

Research on the Construction of Case Library for Middle School Mathematics Teaching Design

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Abstract: The current master's degree programs in education in China generally face problems such as limited practical connections, insufficient integration of disciplines, and low participation in education master's programs. In order to improve the quality of education master's training, it is urgent to improve the construction of a case library for teacher education courses. Under the guidance of the new curriculum reform concept, suggestions for writing teaching designs have been proposed for the teaching content of middle school mathematics. High quality teaching design cases have been constructed to help education masters transform theoretical knowledge into educational experiences, increase their experience in applying educational theories to solve practical problems, and enhance their professional competence in middle school mathematics education.

Keywords: Case library; New curriculum reform; Middle School Mathematics Teaching Design

1. Introduction

The current master's degree programs in education in China generally face problems such as limited practical connections, insufficient integration of disciplines, and low participation in education master's programs^[1]. These problems directly affect the quality of education master's training. On the other hand, with the rapid development of educational informatization, traditional teaching methods are no longer able to meet the needs of modern high school mathematics teaching. Currently, the education sector is facing profound changes, especially in the field of mathematics teaching. It is not only necessary to focus on students' mastery of basic knowledge, but also to cultivate their mathematical thinking ability, application ability, and innovation ability.

The construction of a case library for middle school mathematics teaching design has adapted to the development needs of the times, closely linked with the actual situation of primary and secondary schools, and promoted the integration of mathematics education master's courses. It is precisely a solution proposed to address this challenge. Teaching design cases enrich the classroom teaching content of teacher education courses, build a bridge between educational theory and educational practice, help Master of Education transform theoretical knowledge into educational experience, increase the experience of applying educational theory to solve practical problems, and improve the professional ability of Master of Education^[2]. The construction of a case library for middle school mathematics teaching design should adhere to the requirements of teacher professional standards and education master's training programs, targeting mathematics education masters.

2. The significance of constructing a case library for middle school mathematics teaching design

As a collection of teaching resources, case libraries can gather rich mathematical teaching design cases, providing diverse teaching ideas and methods for mathematics education masters. Through a case library, Master of Mathematics Education can gain a more intuitive understanding of excellent teaching designs, draw on successful experiences and teaching strategies, and thus improve their teaching level. In addition, the construction of a case library for middle school mathematics teaching design also helps to promote the in-depth development of teaching research. The cases in the case library can serve as research materials, providing real teaching scenarios and data support for Master of Mathematics Education, facilitating targeted teaching research. At the same time, the construction of a case library can also promote communication and cooperation among mathematics education masters, forming a good atmosphere for common development.

The research on the case library of middle school mathematics teaching design has multiple significance, specifically manifested in the following aspects:

2.1 Promoting the improvement of teaching quality

The construction of a case library can provide rich teaching resources and teaching ideas for mathematics education masters, helping them better understand and grasp the key and difficult points of middle school mathematics teaching. By drawing on the excellent teaching designs in the case study library, Master of Mathematics Education students can utilize the case library to observe and learn from teaching cases, continuously enhance teaching skills, constantly optimize their teaching methods and strategies, improve their teaching abilities, strengthen the specificity of teaching, thus enhancing teaching quality and effectiveness. Besides, the construction of the case library can also promote communication and cooperation among Master of Mathematics Education students. They can share their teaching experiences and insights through the case library, learn from each other, and create a conducive atmosphere for mutual development. This exchange and cooperation help to elevate the overall level of secondary school mathematics teaching. Additionally, the teaching cases in the case library can provide inspiration for Master of Mathematics Education students and stimulate their potential for teaching innovation.

2.2 Promoting innovative development in education and teaching

The construction of a case library can not only provide teaching support for Master of Mathematics Education, but also provide strong support for the innovative development of education and teaching. By conducting in-depth research on teaching cases in the case library, Master of Mathematics Education can identify problems and shortcomings in teaching, propose targeted improvement plans and innovative ideas, and promote the continuous development and progress of middle school mathematics teaching. These innovative ideas and solutions help to break through traditional teaching frameworks, injecting new vitality into educational practices, promoting the modernization and scientification of high school mathematics teaching. With the continuous development of educational technology and the updating of educational concepts, mathematics teaching also needs to keep pace with the times, adapting to new teaching environments and requirements. By utilizing teaching cases in the case bank, the Master of Mathematics Education can understand the latest trends in education and research findings, integrate these new elements into their own instructional design, and drive the modernization process of high school mathematics teaching.

