A Study on the Implementation of Teaching Mathematical Modeling Classes Based on Mathematical Learning Objectives

Lijie Wang[1,*], Mingyu Shi[1]

[1]Central University for Nationalities, BeiJing, China

Abstract. Mathematical modeling literacy is one of the six core literacies in high school mathematics and occupies an important place in the objectives of the high school mathematics curriculum. "The core element of mathematical modeling literacy is to abstract mathematically from real problems, express them in mathematical language, and construct models to solve them with mathematical methods. The STEAM education concept has received much attention in the education field because of its effective integration of "science, technology, engineering, art and mathematics" in the practice of education and teaching, which not only makes up for the shortage of traditional teaching in knowledge inquiry, but also helps to improve the problems of traditional classrooms. This paper explores the development of mathematical modeling literacy in high school by drawing on the STEAM education concept, and examines the effectiveness of the integration of the two through specific teaching cases.

1 Introduction

The STEAM education concept is the best choice to meet the requirements of the new curriculum for the development of core literacy in mathematics for high school students. STEAM is the abbreviation of Science, Technology, Engineering, Art and Mathematics, a new foreign educational concept that aims to cultivate innovative talents who have the autonomy to solve real-world problems through interdisciplinary integration. STEAM education is essentially an integrated curriculum education, which can make up for the shortcomings of sub-disciplinary teaching that neglects inter-disciplinary connections [1]. Moreover, STEAM education emphasizes the authenticity of the context, which usually requires students to work in teams to complete projects by integrating multidisciplinary knowledge, which helps to enhance students' learning ability, practical ability, and innovation ability [2]. The STEAM education concept applied to secondary school mathematical modeling training is essentially concerned with the connection and integration between disciplines, emphasizing students' core literacy development, scientific interdisciplinary learning, applying mathematical knowledge to life, enhancing the understanding of the value of mathematical disciplines, aiming to cultivate comprehensive and multi-disciplinary innovative talents, and helping to enhance students' literacy for the comprehensive and sustainable development to meet the needs of modern society [3].

2 The construction of mathematical modeling literacy development curriculum under the concept of STEAM education

The necessity and feasibility of integrating STEAM education concept with high school mathematical modeling, whether from the requirements of curriculum standards for high school mathematics curriculum, or from the overall development and training requirements of students, the STEAM education concept of building a mathematical modeling classroom is a good fit [4].

2.1 Principles of building a high school mathematics modeling classroom under the concept of STEAM education

The core of building a mathematical modeling classroom under the STEAM education concept is the integration of disciplines and connection to the practical STEAM education concept and the development of mathematical modeling literacy both focus on students proposing and solving problems, exploring together in groups to acquire knowledge of each discipline [5], and applying it to the practical [6]. From the requirements of STEAM education concept and mathematics classroom, this paper will summarize the basic principles of building a high school mathematics modeling classroom under the STEAM education concept [7].

* Corresponding author: 1002953538@qq.com

3 Teaching concepts of mathematical modeling classroom under the concept of STEAM education

A study of the teaching literature related to STEAM education philosophy reveals that STEAM education philosophy advocates interdisciplinary independent inquiry learning, where problems are logically designed to integrate multidisciplinary knowledge in order to develop students' hands-on skills and innovative thinking. During the activity sessions, students' mathematical and engineering thinking is improved, and students become more proficient in information technology, implement the spirit of science, and enhance artistic literacy. However, such an active classroom is open and free, requiring effective teacher guidance to take control of the classroom. To implement the STEAM education concept, teachers need to select content that is not only interesting but also appropriate to the reality to avoid boring classroom and to fully motivate and affirm students in the classroom. STEAM education and mathematical modeling courses both start from real-world situations, and I structured the two into a mathematics classroom where students identify problems, make conjectures, collaborate, and investigate, and determine models from real-world situations to solve the problems. The difference between the math activity class and the traditional classroom is that it is based on the concept of STEAM education, which enhances students' abilities in all areas through interdisciplinary integration. The whole classroom is driven by multidisciplinary practical problems, and students' independent problem solving is oriented to comprehensively develop students' literacy in all disciplines, acquire basic knowledge and skills, and improve students' application and innovation skills, so that they can participate more actively in future mathematics classes [11].

