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Turning Knowledge into Literacy: The Cultivation Strategy of Logical Reasoning

—Taking Hua Yinglong's Parallelogram Area as an Example

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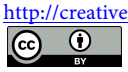

Abstract

Turning knowledge into literacy is the pursuit of many mathematics teachers. By watching and evaluating the classroom record of Hua Yinglong's about the area of parallelogram, we will find that the general paths of transforming knowledge into literacy include: (1) Reconstructing the teaching materials and integration of literacy; (2) Designing rich activities to help literacy penetration; (3) Creating a classroom environment in which students dare to think, share and question; (4) Mastering the lively rhythm to organize the implementation of classroom teaching.

Subject Areas

Mathematics Education

Keywords

Area of Parallelogram, Knowledge, Accomplishment, Transformation

1. Introduction

Hua Yinglong is an adjunct professor at Beijing Institute of Education, a member of the editorial board of the National Compulsory Education Curriculum Standard Experimental Textbook (Beijing Normal University Edition) and the editor in chief of the volume [1]. China Education Television has broadcast his teaching videos many times. CCTV has made special reports on him in the column of "Contemporary Education" and "People's Education" in the column of "Life of Famous Teachers", and China Education Daily has launched a series of reports on "Hua Yinglong's education and teaching art". He is now the vice-principal of Beijing No. 2 Experimental Primary School and has written books

such as "I Teach Mathematics Like This", "I Am Mathematics", "Personalized Lesson Preparation Experience" and so on.

As Hua Yinglong's "Area of Parallelogram" is selected for this classroom record and analysis, we found that he has unique opinions on dealing with teaching materials, designing teaching methods, and the implementation of classroom organization after consulting the literature. Therefore, we mainly pay attention to these aspects when analyzing the classroom record. Secondly, we found that Hua Yinglong especially liked the teaching process of "three-stage walking", that is, participation before class, discussion in class and extension after class. Therefore, we also recorded this classroom record according to the teaching process of "three-stage walking" (the specific record is presented in the appendix). The text content is the overall analysis of the classroom, which we roughly divide into four parts.

In addition, the most important point of this class is the penetration of the idea of "transformation" in the mathematical literacy of "logical reasoning", so we will focus on the analysis in the text.

2. Reconstruction of Teaching Materials and Integration of Literacy

Teachers should not only teach teaching materials, but apply teaching materials. Teaching with teaching materials means the reconstruction of teaching materials. The reasonable reconstruction of teaching materials is not only conducive to our better teaching, but also conducive to the penetration of core literacy.

As Hua Yinglong said, "in a person's life, the most useful thing provided by mathematics teaching is not necessarily mathematics knowledge, but mathematics thought and mathematics spirit" [2]. In the process of textbook reconstruction, we should pay attention to: reconstruction is not only to make the knowledge points easier for students to master, but also to make students better feel the core literacy to be penetrated in this class. Teachers must pay attention to how to infiltrate students' thinking in the process of mathematical reasoning.

Next, we will analyze the reasonable reconstruction of Hua Yinglong's teaching materials from several links of this class.

2.1. New Situations Bring New Thinking

2.1.1. "Cutting and Spelling" Deepens the Transformation of Ideas

Hua Yinglong is leading students to carry out the activity of "cutting and spelling" to explore the area of irregular graphics, which is not available in textbooks.

> "Show the figure (irregular) and ask the students to calculate its area by using the transformation idea.
> Student: cut out the convex triangle and translate it to the vacant place to become a rectangle.
> Students demonstrate on stage (hands-on operation).
> Teacher's summary: turn what cannot be solved into what can be solved.
> Teacher: what has changed and what hasn't changed?

Student: the appearance has changed, but the area has not changed."

Hua Yinglong's reconstruction of teaching materials in this way can infiltrate the practice of transforming ideas before derivation, which can not only lay a foundation for the subsequent derivation of parallelogram area calculation formula, but also feel the magic of transforming ideas in hands-on practice, which is more conducive to the cultivation of mathematical literacy.

