Take the Big Ideas as the Core of the Middle School Physics Module Design

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ABSTRACT
In an era when innovative talents are more and more valued, attainment-oriented education and teaching should come into being. The new curriculum reform The new curriculum reform requires the cultivation of students' core accomplishment and the promotion of students' all-round development, but the students' ability of The new curriculum reform requires the cultivation of students' core accomplishment and the promotion of students' all-round development, but the students' ability of generalization and integration of physics knowledge is poor in front-line teaching. In this paper, a modular teaching method and evaluation standard are designed based on the big ideas theory, In this paper, a modular teaching method and evaluation standard are designed based on the big ideas theory, which is convenient for teachers to integrate teaching materials and carry out modular teaching, so that students can learn to integrate knowledge and In this paper, a modular teaching method and evaluation standard are designed based on the big ideas theory, which is convenient for teachers to integrate teaching materials and carry out modular teaching, so that students can learn to integrate knowledge and construct their own framework system.

Keywords: *Big ideas, junior high school physic, module design*

1. INTRODUCTION

With the development of society and the advancement of technology, the teaching field has become diversified in terms of teaching methods and other aspects, and the centre of teaching has changed from knowledge-centred to literacy-centred. On 8 April 2014, the Ministry of Education promulgated the Opinions on Comprehensively Deepening Curriculum Reform and Implementing the Fundamental Task of Building People's Moral Character[1] , which states that core literacy refers to the essential character and key competencies that students should possess to be able to adapt to lifelong development and social development The core literacy refers to the necessary character and key abilities that students should possess to meet the needs of lifelong development and social development. The development of core literacy answers the fundamental question of what kind of moral character to build and what kind of person to make. The Physics Curriculum Standards for Compulsory Education (2022 Edition) also proposes the construction of a physics curriculum system with clear directions, a clear structure and a clear hierarchy, focusing on the progression of the themes in the physics curriculum and the backward and forward linkages, so as to cultivate the correct values, essential characters and key competencies that students need to adapt to their lifelong development and the development of society. In recent years, the direction of the Chinese examinations in China has shown that the content of the examination is no longer limited to simple concepts and models, but is closely related to everyday life, from life to physics and from physics to society. Therefore, helping students to integrate knowledge, develop scientific thinking and enhance their investigative skills is a great contribution to the development of students' core literacy as well as to improving their competitiveness in the future society.

Under the guidance of the new 2022 edition of the curriculum, the mission of the physics course is to help students understand nature and solve practical problems from the perspective of physics, with an emphasis on developing students' investigative skills and scientific thinking. However, it is still difficult to reconcile the relationship between examination-based education and literacy formation in front-line junior secondary physics teaching, and faces serious problems: First, most teachers design their teaching according to lesson time, often ignoring the links between lessons. Many teachers are accustomed to designing their teaching for the class period, and their teaching activities are confined to a single class period. The result can lead to teaching objectives and teaching content remaining at a superficial knowledge level, making it difficult for students to construct a complete knowledge framework. Secondly, the teaching process is stereotyped. Some teachers still adopt the "one lecture to the end" approach, simply following the order of the catalogue in the textbook to instill fragmented knowledge into students. However, junior high school students are in the transition stage from figurative thinking to abstract thinking and have poor integration skills, making it difficult for them to integrate and sort out fragmented knowledge. Therefore, it is an urgent problem for teachers to break the limitations of lesson design and integrate and summarize the fragmented knowledge before teaching the fragmented knowledge to students. It is particularly important to refine key concepts from the textbook, integrate key points and teach them in a progressive manner, based on students' cognitive characteristics and developmental patterns.

2. THEORETICAL FOUNDATIONS

The first research on Big Ideas dates back to the last century, when the American educational psychologist Jerome Bruner suggested that "it is important to help students understand the basic structure of the subject, which will help them to solve practical problems outside the classroom or to solve problems they will encounter in future classroom training[2]. In his cognitive learning theory, he emphasizes that "conceptualization requires the use of certain strategies", which also reflects the need for In his cognitive learning theory, he emphasizes that "conceptualization requires the use of certain strategies", which also reflects the need for certain pedagogical designs and curriculum constructions to achieve students' conceptual understanding and cognitive development [3]. The Big Idea is also the superordinate knowledge in Ossubert's "prior organizer" theory and "meaningful learning", i.e the Big Idea is the "organizer" that integrates the curriculum knowledge and is the one that summarizes and integrates the knowledge of each unit and chapter of the curriculum. It is an important means of summarizing and constructing knowledge across units and chapters of the curriculum [4]. In addition to this, Olsen also suggests from the perspective of cognitive development that the Big Idea is a central concept that can be retained long after students have left school and forgotten concrete experiences and facts [5].

