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Research on Teaching Design of Mathematical Function Unit in Senior High School under the Guidance of Core Accomplishment

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Abstract

Under the background of core literacy education, teachers need to break through the concept of traditional teaching and cultivate students' key abilities from the standpoint of what they really need. This paper first introduces the significance and research status of the teaching design of mathematical function unit in high school under the guidance of core literacy, then analyzes the problems existing in the teaching design of mathematical function unit in high school under the guidance of core literacy, and puts forward some strategies for the teaching design of mathematical function unit in high school under the guidance of core literacy, and finally emphasizes some problems that need attention in the implementation of unit teaching. Through the function unit teaching design, we can better realize the teaching goal of cultivating and improving students' core literacy, which has certain practical significance.

Keywords

Core Literacy, Unit Instructional Design, Function

1. Overview of High School Mathematics Function Unit Teaching Design Guided by Core Literacy

1.1. Unit Teaching Design Guided by Core Literacy

The Implementation Suggestions for the "General High School Mathematics Curriculum Standards (2017 Edition, Revised in 2020)" point out that mathematics teaching should propose teaching recommendations for cultivating students' core literacy in terms of teaching objectives, teaching context creation, grasping teaching content, selecting teaching methods, and applying information technology (Fang, 2021). In order to implement mathematics core literacy, teach-

ers need to break the traditional teaching design, stand on the "shoulders" of knowledge, and have a comprehensive understanding of the teaching content in order to find the main line for unit teaching. Unit teaching is a process in which teachers, based on the relevance of knowledge and the cognitive laws of students, analyze, integrate, and explain teaching content, combining it with their own teaching practice. The focal point of achieving this process is the unit teaching design. Unit teaching design generally includes the following six parts: first, starting from students' conditions; second, relying on teaching content; third, guided by teaching objectives; fourth, focusing on teaching activities; fifth, limited by teaching time; sixth, feedback from teaching evaluation (Wu, 2021).

1.2. Significance of High School Mathematics Function Unit Teaching Design Guided by Core Literacy

Unit teaching design can help teachers break the traditional teaching model and use innovative teaching methods to enhance students' core literacy through a comprehensive teaching approach. It can assist students in breaking through the boundaries of individual knowledge systems, establishing a holistic knowledge system, strengthening their understanding of the connections between different knowledge areas, and promoting continuous learning. The textbook is the main basis for teachers' instruction and students' learning. In the function part of high school mathematics textbooks, the teaching focuses on understanding the concept of functions and learning power function models, analogously studying exponential functions and logarithmic functions, including their concepts, graphs, and properties, in order to apply functions to solve practical problems and lay the foundation for learning trigonometric functions.

Functions are a key component throughout high school mathematics and serve as fundamental tools for solving mathematical problems. Functions and their associated mathematical thinking methods permeate various areas of mathematics, including algebra and geometry. Understanding abstract concepts can be challenging for students. In addition, basic elementary function models, such as power functions, exponential functions, and logarithmic functions, as well as the properties of functions, including monotonicity, maximum and minimum values, present both focal points and challenges in teaching. Therefore, function unit teaching design can help teachers break away from traditional teaching focused on time allocation and assist students in better understanding function knowledge through a holistic approach.

1.3. Investigation and Analysis of High School Mathematics Function Unit Teaching Design Guided by Core Literacy

Unit teaching design has been studied both domestically and internationally. The earliest development of unit teaching design can be traced back to the late 19th century in Europe. Belgian educator Decroly (Zhang, 2015) proposed the teaching method centered around unit teaching based on his experimental whole-school teaching approach, known as the Decroly method. In the 20th cen-

tury, the birth of pragmatic education further promoted the development of unit teaching. One of Decroly's students, Kilpatrick, introduced the idea of instructional design, which was historically referred to as the unit teaching method. In China, unit teaching design can be traced back to the 1920s when Liang Qichao proposed the "group comparison teaching method" (Liang, 1932). With John Dewey's visit to China, the spread of pragmatic unit teaching theories in our country accelerated, initially primarily focusing on the Chinese language subject. In the 21st century, the number of Chinese scholars researching unit teaching has increased, and with the emergence of the concept of core literacy in various subjects, scholars believe that the key to implementing core literacy lies in unit teaching design.

Different scholars hold different views on high school mathematics function unit teaching design, and teachers have used various teaching methods depending on their interpretations of the definition of functions. For example, Lv Shihu et al. (Lv et al., 2008) believe that in function teaching design, it is necessary to focus on the practical background of functions. By analyzing the function relationships in practical problems, they abstract the concepts of functions and basic function models. Functions are not only mathematical knowledge but also tools for solving practical problems. Teaching functions can help students appreciate the beauty of mathematics.