2.1.2. Substitute into Life and Think in Solving Problems

Hua Yinglong arranged activities to substitute into reality after the students preliminarily inferred the area of the parallelogram. This design creates a problem situation for students: although the previous cutting method cannot be used, the transformed mathematical ideas and the content learned in the previous link can be used to solve the problem.

"Teacher: how to calculate the area of parallelogram pool in life? Can you cut it?
Student: No.
Teacher: can we calculate directly without conversion?
Student 1: you can draw the swimming pool on the draft paper and then cut it.
Student 2: after knowing the base and height of the parallelogram, you can calculate it directly."

This problem perfectly fits the "Recent Development Zone" of students, which is conducive to the derivation and learning of students' knowledge; on the other hand, it embodies the application of mathematical thinking methods, allows students to flexibly use mathematical methods in practical problems, improves students' ability to solve problems, and lays a thinking foundation for subsequent learning; in addition, students' mathematical literacy has been further exercised.

2.1.3. Divergent Students' Thinking by Using Multi Solution Problems

Hua Yinglong also reconstructed the teaching materials in the last link. He set up new problems. There are two solutions: one is to convert irregular graphics into rectangles; the other is to transform it into a parallelogram and use the knowledge learned in this lesson to solve this problem.

"Students demonstrate on stage.
Teacher's summary: you can convert the graph into parallelogram for calculation.
The students demonstrated on the stage again.
The teacher summed up again: one kind of method is to transform into a rectangle, and the other is to transform into a parallelogram. All use the idea of transformation.
Teacher: both methods use the idea of transformation. Which method is better?

Students think and discuss, and share after the discussion.

Student: the second method is the best because its steps are simpler and the transformation is more in place.

Teacher: it turns out that different transformation methods bring different convenience."

Students will propose two methods and discuss which method is the best. However, after Hua Yinglong's summary and guidance, the students agreed that the second method was good. Through the creation of this topic, Hua Yinglong has effectively deepened students' understanding of the calculation formula of parallelogram area, and can also let students experience the process of transformation again and feel the transformation more deeply.

2.2. Turn Complexity into Simplicity and Trim the Context of the Classroom

Hua Yinglong deleted the content of "number square" in the textbook. Such a change is conducive to the connection of the whole class link. From the classroom record, we can find that Hua Yinglong wants students to master knowledge and ideas in the process of splicing. If the link of number square is inserted in this process, the classroom will appear fragmented and repeated. If you want to add this link, you can put it as a test link in the second half of the classroom.

From Hua Yinglong's reconstruction of teaching materials, we realize that only by carrying out the reconstruction of teaching materials with the consciousness of "infiltrating the core literacy", can students not only master the mathematical knowledge that needs to be learned in the classroom, but also feel the mathematical thought and creative mathematical behavior in the process of learning, so as to improve the core literacy.

3. Deep Penetration

Hua Yinglong's lesson focuses on "transformation". Transformation is mentioned in the three paragraphs of the class, and the thought goes from simple to deep, from the application of transformation in life to the specific application of geometric body quadrature calculation, and takes "cutting and spelling" as the springboard to help students understand.

Looking at the general knowledge of this unit, we can find that in this unit, the derivation of the area formula of parallelogram, triangle or trapezoid is carried out in the process of "splicing" transformation. As the starting course of this unit, the area of parallelogram needs to be absorbed and consolidated by students through practice [3]. Hua Yinglong's class well reflects this point. From the classroom record, we can find that he designed more operational cutting and spelling transformation exercises to let students do it by themselves, which can play a positive guiding role in students' thinking and pave the way for subsequent teaching.

In this lesson, we specifically summarized the following aspects, which can

make us more intuitively feel the depth of the teaching method designed by Hua Yinglong:

3.1. Elicit Transformation by Guessing

In the pre class participation, Hua Yinglong made the students feel the idea of transformation by asking them to guess their age, that is, by changing one thing into another, we can get the answer we want.

