RESEARCH ON HIGH SCHOOL MATHEMATICS FUNCTIONS TEACHING FROM THE PERSPECTIVE OF UNIT INTEGRATION

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ABSTRACT

The Ordinary High School Mathematics Curriculum Standards (2017 edition, revised in 2020) emphasize the need to grasp teaching content from an overall perspective, highlighting the core of mathematical unit teaching design: to form a holistic view and achieve structuring. This paper mainly takes the "Function" module in high school mathematics as an example to explore how to better teach this large unit from the perspective of unit overall teaching, providing some guiding suggestions for future teaching.

Keywords-Unit Overall Teaching; High School Mathematics Teaching; Function.

I.The Introduction

Unit overall teaching is a hot topic in contemporary mathematics education research. The promulgation of the "Compulsory Education Mathematics Curriculum Standards (2022 edition)" provides a clear definition of unit overall teaching, stating that it is guided by the unit theme, starting from students'knowledge experiences and cognitive structures, and reasonably arranging teaching content and designing teaching activities from a holistic perspective[1].This approach allows students to deepen their understanding and grasp of the overall knowledge within the unit, thereby improving the efficiency of classroom teaching overall. It can be seen that unit overall teaching is not a traditional segmented teaching model; rather, it allows students to see the entire system of mathematical knowledge and form a holistic view of mathematics. Moreover, according to the spirit of the new curriculum standards, future mathematics teaching will also present learning tasks in the form of task groups based on the learning tasks, themes, and practical activities at various stages. Therefore, mathematical unit overall teaching is extremely important. However, in current frontline teaching, many teachers, influenced by traditional teaching methods, prefer to adopt an independent lesson teaching approach, treating each lesson within the unit as separate[2].This leads to a lack of integration of some knowledge within the unit, preventing students from using previously learned knowledge to solve new problems. Thus, it is essential to apply unit overall teaching methods in high school mathematics education.

As one of the four main lines of content in the high school mathematics curriculum, functions not only provide a common foundation for students' development but are also part of the requirements for the mathematics academic proficiency examination and the college entrance examination. Functions are fundamental concepts in modern mathematics and serve as the basic mathematical language and tool for describing relationships and laws among variables in the objective world[3]. They play a crucial role in solving practical problems. In the teaching guidelines for the function module within the new curriculum standards, it is mentioned that teachers should view the content of functions as a whole, guiding students to understand the concept of functions from the perspectives of the dependency relationships between variables, the correspondence between sets of real numbers, and the geometric intuition of function graphs. Teachers should help students recognize the overall properties of functions by sorting out their monotonicity, periodicity, odd/even properties (symmetry), and maximum (minimum)

values, and experience the entire process of using functions to solve practical problems. Therefore, this paper aims to analyze and explore high school function teaching from the perspective of unit overall teaching, thereby improving teachers' understanding of function teaching and helping to guide and cultivate students' holistic learning of mathematical knowledge.

Ⅱ. Analysis of the Current Situation of High School Function Teaching

A.Dispersed Overall Goal Positioning for the Function Unit and Weak Overall Teaching Concepts

Teaching objectives primarily focus on a clear description of the changes that will occur in students during the teaching process, meaning that teaching activities are guided by teaching objectives and are always conducted with the aim of achieving these objectives. However, literature reviews reveal that the design of teaching objectives for the function module is generally vague and dispersed, lacking systematicity, logic, and specificity. Teachers also show a lack of holistic consideration regarding core competencies and methodological ideas, resulting in unclear positioning of objectives at the thematic, unit, and lesson levels[4].This is because unit overall teaching objectives have a hierarchical nature, yet most teachers rarely conduct structural analyses of the textbook when designing objectives for function teaching. Consequently, this leads to a vague overall positioning of the teaching objectives for the function module. Even when some teachers set objectives from the overall to the specific, the hierarchy among these objectives is not apparent, and there are instances where sub-objectives are simply copied from a template[4]. This further results in a chaotic overall teaching objective.Additionally, due to the complexity of high school function content, which includes function concepts and properties, power functions, exponential functions, logarithmic functions, trigonometric functions, and applications of functions, each of these small modules contains numerous knowledge points. This complexity leads some teachers to rarely construct and summarize the overall knowledge of the function unit during the explanation of each small knowledge point. As a result, there is a lack of a holistic view of functions, which can cause students to experience fragmented knowledge. Over time, this hinders the cultivation of students'holistic thinking.