2. Analysis of Existing Problems in High School Mathematics Function Unit Teaching Design Guided by Core Literacy

2.1. Lack of Clear Unit Teaching Design Themes

The foundation of unit teaching design lies in the division of unit themes. Unit themes can be based on a single unit in the textbook, the integration of several units into one larger unit, or organized based on the six core literacy components in mathematics. Some teachers have unclear division of unit themes and a lack of clarity in identifying the core knowledge of the unit. If the theme division is unclear, it will lead to incorrect design of unit teaching objectives, making it difficult to identify the key and challenging aspects of the unit. For example, in the design of the high school mathematics function unit, teachers often take Chapter 3 of the People's Education Press version A of the compulsory first volume of high school mathematics as the theme of the unit. In this chapter, the focus is on abstracting the function definition from practical problems, and once students understand the function definition, they establish power function models. Such a theme division is not conducive to students' unified understanding and recognition of function models (power functions, exponential functions, logarithmic functions), and it may result in a fragmented understanding of knowledge related to function models.

2.2. Inaccurate Analysis of Unit Teaching Content

When analyzing the content of the high school mathematics function unit, it is

necessary to conduct a thorough analysis of the teaching content. Firstly, it is important to analyze how the textbook introduces scenarios, how it guides student thinking through inquiry activities, and how it assesses student learning through exercises. Secondly, it is necessary to make adjustments to the teaching content by comparing different versions of textbooks. In the analysis of teaching content, it is important to analyze the problem from the perspective of students and consider the completeness and coherence of the knowledge from their point of view, thus helping students establish a comprehensive knowledge system. In this process, teachers often overlook the transfer of knowledge between disciplines, resulting in less connection between mathematical knowledge and knowledge of other subjects. For example, when studying the initial phase, phase, period, and frequency of function $y = A\sin(\omega x + \phi)$, the focus is only on the mathematical study of trigonometric functions, without relating it to other subjects. For instance, the mathematical study of the harmonic oscillation of function $y = A\sin(\omega x + \phi)$ in physics, which leads to a disconnect between knowledge across different subjects.

2.3. Detachment from Real-Life Problems in Unit Teaching Process Design

In the design of the high school mathematics function unit teaching process, it is common for the content to become detached from real-life applications, where the connection between real-life situations and mathematical models is not fully established. In the unit teaching process design, functions are defined and function models are introduced based on real-life problems. However, the process of applying the function models back to real-life problems is more abstract and often neglected by teachers in the unit teaching process design.

3. Strategies for High School Mathematics Function Unit Teaching Design Guided by Core Competencies

3.1. Clarity of Unit Knowledge Structure

The unit knowledge structure consists of the internal connections within the subject, the connections between different subjects, the knowledge relating to real-life contexts, and the teacher's experiential summary of knowledge. For example, in the high school mathematics function unit, the knowledge structure refers to the connections within the function knowledge, the associated knowledge between mathematics and physics, chemistry, and other subjects, and the teacher's experiential knowledge of function modules. Learning new mathematical knowledge needs to be based on relevant knowledge, and there should be clear correlations between different units and their knowledge structures. In mathematics, the answers to problems are clear and unique, and the problem-solving methods and approaches are often interconnected or similar. Mathematics emphasizes learning methods and thinking patterns. The establishment of the knowledge structure in the high school mathematics function unit is pri-

marily based on the curriculum standards, which guide the preparation of textbooks and corresponding reference materials and serve as an important basis for assessing teaching quality (Li, 2018). Under the curriculum standards, teachers can grasp the teaching design comprehensively, clarify the knowledge structure, and accurately determine the depth and breadth of teaching.

The intrinsic basis for the unit knowledge structure lies in the subject knowledge and the inherent logical relationships between different knowledge areas within the subject. The knowledge in the high school mathematics function unit can be divided into the concepts and properties of functions, common function models, and applications of functions, all of which have strong logical relationships between them. We first introduce the concepts and properties of functions, then introduce common function types and their properties, and finally analyze the applications of functions in real-life contexts. Additionally, the elementary functions studied in this unit are all related to $z = x^y$ and are studied following the $y = x^a \Rightarrow y = a^x \Rightarrow y = \log_a x$ task chain. There is a strong interconnection between the knowledge areas. The knowledge within the unit's knowledge structure also needs to have strong interconnections.

