teaching competency higher than the criterion of 70 percent after learning through the Mathematics Teaching Theory course based on Deep learning?

2. How satisfied are student teachers with learning through Mathematics Teaching Theory courses based on Deep learning?

Research Objectives

The objectives of this research were to determine the effectiveness of implementing the Mathematics Teaching Theory course based on Deep learning to enhance student teachers' mathematics teaching competency.

1. To compare student teachers' mathematics teaching competency after learning through the Mathematics Teaching Theory course based on Deep learning with the criterion of 70 percent.

2. To assess the student teachers' satisfaction with the Mathematics Teaching Theory course based on Deep learning.

Literature Review

Mathematics teaching theory course based on Deep learning

As an advanced learning method, deep learning emphasizes the cultivation of understanding, critical thinking, and knowledge transfer ability. Marton & Saljo (1976) first proposed the concept of deep learning, pointing out that deep learning focuses on understanding and connection, while shallow learning relies on mechanical memory and repetition of isolated information. Beattie et al. (1997) further elaborated on the characteristics of deep learning, believing that it is a learning method for understanding, emphasizing critical understanding, the connection of previous knowledge, and the exploration of logical relationships. Entwistle (2000) pointed out in his research that deep learning is an active learning method, including connecting ideas, finding models and principles, using evidence, and checking the logic and correctness of arguments. Scholars generally believe that deep learning is not only a learning method that includes active and high-level cognitive processing, but also an active and highly engaged learning process. He & Li (2005) emphasized that deep learning connects new and old knowledge based on understanding, and can transfer the learned knowledge to new problem situations. Pellegrino and Hilton (2012) believe that the core of deep learning lies in the transfer of knowledge and skills, that is, students can apply what they have learned in different situations. An (2014) also pointed out that deep learning is a kind of understanding-oriented learning, emphasizing knowledge integration and transfer. Zhang Kangli (2017) defines deep learning as an understanding-oriented learning process that emphasizes the effective transfer and innovative application of knowledge. In short, deep learning is not only a learning method but also a learning goal that aims to cultivate students' key abilities such as critical thinking, problem-solving ability, teamwork, and effective communication (Guo, 2017).

The characteristics of deep learning include knowledge integration, transferability and problem-solving ability, and process reflection. Knowledge integration involves the connection between new and old knowledge, transferability refers to the ability to apply knowledge to new situations, and process reflection is continuous self-evaluation and adjustment (An, 2014). In terms of the teaching process, Zhang (2018) proposed a teaching model for deep learning in high school mathematics, including pre-class pre-assessment, teaching new knowledge and cooperative exploration during class, and post-class evaluation

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and reflection. The hybrid teaching design supports deep learning in an information environment. Thus, a hybrid teaching model that promotes deep learning for college students.

In the article "Practice and Exploration of Classroom Teaching Reform in Mathematics Teaching Theory", the author proposed that the idea of this course reform should highlight the concept that "everything is centered on the development of student's abilities and students' ability to teach is the basis", set up diversified learning tasks for different mathematical contents, and implement a practical classroom teaching model with "case study, inspiration, and guidance, cooperative communication, practical exercises, exploration, and innovation" as the main features so that students can become contemporary normal school students who "can learn, teach, and teach and research". Liu (2012) proposed in the article "Exploration of Teaching Reform of Mathematics Teaching Theory Courses in Normal Colleges" that in the teaching of mathematics teaching theory, teachers should first change their teaching methods. In addition to continuing to maintain the past lecture method, they should vigorously advocate independent, cooperative, and exploratory learning methods, provide students with a learning environment and conditions for independent thinking, independent exploration, hands-on practice, cooperative communication, and reading and self-study, so that students can experience and experience the process of innovation in the learning process. Hou & Yang (2012) took the mathematics teaching theory course as an example to study the reform of teaching content and teaching methods. These studies provide references for college teachers in the teaching reform of "Mathematics Teaching Theory".

Combining scholars' research on deep learning characteristics, teaching strategies, and mathematics teaching theory courses, combined with the teaching objectives and talent standard requirements of mathematics undergraduates in normal universities, this paper constructs the teaching process of mathematics teaching theory courses based on deep learning:

Step1:Introduce a scenario

Teachers create specific learning situations and display teaching cases or teaching problem situations.

