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The overall teaching design of physics units using transfer learning of big concepts:Taking" Electrical Power" as an example

Han Jingxi, Jiang Jilei

No.11 Middle School in Zibo, Zibo, 255200, Shandong, China

Abstract: *After the release of the "Physics Curriculum Standards for Compulsory Education" (2022 edition), the new concept of large unit teaching immediately sparked a craze in the education industry. How to organically integrate the new curriculum standard with the large concept unit and design a teaching design that meets the requirements of the new curriculum standard is the key. This article takes classroom teaching as the main axis, and uses Chapter 14 "Electric Power" in the first volume of the ninth grade of the Luke edition as an example to design from six aspects: unit learning objectives, reconstruction of unit learning content, unit activities, unit learning evaluation, and unit homework design, Visualize the design of large unit teaching in frontline teaching in a three-dimensional manner.*

Keywords: *Large concept, Large unit teaching design, Electrical power*

1. Introduction

In the context of the new curriculum standards, the concept of teaching design for large units undoubtedly exists as innovation. Large unit teaching design refers to the establishment of a major theme or task, the thorough analysis of the learning content of the textbook, the restructuring and integration of the textbook structure, and the formation of a complete teaching design with elements such as themes, goals, tasks, situations, and evaluations.

2. The concept of discrimination and theoretical basis

Big concept is not a new word, which originated from Bruner. Bruner believes that the purpose of teaching is to master the basic concepts and the various connections in the basic principles of subject knowledge. Knowledge is not rigid and single, but is well-connected, so teachers should help students master the structure of the classroom to solve various problems in and out of class.

On the basis of concrete facts and experience itself, the big concept is a summary of thinking, which is central, and it can integrate scattered knowledge around [1]; Big concepts can be migrated, and the ultimate goal of migration is to solve practical problems [2]. At the same time, Ausubel's cognitive structure transfer theory also agrees that all meaningful learning is built on the cornerstone of the existing cognitive structure.

In order to put the learning theory of big concept transfer into practical teaching, large unit teaching came into being. Teaching large units can help students understand the linear relationship of learning knowledge, change their knowledge memory process from scattered to whole, and promote their deep learning, which is also helpful to cultivate their coherence and develop their thinking mode. The unit design with the big concept as the core can deeply explore the educational value of the subject to people from the overall and local perspectives, and show the all-round and comprehensive characteristics of the core literacy.

3. Taking the "Electric Power" unit as an example for overall unit design

This section is designed from six aspects, including the theme and objectives of unit learning, content reconstruction, activities, evaluations, and unit and homework design.

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3.1. The theme of unit learning

3.1.1. Unit Learning Theme-Curriculum Standard Content Requirements

The learning content of this unit is in the curriculum standard (2022 edition), which belongs to the energy-level theme. The specific curriculum standard requirements are shown in Figure 1:

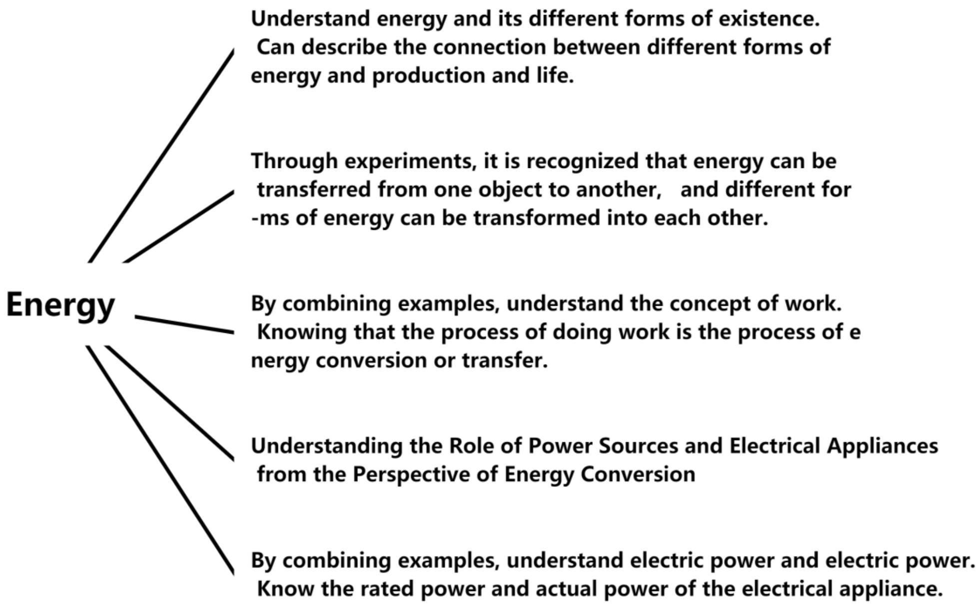

Figure 1. Energy part of Compulsory Education Physics Curriculum Standard (2022 edition).

3.1.2. Unit Learning Theme-Curriculum Standard Academic Requirements

The curriculum standard of this unit mainly comes from the new curriculum standard, as shown in Figure 2:

①Can enumerate examples of energy transformation and transfer, explain common natural phenomena from the viewpoint of energy transformation and conservation, solve related problems in daily life, and form a preliminary concept of energy ②Have the consciousness to question some inappropriate claims according to the viewpoint of energy conservation	①It can discover and put forward problems about energy and make conjectures and assumptions by observing things around it; ②Be able to make a simple inquiry scheme, eliminate simple experimental faults, read and record experimental data correctly, display and process data in various ways, and draw experimental conclusions; ③Be able to write experimental reports and express scientific research and results in writing or orally through the reports	①Can realize the great significance of improving efficiency from the perspective of energy transformation; ②Can realize the importance of saving energy and energy from the angle of energy conversion and transfer with certain direction

Figure 2 .Academic requirements of the new curriculum standard "electric power".

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3.1.3. The learning theme of this unit-analysis of learning situation

Knowledge reserve: Students have already learned mechanical energy and its conversion, work, power, and other related knowledge in eighth grade, laying the foundation for transfer learning of key and core concepts in this unit. After learning about series and parallel circuits, as well as Ohm's law, students have a certain reserve of electrical knowledge.

Capacity reserve: The ability to design and connect circuits has been improved, laying a necessary theoretical and practical foundation for learning electrical power.

3.2. Unit learning objectives

Based on the above analysis of curriculum standards, teaching materials and learning situation, in order to promote the formation and development of students' core literacy, the learning objectives of this unit are established as: physical concept objectives, scientific thinking objectives, scientific inquiry objectives, scientific attitude and responsibility objectives. The specific content is shown in table1.

Table 1 ."Electric Power" unit learning objectives

Physical concept	Can systematically understand the concept of electric energy, electric power and Joule's law; Can correctly distinguish rated power from actual power Joule's Law can be used to explain common phenomena in life
Scientific thinking	The source and utilization of electric energy from the perspective of "energy transformation and transfer"; Learn scientific thinking according to the course content; Can question unreasonable statements in life from the perspective of physics and give reasons
Scientific inquiry	Be able to discover and ask questions about energy and make conjectures and assumptions Make a simple inquiry plan Will troubleshoot simple experimental faults The ability to read and record experimental data correctly and draw experimental conclusions through and process data, and to explain scientific inquiry and results preliminarily
Scientific attitude and responsibility	Understand the meaning of energy from the perspective of energy transformation and conservation, and cultivate the sense of responsibility for energy conservation and emission reduction; Cultivate a scientific attitude of rigorous and serious respect for facts; Establish the consciousness of serving human beings with science, and students' sense of social responsibility

3.3. Reconstruction of unit learning content and unit activities

This unit is Chapter 14 Electric Power, the first volume of the ninth grade of Physics textbook published by Luco Edition, which includes chapters such as Electric Energy, Electric Power, Electric Power, Measuring Electric Power of Small Light Bulbs and Joule's Law. Considering that it is helpful to the development of students' energy concept and the deepening of the concept of energy conservation, the teaching materials and teaching content are developed twice, and the teaching content of this unit is reconstructed according to the curriculum standards, and the theme of the unit is determined as "Energy transformation in the process of light bulb lighting".