"Teacher: before class, ask the teacher how old you are. Let's guess first. First ask a classmate, how old are you?
Student: 11 years old.
Teacher: the teacher's son is 12 years old. Can you guess how old the teacher is?
Student: 40 years old.
Teacher: why?
Sheng: my father is forty. Your son is about the same age as me, so there should be little difference between your age and my father.
Teacher: Here we use the idea of transformation. We transform the unfamiliar into familiar and complex into simple."

This seemingly simple design brings many benefits, shortens the distance between teachers and students, and allows teachers to better interact with students in the next classroom; Secondly, using children's favorite "guessing games" to introduce into the classroom can effectively attract students' attention and stimulate students' interest in learning; Finally, through this game, students can feel the transformed ideas smoothly and lay a good foundation for subsequent teaching.

3.2. Creating Problems, Feeling Transformation

At the beginning of the discussion in the class, Hua Yinglong designed a topic to seek the area of combined graphics. The design of this topic has helped students enter the "Recent Development Zone" well, so that students can apply it in practice after initially feeling the transformed ideas; so as to better prepare knowledge, skills and experience for the next new course learning.

"The teacher shows the figure (irregular) and asks the students to calculate its area by using the transformed idea.
Student: cut out the convex triangle and translate it to the vacant place to become a rectangle.
Students demonstrate on stage (hands-on operation).
Teacher's summary: turn what cannot be solved into what can be solved.
Teacher: what has changed and what hasn't changed?
Student: the appearance has changed, but the area has not changed."

But I had a question when I was listening to the class—do I need to dimension the convex and concave parts of irregular graphics (lack of logic, that is, why can

the convex and concave parts just match up)?

After consulting the relevant literature of Hua Yinglong, we found the answer. Hua Yinglong believes that: from intuitive geometry to experimental geometry to demonstrative geometry is the basic history of geometry development, while what we learn in primary school is intuitive geometry, and it is possible to gradually learn demonstrative geometry in middle school. Therefore, this design can create a situation of geometric development for students.

3.3. Transform by Cutting and Splicing Operation

When teaching intuitive geometry, Hua Yinglong adopted the practical activities like "look, cut, spell and measure" loved by children. Let students make use of what they see, touch and move in their own activities, and integrate them at one time, which can better promote the internalization of knowledge and transform ideas, and form the concept of space (therefore, it can also answer my previous question at this level. If the size is marked for students, students may be able to directly infer the results. The lack of intermediate practical links is not conducive to the internalization of knowledge and mathematical literacy).

"Teacher: then how to calculate the area of parallelogram?
Students operate by themselves, use small pieces of paper on the table, and communicate in groups.
Students come to the stage to exchange ideas and demonstrate.(students cut the parallelogram to form a rectangle)
Teacher: do you have any different ideas?
Student: No.
Teacher: why cut along the high?
Student 1: the height remains unchanged and the area remains unchanged.
Student 2: it can be guaranteed to form a rectangle.
Teacher: how to calculate?
Student: length by width.
Students calculate and get the answer."

Although the knowledge point of this lesson is "area of parallelogram = bottom". It is not easy for students to master, but it is not easy for them to use; In addition, another goal of this class is to infiltrate the core quality of "transformation" into students' thoughts. Therefore, only by designing such links as "practice, feeling, practice, re-feeling, practice and summary" in this class can students fully feel and understand knowledge and improve their core quality.

Generally speaking, in this class, the method of mathematical thinking (*i.e.*, transformation) and the process of feeling mathematical thinking are more important than mastering the calculation formula of parallelogram area. As teachers, when designing teaching methods, we need to pay more attention to how to let students feel, understand and absorb the mathematical thought of "transformation" in activities and practice, to train students' core literacy, only by achieving the penetration of literacy can it be regarded as a deep teaching method.

4. Create a Classroom Environment Where Students Dare to Think, Share and Question

The exercise of core literacy needs teachers and students to complete together, but in my opinion, the main role of core literacy exercise is students, and teachers mainly play a guiding role. So how should teachers guide students to exercise core literacy? After listening to Hua Yinglong's class, we think one of the most fundamental conditions is to create a classroom environment for practice and thinking, so that students dare to think, share and question. We will analyze this from the following aspects.