Step2:Cooperative learning

Students are randomly grouped according to their level differences, and the groups conduct collaborative inquiry, discuss questions raised by the teacher, and complete class assignments and tests together.

Step3:Teacher-student interaction

Group members conduct in-depth discussions on common and difficult issues that arise, and teachers promptly participate and provide help based on students' discussions.

Step4: Results display and evaluation

Groups work together to design works based on the results of inquiry and discussion and select representatives for presentation.

Step5: Summary and reflection

Students use mind maps or summary reports to summarize the difficulties encountered during the learning process and the learning experience accumulated and write suggestions for adjustments and improvements to promote their Deep learning.

Step6: Knowledge extension

Students complete extended exercises related to the learning content of this lesson and submit them to the teaching platform. Then students evaluate and communicate with each other, and summarize and reflect based on the discussion results, problems encountered, and experiences gained during the learning process, to achieve Expansion and extension of knowledge.

Mathematics teaching competency

Through the review of relevant literature, it is found that there are a large number of literature records on the research of "mathematics teaching competency" on the China Journal Network, and the earliest literature can be traced back to 1953. The number of studies before the 1980s was relatively small, but after entering the 21st century, the number of studies has increased significantly, and the research methods cover both qualitative and quantitative types. Zuo (2011) pointed out that the teaching ability of mathematics

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teachers mainly includes teaching design ability, teaching implementation ability, teaching evaluation ability, and teaching and research ability. Chen (2008) emphasized that in the context of the new curriculum, mathematics teachers need to cultivate communication and cooperation ability, curriculum resource development ability, information technology integration ability, educational research ability, educational wisdom, and lifelong learning and development ability. Zhang Jiyi (2007) believes that professional mathematics teachers should have profound mathematical literacy, strong educational expertise, high mathematical ability, teaching decision-making ability, and teaching and research ability. Fu & Liu (2005) proposed a new ability structure for mathematics teachers in the context of social development and educational reform, including basic ability, mathematical ability, mathematical teaching ability, and extension ability, among which mathematical teaching ability is the core factor that determines the status and role of teachers. Liu & Cheng (2009) mentioned in the "Mathematics Teaching Theory" that the promotion and implementation of the new curriculum have put forward new requirements for mathematics teachers, and their teaching ability should include design, implementation, monitoring, reflection, and innovation ability.

This study defines mathematics teaching competency as the professional ability of student teachers in mathematics teaching activities in primary and secondary schools, which is specifically divided into four dimensions: teaching design ability, teaching implementation ability, teaching evaluation ability, and teaching reflection ability. Teaching design ability refers to the teacher's ability to rationally plan teaching activities and strategies based on their understanding of mathematics curriculum standards, textbook content, and student situations; teaching implementation ability is reflected in the process of teachers organizing students to learn knowledge and skills, experience mathematical ideas and methods, and immediately respond to and adjust the content generated in the classroom; teaching evaluation ability is the teacher's active judgment and evaluation of teaching activities during the teaching process to optimize teaching effectiveness; teaching reflection ability refers to the teacher's ability to think deeply about the teaching process and results to achieve effective teaching, and to promptly discover and solve teaching problems.

Conceptual Framework of the Study

In this research, the independent variable is the implementation of the Mathematics Teaching Theory course based on Deep learning(An, 2014), and the dependent variables are mathematics teaching competency (Liu & Cheng (2009)) and student teachers' satisfaction with this course.

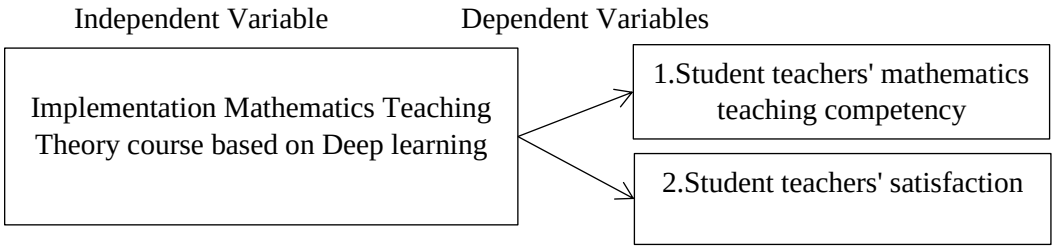

Figure 1 The Independent Variable and Dependent Variables

Research Methodology

Population and Samples: The population was 120 third-year student teachers (4 classes) in Zhoukou Normal University. The sample was 30 third-year student teachers (1 class) derived from cluster random sampling.