4 The "five stages and five links" teaching model

4.1 The meaning of "five stages and five links" teaching model

Based on the "constructivist" contextualized learning, "learning by doing" theory and "project-based learning" theory, the "five stages" teaching design model proposed by Hu Xiangke and the "five links" teaching model proposed by Zeng Yaqiong on project-based teaching method, the "five stages and five links" teaching model is proposed, which carries out mathematical modeling classroom from teacher activities and student activities.
The "five links" teaching model mainly lies in the learning process, students through the project-based learning, a variety of skills to be exercised, teachers in the students to find the results of the process to play a guiding role and show the results to play a guiding role. The model is summarized as follows: student-led, teacher-led, and project-based. The details are as follows figure 1:

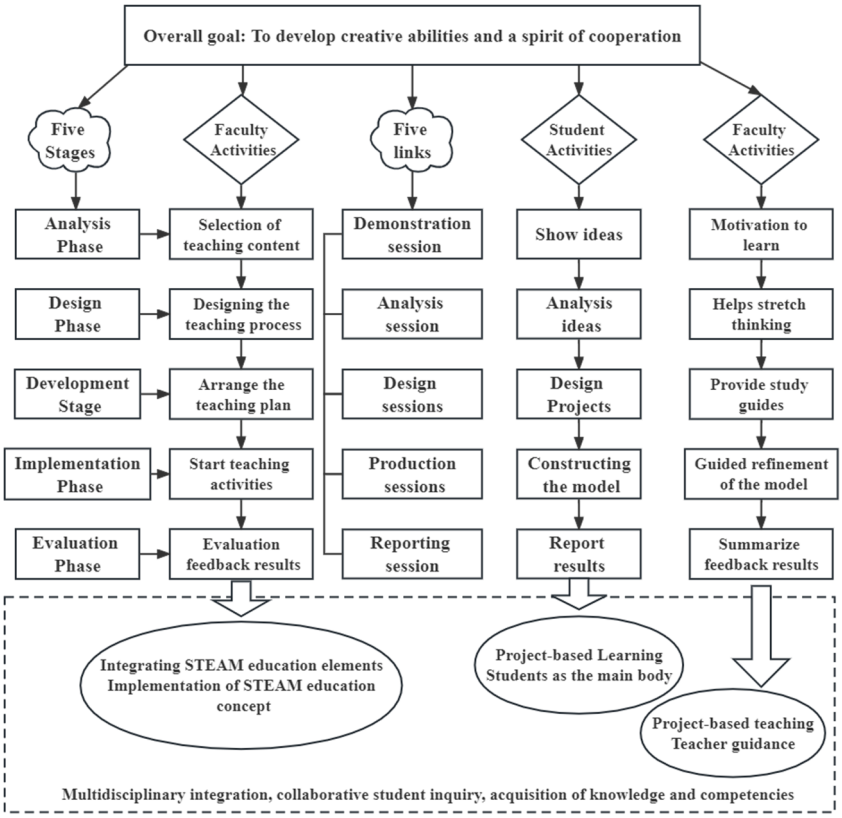

Fig. 1. Flow chart of "five stages and five links" teaching model

4.2 "Five-stage teaching design

Under the concept of STEAM education, the ADDIE model, a design model for mathematical modeling activities in the class, is based on the following five phases: analysis, design, development, implementation, and evaluation phases. Each phase is designed under the STEAM education concept, which incorporates scientific knowledge, technological tools, engineering thinking, and artistic thinking throughout the design of the high school mathematics activity lessons.

4.2.1 Analysis Phase

The analysis stage focuses on the selection of teaching contents, analysis of teaching objectives and brief analysis of students' learning conditions. In the selection and integration of teaching contents, we first interpreted the contents of high school mathematics subjects, analysed the high school mathematics curriculum standards, integrated the STEAM education concept, reasonably selected teaching contents involving other subjects, and arranged teaching practices in due course. When examining the instructional goals, STEAM literacy goals such as science literacy goals and engineering literacy goals are added to the specific goals, and students are using science to solve problems and acquire multidisciplinary knowledge and multiple skills. When analysing students, we consider their existing foundation and enthusiasm for learning, set up practical situations that interest them, and guide them to think and solve problems using STEAM education concepts.

4.2.2 Design Phase

This phase focuses on developing teaching strategies and designing the teaching process to prepare for the launch of instruction. The teaching method of student-led and teacher-led inquiry, class lectures adopting cooperative learning, linking to reality, and students identifying problems and exploring the essence of the problems from reality are the teaching strategies developed. The teaching process was designed in three parts, before, during and after the class. Before the lesson, students identify problems, determine elements, consult information, collect data, understand the science, and complete preparation from the real world. The lessons include scientific analysis of problems, hands-on investigation using engineering thinking, building models using mathematical methods, data analysis using technical means, and beautifying models with an aesthetic eye. and acquire multidisciplinary knowledge and skills to use them. After the lesson, students transfer and apply what they have learned to analyse other real-world problems and develop creative and hands-on skills. In the design phase and preparation of materials, the integration of STEAM theory requirements should be fully considered, and the specific teaching framework is designed as follows in figure 2:

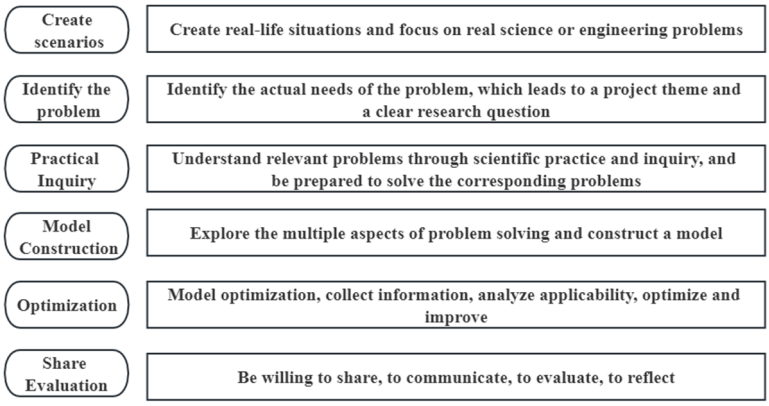

Fig. 2. Teaching Framework

5 The "Five Links" teaching model

The classroom under the "five links" teaching mode requires knowledge integration and innovative spirit, which is different from traditional teaching in that it pays more attention to students' subjectivity, creates various projects to guide students to design each learning link independently, and the group integrates relevant resources to produce innovative works [8], and advocates students' active learning, cultivating awareness of engineering application, independent design [9],cooperation and communication, and innovative spirit throughout the process. The links are as follows figure 3:

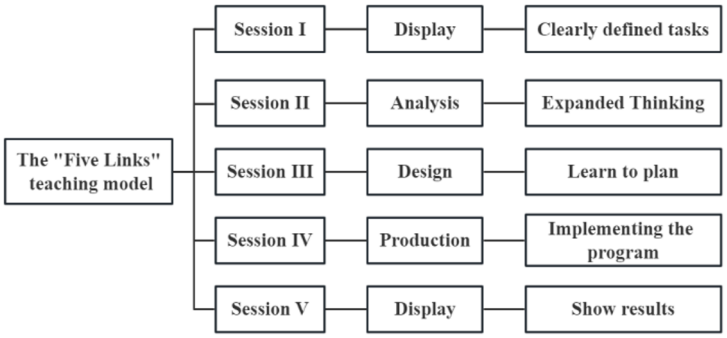

Fig. 3. Flowchart of the "Five Links" teaching model

The first session: the presentation session, students show their ideas about the given project [10], the teacher timely affirm the students' ideas, even if the students' ideas have the same, it does not matter, effectively guide students to put forward innovative ideas, through the teacher's guidance to stimulate students' interest in learning.

The third session: the design session, which is a process of planning, hypothesis, will be expressed in the form of ideas and feelings, is the previous step to create concrete objects, very exercise students' creativity.

The fourth session: the production session, i.e. the implementation of the designed ideas according to the actual situation, for the purpose of consolidating knowledge. In the process of making, students' hands-on skills are improved and their sense of cooperation is enhanced [11].

The fifth session: reporting session, this session in the group exchange after the selection of representatives to speak or take turns to speak, play the spirit of group cooperation and individual strengths, the best group results to show.

The mainly focus is on cooperation, students first think independently, then gather ideas and divide the work to complete together, and get comprehensive development in independence and cooperation. A reflection session is added at the end, in which students find their own shortcomings and further improve the finished product, and their own level of thinking and awareness is further enhanced. Students keep reflecting and correcting, and repeatedly among them, their understanding of knowledge will be deeper, their experience will be richer, and they will further improve their quality in all aspects. Specifically, the following table 1:

Table 1. Flow Chart

Classes		**Name**		**Group Name**	
Team members and division of labor					
Design					
Production:		Corresponding knowledge:			
Improvements:		Changes in knowledge points:			
Work Introduction:					
Summary:					

6 Conclusion

The integration of STEAM education concept can strengthen students' application awareness and enhance their practical skills. For example, in the teaching practice of "Correlation", students can actively collect data, learn to operate information technology, apply different function models, and reasonably explain the constructed models. As a result, students' ability of abstract analysis of practical problems is well exercised; by observing students' classroom performance, it is found that most of them can actively participate, cooperate and communicate, describe problems in detail and express their views clearly in mathematical language; in solving integrated practical problems, students can build mathematical models based on their existing mathematical knowledge base and experience the process of applying mathematical knowledge and mathematical methods to solve real-world problems.

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