3.2. Accurate Analysis of Unit Teaching Design Elements

The elements of unit teaching design mainly include content analysis, student learning analysis, and teaching method analysis. The analysis of teaching elements is an important part of unit teaching design and provides a foundation for the subsequent design of teaching objectives and arrangement of teaching activities. Teachers approach the unit from a holistic perspective, conducting in-depth exploration of the essence of knowledge, analyzing the logical relationships between different knowledge areas, and giving deep thought to the application of thinking methods in teaching. For example, the analysis of elements in the design of the high school mathematics function unit is as follows (**Table 1**).

Based on the above analysis of teaching elements, regarding the teaching content, we need to analyze the textbook from a holistic perspective and conduct a systematic analysis of the knowledge. In terms of analyzing student learning conditions, we should consider their existing knowledge foundation and learning abilities in order to properly plan classroom teaching activities. As for teaching methods, teachers should prioritize students as the main participants, cultivate their learning habits, and guide them to become self-directed learners.

3.3. Clear Objective Design Is Necessary for Unit Teaching

The design of unit teaching objectives has a guiding role throughout the entire teaching process. It is a pre-set target for students to achieve teaching effectiveness before carrying out teaching activities. Ultimately, it should be implemented in students' own development. The design of unit teaching objectives should consider the requirements of curriculum standards, the development of mathematical core competencies, and students' basic situations.

Table 1. Analysis of elements in the design of high school mathematics function unit.

	Content Analysis
Teaching Content:	In the high school stage, functions are not only the main content of classroom teaching, but also serve as tools and foundations for learning equations, inequalities, sequences, and derivatives. High school functions are an in-depth study of functions from middle school. While middle school adopts the "variable approach", high school establishes the "correspondence approach", which is more generalized than the "variable approach". By studying power functions, exponential functions, logarithmic functions, trigonometric functions, and elementary functions, students can understand the thinking methods of functions and their close connections with other teaching contents. These important function models also have significant practical significance.
Student Learning Analysis:	Students have already learned about sets and logical language, which they can use to express functions. In middle school, students have been introduced to linear functions, quadratic functions, etc., and have a preliminary understanding that studying the properties of function graphs is necessary. In their previous learning, students have also engaged in multiple explorations of definitions and have used the method of extrapolation, developing certain exploration skills.
Teaching Methods:	Teachers adopt a combination of lecturing and self-inquiry learning methods to help students develop a deep understanding of the concept of functions. The teacher uses guided inquiry and group cooperation to deepen students' understanding of abstract function models.

For the high school mathematics function unit, the design of teaching objectives should start with the overall theme of functions, combining student learning conditions and the requirements of the mathematics curriculum standards, to design hierarchical teaching objectives. The high school mathematics curriculum standards state that through learning related knowledge of functions, students can have a deeper understanding of the nature of functions and learn to use functions to solve real-world problems. The design of teaching objectives for the high school mathematics function unit should be based on the curriculum objectives, but since unit teaching objectives are ultimately implemented in classroom teaching, they also need to be designed based on students' existing knowledge foundation and learning abilities.

3.4. Unit Teaching Process Design Should Be Implemented into Lesson Plans

The design of unit teaching process should be implemented into specific lesson plan designs in order to achieve the unit teaching objectives. Teachers should design specific lesson teaching segments based on the specific teaching content and choose different teaching strategies for instruction. For example, in the lesson on the concept of functions, the first step for the teacher should be to determine the requirements of the concept of functions within the entire unit theme, and the second step should be to determine the objectives for the concept of

functions in the unit's learning objectives.

3.5. High School Mathematics Function Unit Evaluation and Reflection Need to Be Profound

Unit teaching evaluation and reflection should not only focus on the surface level of teaching or the transmission of knowledge, but should be implemented in various aspects of students' development, specifically whether their core competencies have been improved through the unit teaching. Unit teaching evaluation and reflection can analyze whether students' mathematical core competencies have been enhanced based on their classroom performance, depth of understanding of knowledge, and changes in thinking during the learning process.

Unit teaching evaluation provides feedback on students' learning abilities, thinking abilities, and problem-solving abilities. It includes the evaluation and reflection of students' learning abilities, knowledge application, and transfer abilities. For example, in the evaluation of a lesson on function types, in terms of learning abilities, students are able to learn about the relevant knowledge of power functions under the guidance of the teacher, experience the process of learning power functions, and apply the research methods of power functions to exponential functions and logarithmic functions through analogy. They are able to use the analogy method to apply the research methods of elementary functions to the learning of trigonometric functions, sequences, and other knowledge. In terms of knowledge application and transfer abilities, they can abstract function models from practical problems and use them to solve real-world problems. In terms of learning abilities, students are able to complete corresponding teaching activities under the guidance of the teacher, summarize the learning methods for corresponding function models, and reflect on and improve their learning process.