Research Instruments: Research instruments are the tools for researching to collect data. The research instruments which were used in this study were:

1. Experimental instruments

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1.1 Mathematics Teaching Theory course based on Deep learning: The Mathematics Teaching Theory course based on Deep learning includes six steps: 1) introduce a scenario, 2) cooperative learning, 3) teacher-student interaction, 4) results display and evaluation, 5) summary and reflection, 6) knowledge extension. Five experts evaluated the draft course, in 25 items of the course evaluation form, the lowest mean score was 4.00 (SD=0.71), and the highest mean score was 4.80 (SD=0.45). It was revealed that the Mathematics Teaching Theory course based on Deep learning was at a high level (M=4.42， SD=0.68).

1.2 Lesson plans: Five experts evaluated the eight lesson plans, in 14 items of the seven lesson plans evaluation form, the lowest mean score was 4.00 (SD=0.71), and the highest mean score was 4.80 (SD=0.45). It was revealed that lesson plans were at a high level (M=4.40, SD=0.72).

2. Instruments for collecting data

2.1 Mathematical teaching competency observation form: The observation form had a total of 15 items. The index of Item Objective Congruence (IOC) value of 15 items in the observation form was 0.80 at the lowest and 1.00 at the highest. The result of analyzing the IOC index showed that all the items were appropriate and could be used in the observation form. Analyze the item of the observation form and find out that item Reliability(0.804) more than 0.70. This showed that the quality of the mathematical teaching competency observation form was good. (Cronbach,1951)

2.2 Student teachers' satisfaction questionnaire: The questionnaire is provided to 5 experts for content validity check and suggestions. The result of analyzing the IOC index(0.80-1.00) showed that all test items were appropriate and could be used in the test. The Cronbach's Alpha coefficient of the reliability of the student satisfaction questionnaire is 0.807, which is greater than 0.70. Therefore, the reliability of the student satisfaction questionnaire meets the requirements (Cronbach, 1951)

Data Collection: The procedures of data collection were as follows:

1. The samples were taught by the Mathematics Teaching Theory course based on Deep learning.
2. After completing the instructions, the samples received the post-test by using the instrument.
3. The samples were given the student teachers' satisfaction questionnaire.

Data Analysis: In this study, data were analyzed by using statistical methods according to the research objectives.

1. Compare student teachers' mathematics teaching competency after learning through the Mathematics Teaching Theory course based on Deep learning with the criterion of 70 percent by using a t-test for the dependent sample.

2. Analyze the student teachers' satisfaction toward the Mathematics Teaching Theory course based on Deep learning using Cronbach's Alpha method (Cronbach, 1951) and determine the level of student teachers' satisfaction.

Research Results

According to the research objectives, the results were as follows:

1. The result of comparing the student teachers' mathematics teaching competency after learning through the Mathematics Teaching Theory course based on Deep learning with the criterion of 70 percent by using a t-test for dependent samples.

Table 1 The results of student teachers' mathematics teaching competency after learning through the Mathematics Teaching Theory course based on Deep learning with the criterion of 70 percent

Components	N	Full score	Criteria score	M	SD	t	p
1)Teaching design ability(lesson plan)	30	20	14	16.07	1.55	56.70*	.000
2)Teaching implementation ability	30	25	17.5	20.03	2.08	52.86*	.000
3)Teaching evaluation ability	30	20	14	15.80	1.54	56.19*	.000
4)Teaching reflection ability	30	10	7	8.37	1.00	45.85*	.000

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Components	N	Full score	Criteria score	M	SD	t	p
Overall(mathematics teaching competency)	30	75	52.5	60.27	5.27	62.62*	.000

*$P < .05$

1) The mean scores of the student teachers' teaching design ability after learning through the Mathematics Teaching Theory course based on Deep learning was 16.07 from possible full marks of 20 and the standard deviation was 1.55 which was statistically higher than the criterion of 70% at .05 level of statistical significance (t=56.70, p=0.00< .05).

2) The mean scores of the student teachers' teaching implementation ability after learning through the Mathematics Teaching Theory course based on Deep learning was 17.5 from possible full marks of 25 and the standard deviation was 2.08 which was statistically higher than the criterion of 70% at .05 level of statistical significance (t=52.86, p=0.00< .05).

