Research on Large Unit Teaching Guided by Mathematical Key Competencies

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Abstract: Key competencies are important guiding ideologies for educational reform in the new era, and it is necessary to adapt to personal lifelong development and social development. Only with these qualities can students successfully adapt to society, promote social development while achieving self-realization. This article explores the curriculum reform of Advanced Mathematics based on key competencies, introducing large unit teaching in the classroom, transforming knowledge structure from singular to holistic, from fragmented to systematic, in line with students' cognitive laws, improving their mathematical key competencies, and promoting their comprehensive development.

1. Introduction

Key competencies first appeared in research reports by the Organization for Economic Cooperation and Development (OECD) and the European Council. The OECD launched the "Definition and Selection of Competencies: Theoretical and Conceptual Foundations" (DeSeCo) research project in 1997, and then used the term in the 2003 research report "Key Competencies for a Successful Life and a Well Functional Society". In 2005, the OECD released "The Definition and Selection of Key Competencies: Executive Summary" to enhance the operability of key competencies in education.[1]

In 2014, the Ministry of Education issued the "Opinions on Fully Deepening Curriculum Reform and Implementing the Fundamental Task of Moral Education" [2], proposing that "the Ministry of Education will organize research on the key competency system and explore the character and ability required by students to adapt to social developments. "

In 2016, the research results of "Key Competency Development for Chinese Students" were released. The development of key competencies among Chinese students is based on the principles of scientificity, timeliness, and ethnicity, with the cultivation of "well-rounded individuals" as the core. It can be divided into three aspects: cultural foundation, independent development, and social participation.[3]

Since then, there has been a wave of research on key competencies in the education sector, which has not declined to this day, and many experts and scholars have participated in discussions.

Zhong Qiquan [4] proposed that " key competency" is the soul of a course, and all teaching activities should be centered around " key competency", rather than being directly taught to classmates by teachers. It is acquired by teachers in creating problem scenarios, which can help teachers master the course as a whole and reduce scattered knowledge transmission.

Ma Yunfei [5] and others believe that the design of authenticity problem is an important way to transcend the chaos of problem design, truly return to high-quality problem design, deepen the teaching reform, implement the new curriculum standards, form the key competencies of subject, achieve training goals, and promote the high-quality development of basic education.

Xie Jihong [6] and others believe that core literacy research in the field of education will be integrated into the outstanding traditional Chinese culture, strengthen the evaluation research of disciplinary core literacy and the research of classroom teaching mode, and explore the core literacy of teachers.

Developing students' key competencies is an important measure to implement the fundamental task of cultivating morality and talents, and it is also an urgent need to adapt to the trend of global

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education reform and development, and enhance China's international competitiveness in education.

"Large unit teaching" is an effective way to improve key competencies. This teaching method emphasizes the continuity of teaching content and the logic of knowledge, which not only promotes knowledge learning and skill improvement, but also exercises students' comprehensive ability, collaborative ability, and practical ability, effectively improving their key competencies.

2. Large Unit Teaching

The large unit teaching method can be traced back to the "New Education Movement" and "Progressive Education Movement" that emerged in Europe and America in the late 19th century.

Firstly, Ovide Decroly from Belgium proposed the “Decroly Method”, which is the embryonic stage of unit teaching. Afterwards, the American educator John Dewey advocated for pragmatic unit teaching, and his student William Heard Kilpatrick formed the theory of design teaching method (also known as unit teaching method) on this basis.

In 1931, American educational psychologist Morrison proposed the "Morrison Plan", also known as the “Morrison Unit Teaching Method”, which allows students to learn a textbook or solve a problem within a few days or a week. The teaching process is divided into five steps: exploration, prompts, self-learning, systematization, and retelling. [7]

The development of large unit teaching method in China can be traced back to the education reform in the early 20th century. With the spread of Western educational concepts, Chinese educators have begun to explore and practice new teaching methods, including unit teaching method.

In recent years, with the continuous deepening of education reform and the proposal of new curriculum standards, the "large unit teaching method" has further evolved.

A search on CNKI using the term "large unit teaching" showed 471 academic journals, 326 thesis papers, and 421 conference papers in Chinese, and showed an increasing trend year by year. This indicates that the theory of large unit teaching is receiving more and more attention from domestic scholars.

Cui Yunkuo [8] believes that unit teaching design is an important manifestation of teaching professionalism. It is a professional design based on the student's perspective and the complete learning process carried out by students around a certain unit. The design of large units targeting the core competencies of disciplines is an inevitable requirement for implementing moral education, developing quality education, and deepening curriculum reform in discipline education. It is also a key path for the implementation of core competencies in disciplines.