B.The Overall Teaching Design of Function Units is Formally Structured, with Low Implementation Levels

Teaching design involves teachers organizing various elements of teaching in an orderly manner based on curriculum standards and student characteristics, thereby determining suitable teaching plans. However, literature reviews and interviews with high school mathematics teachers reveal that most teachers are unclear about the model of overall unit teaching and how to implement it. Consequently, in the teaching design for the function module, teachers primarily rely on the content of the textbook. When explaining knowledge, they mainly refer to teaching reference books and online teaching PPTs[5]. This approach primarily involves systematically lecturing the textbook knowledge according to the flow of the textbook without optimizing or reorganizing the knowledge. This phenomenon is more prevalent among new teachers, while some experienced teachers, due to years of knowledge presentation, develop their own comprehensive teaching designs, often breaking the textbook's knowledge structure to construct function knowledge as a whole. Although most teachers design good teaching plans from the perspective of overall large units, the implementation context is often variable. Therefore, during the practical process, teachers may not achieve the desired implementation effects. Additionally, due to teachers' limited capabilities, the integration of small knowledge points with each other, as well as with larger knowledge points, is not very proficient. Consequently, teachers tend to set the teaching goals for each class at mastering the knowledge points of that lesson, rather than delivering the content from a holistic perspective.

C.Prominent Issues in the Function Teaching Process, Overlooking Student Subjectivity

The teaching process refers to the teaching activities conducted by teachers and students to jointly achieve teaching tasks, consisting of both teaching and learning. In the teaching process of functions, there is a significant difference between middle school and high school function knowledge. Middle school function knowledge mainly describes and characterizes the relationship between two variables, while high school functions are primarily defined from the perspective of sets. Specifically, each element in set A corresponds to a unique element in set B through a specific relation[1]. This means that high school functions are more abstract and complex. Many teachers may spend several lessons on a small knowledge point, leading to slow teaching progress and low efficiency. However, if teachers aim to improve teaching efficiency by cramming a large amount of content into each class, this can result in a rapid classroom pace, causing students to be in a state of partial understanding. Furthermore, because high school mathematics teachers typically do not teach only one class, some teachers apply their teaching processes uniformly across all classes, neglecting the uniqueness of each class and violating the student-centered approach advocated by the new curriculum reform. Every student is a unique individual.

D.Single Evaluation of Overall Unit Teaching, Mismatch Between Teaching and Evaluation

Teaching evaluation primarily involves assessing both teachers' instruction and students' learning, occurring during and after a lesson. Due to the complexity of the function content, teachers rarely engage with students interactively, primarily focusing on their own explanations. Additionally, at the high school level, teachers' evaluative language tends to be quite uniform, using phrases like "good," "very good," and "excellent," which lack substantive feedback[6]. After the teaching process, teachers mainly rely on homework and exams to assess students' mastery of function knowledge, which constitutes a very singular evaluation model. Furthermore, when conducting final assessments, teachers tend to focus solely on high-stakes exam points, failing to evaluate students' learning outcomes from an overall unit perspective. In the three aspects of "teaching," "learning," and "evaluation," teachers tend to be unbalanced, with most leaning towards "teaching," that is, knowledge transmission, while neglecting student "learning." The evaluation of teaching also emphasizes students' grades, which can lead students to feel powerless about their poor math performance and may cause them to lose interest in learning mathematics.

III.Suggestions for Teaching Functions in High School

A.Clarify Overall Teaching Objectives for the Unit and Enhance the Concept of Holistic Teaching

The determination of goals influences the direction of the entire teaching plan and affects the teacher's selection and combination of teaching content. Specific lesson objectives should be refined around the unit objectives, requiring teachers to explore the logical and sequential connections between the overall teaching goals and individual lesson objectives. In the teaching of the function module, the overarching abstract teaching goal is to enhance students' mathematical abstraction, logical reasoning, and mathematical operation skills through the study of function knowledge. However, this large unit is divided into four specific sub-units: the concept and properties of functions, power functions, exponential functions, logarithmic functions, trigonometric functions, and the application of functions. Taking the trigonometric functions sub-unit as a specific example, trigonometric functions are important function models that describe various periodic motion phenomena in the real world. After learning this sub-unit, students should understand the definitions of sine and cosine functions, the corresponding relationships of trigonometric functions, and the meanings of the symbols $\sin\alpha$, $\cos\alpha$, and $\tan\alpha$[8]. When viewed within the larger unit of functions, the study of trigonometric functions primarily aims to develop students' understanding of functions and to guide them through the

process of abstracting the concept of trigonometric functions, thereby enhancing their mathematical abstraction skills. Additionally, teachers should strengthen their holistic teaching perspective by viewing the function module .