3) The mean scores of the student teachers' teaching evaluation ability after learning through the Mathematics Teaching Theory course based on Deep learning was 15.80 from possible full marks of 20 and the standard deviation was 1.54 which was statistically higher than the criterion of 70% at .05 level of statistical significance (t=56.19, p=0.00< .05).

4) The mean scores of the student teachers' teaching reflection ability after learning through the Mathematics Teaching Theory course based on Deep learning was 8.37 from possible full marks of 10 and the standard deviation was 1.00 which was statistically higher than the criterion of 70% at .05 level of statistical significance (t=45.85, p=0.00< .05).

The mean score of the overall(mathematics teaching competency) was 60.27 from possible full marks of 75 and the standard deviation was 5.27 which was statistically higher than the criterion of 70% at .05 level of statistical significance (t=62.62, p=0.00< .05).

It can be seen that the mathematics teaching competency of the student teachers who learning through Mathematics Teaching Theory courses based on Deep learning was higher than 70%.

2. The result of analyzing student teachers' satisfaction after implementing the Mathematics Teaching Theory course based on Deep learning.

The researcher used the satisfaction questionnaire to survey the third-year student teachers of Zhoukou Normal University and randomly selected 30 students' data for analysis (The same students to post-test).

Table 2 The student teachers' satisfaction with the Mathematics Teaching Theory course based on Deep learning

Items of satisfaction questionnaire		M	SD	Satisfaction level
Section	Item			
Section 1: Teaching content	1. The content of the Mathematics Teaching Theory course based on Deep learning is easy to understand.	4.13	0.63	High level
	2. With a Mathematics Teaching Theory course based on Deep learning, you can proactively complete tasks assigned by your teacher.	4.10	0.48	High level
	3. In the Mathematics Teaching Theory course based on Deep learning, active participation in group discussions is encouraged.	4.10	0.61	High level
	4. The teacher adopts a case analysis and problem-driven approach in the course.	4.17	0.70	High level

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	5. In the course study of Mathematics Teaching Theory based on Deep learning, you think it will help improve your mathematics teaching competency.	4.10	0.61	High level
Section 2: Instructional strategy	6. Your engagement and communication during class serve to enhance your capacity for self-directed exploration and learning.	3.80	0.61	High level
	7. You have the opportunity to work and share ideas in group cooperative learning, and group cooperative learning stimulates your interest in learning and active participation.	4.00	0.74	High level
	8. Teachers provide tailored guidance to students to foster learning experiences.	3.97	0.56	High level
	9. The situational setting adopted by teachers in the classroom is helpful to improve learning efficiency.	4.10	0.66	High level
Section 3: Teaching resource	11. Pre-class learning tasks and videos are helpful for your learning.	4.07	0.69	High level
	12. Online learning platforms, online resources, and other teaching technologies are very helpful for you to obtain learning materials and interactive learning.	3.97	0.61	High level
	13. Teaching resources and media can be well combined with practical problems, which helps improve mathematics teaching competency.	3.97	0.67	High level
Section 4: Evaluation	14. When compared to traditional classroom methods, you have a preference for the Deep learning teaching approach.	4.00	0.59	High level
	15. In the Deep learning method, a deeper grasp of knowledge points is achieved through instructor-led problem-solving, structured knowledge delivery, and student interactions.	4.20	0.71	High level
	16. The use of Deep learning teaching is anticipated to foster a deeper comprehension of the subject matter you are studying.	4.17	0.59	High level
	Total/Overall	4.06	0.62	High level

The result of this table showed that the student teachers' satisfaction with the Mathematics Teaching Theory course based on Deep learning was at a high level (M= 4.06, SD=0.62). In the 16 items of the satisfaction questionnaire, the lowest mean score was 3.80 (SD=0.61), and the highest mean score was 4.20 (SD=0.71). Even the lowest item still reached a high level.

Conclusion

By comparing and analyzing the post-test results of third-grade student teachers of the Mathematics Teaching Theory course based on Deep learning with the 70% standard, the following conclusions were drawn after the implementation of the intervention of the Mathematics Teaching Theory course based on Deep learning:

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1. The mean score of student teachers' mathematics teaching competency was 60.27 from possible full marks of 75 and the standard deviation was 5.27 which was statistically higher than the criterion of 70% at a .05 level of statistical significance (t=62.62, p=0.00< .05).