In domestic research on physics teaching for big ideas, many researchers have followed Win-Hallen's definition of big ideas, which are concepts that can be used to explain a large number of facts, objects and phenomena [6]. In constructing instructional objectives, they are no longer based solely on facts and experiences, but gradually move closer to the core concepts, which helps students to apply the core concepts to practical problem solving. Chen Kechao et al. argue that the big ideas in physics are not just simple concepts, laws and principles, but a few key concepts or ideas extracted from a large number of concepts, which can link up to construct a large number of concepts and facilitate the transfer of applications between concepts[7]. Deng Jingwu believes that big ideas point to the more essential ideas behind concrete knowledge, refining them from three dimensions and dividing the hierarchy of knowledge structure [8]. Cao Baolong believes that big ideas are the core concepts that can grasp the concepts and laws of physics as a whole, linking the many knowledge points of physics subjects into a whole [9]. From a comprehensive perspective, the definition of big ideas in secondary school physics teaching research is mostly based on scientific big ideas, integrating curriculum standards, and defining big ideas as superordinate concepts that contain subject knowledge, ideas, models and methods, and can unify lower concepts for migration and application, i.e. physics subject big ideas.

The big conceptual features of the subject vary from subject to subject. In the design of the science content in the Physics Curriculum for Compulsory Education (2022 Edition), we can see that the standard divides the five main parts of the Physics Curriculum under the thematic framework of "Matter", "Motion and Interactions", "Energy", "Experimental Investigation", "Interdisciplinary Practice" and the resulting Tier 1 and Tier 2 headings. "The five main sections of the standard - 'Matter', 'Motion and Interactions', 'Energy', 'Experimental Investigation' and 'Interdisciplinary Practice' - and the resulting Tier 1 and Tier 2 headings are all consistent with the teaching of the Big Ideas. The five main sections, 'Energy', 'Experimental Investigations' and 'Interdisciplinary Practice', and their derived primary and secondary headings, all coincide with the teaching of the Big Idea. Deng Jingwu proposed that the big ideas in physics should reflect the characteristics of physics disciplines and have the features of generality, abstraction, universality and transferability [8]; Ren Huhu summarized that the big ideas have six characteristics: abstraction, centrality, meaning, structure, development and transferability [10].

From the above-mentioned extensive research, we found that using the big ideas idea to lead physics teaching can help to link a large number of basic concepts, explain life phenomena, and promote good transfer applications after students have mastered concepts, methods and models. In this paper, we will use the framework of the Physics Subject Competency Performance Indicator System constructed by Guo Yuying's team as a reference [11], and permeate the big ideas idea to divide the unit knowledge system into four areas: learning comprehension, experimental investigation and migrating application, and quality formation (Figure 1), so as to categorise the fragmented knowledge and help students to classify the levels. Students internalise and process and relate their knowledge through learning and understanding, apply their scientific content and thinking to real-life situations through application, and finally apply their knowledge to new problems or things through transfer and innovation. This paper provides a way of thinking about the use of big ideas for module construction, with the intention of helping students to integrate fragmented knowledge, develop core literacies and improve their ability to transfer and apply practical knowledge.

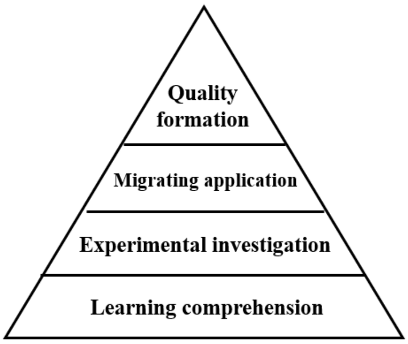

Figure 1 Modular teaching hierarchy chart

3. Specific strategies for modular design of large concepts

3.1 Approaches to module design using big ideas to integrate the content of teaching materials

The curriculum standards for compulsory education have been updated and progressed through continuous reform. In the Compulsory Physics Curriculum Standards (2022 Edition), the content of the curriculum is divided into a total of five first-level themes in three categories: physical content, experimental investigations and interdisciplinary practices. The themes are cascaded and linked backwards and forwards, and the way they are divided is in line with the concept of the Big Ideas. In front-line teaching, teachers can apply this thinking to integrate the content of the materials through a modular design.