2.3 Cultivate students' interest and ability in learning mathematics

Excellent teaching design can stimulate the learning interest and enthusiasm of the Master of Mathematics Education, improve the learning efficiency and effectiveness of the Master of Mathematics Education. The teaching design cases in the case library often contain rich teaching scenarios and activities, which can help the Master of Mathematics Education better understand and master mathematical knowledge, and improve the mathematical literacy and application ability of the Master of Mathematics Education. These cases can also provide teaching demonstrations for Master's in Math Education, helping them to better carry out math teaching work. It also offers templates and references for them to draw on, making them more confident and competent in their future teaching practices.

2.4 Promoting the sharing and optimization of educational resources

The establishment of a case library helps to achieve the sharing and optimization of educational resources. On the one hand, the case library can centrally display and share high-quality mathematics teaching design cases, benefiting more mathematics education masters. These cases may come from the practical experience of frontline teachers or from in-depth research by educational experts. They are all valuable assets in the field of mathematical education. Through the case repository, educational masters can easily access these high-quality resources, thereby broadening their horizons and gaining insights. On the other hand, the case library is not set in stone, but rather a dynamic and evolving system. It can be continuously updated and improved according to teaching needs, maintaining its timeliness and applicability, thereby maximizing the role of educational resources.

In summary, the research on the case library of middle school mathematics teaching design not only

has important practical significance, but also profound educational value.

Through in-depth research and practice, we can continuously improve and optimize the construction of case libraries, providing strong support for the development of middle school mathematics teaching.

3. Suggestions for Writing Case Studies in Middle School Mathematics Teaching Design

Firstly, it is necessary to clarify the middle school mathematics knowledge points involved in the case library, including basic concepts, theorems, formulas, etc., and combine them with textbooks and curriculum standards to ensure the accuracy and systematicity of the content. Based on the teaching content, each case should establish clear and specific teaching objectives, including knowledge and skills, processes and methods, emotional attitudes and values, etc., to provide a basis for the design of subsequent teaching activities. Teachers select appropriate teaching strategies based on teaching objectives and student characteristics, such as heuristic teaching, problem-based teaching, cooperative teaching, etc., to improve teaching effectiveness. Attention should also be paid to the application of teaching techniques, such as questioning skills, guidance skills, explanation skills, etc., to stimulate students' interest in learning and promote their thinking development.

Secondly, in the process of case design, designers should attach importance to utilizing modern teaching media, such as multimedia courseware, teaching videos, online resources, etc., to enrich teaching content and improve teaching efficiency. In designing cases, various teaching resources should be integrated, including textbooks, teaching aids, exercise banks, etc., to provide strong support for teaching design. Design diverse classroom activities, such as group collaboration, role-playing, math games, etc., to enable students to learn mathematics in a relaxed and enjoyable atmosphere. The case includes the arrangement of mathematical practical activities, such as mathematical exploration and modeling, to cultivate students' practical abilities and innovative spirit.

Thirdly, diversified evaluation methods should be adopted, including homework evaluation, classroom performance evaluation, test evaluation, etc., to comprehensively understand the learning situation of students. Homework assessment should focus on the depth and breadth of students' understanding of knowledge, promoting self-reflection through corrections and comments. Classroom performance assessment should evaluate students' mathematical thinking and communication skills by observing their performance in classroom discussions, group work, and other activities. Test assessment should involve designing a variety of question types to comprehensively assess students' mathematical abilities and problem-solving skills. Establish an effective feedback mechanism, provide targeted guidance and suggestions to students in a timely manner, and help them better master mathematical knowledge.

Fourthly, the design of the case study should not only focus on the instructional design itself, but also emphasize its actual effects. Changes in students' academic performance, learning attitudes, and other aspects are used to evaluate the effectiveness of instructional design and to provide references for future teaching design. Thoroughly reflect and summarize the teaching process and results, teachers analyze successful experiences and shortcomings, and provide reference and improvement directions for subsequent teaching design.