The first-level theme of the curriculum standard "energy" is a big concept in this unit, which includes energy, energy transformation and transfer, and finally forms the concept of energy conservation. Electric energy belongs to the core concept under the concept of energy. The important concepts are physical concepts such as electric power, electric power and Joule's law, which evolved in the process of electric energy conversion. It is based on the thinking process that the big concept is transferred to the core concept, and then the important concept is derived, which determines the design idea of the big unit in this chapter.

In the study of this unit, the common light bulb in life is taken as the situation, and the energy in the process of light bulb electrification is transformed into a research problem throughout the unit. In the phenomenon of light bulb emitting light, through "where does electricity come from?" "How is the energy converted when it emits light?" "What else can electricity do for us?" These questions will stimulate students' desire to explore the generation and application of electric energy. They will discuss it in the first class of Electric Energy. In the next class, through two light bulbs with different brightness as a situation, students will be guided to understand that the electric energy consumed by the two light bulbs is not the same in the same length of time, that is, the work done by the current is different, so as to further explore various factors that affect the electric power. In the experiment, students can find that the luminous brightness of the light bulb can be changed, and guide students to think, "What affects the brightness of the light bulb?" , smoothly progressed to the teaching link of Electric Power. By observing the process of light bulb from dim to bright and then to extinction, students were made aware of the harm of high voltage. In the fourth class, students need to design experiments to measure the electric power of light bulbs under different voltages and their correlation, and at the same time, they will gradually draw out the values of voltage and electric power on the nameplate.Rated voltage、Actual voltage、Rated electric power and actual electric power，the concept that when the light bulb is on for a period of time, it will feel very hot when contacted, but the wires in the circuit have almost no temperature sense. In the fifth class, we set up an experiment to interpret the thermal effect of electric current, which provides a real situation for students to explore the influencing elements of electric heating.

3.4. Unit activities

This unit makes use of the situation that the light bulb emits light, and through the way of problem-leading, enables students to transfer the big concept of "energy" to the core concepts and important concepts of electric energy, electric work and electric power from the perspective of energy transformation with the progress of class hours. With the support of the existing knowledge system, we will use the big situation throughout this unit. In the specific teaching process, we will decompose the overall goal into class objectives, use a variety of learning methods and activities to achieve the goals of each class, and conduct classroom evaluation according to the predetermined evaluation criteria. For the theme of energy conversion when light bulbs emit light, we will use five lessons, including five parts: Electric Energy, Electric Work, Electric Power, Measuring the Electric Power of Small Light Bulbs and Joule's Law. The following is a detailed activity description for each class:

In the first class "Electric Energy", we create a real life situation-light bulb lighting, introduce it from this common situation, and promote the progress of the course through classroom activities according to the specified classroom objectives. In the first activity, we help students understand how electricity enters every household by demonstrating the power generation process; At the same time, we also show the operation mode of home appliances such as hair dryers and the electric energy consumption shown by smart plug, so that students can understand that the process of converting electric energy into other forms of energy is the working mode of various electrical appliances. Based on the correlation between work and energy in the eighth grade course, it is proposed that the process of transforming electric energy into other energy is the process of doing work by current. For example, in the process of boiling water in an electric kettle, the phenomenon of heat generated by current during operation is called the thermal effect of current. Judging whether the students have achieved the class goal by telling the process of power generation and the energy conversion in the process of power generation. Activity 2, using the actual electricity bill in life, arouse students to think about the measurement and calculation of electric energy. Create a real situation for students to practice using the electric energy meter, and judge whether they have achieved the literacy goal by whether they can read the electricity bill, calculate the electricity bill, know the electric energy meter and read it, and whether they can measure the electricity consumption of a certain electrical appliance through the electric energy meter and stopwatch. Activity 3: Show pictures to let students know the function of electricity once, and judge whether students have the consciousness of saving electricity initially according to whether they can tell the way to save electricity.