Liang A-Li [9] believes that in large unit teaching, teachers should reorganize the units, reconstruct the schema, and reconstruct the curriculum; To focus on the goal of "cultivating morality and nurturing talents", the main content should be mathematics curriculum standards and key mathematical competency, and the main goal should be to improve students' mathematical learning ability. Knowledge related to mathematics should be integrated, mathematical thinking methods refined, and educational ideas transformed.

Xu Qinhe and Li Yongting [10] believes that the design of the "large unit" topic conforms to the teaching principles of the new curriculum standard. The positive impact of large unit design is reflected in three aspects: developing students' subject core abilities, improving teachers' curriculum awareness, and deepening classroom teaching reform. In the process of mathematics teaching, teachers can organically combine the content of different chapters, so as to better play the role of large unit teaching.

The "large unit teaching" emphasizes the internal logic of knowledge and the active construction of students, which helps to improve their understanding and application ability. In the complex and highly coherent subject of Advanced Mathematics, the large unit teaching method is particularly suitable.

Based on a survey of university teachers, this article believes that "large unit teaching" is a secondary development and overall design of teaching content, which is a "beyond content" teaching. It can effectively organize fragmented knowledge and skills in the subject, and help design continuous and consistent courses. When using big unit thinking in the classroom, it can help students go beyond

concrete thinking and reach higher levels

The large unit teaching method can be divided into 5 steps as shown in Fig. 1. Firstly, sort out and analyze the content of higher mathematics, and extract large units. These units can be extracted according to the chapters of the textbook, as well as a certain theme or content; Each unit should have clear learning objectives, key content points, and teaching methods. Then, based on the key theme of the main unit, design the teaching level, which is the second level unit; Clarify the learning objectives and competencies requirements for each unit; Select teaching methods based on the analysis of the learning situation. During the teaching process, teachers should always pay attention to students' learning initiative and participation, and constantly stimulate their thinking activities. After the teaching activities, teachers should promptly assess the learning effectiveness of students, reflect on the shortcomings in teaching, continuously improve and perfect teaching methods.

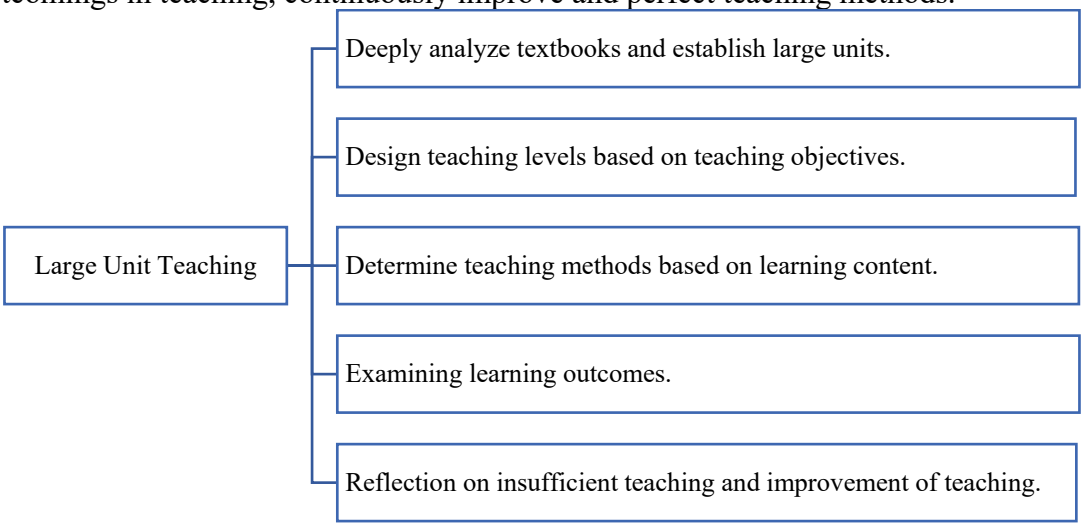

Fig. 1 The Steps of Large Unit Teaching

In large unit teaching, teachers should pay attention to the connection and transition between units, ensuring that students can smoothly enter the next unit of learning on the basis of mastering the previous unit. At the same time, the teaching methods and means of each unit should also be adjusted according to its content characteristics and the actual situation of students.

For example, for some theoretical units, teaching methods such as lecture and discussion can be used. For some units with strong applicability, case analysis, experimental teaching, and other methods can be used.

