

# Development, Problems and Strategies of STEAM Education

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**Abstract:** STEM education has been the spotlight as it is suitable for the demand of the future social development on talents since it was proposed by the National Science Board (NSB) in the 1980s. With the advancement of research on this education model, the arts of mingling was extended with the aim to promote the STEAM education that was committed to cultivate the all-round talents in scientific innovation. This paper will discuss the development process, existing problems and strategies of STEAM education in order to provide reference for the development of STEAM education.

## 1. Introduction

With the development of the information and the knowledge, the core elements of competition among countries are gradually transformed into scientific and technological innovation. The change of demand of social development on talent demand will inevitably affect the direction of talent training in the field of education. Talents is an important carrier of human resources. The cultivation of talents with scientific and technological innovation has increasingly become the focus of education at all levels. STEAM education, as a kind of education to cultivate students' capabilities in scientific and technological innovation, is in step with the requirements of social development for talents, and is gradually paid attention to by governments and academia all over the world.

## 2. The History of STEM Education

STEAM education originates from STEM education, which is the extension and improvement of STEM education.

### 2.1 The Background of STEM Education

STEM education was first proposed by NSB in America. During the Cold War Period, America suffered successive setback in military race with the Soviet Union. Soon after, the publication of the article of *A Nation at Risk --The Imperative of Educational Reform* aroused the thinking about the quality of education in schools guided by progressive education. The abolish of basic and systematic education and reduction of academic standards lead to the deterioration of educational quality. [1] The education has draw ire of the public in America and the government and institutions at all levels were prompted to be reflective of the policies in fields of science and technology and the reform with the theme of science and technology was launched by the educational circle." [2] STEM education came into being accordingly. STEM is the acronyms of the four disciplines of science, technology, engineering and mathematics and the implementation of these four disciplines were to cultivate qualified talents for the jobs related to the four disciplines after they entered the society. In 1968, NSB published Undergraduate Science, Mathematics, and Engineering Education that was regarded as the first guidance document on STEM education [3].

### 2.2 Extension of STEM Education

#### 2.2.1. STEAM Education

STEM education aims to cultivate talents in science and technology for the development of the society in the 21st century. However, "Although STEM education had accelerated the training of science and engineering talents in the United States and improved the employment rate of science and engineering talents, the quality of STEM graduates were far from satisfaction from the perspective of educational outcomes." [4] Therefore, relevant organizations in the United States once again reconstructed the conceptual model of STEM education. Based on STEM education and art in STEAM education, Grete Akerman and her team designed the STEAM education framework and launched the STEAM Education Training Certification.

### 2.2.1.1. The Progress of STEAM

Art was integrated into STEAM education based on the original STEM education with the aim to help students understand the connections between different disciplines from multiple perspectives, thus improving their ability to solve practical problems. Most scholars believe that the plural form of Art (Arts) should be used to refer to the humanities. Professor Yakman believes that the 'A' should encompass a broader range of subjects in humanities, including social studies, language, form, music, aesthetics and performance."[5] The progress of STEAM education is not only the addition of one subject, but also the expectation that the talents cultivated through the integration of arts courses will not only be able to do the work related to the four subjects, but more importantly, be imaginative and innovative.

### 2.2.1.2. Features of STEAM Education

#### A. Interdisciplinary Integration

The teaching of individual course adopted in traditional education is beneficial to improve the efficiency of teaching, which is one of the reasons why the teaching mode of individual course is still carried out. However, the problems in real life are often characterized by the complexity of the situation and the imperfection of the problem structure. At this time, the disadvantages of the individual curriculum are gradually revealed. The unique advantage of STEAM education lies in the interdisciplinary integration, which involves the organic integration of five disciplines, that is, "the discussion of problems or projects was made based on knowledge of science, technology, engineering, art and mathematics under the guidance of constructivism and cognitive science theories".[6] In other words, knowledge integration should be based on certain issues or projects, so project or issue design is crucial to the effectiveness of STEAM education.