2. The student teachers' satisfaction was very high level. The lowest mean score was 3.8 and the highest was 4.2, higher than 3.51. The mean scores of student teachers' satisfaction with the Mathematics Teaching Theory course based on Deep learning was at a high level (M = 4.06, SD = 0.62).

This study used SPSS software to evaluate student teachers' satisfaction with the Mathematics Teaching Theory course based on Deep learning. The results showed that student teachers were highly satisfied with the Mathematics Teaching Theory course based on Deep learning. Student teachers believe that the Mathematics Teaching Theory course based on Deep learning can help them build a mathematical knowledge system and cultivate self-learning and problem-solving abilities. In the classroom, student teachers can conduct cooperative exploration and exchange discussions through specific learning situations created by teachers and can combine existing knowledge with new knowledge, thereby improving the ability to transfer and apply knowledge. In this process, student teachers can better acquire knowledge, deepen their knowledge, and significantly improve their mathematics teaching competency.

Discussion

The following points based on the research results were discussed:

1. In the preparation stage of developing the Mathematics Teaching Theory course based on Deep learning, the researchers analyzed the advantages of deep learning, the principles, goals, content, instructional strategy, learning materials, and evaluation of the Mathematics Teaching Theory course based on Deep learning. Referring to the deep learning design steps proposed by experts and scholars at home and abroad, it was finally determined that the mathematics teaching theory course based on deep learning consists of six components: (1) principles, (2) objects, (3) content, (4) instructional strategy (including 6 steps), (5) teaching materials and resources, and (6) evaluation. Experts evaluated the Mathematics Teaching Theory course based on Deep learning, and the results showed that the course was highly appropriate (M=4.42, SD=0.68). This is because 1) the learning activities designed in the course plan are rich and colorful, which can help students and teachers combine the results of pre-study with new knowledge and improve their knowledge transfer and application capabilities. The teaching process usually includes tasks to solve practical problems, such as case analysis and simulation teaching. These tasks require student teachers to combine theoretical knowledge with practice, thereby cultivating their critical thinking and innovation capabilities (An, 2014). 2) In terms of evaluation, by combing the literature and combining the research results of Zuo (2011), Zhang (2007), Fu & Liu (2005, Cheng & Liu (2013), etc, the elements of mathematics teaching competency suitable for this study were summarized, and on this basis, a mathematics teaching competency measurement tool was constructed. The measurement tool takes into account multiple dimensions such as theoretical understanding, teaching skills mastery, and actual teaching performance. The evaluation is centered on student development, highlights the practical characteristics of teaching theory courses, and focuses on process evaluation. A (2014) also has the same view. He believes that continuous evaluation and timely feedback are effective ways to guide students to deeply reflect on their learning status and adjust their learning strategies in time to achieve deep learning. It can not only encourage students to deeply understand the learning content and improve their learning strategies, but also help teachers adjust their teaching strategies in time and enhance the effectiveness of classroom learning.

2. After studying the Mathematics Teaching Theory course based on Deep learning, student teachers' mathematics teaching competency was higher than the determined criterion of 70% at the .05 statistical significance level, Student teachers' satisfaction was at a high level. This is because, 1) the course content is carefully designed, and the teaching process adopts case analysis and problem-driven teaching methods. Students can easily understand complex mathematical concepts and teaching theories, and apply theoretical knowledge to practical situations. 2) Mathematics Teaching Theory courses based on Deep learning

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advocate a learning process that focuses on knowledge integration, transfer, and problem-solving. Through deep learning, student teachers can not only master mathematical knowledge and teaching skills but also learn how to apply these knowledge and skills in different teaching scenarios. This enables them to flexibly apply the knowledge they have learned and creatively solve problems when faced with specific teaching problems. 3) Deep learning emphasizes learners' reflection throughout the learning process, which is especially important for teachers. Student teachers are encouraged to reflect on their teaching practices, identify strengths and weaknesses, and continually adjust their teaching methods based on feedback. Through reflective practice, student teachers can continuously evaluate and optimize their teaching methods and gradually improve teaching effectiveness and quality (Zhang, 2014). 4) Mathematics Teaching Theory courses based on Deep learning encourage students to take the initiative to complete tasks and actively participate in group discussions. This helps to improve student's learning interest, teamwork ability, and communication skills, and can also give students a sense of achievement and satisfaction. Thereby increasing satisfaction. 5) The personalized guidance provided by teachers helps meet the different needs of students so that each student can receive effective support, which helps improve student satisfaction. The results of student learning satisfaction are consistent with the research of Tan (2021). After course teaching based on deep learning, students' learning initiative and enthusiasm have been greatly improved. Students are willing and conscious to participate in classroom activities and actively complete According to the corresponding learning tasks, compared with the single learning mode of the traditional classroom, their satisfaction is higher.

