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Comparing STEM Education in the United States and Mainland China

Yi Wang[1,a,*]

[1]*Graduate school of The Education University of Hongkong, Lo ping Road, New Territories, Hongkong*
a. 3180200374@caa.edu.cn
**corresponding author*

Abstract: Science, Technology, Engineering, and Mathematics (STEM) education is well-known as one of the most significant issues in both China and the United States. It makes almost no difference whether a school is public or private; both the administration and the curriculum place a high value on the objective of enhancing the efficiency of STEM course delivery methods and ensuring that these approaches are appropriate for the course orientation. However, since China and the United States have distinct educational systems, the sorts of lessons accessible to pupils in each country will be significantly different. Based on the dispute over STEM education in these two countries, this review article compares STEM education in the United States and China in terms of curriculum origin, curriculum development, and the goal of STEM education in both countries. The challenges that currently exist in STEM education delivery are also explored. The main findings of this article are: STEM courses are still in the development stage in the US and China; The aim for STEM teaching is different from the US and China; The Method for Teaching STEM courses is different from the US and Mainland China. Meanwhile, teaching and assessment approaches are being proposed as a response to these ongoing difficulties in academia and the education industry. Therefore, this article can provide contributions to inspiring future STEM Education in both U.S. and mainland China.

Keywords: STEM education, United States and China, curriculum setting, teaching and assessment, challenges

1. Introduction

The United States of America is recognized as being the first country to propose utilizing the acronym STEM, which stands for science, technology, engineering, and mathematics. To keep up with the growth of society, notably in manufacturing and Internet technologies, an increasing number of countries are spending extensively on research and reinforcing efforts to increase the usefulness of student courses [1]. This is completed to stay up with the growth of civilization. STEM education is significantly more vital than the acronym's first three letters suggest. It is a sort of project-based learning that emphasizes student participation and incorporates subjects from the STEM areas [2]. The Ministry of Education's "Education Informatization" policy made it abundantly clear in 2016 that learning approaches, for example, maker education and STEM education should be studied in order to provide the next generation with a firm understanding of the

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importance of knowledge and innovation as they are mature [3]. The most obvious challenge is that academics must face is adapting STEM instruction to China. This article compares the STEM education systems in China and the United States to create a benchmark against which the potential STEM education models in each country can be compared.

2. The Description of STEM Education in the United States

2.1. The Development of STEM Courses in United States

Despite the fact that the United States educational system is widely regarded as one of the best in the world, recent studies have revealed that American children's test scores in science and mathematics have room for improvement when compared to those of international students and children from other countries [1],[4]. Based on [4] study, the United States of America was ranked 38th overall and 24th in science and mathematics. Over the course of many decades, a number of nations' standing in key STEM education rankings varied. The United States was placed ninth in reading, eleventh in science, and thirty-first in mathematics. The National Center for Education Statistics data was used to compile these rankings [1]. The United States is the most popular study abroad destination for all levels of STEM programs, which continues to be unparalleled in terms of overall intellectual excellence.

A variety of factors have led to the increased popularity of STEM degrees as well as careers in firms that are closely related to them. The objective of the United States of America is to cultivate a labor force that is more economically, scientifically, and technologically skilled in a variety of these related fields of study and employment [5]. The American educational system actively fosters a rise in the number of international students who pursue jobs in fields such as engineering, science, technology, or mathematics. STEM studies are available at a number of universities around the United States for students who are interested. The graduate employability rankings of the leading STEM programs at universities in the United States are well recognized. This is because these colleges are not only well rated in terms of education, instruction, and related metrics, but they also provide the greatest STEM programs [6]. In fact, four of the top five slots in the QS Graduate Employability Rankings 2022 are held by American educational institutions, including The Massachusetts Institute of Technology, Stanford University, the University of California, Los Angeles, and Harvard University. The education that children in the United States get in the domains of science, technology, engineering, and mathematics is to a large extent rigorous and will put the students' skills to the test on every level; nevertheless, it will also aid in the student's personal growth [7].

2.2. The Structure of STEM Courses in United States

Applicants must double-check the accuracy of their Optional Practical Training (OPT) data at the initial phase of the STEM application process. They will be allowed to go to the next phase once they have decided whether the information about their company and current location is correct [8]. If it is discovered that the information they supplied regarding their current location or occupation is incorrect, they must complete a 12-Month OPT Report. Before writing their STEM OPT I-20, International Space Station (ISS) first ensure that the year OPT information in their SEVIS record is correct and up to current. The candidate must fill out the STEM OPT Extension I-20 Request and submit it to ISS during the second phase of the procedure [9].

In this case, leaving the E-Verify field on Form I-765 blank is allowed in the United States. This is due to the fact that the US does not mandate its citizens to utilize E-Verify. ISS has a list of companies that refuse to provide E-Verify numbers to university experts because these companies intend to file OPT extension requests for their employees [10]. If the manager is not on the list, the

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ISS consultant may go out to the students or establish contact with them in order to obtain a letter of support from the management detailing their plan [6]. Students are frequently requested to pay the $200 Post-Completion Training fee and preserve a copy of the email receipt they get after doing so. The request for STEM OPT extension on the I-20 must be supported by a duplicate. Finally, learners must submit an online request for an extension of their STEM OPT on Form I-20 [11].