In the first activity of "Electric Power", we take the class goal as the background, explain the class goal by designing a specific situation, and observe the difference of power consumption between two light bulbs with different brightness at the same time. In this way, students can understand the principle of how much work is done by current, and judge whether students can distinguish the difference in power consumption of light bulbs with different brightness, so as to confirm whether they have established the concept of electric work. Activity 2, carry out experiments to explore "the factors that affect the amount of work done by current", and judge whether the students have achieved the literacy goal of scientific literacy exploration by whether they can design the experimental scheme, whether the control variable method is correctly applied in the process, whether they can correctly use instruments, eliminate simple faults, correctly read and record data, and analyze and describe the experimental phenomena and conclusions. Activity 3, practice the flexible application of formula $W=UIt$ through the calculation of electric power and energy in real situations, and judge whether the students can achieve

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the literacy goal by whether they can correctly use the formula to calculate electric power and energy and whether the solution process is standardized.

In the discussion of Electric Power, the first activity is to introduce a new lesson by skillfully using the situation according to the course objectives, and build the theoretical framework of electric power with the knowledge that has been mastered before. In this process, the difference of the rotating speed of the ammeter is shown when the electrical appliances with different powers are connected to the circuit, so that students can understand the difference of the speed in the process of current work. Finally, according to the students' description of the physical meaning of electric power, it is estimated whether they have successfully established the concept of electric power. Activity 2: Through analogy transfer, students can learn the knowledge about electric power independently, measure electric power indirectly by using electric energy meter and stopwatch, and deepen their understanding of the physical meaning of electric power. According to whether students can correctly write the definition of electric power and flexibly use their knowledge to make relevant calculations, they can judge whether they have achieved their goals. Activity 3, guide the students according to the formula $P=\frac{W}{t}$ To derive a new formula P=UI, and guide students to use the formula of electric power to measure the electric power of light bulbs, and judge whether the goal has been achieved by using the formula for related calculations.

In the fourth class "Measuring the Electric Power of Small Light Bulbs", activity 1, create a situation. When buying a light bulb, the salesperson will ask "How big a light bulb to buy". Using this real situation, students will think about what "big" means here. According to whether students can say "big" and "small" refers to electric power, tell why the size of electric power is used as the selection standard for electrical appliances to judge whether students are using it. Next, the experiment is carried out, the goal of which is to measure the power of small bulbs under different voltages, and to use Excel software to process and analyze the experimental data. This experiment will help us to clarify the consistency between the actual power of small bulbs and the voltage changes at both ends of the bulbs. Observe whether students can accurately measure and calculate electric power through teamwork, and explain the relationship between rated voltage 、actual voltage 、rated power and actual power, which will be used as a standard to evaluate whether the objectives of the activities are achieved or not. Activity 3, give some nameplates of electrical appliances, let students tell whether these electrical appliances can be used normally in home circuits, and judge whether students can use what they have learned to solve practical problems.

In the fifth class of Joule's Law, activity 1, by using the phenomenon that the tin foil can be ignited by shorting the battery end, the current thermal effect in the book is linked with the life phenomenon, and whether the students can achieve their goals can be judged by enumerating examples of current thermal effect. The second activity is to lead the students to touch the light bulb and connected wires that glow after being electrified for a period of time, infer what factors may affect the conversion of electric energy into heat, design and conduct experiments, and evaluate whether the goal has been achieved by using the control variable method to design experiments and draw the conclusions proved by experiments. In activity 3, students can apply what they have learned to understand Joule and Joule's law, and guide them to think about the difference between pure resistance circuits and impure resistance circuits. By evaluating whether they can explain the relationship between electric heating and electric energy, and make relevant calculations, whether they can provide examples of electric heating serving us in our lives, the possible impact of electric heating on our lives, and what measures we should take to prevent the possible harm caused by electric heating, we can evaluate whether they have the awareness of safe use of electricity.

From the design of the last five class hours, it can be seen that the whole teaching of large units is under the guidance of big concepts, and the big situation runs through it. At the same time of concept development, we learn related physics concepts, go through scientific inquiry and thinking process, develop scientific attitudes and responsibilities, and realize the synchronous development of all aspects of core literacy.

3.5. Unit learning evaluation

Core literacy is a complex learning result,and it is difficult to examine students with a single evaluation method.

