International Journal of Innovation and Research in Educational Sciences
Volume 5, Issue 3, ISSN (Online) : 2349–5219

Research on the Cultivation of High School Students' Mathematical Modeling Literacy Based on Analytic Hierarchy Process

Yu Xu [1] and Hui Xu [1*]
(Department of mathematics, School of science, Yanbian University, Yanji, China.
Corresponding author email id: 1402413349@qq.com

Date of publication (dd/mm/yyyy): 10/06/2018

***Abstract* – Core literacy is the focus of education which is highly concerned by the international community. It is also the main direction of the new round of deepening curriculum reform in China. In the background of improving the core literacy and modeling ability of mathematics, this paper firstly uses analytic hierarchy process (AHP) to study the ranking of the six core math literacy, and analyzes the problems in the training of high school students' modeling ability of senior middle school students, and puts forward several suggestions for how to use mathematical modeling theory in high school mathematics teaching.**

***Keywords* – Analytic Hierarchy Process, Core Literacy, High School Mathematics, Mathematical Modeling.**

I. INTRODUCTION

In recent years, the word "core literacy" has attracted much attention in the educational field. Among the six core qualities, which literacy is the most easily neglected, which literacy should be more important? This paper collects data through questionnaire survey and takes it as the weight, and uses the analytic hierarchy process to rank six core qualities. According to the ranking of the six core competencies, this paper mainly analyzes the problems existing in the cultivation of mathematical modeling literacy. In order to improve students' mathematics literacy, some suggestions on how to infiltrate mathematical modeling thought in high school mathematics classroom are put forward. In the standard of mathematics curriculum for ordinary high school (2017 Edition), mathematical modeling is one of the six core qualities, which requires that the concept of mathematical modeling run through the whole high school mathematics education, and the mathematical modeling is used as the main line and the specific class time is arranged. This is also a symbolic result of the development of mathematics curriculum in China's basic education stage, as in [1].

II. USING AHP TO RANK THE RANKING OF CORE LITERACY

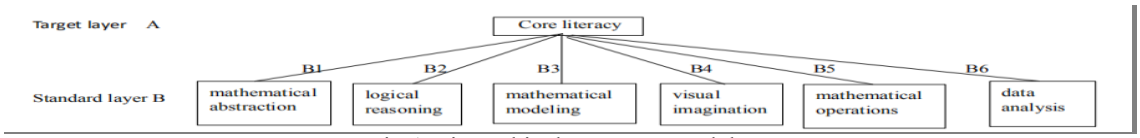

Fig.1 Hierarchical structure model

Strengthening students' core literacy is the concept of future education. In twenty-first Century, idealized talents are individuals with core qualities. No matter what kind of teaching mode is for the cultivation of ideal talents, from natural science to social science, from professional research to daily life, mathematical modeling depends on the subject situation and life situation, and in solving many practical problems, it embodies the irreplaceable instrumental value of mathematics [2].

To improve the core literacy of senior high school students, we should consider six core qualities, namely the criterion level, as follows: mathematical abstraction(B1), logical reasoning(B2), mathematical modeling(B3), visual imagination(B4), mathematical operations(B5), data analysis(B6), and the establishment of AHP models is shown in Fig.1.

Two comparisons of factors are adopted to establish a pair comparison matrix. That is to say, two factors *xi* and *xj* are taken each time, and the ratio of the influence of *xi* and *xj* on improving the comprehensive ability of students is expressed by *aij*. All comparison results are represented by matrix A , which is called pairwise reciprocal matrix . It is easy to see that if the ratio of *xi* and *xj* to improve students' comprehensive ability is *aij*, then the ratio of *xj* to *xi* should be *aji = 1/(aij)*.

A. Structural Judgment Matrix

According to the theory of analytic hierarchy process, this paper takes the data of questionnaire survey as the weight ratio of the two core qualities, and obtains the judgment matrix of the criterion layer as the following table.

Table 1. The judgment matrix of the standard layer

A	B1	B2	B3	B4	B5	B6
B1	1	6/19	3/7	23/27	1	4/21
B2	19/6	1	31/19	31/19	37/13	1
B3	7/3	19/31	1	7/3	3/2	2/3
B4	27/23	19/31	3/7	1	23/27	8/17
B5	1	13/37	2/3	27/23	1	7/18
B6	21/4	1	3/2	17/8	18/7	1

B. The Eigenvector and the Maximum Eigenvalue

The corresponding eigenvector of the judgment matrix

A, namely Aw = (λ max) w, is the relative importance of the component of W, namely the weight coefficient. Here, we calculate the weight coefficient by using and integrating.