2.3. The Aim of STEM Course in the United States

Jobs related to STEM are frequently listed among the most coveted and lucrative alternatives available. To sustain its economic dominance, the United States has maintained its position as the world's top authority in a variety of fields. In the United States, education in the domains of STEM creates the framework for scientific and technological breakthroughs that have the potential to enhance people's quality of life [6]. When students complete their STEM degrees, they open themselves up to a wide range of career and research opportunities. A specialized employment team is also available to help to discover a renowned position at universities in the United States of America. Students from other nations are drawn to study in the United States because corporations and institutions in the country respect and recognize the level of education provided.

Jobs involving science, technology, engineering, and mathematics are in high demand in the United States (STEM). The nation aspires to cultivate a workforce with advanced economic, scientific, and technical talents, either directly or indirectly related to these fields, in order to satisfy its labor demands [1]. Academic institutions in the United States are focusing their efforts on encouraging more students to pursue careers in STEM since the country has a global image as an innovator and leader in these fields. Another purpose of STEM education is to provide students with skills that will increase their employability and prepare them to meet the current labor market expectations. It comprises every possible mix of information and experience. Every component of science, technology, engineering, and mathematics contributes significantly to a well-rounded education [11]. Students that attend science lessons gain a complete understanding of the world around them. As a result, they can gain research and critical thinking abilities.

3. The Description of STEM Education in Mainland China

3.1. The Development of STEM Education in Mainland China

Education centered on science, technology, engineering, and mathematics is not a novel notion in China; yet, both its name and meaning have evolved through time. The Ministry of Education issued guiding opinions on comprehensively and deeply promoting educational information during the 13th five-year plan period in 2015 [12]. It was suggested in the paper to explore innovative education approaches such as Science, Technology, Engineering, the Arts and Math (STEAM) education and maker education. In its 2016 publication of the Thirteenth Five-Year Plan for Informatization of Education, the Ministry of Education included the following request. Regions with circumstances should aggressively investigate the use of information technology in the crowd creative space, interdisciplinary learning, maker education, and other forms of education. The educational model's application focuses on fostering students' overall development, improving students' information literacy, awareness of innovation, and ability to innovate, and emphasizing the supporting and guiding roles that information technology plays in developing future high-caliber talent [10].

In 2017, the Chinese Academy of Educational Sciences unveiled the "STEM Education 2029 Action Plan" and the STEM Education Research Center. Beijing is home to the STEM Education Research Center. In light of China's present political and economic situation, business professionals and academics have established a 10-year plan to promote STEM education [13]. Furthermore, it

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will provide specific instances to demonstrate the present issues in STEM teaching. It follows a specific strategy to enhance STEM education.

3.2. The Structure of STEM Courses in Mainland China

Teachers of STEM disciplines in China are obliged to set regulations, verify their students' compliance with such policies, and supervise their students' cognitive learning processes [13]. The development of problem-solving skills by pupils in accordance with the prerequisites for developing creative talents typically correlates to students passing through distinct developmental phases. STEM approaches are linear, which corresponds to the curricular ideas proposed by Ralph Tyler in China in the 1970s [14]. The first STEM Education Curriculum Outline in Jiangsu Province, China, follows the project- and outcome-driven, economically driven STEM education approach, with an emphasis on structurally integrated, locally relevant designs [6]. This was done to guarantee that the curriculum met the Chinese government's criteria. The five dimensions articulated and condensed in the Outline are knowledge integration, methodical design and innovation, experiment and expression, cultural experience and recognition, scientific attitudes and accountability. These are the dimensions by which China's STEM education goals will be met [14].

In China, STEM education is largely considered a policy problem, encompassing issues of planning and execution, with the primary goal of encouraging economic growth and developing the capacities of the next generation of workers. As a direct result of supportive government policies, public and private schools around the country have begun to undertake STEM education projects. There is an actual need for full-time instructors with experience in STEM education or sectors relevant to it to guarantee that STEM programs are carried out efficiently. China has prioritized the adoption and growth of STEM education within the scope of technical and scientific discourses. STEM education is created and executed simply as a developmental technique in schools tainted by scientific innovation and transdisciplinary ideas. This study draws to the notice a number of various facets of scientific research techniques. In addition to the previously described distance in science and instrument mastered, the study emphasizes the feature of virtuosity itself as the major topic of inquiry [14].