4.1. Let Students Think with "Guessing Riddles"

At the beginning of the class, Hua Yinglong raised the question of "guessing age". In the above analysis, we know that this guessing link can effectively shorten the distance between students and teachers and introduce transformation ideas, but this link also plays a very important role in the construction of the classroom environment.

"Teacher: first ask a classmate, how old are you?
Student: 11 years old.
Teacher: the teacher's son is 12 years old. Can you guess how old the teacher is?
Student: 40 years old.
Teacher: why?
Student: my father is forty. Your son is about the same age as me, so there should be little difference between your age and my father.
Teacher: Here we use the idea of transformation. We transform the unfamiliar into familiar and complex into simple."

This question seems to help students initially feel the transformed mathematical ideas. In fact, it also tells students that the teacher who teaches you today is very approachable and interesting. Hua Yinglong said: having a childlike innocence in the teaching process can find the contact point and resonance point in the process of communicating with children and grasp the opportunity of Education [4]. So in this way, students can dare to share their views with teachers, dare to question teachers and be willing to think about the questions raised by teachers in the next class.

4.2. Use "Group Discussion" to Let Students Share and Question

In the discussion session in class, Hua Yinglong set up two group discussions and sharing sessions, interspersed with an evaluation of students' sharing and guiding the next discussion, and set up a group discussion at the end of the class.

"1. Group discussion to explore how to calculate the area of parallelogram
Teacher: then how to calculate the area of parallelogram?

Students operate by themselves, use small pieces of paper on the table, and communicate in groups.

Students come to the stage to exchange ideas and demonstrate.(students cut the parallelogram to form a rectangle)

2. Group discussion on the relationship between parallelogram and rectangle

Teacher: what are the similarities between a rectangle and a parallelogram?

S1: the area of both is the same.

Student 2: a rectangle is a special parallelogram. The angle between the two sides is a right angle.

The teacher gave a physical demonstration.

What does group discussion matter.

Discussion results: the width of a rectangle = the height of a parallelogram, and the length of a rectangle = the bottom of a parallelogram.

3. Discuss in groups which method is best

Teacher: both methods use the idea of transformation. Which method is better?

Students think and discuss, and share when the discussion is over."

The three related discussion designs not only allow students to think and practice in the group discussion, but also give students the opportunity to share within the group and the class. More importantly, the teacher's summary and guidance in the middle not only greatly enhanced students' confidence and enthusiasm, but also preliminarily summarized the calculation formula of the parallelogram area, deepened the infiltration of transformation thought, which can be said to be multiple [5]. Of course, the last group discussion provided students with two options, they would express their opinions and analyze their own and others' opinions, and their ability to think, question and reflect would be naturally exercised.

4.3. Give the Class to the Students

Hua Yinglong hardly showed the target knowledge directly in the whole class, and most of the knowledge was analyzed by students. For example, when exploring the area of the parallelogram, Hua Yinglong set up a group discussion and independent thinking link. Through this link, students are given time to think about problems and get answers through their own thinking. What teachers need to do is to integrate and analyze everyone's answers and finally show everyone the crystallization of their thinking.

Such teaching methods will undoubtedly transform the classroom into a generative classroom. When we teach, we often fear this kind of classroom, because we worry that students can't get the desired results, and what students generate is not what I want. However, this class shows that as long as the teaching links are connected and related, and as long as the teacher's guidance direction is correct, teachers should safely return the classroom to students. Students will naturally

generate the answers we want, or even better answers, in the classroom environment created by teachers that dare to think, share and question.

Therefore, a good classroom environment can not only make the classroom more smooth and ensure the completion of teaching objectives, but also enable students to think, share and question in the created environment, strengthen mathematical thought and exercise core literacy. This is a more important part than knowledge, and students can also "turn knowledge into literacy".