B.Analyze Textbooks and Student Situations to Improve the Operability of Teaching Design

Before conducting holistic unit teaching design, it is essential to analyze the textbook in detail. For example, when analyzing the trigonometric functions sub-unit, we can divide it into six sub-units: the concept of trigonometric functions, angles and radian measures, induction formulas, the graphs and properties of trigonometric functions, trigonometric identities, and the function $y = A \sin(\omega x + \varphi)$. In analyzing this sub-unit, we can adjust the teaching order of these sub-units based on specific teaching practices and then unify them into the concept of trigonometric functions to reorganize the knowledge structure. Furthermore, it is crucial to consider students' prior knowledge and experiences. Before learning this sub-unit on trigonometric functions, students have already learned about angles, their measurements, acute angle trigonometric functions, the properties of circles (symmetry), and similar shapes, as well as power functions, exponential functions, and logarithmic functions. All of this provides a solid foundation for students' understanding of trigonometric functions. Only by thoroughly analyzing the textbook and effectively and specifically assessing students' learning conditions can teachers ensure that their teaching designs are operable.

C.Implement Unit Teaching to Enhance Teachers' Professional Competence

During the teaching process of functions, teachers should consciously implement unit teaching. First, they should emphasize the transfer of function knowledge, identifying connections between various sub-units and topics. For instance, when teaching power functions, exponential functions, and logarithmic functions, these knowledge points are explained based on the basic forms, graphs, and properties of functions. Therefore, these small knowledge points should not be treated in isolation; instead, they should be viewed as an interconnected whole. Second, the teaching process should have a clear structure. Each sub-unit has its own hierarchy, and the design should progress from different chapters within the same knowledge domain to each specific knowledge point. While teaching the content, teachers should seek connections between knowledge points, focus on linking scattered knowledge points, and explore integration points among similar chapters, thereby teaching students learning methods rather than merely imparting professional knowledge[7]. Lastly, teachers can also learn more about how to apply holistic unit teaching in the context of function teaching, which will enhance their professional competence.

D.Optimize the Teaching Evaluation System to Promote Sustainable Assessment

In the design of holistic unit teaching, it is essential to clarify four aspects: what to evaluate, how to evaluate, who the evaluation targets are, and who will conduct the evaluation. When assessing high school students' learning in the function module, we should determine whether students have fully grasped the knowledge of functions and whether they can construct knowledge from the overall framework of the unit. Additionally, we should assess whether students can apply function knowledge to solve real-life problems. Furthermore, from the perspective of the new curriculum reform, it is important to examine whether students' core competencies have developed, thereby strengthening the sustainability of the teaching evaluation system. Finally, within this evaluation framework, we hope that the three components (teaching, learning, and assessment) are aligned. Therefore, we should not rely solely on students' grades as the only evaluation criterion; instead, we should seek diverse evaluation methods that match teaching, learning, and assessment, thereby improving teaching quality and promoting students' comprehensive development.

IV.Conclusion

It is not difficult to identify that there are many issues in the teaching of functions in high

school mathematics. These primarily include: the overall goal positioning of the function unit is fragmented; there is a weak overall teaching concept; the overall teaching design of the function unit emphasizes form over substance, leading to low implementation levels; the teaching process of functions has prominent issues, neglecting student subjectivity; and the overall teaching evaluation of the unit is singular and mismatched with the teaching itself. In response to these issues, several suggestions have been proposed. However, analyzing high school function teaching through the lens of unit-based overall teaching still requires ongoing research. Only in this way can we enrich the teaching methods for functions, enhance teachers' teaching abilities, and ultimately promote the improvement of students' capabilities.

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