Finally, teachers select representative teaching cases from the case library for in-depth analysis and interpretation. Teachers analyze the advantages and disadvantages of teaching content, teaching strategies, teaching activities, and other aspects in the case study, summarize experiences and lessons learned, and propose specific optimization plans and improvement measures for the problems and shortcomings in the case study to improve the teaching quality and effectiveness of the case study. In addition, teachers should be encouraged to create new teaching cases based on the needs of teaching practice, providing more references and references for mathematics teaching design.

Through the above research content, we can deeply explore and analyze the case library of middle school mathematics teaching design, improve the teaching design ability of mathematics education master's degree, optimize the effectiveness of mathematics teaching, and promote the comprehensive development of students.

4. Examples of Middle School Mathematics Teaching Design Cases

Case 1: A case study on the theme of sequences

Sequence is an important content in middle school mathematics and a key part of the college entrance examination questions. Its application in real life is very extensive. However, the content of sequences has strong logic, requires a large amount of computation, and is difficult for students to understand. Therefore, the teaching effect in teaching is not ideal. The 2017 General High School Mathematics Curriculum Standards emphasize the importance of mathematical culture and point out the need to integrate mathematical culture into classroom teaching^[3]. Mathematical history is the most common way to reflect mathematical culture. Integrating mathematical history into mathematical history can enhance students' interest in learning and deepen their understanding of mathematics. However, the current People's Education Press "Number Series" textbooks have very little content on the history of mathematics, which limits its application in middle school mathematics education. Therefore, this case takes "proportional sequence" as an example, based on sorting out historical literature on "proportional sequence", combined with existing HPM research examples, selecting appropriate historical materials, clarifying the ways and principles of mathematical history infiltration in proportional sequence teaching, and on this basis, conducting teaching design research on related knowledge of proportional sequence. Through the study of the case study "Teaching Design Research on High School Proportional Sequence Based on HPM", the Master of Education will master how to conduct teaching design research on proportional sequence based on HPM theory. This case provides a reference for Master of Education on how to use HPM theory for sequence teaching.

Case 2: A case study on the theme of graphics and geometry

"Similarity" is one of the representative models of middle school mathematics graphics and geometry, which is a geometric knowledge that middle school students must master and has extremely high comprehensiveness. The curriculum standards also require students to be able to use similarity forms to solve practical problems. The proposal of the "big concept" means that China's new curriculum reform has taken another step forward. The mathematics classroom has shifted its focus from "knowledge generation" to "literacy implementation". In the context of the clear proposal of the "big concept", in order to implement the cultivation of students' core subject literacy, unit teaching from the core perspective of the "big concept of mathematics" has received widespread attention from the academic community. How to design unit teaching guided by "big concepts" has become a current question that needs to be answered. Therefore, this case focuses on the "big concept of mathematics" and takes the "similar form" unit teaching design as the specific research object, seeking the design path of middle school mathematics unit teaching from the perspective of the "big concept", and formulating a unit teaching design plan for cultivating students' mathematical core literacy. This case takes the "Similarity Form" unit as an example to conduct research on the design of junior high school mathematics unit teaching from the perspective of big concepts. It provides a case demonstration of big concept unit teaching for Master of Education, helping Master of Education understand how to design unit teaching with big concepts as the core, meet the cultivation requirements of developing students' core mathematical literacy, and achieve the value goal of moral education.

Case 3: A case study on the theme of numbers and algebra

Integrals are an important content in middle school mathematics teaching, playing an important role in connecting the past and the future. They are not only an extension of the primary school stage but also an important foundation for subsequent higher grade learning. However, in integrated teaching, students face problems such as weak grasp of basic concepts, easy calculation errors, and difficulty in starting comprehensive questions. At the same time, teachers also face problems in the teaching process, such as not mobilizing students' learning enthusiasm, not doing a good job in transferring and analogizing new knowledge, lacking clear and logical organization and logic in problem analysis, not effectively combining teaching theories, and lacking clear standards and scientific basis in practice. The ACT-R theory can scientifically explain various intellectual activities, such as human acquisition, organization of knowledge, and various intellectual activities. Teaching is closely related to various human intellectual activities, so this theory has had a significant impact on teaching research. This case takes the "integral" unit as an example, and conducts research on the design of middle school mathematics unit teaching under the ACT-R theory. It provides a case demonstration for the application of educational theory in unit teaching for education masters, and encourages them to carry out teaching practice activities under scientific theory, which has a certain driving effect.