5. The Organization and Implementation Should Grasp the Lively Rhythm

Although Hua Yinglong believes that a class should be carried out in accordance with the "three-stage style", this does not mean that the classroom should be divided into three parts. Teachers should have the consciousness of "the whole class is a whole" when teaching, and reasonably arrange the classroom rhythm based on this consciousness, so that students will not be tired of thinking because of listening to the class for a long time, or lack of attention due to long-term activities and shift the focus of the classroom, from which we can fully feel his mastery of classroom rhythm control technology.

In this class, we can learn from each activity arranged by Hua Yinglong that there is a great correlation, from understanding the transformation in "guessing age", to cutting and spelling irregular graphics to use the transformation, and then to using the transformation to solve problems (how to calculate the area of parallelogram), and so on. Each step is linked. However, careful design is far from enough. Only by mastering the lively rhythm can the whole class be perfectly connected in series within 40 minutes and make the whole class an organic whole.

Hua Yinglong believes that "rhythm" refers to the development process of a class, which should have details, density, speed, weight, ups and downs, primary and secondary, and unify them harmoniously to form a whole [6]. In this class, Hua Yinglong's stay time in each link is controlled at about five minutes. This rhythm can effectively let students experience the links in the classroom, let students master the area calculation formula of parallelogram, permeate the transformed mathematical thought, and exercise the mathematical core literacy of students' logical reasoning.

So how can we master the lively rhythm? I think we need to do the following:

5.1. Teach from a Holistic Perspective

When teaching, we should treat the whole class as a whole, not divide the whole class into several parts. Many teachers have such problems when teaching: for example, after the introduction, they think that the first part of the class is over, and then the second part. This habit of teaching can lead to a sense of fragmentation between links. Therefore, we should treat the whole class as a whole when teaching and make each link become a part of the class.

5.2. Grasp the Relevance between Activities When Designing

We consider link of teaching design to the presence of correlation between activity and activity, there are correlation activities can let students in the class have a sense of rhythm, there is no correlation between activity will make the classroom become boring, each link into each task, the students' attention not only to fade, teachers will gradually lose the enthusiasm of the teaching, become active task of machines. Therefore, we should pay attention to the relevance of activities when designing activities, which is an important part of the classroom rhythm.

5.3. The Design of Activities Should Be Refined, Varied Harmonious and Unified

The design of the activity should not only consider the relevance, but also consider whether the activity itself has refined changes. If an activity lasts too long, it will be too burdensome, and the design of the activity should consider whether there is any change. If the activity of a class is invariable, students will inevitably feel boring, and the teaching effect is bound to be bad. Therefore, when designing activities, we should take into account the refining and changing development of activities.

6. Summary and Reflection

6.1. Research Summary

Through the research and analysis of Hua Yinglong's class, we believe that if we want to turn knowledge into literacy in the process of teaching, the feasible path includes the following four aspects: (1) Reconstructing the teaching materials and integration of literacy; (2) Designing rich activities to help literacy penetration; (3) Creating a classroom environment in which students dare to think, share and question; (4) Mastering the lively rhythm to organize the implementation of classroom teaching. In general, the key to realizing the transformation of knowledge into literacy lies in the interaction between body and environment, knowledge and environment, as well as individual and others [7]. Only by skillfully using the above four aspects, knowledge can be transformed into literacy in the process from teaching design to actual teaching, so that students can learn something more important than knowledge in class, namely mathematical literacy.

6.2. Insufficient Research

Of course, there are some limitations to this study. First of all, the number of classroom observation is too small, and the representativeness of the conclusion is weak. This study takes a mathematics class of teacher Hua Yinglong as the research object. Although this class has strong research value, the conclusion can not be directly applied to other mathematics classes due to the small number of lectures, which is less representative. Secondly, the subject of this study

is limited to mathematics and can be further developed to other subjects. Finally, there is a lack of teaching practice to demonstrate the conclusion. The teaching design and teaching methods summarized through the observation of this class have not been deeply studied by other teachers, so they need to be studied in practice.

Conflicts of Interest

The authors declare no conflicts of interest.

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