Teachers can divide the content of a textbook into modules, such as mechanics modules, thermal modules, electricity modules and optics modules. The content of a particular module may not be confined to just one unit, and sometimes the content under the same module will be scattered in different unit chapters. This requires teachers to be bold enough to integrate the content of the textbook and not just confine their lectures to a step-by-step approach based on the textbook catalogue. For example, in the mechanics module of Shanghai Science Edition, Chapter 6, "Familiar and Unfamiliar Forces", was taught in the first semester, while Chapter 7, "Forces and Motion", Chapter 8, Section 1, "Pressure" and Chapter 9, Section 1, "Buoyancy", are taught in the next semester and are scattered. The teacher can integrate their contents to form a "mechanics module" for teaching. In other words, under the "Mechanics Module", teachers use "Force and Motion" as the big ideas to integrate all the mechanics content in this textbook and form a framework for teaching.

When designing modular teaching, it is important to connect the dots and link the content to be covered in the module together in a natural way. Teachers should focus on grasping the relevance of the knowledge points before and after the module, and organise the fragmented knowledge points in an effective way. The first step is to plan the total number of lesson hours for the module, then list all the knowledge points in the module in a sequential framework and distribute them to students in the form of a guide, etc., so that the progressive order of the whole learning process is clearly explained to students and they have a clear idea of what they are going to learn, which gives them an overall concept of the module and an overall framework system for the knowledge they need to master and learn, so that they know They know what they have to learn, how much they have learned, how much they still need to master, and how many lessons they need to master the content in total. The teacher introduces the module with a real-life example, for example by playing a piece of music, and then explains to the students that in the next three lessons, the teacher will take them through the content of 'sound', and each of them will be given a piece of A4 paper recording all the knowledge points of the chapter. Firstly, sound is everywhere in our lives, so how is it produced? How do sound-producing objects make sound? Secondly, after sound is produced, how does it reach our ears? That is, how does sound travel? Thirdly, we can hear all kinds of sounds in the world, so what are the characteristics of all these sounds? Fourthly, there are always sounds that we don't want to hear, so how do we keep the sounds we don't want to hear out of our ears? How to prevent noise? Fifthly, can our ears hear all sounds? What are the sounds that we cannot hear? The sounds that we can hear can be used for our daily communication and can be made into music for us to enjoy, but what is the role of the sounds that we cannot hear in our lives? By moving from macro to micro lectures, we help students build modularized big ideas and promote them to gradually form their own big ideas system.

3.2 Evaluation methods and rationale for modular design with a big idea at its core

In this paper, we develop a Physics Competency Assessment Form based on Professor Guo Yuying's "Research on Physics Competency and its Performance"[11] and the modularized teaching design based on the big ideas in the above paper. mastery level. The measurement is divided into four sections, with progressive levels of progression, to assess students' learning comprehension, experimental investigation, transfer application and literacy formation.

Table 1 Physics Subject Competency Assessment Form

Physics Subject Competency Assessment Form		
Subject competence	Evaluation content	Evaluation criteria
Learning comprehension skills	Based on a modular design of teaching con-tent with a big ideas focus, stu-dents' m-astery of written cate-gories such as conceptual cate-gories and form-ulae in a single module is mea-sured.	Students are able to de-velop a mas-tery of written cate-gories of kn-owledge from a single module and are able to connect the dots and interconnect these.
Experimental investigation skills	Based on a modular design of teaching con-tent with a big ideas at its core, students' mast-ery of the exper-imental classes in a single mo-dule is meas-ured.	Students will be able to develop a mast-ery of the exper-imental catego-ries in a single module and will be able to link experimental kn-owledge to lear-ning underst-anding.
Migrating application skills	Students are tested on their ability to transfer this mo-dular approach to learning using big ideas as the core to other modules after learning a single module, and they need to undertake seve-ral modules to gradually master the modular app-roach to learning using big ideas.	Students will be able to master modular learning using big ideas after studying one or several single modules and will be able to com-pare and con-trast different modules to find their similarities and differences and be able to transfer and a-pply the big ideas learning methods from different modul-es to each other.
Quality formation	To test whether stud-ents can develop a good grasp of physics conce-ptual categories and develop good scientific thinking, strong experimental investigation skills and scien-tific attitudes and responsibilities through modular learning with a big ideas focus.	Students are able to form their own modu-lar system of big ideas, to make good mastery and connections between the pr-evious learning comprehension categories and experimental investigations, to integrate single modules on their own, to have their own ways of trans-ferring and app-lying different modules, and to relate the know-ledge of the material to real-life situations.

4. CONCLUSION

The modular design of teaching materials based on big ideas helps teachers to sort out the hierarchical relationship between the knowledge content of the materials, and is also a key point for linking knowledge teaching and core literacy development. Using big ideas to integrate fragmented knowledge, modular teaching design starts with dissecting the material and integrating the objectives, internalising knowledge and conceptual progression as the key, and applying practice and transferring innovation as the guarantee for modular teaching design. The modular design of teaching with big ideas as the core can improve learners' scientific thinking skills and develop students' core literacy.

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