Design of "Three-layer Progressive" STEM Teaching Model

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Abstract

With the rapid development of global economy and science and technology, STEM education has become an important way to adapt to future talent needs. STEM education takes interdisciplinary as its core and focuses on cultivating students' scientific inquiry and innovative spirit. In order to promote the role of STEM, the article designs a "three-tier progressive" STEM teaching model based on the research on STEM education.

Keywords

STEM education, Interdisciplinary, Teaching model.

1. Introduction

With the rapid development of the global economy, the competition for scientific and technical talents in various countries has become increasingly fierce, and the ability to innovate is an important goal for talent training in various countries. STEM education integrates the characteristics of mathematics, science, technology and engineering, integrates the original single subject, and is not only a superficial intersection, but also an internal integration. It has a significant role in cultivating students' scientific inquiry and innovative spirit.. In 1986, the US government issued " Undergraduate Science，Mathematics and Engineering Education ".[1] Put forward the concept of STEM education, in 2018, "Develop a successful route: Charting a Course for Success: America's Strategy for STEM Education [2], The United States has always attached importance to the development of STEM education, and during the period introduced various policies to promote the cultivation of talents in STEM education. My country pointed out in the "STEM Education White Paper" that STEM education helps to cultivate students' key ability to adapt to the future and may continue to play a role in future life and work. Therefore, it has become a strategic choice for education reform in all countries in the world.[3] STEM education is currently in a period of rapid development in my country, especially in the K12 stage. Various STEM teaching methods are emerging one after another, which has played a positive role in promoting the development of STEM teaching.

Based on this, this article sorts out and researches related models, modes, activities, etc. of STEM teaching, grasps the core characteristics of STEM interdisciplinary, and builds a "three-tier progressive" STEM teaching model in order to promote the development of STEM education.

2. Connotation and Function of STEM Education

STEM education is mainly concentrated in western developed countries, especially in the United States, Britain and other places. Yakman, a scholar at Virginia Tech in the United States, first proposed this form at the National Science Foundation in 1990, and later opened scratch courses at MIT, which were popular among other researchers.[4] STEM is the abbreviation for the four disciplines of Science, Technology, Engineering and Mathematics, emphasizing the integration of multiple disciplines. Its core feature is interdisciplinary. The interdisciplinary here is not simply superimposing multiple disciplines, but integrating different discipline literacy and discipline characteristics, organically integrating multiple disciplines, forming a whole, and appearing as a complete teaching system . Interdisciplinary as the most important core feature of STEM education means that in STEM education, educators no longer focus on a specific subject or focus too much on subject boundaries, but instead focus on specific issues and emphasize the use of science "Technology," engineering or mathematics and other disciplines interrelated knowledge to solve

problems, to achieve the educational goal of improving students' ability to solve practical problems from the perspective of comprehensive application of multidisciplinary knowledge across disciplines.[5] In addition, STEM also has the characteristics of experience, interest, and context, which provide conditional support for cultivating students' innovative ability and high-level thinking.

STEM education promotes learning methods, teaching models, and student abilities. 1. In terms of learning methods, it has promoted the emergence of a learning community. Although students have always been emphasized in education, students are the main learning method as a single subject, which does not meet the requirements of the new era for students' cooperative ability . STEM education emphasizes collaborative learning in context, which greatly breaks the barriers between individual learning and makes learners become a whole in cooperation. They can share interdisciplinary learning resources, optimize interdisciplinary learning behaviors, and sublimate disciplinary learning concepts.[6] 2. In terms of teaching mode, STEM education has changed the traditional teaching method, attaching importance to the application of constructivism in teaching, emotional and contextual teaching, project-based teaching, and the most important thing is the addition of interdisciplinary effects to a single teaching mode. Make teaching interesting and integrated. It is to find the solution to the problem as the learning task, and carry out task-driven learning. In the process of solving real situational problems, let students actively confirm goals, find resources, construct paths, and solve problems. [7] 3. In terms of student abilities, STEM education aims at cultivating students' scientific spirit and innovative ability, so that students can help them in the process of solving real problems, cultivate their spirit of scientific inquiry, enhance students' ability to solve real problems, and meet reality Higher-order thinking skills required.