4. Analysis of Issues to Be Addressed in the Implementation of High School Mathematics Function Unit Teaching Design under the Guidance of Core Competencies

In the implementation of high school mathematics function unit teaching design, there may be issues such as insufficient knowledge connection, insufficient depth of students' understanding of knowledge, and lack of students' motivation to learn. A specific analysis is as follows:

4.1. Pay Attention to the Connection of Teaching Knowledge When Dividing Lessons

After the completion of the function unit teaching design objectives, it is necessary to divide the unit teaching into specific lesson plans. We need to consider the logical relationship between lessons and the knowledge within the lessons, and pay attention to the connection of knowledge. In the process of division, there should not be a lack of connection between modules. For example, in the connection between the lesson on the concept of functions and the lesson on ba-

sic function models, teachers need to guide students to abstract independent and dependent variables from real-world problems and summarize the function models. Strengthening the connection between knowledge can help students understand and master the knowledge.

4.2. Pay Attention to Stimulating Students' Learning Interest

In actual teaching, teachers often overlook the stimulation of students' learning interest and tend to use one or two questions for teaching without providing a guided question chain. For example, in the teaching of logarithmic operations during the lesson on function models, teachers can use a question chain to guide students (Table 2). Using a question chain can stimulate students' interest in learning and achieve teaching effectiveness.

4.3. Pay Attention to the Ability to Transfer and Apply Knowledge

During the unit teaching process, there is insufficient focus on the transfer and application of knowledge. For example, under the guidance of the teacher, students learn the concept and properties of power functions and analogously analyze exponential functions and logarithmic functions to master the methods of transferring and applying knowledge. Teachers should focus on cultivating students' ability to transfer and apply knowledge throughout the teaching process, which fundamentally helps students understand and apply knowledge.

5. Conclusion

Functions are an important part of high school mathematics. The design of the unit teaching for the high school mathematics function unit analyzes the knowledge from a holistic perspective and guides the teaching of functions in a hierarchical manner. Guided by deep learning theory, this study explores the design of the high school mathematics function unit teaching, providing valuable insights for high school mathematics teaching. In the context of the era of core

Table 2. Problem string teaching design.

Question Chain	Design Intention
Question 1: Given $a^m = M$, $a^n = N$, what is $\log_a M = ?$ $\log_a N = ?$	The intention is to introduce the relationship between exponentiation and logarithm and solve simple logarithmic equations.
Question 2: Given $a^m \cdot a^n = a^{m+n} = MN$, what is $\log_a MN = ?$	Through the analogy of thought, applying the property of exponentiation with the same base, we can derive the property of logarithm with the same base for multiplication.
Question 3: Given $a^m \div a^n = a^{m-n} = \frac{M}{N}$, what is $\log_a \frac{M}{N} = ?$	Using the same analogy method as in the previous question, applying the property of exponentiation with the same base for division, we can derive the property of logarithm with the same base for division.

competencies in education, this article analyzes the issues in the design of unit teaching in high school mathematics, such as unclear teaching themes, inaccurate analysis of teaching content, and detached design of unit teaching processes. Five strategies for high school mathematics unit teaching under the guidance of core competencies are proposed. Finally, the attention to be paid during the implementation of unit teaching is analyzed. Through unit teaching design, students' interest in learning mathematics can be enhanced, their confidence in mathematics can be strengthened, and good habits in learning mathematics can be cultivated. At the same time, it further encourages frontline teachers to think and explore how to innovate unit design to improve students' core competencies in mathematics.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Fang, C. L. (2021). Designing Unit-Lesson Teaching Focusing on Core Competencies in Mathematics: Taking the High School Unit "Quadratic Functions, Equations, and Inequalities" as an Example. *Mathematical Bulletin, 60,* 30-35.

Li Yongting. (2018). *Research on Holistic Teaching Design Model of Unit Knowledge Structure.* Ph.D. Thesis, Nanjing Normal University,.

Liang, Q. C. (1932). *Teaching Methods for Composition in Secondary Schools and Above.* Zhonghua Book Company.

Lv, S. H., & Wang, S. Z. (2008). Design Ideas and Teaching of Functions in the New High School Mathematics Curriculum. *Curriculum, Teaching Material and Method,* 49-52+86.

Wu, L. L. (2021). *Research on Designing High School Function Unit Teaching Based on Deep Learning.* Master's Thesis, Fujian Normal University.

Zhang, B. X. (Ed.) (2015). *History of Foreign Education.* Education Science Press.