3.3. The Aim of STEM Course in Mainland China

In China, education in one or more of STEM's component subjects is referred to as "STEM education." STEM education encompasses the disciplines of science, technology, engineering, and mathematics. In other contexts, the phrase may refer to integrated, interdisciplinary, or multidisciplinary approaches. The rules and practices of China's STEM education system demonstrate that the major focus is on the development of students' skills and capacities [15] Individuals must have the requisite conceptual understandings, procedural skills, and talents to handle personal, social, and global concerns. It prioritizes strengthening procedural abilities, conceptual understanding, and practical applications of various areas of competence over moral and ethical issues. This paper fails to address the ethical side of knowledge in his criticism of STEM education, which suffers from a lack of conceptualization in the curriculum [16]. This is problematic since STEM education is conceptually deficient.

When examined in the perspective of practice, STEM education in China reignites a discussion of the country's ethical challenges. According to [13], making ethically correct judgments that result in 'good' or 'right' consequences for others or for one's own life is what the study implies. The focus that will be placed on problem-solving, interdisciplinary learning, and project-based learning will be distinct from the worldwide emphasis that is placed on STEM education and single-subject instruction. It facilitates the transition from science education to education in STEM+ sectors [13].

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The introduction of STEM curricula in Chinese schools is meant to establish an atmosphere in which young people may start to examine the relevance of their own lives and the world around them. This may be performed most successfully by presenting a basic phrase or concept that allows students to think on their own unique experiences in light of the statement or notion [14]. Another objective is to break through to the actual stillness that lies beyond formal language, which is ironically the place where one might discover oneself while they are in the process of being released from it.

4. The Comparison of STEM Education in the United States and Mainland China

4.1. Based on Methods of Teaching of STEM Course

In the United States, the most prevalent technique used to train students in STEM subjects is known as problem-based learning. Students are obliged to assess and evaluate an issue before going on to the next level, which is the fundamental contrast between this technique and project-based learning [11]. Considering the fact that there is usually more than one solution that is suited to an issue, this calls for a substantial bit of thinking. Leadership, teamwork, and unique ideas are all encouraged by this strategy. Have pupils construct their own company ideas to address a social want as an example of project-based learning [15].

Project-based learning is adopted by the majority of STEM instructors in the United States. Through involvement in a project, students are provided with the chance to develop new talents and apply the knowledge they have received [4]. They spent a large amount of time researching the issue and coming up with a solution to it. As a teacher, it is the learner's obligation to play the role of a facilitator and to encourage children to take entire ownership of their work, from the very first step to the very last. Creating an app or a model of a bridge are two examples of the sorts of projects that may be utilized in STEM-based project-based learning [16].

Both a training framework and experienced STEM instructors are limited in supply in China. For example, there is no official admissions mechanism in place for the accreditation of new instructors in the STEM professions [10]. Only STEM education lays an emphasis not only on integrating the curriculum of preschools but also on putting theory to practice in primary education. The essential principle of a scene-based teaching approach has not been altered; consequently, it does not matter if the course materials are in the form of slides or cartoons . Only 27.1% of Chinese schools design their own curricula; 58.3% of those that offer STEM courses receive their materials from education research groups or technology businesses [13].

Because the United States STEM Education Initiative encourages students to ask as many questions as they prefer, they are permitted to do so. Teachers also make use of inquiry-based learning, which lays a high focus on the participation of students in the full learning process. These numerous sorts of education support the development of qualities such as critical thinking, questioning, and problem-solving. Because it will be directed by the children themselves, the youngsters will determine the questions they wish to ask [13]. It is the job of the educator to inspire both inquiry and reflection. The most uncommon utilization of this method may be found in China.

4.2. Based on Aims of STEM Course

The main purpose of STEM education in the United States is to increase students' prospects of finding work and to equip them ready to fill gaps in the labor market. It takes into consideration every imaginable set of talents and experiences. Each component of STEM provides a considerable contribution to a student's total education. Students obtain a complete grasp of the world around them via the study of science [3]. They can develop their research and analytical abilities as a result of this. Young people nowadays are more suited to thrive in high-tech employment thanks to

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technological improvements. Students get the opportunity to refine their aptitude to solve issues while also broadening their knowledge via the study of engineering. People may utilize mathematics to investigate facts, remedy faults, and make intelligent judgments while developing solutions. This may be useful [16]. Education in the STEM sector incorporates multiple diverse topic areas under a single roof. On the contrary, the STEM approach to education in China emphasizes creative and divergent thought in addition to the standard curriculum. The next generation is being motivated and encouraged to create new technology. Students gain from taking part in inquiry-based projects that focus an emphasis on practice and creativity [4]. The benefits of education in STEM subjects include conceptual comprehension and the promotion of the practical application of gained material.

5. Conclusion

According to the statistics collected on STEM education in both the United States and China, it helps to the overall endeavor of preparing the world for the future. It is founded on the collaboration and teamwork of individuals from a range of professions working together. When teams are exploited, there is a notable boost in not just profitability but also work satisfaction and output. Students in both states are afforded opportunities to participate in fruitful interdisciplinary cooperation as part of their STEM education. Research and experiments are carried out by scientists, who subsequently report their findings to the team. The professionals in the field of technology supply the tools that can increase a group's total production and productivity. Engineers aid in the resolution of difficulties by creating and monitoring the management of change-promoting platforms.

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