Case 4: A case study on the theme of statistics and probability

Stratified random sampling is an extension of middle school statistical knowledge that holds a crucial position in high school statistics courses, serving as a vital tool for data analysis. It is not just a statistical technique but also an effective tool for solving real-world problems, especially excelling in

handling large-scale data. However, in actual teaching, the concept and methods of stratified sampling often prove challenging for students to comprehend due to their theoretical and abstract nature, leading to less-than-satisfactory teaching outcomes. With the deepening of educational reform, project-based learning as a new teaching approach has garnered significant attention for its ability to stimulate students' interest in learning and develop their practical and teamwork skills. Project-based learning emphasizes enabling students to learn and master knowledge through completing specific project tasks in real-life contexts, aligning well with the practical application scenarios of stratified sampling and facilitating student comprehension. Therefore, starting from "stratified sampling," this case study designs a series of statistically relevant projects closely tied to real-life situations, such as "student consumption habits survey" and "urban air quality monitoring," allowing students to delve into the principles of stratified sampling and learn how to apply stratified sampling methods in practical problems through project completion. Through this case study, an education master will learn how to introduce project-based learning into high school probability and statistics courses and integrate stratified sampling teaching with real projects to enhance student interest and practical skills. Additionally, this case study provides an exemplary application of project-based learning in high school math teaching for education masters, promoting the widespread use of project-based learning in high school math education.

5. Conclusion

The essence of case-based teaching in the Master of Education curriculum is to enhance the teaching professional ability of graduate students and cultivate their comprehensive qualities to adapt to professional positions^[4]. Establishing a case library for professional degree teaching is of great practical significance in promoting the reform of professional degree graduate training models and constructing a graduate education system that adapts to the development of the country and society^[5]. Striving to create a curriculum system that conforms to the characteristics of professional degrees, relying on the construction of case libraries to drive comprehensive reforms in teaching methods for professional graduate students, improving the quality of teaching for mathematics education master's degree, consolidating the professional theory of mathematics education master's degree, and enhancing the practical operation ability of mathematics education master's degree are important ideas for the reform of graduate education in higher education institutions, and are innovative paths for continuously delivering more compound and applied talents to the country.

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A Study on the Reform of Educational Statistics Program Based on Case Study Teaching. (JDYY2114)

Teaching Cases of Secondary School Mathematics Curriculum and Textbook Research Based on the New Curriculum Reform. (YJPAL202304)

References

- [1] Yang Minmin, Tan Dejun. Reflection on the Construction of Micro Course Case Library for Education Master's Teachers [J]. *Journal of Jimei University (Education Science Edition)*, 2019, 20 (03): 16-22
- [2] Lv Zhe. Exploration of the Construction of Teaching Case Library for Preschool Education under the Background of Professional Certification [J]. *Journal of Heilongjiang University of Teacher Development*, 2022, 41 (10): 47-49
- [3] Ministry of Education of the People's Republic of China. *Curriculum Standards for Mathematics in Ordinary High Schools (2017 Edition)* [S]. Beijing: People's Education Press, 2018
- [4] Shen Nanshan, Wang Jiazheng. Understanding and Practice of Building a Case Library for Master's Degree in Education: A Case Study of Hefei Normal University [J]. *Journal of Hefei Normal University*, 2016, 34 (06): 53-56
- [5] Yuan Xiujie, Jiao He, Qi Wei, Wang Zhuoran. Research on the Construction of Teaching Case Library for Professional Degree Graduate Students - Taking Land Evaluation and Evaluation as an Example [J]. *Chinese Journal of Multimedia and Online Teaching (First Ten Days)*, 2020, (05): 225-227.