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The panorama of core literacy [3] . Both formative evaluation in the process of learning and summative evaluation after the completion of learning stages should be paid attention to, so various evaluation methods such as classroom evaluation, homework evaluation and stage test should be fully applied for scientific evaluation.

3.5.1. Evaluation of inquiry activities

In the form of tables, students' performance in inquiry activities is recorded and evaluated, so as to give full play to the diagnostic and incentive functions of evaluation. As shown in the following table 2 :

Table 2: Evaluation of inquiry activities

(full) name			
Evaluation project	Self-evaluation of students	Peer review	Teacher evaluation
Did you participate in the whole process of inquiry?			
Is the experimental report complete and innovative?			
In the process of inquiry, is there any cooperation to discuss together?			
Whether other aspects have been explored, such as improving the exploration methods, research interests or whether new questions have been raised.			

3.5.2. Class quality evaluation

As for class evaluation, we divide it into classroom evaluation and homework evaluation. Classroom evaluation refers to the score of classroom participation, which is based on factors such as students' classroom listening, participation in discussion, team learning and performance of classroom assignments. In order to ensure the fairness of scoring, we introduce three evaluation criteria: self-evaluation, mutual evaluation and teacher evaluation. The total score standard is 100 points, and the score is the average of the students' self-evaluation, other's evaluation and teachers' evaluation according to a certain proportion. Students reflect on the curriculum based on this score result, which has a positive role in promoting their subsequent study. As shown in the following table 3:

Table 3: Class quality evaluation

Name:				Comprehensive score:		self-examination/ introspection
Evaluation project	Classroom evaluation				Homework evaluation after class	
	Participation in the course	The situation of expressing opinions	Cooperative learning,	Homework in class		
Self-evaluation of students						
Peer review						
Teacher evaluation						
evaluation criterion	Do you listen carefully in class? No Deserted, no Doing and nothing in class Close the matter, can Do you keep up with the teacher? The idea.	Is it positive? Raise your hand and speak. Speech content Is it correct, Whether language. Concise and organized The logic is clear.	In group cooperation, it is Whether to actively participate in the discussion On, dare to question, Put forward constructive ideas Opinions. be adept in Help classmates or virtual Heart accepts help.	Can you be serious? Finish quickly Cheng sui Tang Lian Study, homework High quality.	Whether it is done independently, Can you hand it in on time? Job quality High quantity.	
Class content					date	

3.5.3. Overall unit evaluation

After the completion of the whole unit activity, the stage test is completed, and the results of the

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class hour evaluation and stage test are recorded comprehensively. The radar chart can be used to visually see the data distribution, which can help students understand their strengths and weaknesses in the unit learning and reflect on them in time, so that they can review and consolidate more pertinently, It can also well point out the direction for teachers to develop the literacy goals of the following learning content. When conducting learning evaluation, we should strengthen the consistency of evaluation with curriculum standards and teaching, promote the organic combination of "teaching evaluation", improve the quality of evaluation, and give full play to the educational function of evaluation. Relevant charts are shown as follows Table 4:

Table 4: Overall unit evaluation

(full) name		self-examination/introspection
class hour	score	
electric energy	90	
Electric power	93	
electric power	88	
Measure the electric power of small bulb	67	
Joule's law	80	
Unit comprehensive detection	84	

Note: The scores in the table are example data.