The characteristic vector w corresponding to the judgment matrix A is Aw = (λ max)w, where the component (w1,w2,…,wn) of w corresponds to the relative importance of n elements, that is weight coefficient. We refer to the method used in [3]. Here, we use the sum product method to calculate the weight coefficient.

1) Each column element of the judgment matrix is normalized as follows:

$$\overline{w} = a_{ij} / \sum_{i=1}^{n} a_{ij} (i, j = 1,2 \cdots n)$$

2) The normalized judgment matrix is added by line:

$$\overline{w} = a_{ij} / \sum_{i=1}^{n} a_{ij} (i, j = 1,2 \cdots n)$$

3) Normalizing the and acting as an approximate eigenvalue (weight vector):

$$w_i = \overline{w}_{ij} / \sum_{i=1}^{n} \overline{w}_i, w_i = (w_1, w_2 \cdots, \quad w_n)^T$$

4) The λ max is calculated and used as the approximation of the maximum eigenvalue:

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(Aw_{ij})}{w_i}$$

C. Checking the consistency of the matrix

The steps for consistency checking of the judgement matrix are as follows:

1) Calculation of consistency index:

$$CI = \frac{\lambda_{\max} - n}{n-1}$$

2) Find the corresponding average random consistency index RI: for 1-9, Saaty gives the value,As shown in Table 2.

Table 2. The value of RI

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

3) Computing conformance ratio (CR): CR = CI/RI, When CR<0.10 is considered, the consistency of the judgement matrix is acceptable. Otherwise, the judgement matrix should be amended appropriately.

According to the above steps, the consistency of the matrix is tested and CR<0.02206 <0.10 is obtained. So consistency is acceptable.

The matrix A is calculated by MATLAB, and the weight vectors are shown in Table 3 below.

W = [0.0795, 0.2517, 0.1824, 0.1074, 0.1031, 0.2758],

Λ max = 6.1103.

Therefore, the overall ranking results are as follows:

Criterion	data analysis	logical reasoning	mathematical modeling	visual imagination	mathematical operations	mathematical abstraction
Weight	0.2758	0.2517	0.1824	0.1074	0.1031	0.0795

Therefore, the weight vector from this method can be used as the basis for sorting. From the weight vector, we can see that mathematics ranks third in the six core

Table 3 Hierarchical ranking result qualities. However, although data analysis and logical reasoning are in front of mathematical modeling, in the process of establishing mathematical models, it is inseparable from the transformation of practical problems into mathematical problems, logical thinking on mathematical problems and the ability to analyze datas.

III. Problems in the Cultivation of Mathematical Modeling Ability

A. Mathematical Modeling Consciousness Difference

From the ranking of the core literacy obtained by the method of chromatography analysis, the mathematical modeling accomplishment is ranked third in the six core accomplishment, which indicates that the current high school teaching is not very strong on the cultivation of the students' mathematical modeling ability, and the students' mathematical modeling consciousness is slightly poor when they meet the actual problems. Although in the "standard of mathematics curriculum in ordinary high school" (2017 Edition) for mathematical modeling of the arrangement of mathematics, but because of the college entrance examination is not required, mathematical modeling teaching in daily mathematics classroom is not much. Many teachers are still using traditional collective teaching methods step by step. Due to the influence of traditional teaching thought, high school teaching focuses on solving mathematical problems, and divorced from the relationship between mathematical problems and actual problems in the real world, many students only solve math problems, but the ability to solve practical problems is relatively weak.

B. Less Schedules

The analytic hierarchy process (AHP) is a qualitative and quantitative analysis process. From the results, the quality of mathematical modeling needs to be improved. After the basic accomplishment, the arrangement of class time should be increased to cultivate the students' quality of modeling. In the high school stage, the mathematical modeling has not been studied as a special course. Some schools have realized the importance of mathematical modeling and begin to run through the mathematical modeling consciousness in the mathematics classroom. However, the arrangement of less time is not enough to permeate the mathematical modeling thought. In addition, the teaching of mathematical modeling is not only the explanation of the theory, but also the process of the students' experience modeling, so that the thought of

mathematical modeling can be deeply realized. With the increase of students' mathematical knowledge and the growth of mathematical cognitive ability, teachers should let the students experience real mathematical modeling activities many times, accumulate complete and real mathematical modeling experience, and form a good quality of mathematical modeling.