3. Current status of STEM education research

In the field of practice, whether STEM is offered as an independent course that integrates multi-disciplinary knowledge, or as an overall planning and witty teaching strategy to promote in school activities, the effects of STEM teaching are generally concerned by educators. Important issue. [8] Countries have promoted STEM education and teaching in various ways. For example, on December 3, 2018, the White House and the U.S. STEM Education Committee jointly released the report "Developing a Path to Success: American STEM Education Strategy", which proposed the "Polaris Project" to mobilize factors from all walks of life to promote the development of STEM education, and is committed to improve the STEM literacy of the whole people.[9] Finland initiated a national STEM education promotion project represented by LUMA (LUMA is the abbreviation of Finnish luonnontieteet" meaning natural science and mathematics) mathematics and science education development project.[10] Although STEM education in my country started late, it has developed rapidly in recent years, and many related studies have emerged. For example, the evidence-oriented STEM teaching model pointed out that STEM courses are developed around problem solving. In the process of problem solving, students need to understand the problem situation, find a series of evidences to solve the problem, and make scientific analysis of the evidence. After the analysis and reasoning, one or more scientific problem-solving solutions are proposed. [11] In order to provide a support for the use of STEM to solve real problems, the design and practical research of the "support +" STEM teaching model was carried out. [12]

After research, it is found that when using STEM education concepts to teach, they mainly focus on curriculum development and project-based teaching. Among them, the use of technology and engineering design are key links and parts that need to be continuously strengthened. Teaching research in various forms mainly promotes the integration of STEM concepts into teaching, and develops from influencing students' thinking level to spiritual level.

4. "Three-level Progressive" STEM Teaching Model

Based on the above analysis, this research constructs a "three-tier progressive" STEM education model to promote the development of STEM education from influencing thinking to forming spiritualization, as shown in Fig.1. The teaching model of this research is divided into three layers,

which are presented based on the Dell Experience Tower. The lower the bottom, the more specific, and the higher the top, the more abstract. In this model, the levels of target abstraction are different, and the capabilities are continuously improved from low to high.

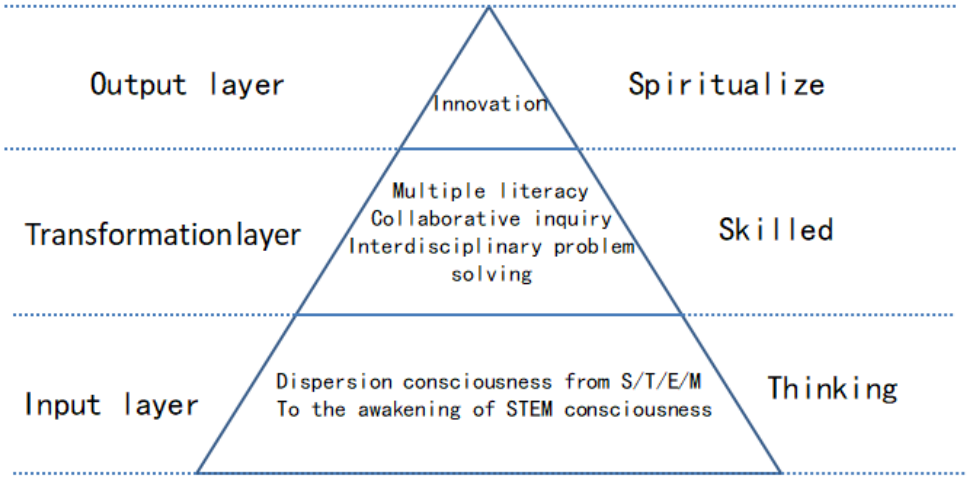

Fig. 1 STEM teaching model of "three-layer progressive"

4.1 The input layer

The input layer is located at the bottom of the model, which is also the foundation layer. As the name implies, the input layer mainly uses appropriate teaching methods to input STEM concepts to students, which makes students gradually cultivate STEM interdisciplinary literacy from the original S/T/E/M disciplinary literacy, but this process cannot be achieved overnight, so in the input layer, as long as it can awaken students' STEM literacy.