Recommendations

Recommendation for implication

Based on the findings and insights from the deep learning-based mathematics teaching theory course, we offer the following recommendations to education practitioners and policymakers who aim to improve the quality of mathematics education:

1. Implement deep learning methods

Adopt deep learning teaching methods: Encourage the adoption of deep learning teaching methods in teacher education programs to promote a more comprehensive understanding of mathematical concepts and their applications. Such methods should emphasize critical thinking, problem-solving, and the integration of real-world scenarios into the learning process.

Promote active learning: Promote an active learning environment that encourages students to explore, ask questions, and collaborate, thereby promoting a deeper engagement with the subject matter.

2. Improve student engagement

Student-centered teaching: Shift the focus from traditional lecture-based teaching to a student-centered approach that encourages active participation, self-reflection, and peer learning. This can be achieved by implementing inquiry-based learning, project-based learning, and other forms of experiential learning.

Increase motivation: Utilize strategies that increase student motivation, such as integrating technology, gamification, and real-life problem-solving scenarios into the curriculum.

3. Instructional competency development

Increase teaching competency: Establish professional development programs aimed at improving educators' instructional competencies, particularly in the areas of instructional design, implementation, evaluation, and reflective practice.

Peer Learning and Collaboration: Promote collaborative learning among educators through workshops and peer mentoring, and share best practices and innovative teaching techniques.

4. Implement an effective assessment system

Holistic assessment: Introduce a holistic assessment system that not only assesses students' mastery of mathematical concepts, but also their critical thinking, problem-solving, communication, and collaboration skills.

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Feedback mechanism: Implement a regular feedback mechanism for teachers and students to reflect on the teaching and learning process, to continuously improve and adapt to individual learning needs.

By implementing these recommendations, a learning environment that supports deep learning can be created, allowing students to master the skills they need to succeed in a rapidly changing world. In addition, these changes will help to improve the quality of mathematics education overall, thereby cultivating future generations to become responsible and capable citizens of society.

Recommendation for further research

Based on the analysis of the current status of mathematics teaching theory courses and the insights gained from the research, the following suggestions are made for future research work:

1. Deepen the practical research on teaching principles

In-depth research on how to apply teaching principles such as student-centered, situational teaching, interactive collaboration, technology-assisted teaching, and assessment to promote learning. This can include case studies to explore how these principles are implemented in different teaching environments and their impact on student learning outcomes.

2. Improve teaching objectives and evaluation systems:

Study how to refine teaching objectives and make them more closely integrated with the evaluation system to ensure that they are scientifically based. Consider using advanced educational measurement and evaluation technologies to conduct more precise assessments of student learning outcomes.

3. Empirical research on deep learning models

Conduct empirical research to evaluate the effectiveness of various deep learning models, such as the design of deep learning teaching models before, during, and after class, online and offline hybrid models, and resource exploration theme teaching models. Study their impact on student engagement, critical thinking, problem-solving skills, and overall learning quality.

4. Student teacher's capacity development survey:

Explore the effectiveness of mathematics teaching theory courses in improving student-teacher capacity. This includes their ability to design mathematics instruction, implement teaching plans, monitor student progress, reflect on teaching practices, and cultivate creativity in classroom planning.

5. Development of diversified assessment methods

Further explore the development of diversified assessment methods that focus on knowledge mastery, skill development, thinking processes, and emotional attitudes. This includes studying how these methods can help student teachers better understand student learning, adjust teaching strategies, and promote student learning progress.

6. Integration of technology and teaching

Explore the role of modern educational technology in assisting teaching and learning. This includes studying how student teachers can improve teaching efficiency, enhance the attractiveness and interactivity of the classroom, and lay a solid foundation for the future use of modern technology tools in teaching.

These recommendations are intended to guide future research efforts to improve the quality of mathematics education and the capabilities of student teachers. By continuously studying and improving teaching principles, assessment methods, and technology integration, researchers can contribute to the advancement of educational practices that promote deep learning and improve student achievement.

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