IV. Improving Mathematical Literacy Based on Mathematical Modeling

A. Let the idea of mathematical modeling run through the classroom and stimulate interest in modeling.

Piaget, a representative of Swiss cognism, holds that "all effective work must be based on some interest". From the perspective of the theory of cognitive and recent development areas, middle school students have a certain level of cognition, and their curiosity is strong and easy to be attracted by new things. At this stage, teachers should select reasonable teaching content to carry out the mathematical modeling course. In the process of mathematical modeling, from the question to the assumption, the analysis of the problem, the establishment of the model and the interpretation of the results, each link is not a smooth sailing, and will inevitably encounter setbacks and failures. If students do not have good modeling interest, it is very difficult to solve problems by modeling thinking.

Mathematical modeling teaching can create interesting problem situations, thus arousing students' thinking and stimulating interest in learning. In the process of transforming the situation into a mathematical model, the key to the teaching of mathematical modeling is how to let students study independently, explore independently, raise problems independently and solve problems on their own. Take an ancient Chinese Title entitled "Sun Zi Suo Jing" as an example: there are thirty-five pheasants and rabbits in the same cage. There are ninety-four feet under them. To solve this problem, we use mathematical hypothetical method and equation method to mathematically solve practical problems and model mathematical problems with mathematical modeling thought. To guide students to observe and analyze the relationship between various things and to dig out mathematical information from the point of view of mathematical thinking, and then abstract out the familiar mathematical models from the specific problems, and achieve the purpose of solving practical problems with mathematical models.

B. Set up lectures on mathematical modeling appropriately to enhance modeling ability.

Because of the complexity of the mathematical modeling process, it is necessary to spend energy and time. It is not enough only by the conventional theory teaching. The mathematical modeling is mainly the application and practice ability. Through the cultivation of the concept of modeling in daily mathematics teaching, students already have the basic knowledge of mathematical modeling. Therefore, the school inviting the famous teachers in the field of modeling to carry out special lectures can not only further improve the students' ability of modeling, but also enhance the students' creative ability and improve the overall quality of mathematics.

C. Encourage students to take part in Mathematical Contest in modeling and improve their mathematical attainment.

Mathematical modeling has entered the compulsory education and high school education stage, especially the new revised standard for high school mathematics curriculum for mathematical modeling, marking the Chinese mathematical modeling and a big step forward. But because the college entrance examination does not require, most schools do not offer mathematical modeling courses. Therefore, encouraging students to take part in Mathematical Contest in modeling, going through the process of mathematical modeling and accumulating mathematical modeling experience are the trend of the times. Participating in the contest of mathematical modeling will help improve students' ability to discover, analyze and solve problems. In addition, the mathematical modeling activities can also help students to improve their abilities in various fields, improve their awareness of mathematics and improve their logical thinking ability, and then achieve the purpose of mathematical modeling courses - to improve their mathematical literacy.

V. Conclusion

The improvement of the quality of mathematical modeling should be rooted in a good atmosphere of mathematics teaching, and the knowledge of mathematics should be carried out under the concept of mathematical modeling. Through observation and operation, analysis and contrast, abstract and generalizations, students have experienced the process of abstracting practical problems into mathematical problems and transforming life prototype into mathematical model, feeling the thought, method and value of mathematical models, developing the ability of abstract thinking and symbolic sense, and improving the application of students. The ability to solve practical problems in mathematics.

References

[1] S. Z. Wang. “Development and Prospect of mathematical modeling in various academic sections of China,” Journal of mathematics education, 2017.
[2] L. Chang, J. S. Bao. “Mathematics core literacy from a situational perspective,” Journal of mathematics education, 2017.
[3] Q. Y. Jiang, X. J. Xie, J. Ye. Mathematical modeling. Higher Education Press, 2005. Fourth Edition.

Author’s Profile

Yu Xu, female, Jilin Province, China, born in September 1995, studying at YianBian University, as an undergraduate of Mathematics and Applied Mathematics.