3. Instructional Design

This article aims to explore the teaching strategy of advanced mathematics based on key competencies, comprehensively analyze the connotation and composition of "unit teaching method", propose specific teaching design, in order to improve the teaching quality and students' comprehensive development.

Before implementing teaching, teachers should conduct thorough research on the textbooks, comprehensively analyze the learning situation of students, and then carry out teaching work based on the actual situation of students.

Advanced Mathematics is a fundamental discipline at the university period, which has a profound impact on students' subsequent professional learning and research activities. However, due to its abstract content and strong logicality, many students feel difficulties in the learning process. Through interviews with students, the main problems they face when learning "double integral" [11]are as follows:

(1) Students have insufficient understanding of complex concepts in "double integral", such as the concept of double integral, which is calculated using Cartesian or polar coordinates. It is difficult for students to understand the differences and connections between them, and they only know how to memorize them by rote;

(2) Students' understanding of "double integral" is fragmented and has not formed a system, which leads to their inability to do comprehensive problems;

(3) Students have weak ability to apply mathematical knowledge, and are unable to concentrate and analyze when solving practical problems;

(4) Some students have a low level of mathematical key competencies.

In order to help students better master the knowledge and skills of higher mathematics, educators need to constantly explore more effective teaching methods, among which the large unit teaching method is worth trying.

When explaining Chapter 10 "Double Integral"[11], teachers should have a deep understanding of the textbook content, comprehensively consider and connect this knowledge to form a whole, and redefine the overall unit goals based on the whole, so that students can integrate and form a system of the knowledge they have learned, in order to improve their mathematical key competencies. Fig. 2 is my hierarchical classification of the chapter.

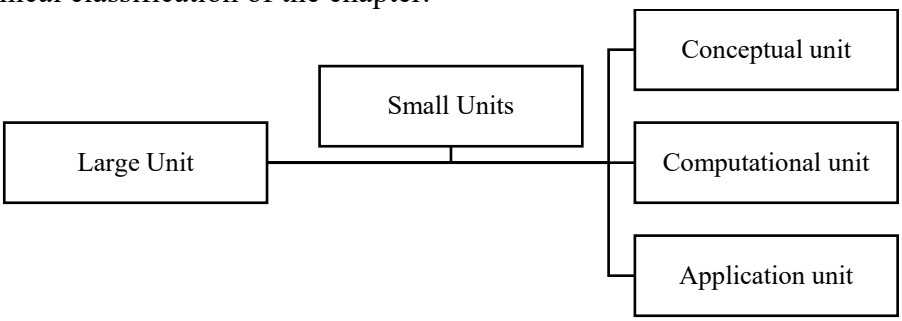

Fig. 2 The Unit Hierarchy Relationship

The Table 1 below is the specific instructional design.

Table 1. Instructional Design

Large Unit : Double Integral			
Knowledge Unit	**Learning Objectives**	**Core Competencies**	**Lesson Hours**
Conceptual unit	1. Master the concept and significance of double integral. 2. Understand the properties of double integrals. 3. Use properties to estimate and compare double integrals.	Exercise students' mathematical abstraction ability and mathematical language expression ability.	2
Computational unit	1. Proficient in transforming double integrals into quadratic integrals in Cartesian coordinates. 2. Proficient in calculating quadratic integrals. 3. The order of points will be changed.	Exercise students' logical thinking ability, spatial imagination ability, and computational ability.	4
	1. Understand the concept and significance of polar coordinates. 2. Master the transformation between Cartesian and polar coordinate systems. 3. Master how to convert double integrals into repeated integrals in polar coordinates and calculate them.	Exercise students' logical thinking ability, spatial imagination ability, and computational ability.	3
Application unit	1. Understand the element method. 2. Able to use double integrals to calculate the volume of a solid. 3. Able to use double integrals to calculate the area of a surface.	Improve students' application abilities; Develop a scientific attitude of seeking truth from facts.	3

In specific teaching, teachers should always pay attention to the overall and progressive nature of

teaching activities. Teachers need to have a clear understanding of each knowledge point in the textbook, as well as a clear understanding of the overall knowledge in the textbook; And the content of each small unit is derived from the previous unit, expanded on this basis, and finally formed as a whole. Teachers should enhance students' thinking ability by analyzing the content they have learned.

For example, when explaining the calculation of double integrals in Cartesian coordinates, I summarized the four types into a small unit, as shown in Figure 3; When explaining the calculation of double integrals in polar coordinates, I summarized the three types into a small unit, as shown in Figure 4.