In this layer, teachers will play a more prominent role, because the students at this time can't clearly understand the STEM education concept and the STEM learning style, but in their long-term study and life, they have more or less been exposed to interdisciplinary related fields, but they are not clear in their minds. At this time, in the initial stage of training, teachers need to create a learning space. In this learning space, the most basic requirement is to have STEM-related facilities, such as a variety of interdisciplinary equipment, related STEM products, and 3D printing equipment with certain conditions. Secondly, if you teach as a project, you can also contact teachers from different disciplines with Build together program, so that the interdisciplinary nature of the program itself will be more obvious. Finally, the created learning space should break the original space barrier, organize outdoor activities while ensuring safety, and organize students from different disciplines to participate in them. Students' activities mainly focus on communication and interaction, making bold guesses and asking questions according to the equipment and products in the scene. Exchange learning experiences and feelings with students from different disciplines. And make a statement and summary at the end of each class, and use STEM knowledge when making a summary. At this level, it is in the thinking stage of STEM learning.

4.2 Transformation layer

Transformation layer, as a transitional part from low-level to high-level, mainly makes the application of STEM skilled. This part focuses on strengthening students' technical ability and engineering design thinking on the basis of their mathematical knowledge and scientific literacy. And achieve the organic integration of multiple disciplines to form a whole.

Teachers play an auxiliary role in this layer, mainly by creating relevant learning situations, guiding students to find problems while entering the situation, and giving appropriate tips for key and difficult points, so as to guide students not to deviate from the learning route. When students ask questions or

think of solutions, teachers need to give timely approval or denial, and provide additional knowledge as evidence, so that students can have evidence to follow when solving problems. When the students complete the implementation of the solution, they will test the students' technical and engineering thinking. Teachers should guide the new technology and ensure the safety of the implementation. After the implementation is completed, the teacher will explain the problem of concentration again according to the students' performance and achievements, and evaluate this study. Finally, students are encouraged to innovate actively and solve related problems in reality. In this model, students must give full play to their initiative and enthusiasm, and find problems that need to be solved according to the situation. Actively cooperate with peers, follow the teacher's tips, analyze problems step by step, and discuss and make the best solutions together. Facing the new knowledge, we should reflect on the original scheme and constantly optimize it. When the technology is used and the project is implemented, it is necessary to cooperate to create and constantly optimize the results. At last, actively reflect, self-evaluate and peer-evaluate, and consciously innovate. This layer will be beneficial to students' multi-reading and writing ability, collaborative inquiry ability and interdisciplinary problem-solving ability improve.

4.3 The output layer

The top layer is also the most abstract layer, which is the layer that outputs STEM literacy. That is to say, after a series of studies, the original thinking consciousness is transformed into spiritual accomplishment. At this time, students integrate STEM into their lives, apply it consciously or unconsciously, and innovate and practice it.

In this layer, teachers will no longer provide the created complete situation, but directly throw out practical problems, and then provide interdisciplinary scattered resources, students make corresponding choices, freely form groups to explore the use of these resource tools, consciously link with practical goals, and use STEM concepts to solve problems interdisciplinary. When the resources selected by the group are insufficient or unmatched, they can actively discuss with other groups to exchange resources. In this process of teachers' basic non-participation, students solve problems independently and truly apply STEM concept to practice. In this way, it is easier to stimulate students' understanding of STEM, and get its profound role. In the process of constant challenge, students can cultivate their own Innovation capacity, and spiritualize STEM and integrate it into their own body.

5. Conclusion

This research is guided by STEN education, combined with the needs of the times for talent training, integrates the concept of STEM education into teaching, creates a progressive teaching model, gives full play to the role of STEM education, and continuously enhances students' understanding of S interdisciplinary And the degree of use. The model is constructed through three stages: input layer, transformation layer, and output layer, which point students to master the thinking, skill and spiritualization of STEM respectively. However, the specific implementation method is not well-targeted, and it is described in a generally applicable manner. Further research and expansion are needed for the research of personalized teaching methods. This article does not involve the implementation of the case. Continuous improvement is needed to promote the effective implementation of the model and contribute meagrely to the development of STEM education.

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