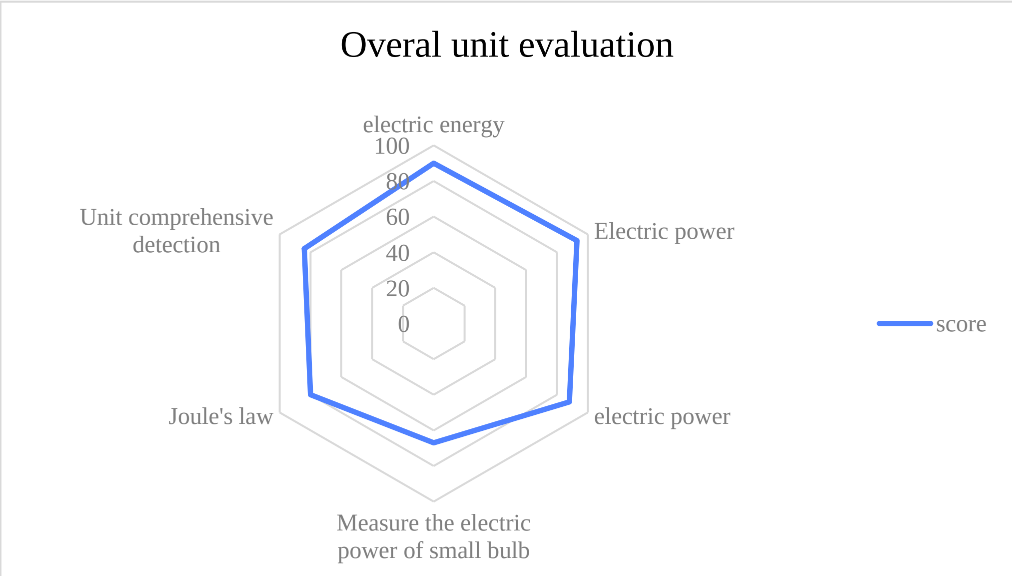

Figure 3. Radar chart of unit overall evaluation

Note: The data in the radar chart comes from the example data in the table.

3.6. Unit work design

3.6.1. Class work

In order to learn and consolidate new knowledge, homework in class includes homework preparation before class, homework in class and homework after class. The task is to learn before class and collect the materials used in the class. The task is assigned to students in the form of a learning task list before class, so that students can understand what tasks need to be completed before class and know which links in the class can use the materials we have collected.

3.6.2. Classroom assignments

Assignments are usually presented in class in the form of classroom exercises. According to the educational objectives and referring to the main context of this unit, we can set our own questions and evaluate students' learning in real time. For example, in the context of "light bulb emitting",we can design relevant questions according to the classroom exercises of "Electric Energy", "Electric Power" and "Electric Power".In order to let students use their knowledge to solve problems in reality, we can let students explain how the energy is converted in the process of light bulb emitting, how much electricity is consumed, and how much electricity can be saved if the use time is reduced by half an hour every day.

3.6.3. After class homework

In order to reduce the burden of students after class, homework is layered to optimize the flexible homework structure such as basic knowledge, ability improvement and practical homework, so that students at different levels can improve their learning. For example, after the third class of Electric Power, layered homework is implemented, and after the fifth class of Joule's Law, layered basic homework and practical homework are implemented.

3.6.4. Unit comprehensive operation

In order to promote the understanding of the overall knowledge of the unit and cultivate the ability to apply knowledge to solve practical problems, project based practical homework can be designed after the basic learning of unit knowledge. For example: [Design scenario] - How can a bulb with a rated voltage of 2.5 V be connected to a 10 V circuit to make it light normally? [Way of completion] - Use the knowledge learned to discuss solutions in groups. According to the scheme discussed, practical operation is carried out by designing and connecting circuits. [Literacy cultivation] - Cultivate students' comprehensive ability to use knowledge to analyze and solve problems, and their practical ability to operate [4] . At the same time, it is also committed to stimulating students' active learning attitude, as well as their enthusiasm for practice and the spirit of innovation.

4. Conclusions

As Professor Liu Hui said, what is the significance of a large unit? "Big" is not simply to gather more and more content, but to organize units with literacy goal clues.Its significance lies in making students feel the connection between learning and real life, thereby stimulating learning motivation, feeling the significance and value of learning, and arousing students' interest in learning.

In teaching, teachers should use a magnifying glass to dig deeply into the textbook, find out the essence of the big concept, plan the structure and sequence of units, and understand the steps of unit design.Through telescope thinking, we can break through the narrow boundaries of micro units, form meso and macro units in our minds, and we can help students establish an overall framework from macro to micro,help them have an overall vision and ultimate goal in mind,.Teachers should always know where we are now and where we want to take students, achieve consistency in “teaching learning evaluation”, and effectively improve students' core literacy.

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