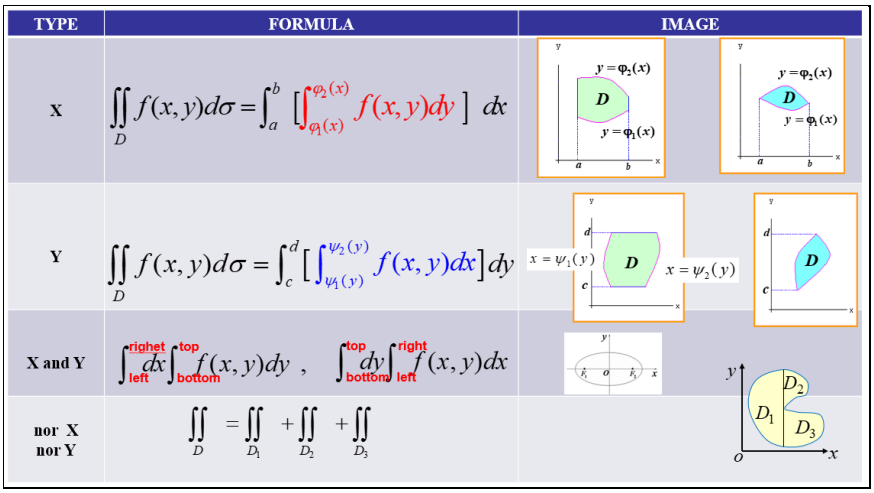

Fig. 3 Cartesian coordinate system unit

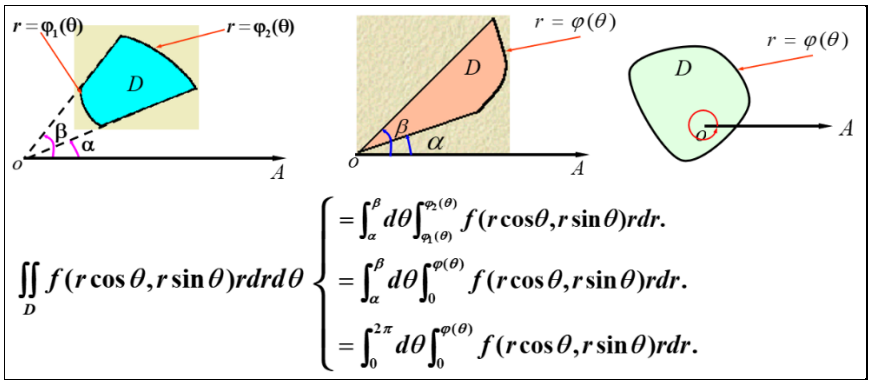

Fig. 4 Polar coordinate system unit

In large unit teaching, teachers should pay attention to the connection and transition between units, ensuring that students can smoothly enter the next unit of learning on the basis of mastering the previous unit.

In addition, the large unit teaching method also emphasizes students' self-directed and cooperative learning. Under the guidance of teachers, students need to actively participate in the learning process of each unit, continuously improving their mathematical key competencies through independent thinking, group discussions, practical operations, and other methods.

4. Summary

In the unit teaching method, evaluation should run through the entire teaching process, including regular testing of students' knowledge mastery, assessment of their problem-solving abilities, and evaluation of their learning attitudes. Through comprehensive and objective evaluation, students' learning status can be timely understood, providing a basis for teaching adjustments.

Below is one of the unit tests on the calculation of double integrals, with a maximum score of 100 points. There are 7 classes participating in the test, with a total of 191 students. Among them, 48 students were absent and their score was recorded as 0. The test results are summarized as Table 2.

Table 2. Test Score Statistics

CH10 Double Integral					
The highest score: 100		The lowest score: 20		The average score: 65.71	
Staged Statistics					
Score	100-90	89-80	79-70	69-60	59-0
Number of students	100	24	10	3	54
Proportion	52.36%	12.57%	5.24%	1.57%	28.27

In this unit test, 52.36% of the students achieved excellent results, exceeding half, indicating good learning outcomes; Although there are also a large number of failed students, subtracting 48 students who missed the exam, the actual number of failed students is 6, accounting for 3% of the total number. It can be seen that large unit teaching has a promoting effect on students' learning

In large unit teaching, teachers play the roles of guides and facilitators. Teachers need to have high professional competence and teaching ability, be able to flexibly manage the classroom, and guide students to explore knowledge in depth. Therefore, teachers should constantly update their educational concepts, enhance their teaching skills, promote the innovative development of large unit teaching methods, and provide higher quality teaching methods and means for higher mathematics courses.

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