#### B. Solution to Practical Problems

The organization for Economic Co-operation and Development (OECD) once put it bluntly: "In the modern world, life is about solving problems."[7] The main purpose of STEAM education is to develop students' problem solving ability through project learning. Therefore, project learning is the main way of learning in STEAM education.

#### C. Teamwork and Communication

Problems in real situations are often characterized by complexity. Therefore, interdisciplinary skills and teamwork and communication skills are required in solving problems in real situations. The learning style of STEAM education is mainly based on group learning, enabling students to complete project learning through teamwork.

### 2.2.2. Transformation from STEAM Education to C-STEAM Education to STREAM Education

With the continuous advancement of research on STEAM education, C-STEAM education and STREAM education have been extended based on STEAM education.

C-STEAM education is a further development of STEAM education by Chinese scholars with the goal of inheriting China's excellent traditional culture. The "C" in C-STEAM education is the acronym for "culture", indicating that the goal orientation is cultural inheritance. In addition, researchers of C-STEAM education also defined the classification framework of C-STEAM projects, that is, "C-STEAM courses can be divided into four main project types in the space quadrant, namely, experience-oriented, technical-training type, exploration-learning type and innovation-creation type, based on the two axes of process-results-oriented, low level-competence-high-competence."[8] C-STREAM education can be seen as an attempt to localize STEAM education.

STREAM was formed with an "R" added to STEAM, which demonstrated the reading/ writing ability. The purpose of the inclusion of the "R" in STEAM education is to enable highly qualified professionals to cope with the need to write reports, lab materials and interact with people.

## 3. Problems and Strategies

As an emerging educational concept, there are still many problems to be discussed in STEAM education in the model construction and actual operation.

### 3.1 Integration and Development of Curriculum Resources

STEAM course resources emphasize the organic integration of knowledge in all five disciplines. This kind of organic integration needs to be based on activities. Learners take the initiative to participate in project or problem solving, and integrate knowledge and skills related to problem solving in this process, so as to develop students' ability of interdisciplinary integration of knowledge and skills to solve problems. The construction of STEAM education curriculum system can be considered from two aspects: first, connect the existing curriculum standards and curriculum system, and integrate STEAM education philosophy into it. Second, fully mobilize the forces of all sectors into the development of STEAM course resources.

### 3.2 Training for Full-Time STEAM Teachers

The interdisciplinary nature of STEAM education undoubtedly imposes challenges to STEAM teachers. Traditional normal education mainly focuses on cultivating single-subject teachers. STEAM education undoubtedly poses new challenges to teachers in disciplinary vision, knowledge reserve, innovation ability and educational concept. The teachers are undoubtedly the important factors determining the successful implementation of STEAM education on the practical level, for which the cultivation of full-time STEAM teachers is extremely urgent.

### 3.3 Construction of STEAM Evaluation System

As an interdisciplinary integrated education, STEAM education must be evaluated in a different way from single-subject education." The assessment of student in STEM performance was conducted by using data from the National Assessment of Educational Progress, trends in International Mathematics and Science Advancements, and the Program for International Student Assessment."[9] The establishment of the evaluation system is not only to evaluate the effect of STEAM education, but also to find out the potential shortcomings of STEAM education mode through evaluation and then adjustment and improvement.

### 3.4 Localization of STEAM Education

Education is a subsystem of society, and its development is inevitably affected by political, economic, educational situation and other factors. STEAM education is bound to be influenced by political, economic and other factors in a country. As Anderson says, "When we talk about the state of global STEM education, we have to be aware of the social, political and educational context."[10]C-STEAM education, as an education model based on Chinese traditional culture, is an attempt to localize STEAM education.

## 4. Conclusion

On the occasion when scientific and technological innovation has become the core competitive factor in various countries, the social demand for talents is that job seekers should be endowed with the ability in interdisciplinary integration, innovation and cooperation and exchange, so as to adapt to the constantly changing environment. The STEAM education as a response to this challenge is bound to be constantly improved with further research.

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