STEAM Education Theory and the Intregration to Piano Teaching in China

Fang Yan and Rujee Srisombut
Bangkokthonburi University, Thailand
Corresponding Author, E-mail: rujee.sri@bkkthon.ac.th

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Abstract

The rise of STEAM education: With the emphasis on comprehensive education and the promotion of STEAM education concept, more and more music schools and piano education institutions are focusing on the application of STEAM education in music education. They realize that integrating science, technology, engineering, art and mathematics into piano teaching can enrich students' learning experience and develop comprehensive abilities. Innovative teaching methods: Some teachers are beginning to explore innovative teaching methods that integrate STEAM education with piano instruction.They are making piano classes more dynamic and interesting by introducing activities such as science experiments, music production, programming and interactive art to stimulate students' creativity and spirit of exploration.

Keywords: STEAM; Education; Theory; Intregration; Piano Teaching; China

Introduction

The content standards are intentionally integrated and focused on achieving the goals of the five content areas in STEAM. Science, Technology, Engineering, Arts, and Math. In interdisciplinary instruction, students are fully engaged in the problem-solving process, and they are excited to use what they already know to find solutions by learning new concepts from different STEAM disciplines. We collaborate with teachers to develop authentic lessons that engage students in solving real-world problems, and in order to solve the problem, they must synthesize their knowledge of the STEAM disciplines to reach a workable solution. In addition, our professional development efforts encourage integration driven by teacher goals.

In order to prepare students for the demands of the twenty-first century, we need a truly integrated approach to teaching the STEM disciplines that allows them to understand the connections between the STEM disciplines. The program is dedicated to helping teachers learn how to integrate math and science concepts into a cohesive STEM curriculum using quality resources.

Although we knew it would be a complex process, linking professional development to the classroom implementation cycle was essential to promoting STEAM-integrated education in our participating schools. In order to create an iterative cycle, teachers were allowed to participate in whole group professional development and then return to their own classrooms to implement new strategies.

In addition to the structure of the schedule, we know that it is important to situate learning during professional development within the participants' classroom and school environments (Putnam & Borko, 2000). When teachers' learning becomes "situated," teachers can begin to change their instructional practices to align with professional development,

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thereby changing and growing their instructional skills and knowledge. This change and growth creates a cyclical process - as pedagogical knowledge and skills improve, teachers have new knowledge and skills to offer during professional development sessions, which in turn improves the quality of collective (and individual) professional development, which continues to improve pedagogical knowledge and skills, and so on. In this type of professional development setting, teachers are engaged with the professional development leader to help co-construct the learning experience, unlike traditional professional development, which views teachers only as participants (or recipients).

The development trend of STEM education in the United States:

(1) STEM education goals: the rise and development of STEM education in the United States is closely related to the U.S. talent strategy, the needs of the Industry 4.0 era, future citizen literacy, and trends in education reform. Therefore, the United States has taken STEM education as an important strategy to enhance national competitiveness since 1986, and attaches great importance to the important role of STEM education in enhancing citizens' future career competency and the competitiveness of the U.S. economy and society.

(2) STEM education system: The development of STEM education in the United States places great emphasis on mobilizing the participation of society as a whole and building a learner-centered STEM education ecosystem from micro to macro.

(3) Leading aspects of STEM education: The 33-year development of STEM education in the United States has gradually led to the formation of a STEM education system that is government-led, with multi-party cooperation among parents, communities, employers, businesses, non-profit organizations and professional associations.

(4) Cross-sectoral cooperation: The United States attaches great importance to cross-sectoral and cross-institutional cooperation among the Departments of Education, Commerce, Defense, Public Health, Labor, Agriculture, Homeland Security, National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and museums, etc., and has clearly planned the goals and responsibilities to be achieved by each of these departments. This is very worthwhile for us to learn.

(5) In terms of STEM education value: it focuses not only on human skills such as critical thinking, problem solving, higher order thinking, design and reasoning, but also on behavioral skills such as perseverance, adaptability, cooperation, organization and responsibility.

(6) In terms of STEM education segments: it moves down from higher education to K-12 and up to early education, trying to build a P-12 STEM education system and emphasizing the sustainability and continuity of STEM education.

This is because we are moving toward the common goal of implementing STEAM instruction that is truly integrative and interdisciplinary, as well as authentic and meaningful. Through our work, we have found that the biggest difference between integrated STEAM and integrated STEM is that one of the most powerful aspects of integration with integrated STEM is the incorporation of empathy (Bush & Cook, 2019). When teachers seek to solve problems on behalf of others or design with others in mind when implementing STEAM lessons, their sense of purpose and lesson engagement increases.

Development of STEAM Education Theory in China in Recent Years

Current Situation of STEAM Education Research in China

(1) Development and Achievements

Although STEAM education in China is a new thing, it is gradually showing a prosperous trend. At present, STEM education has entered a booming stage in China, making obvious progress in educational practice, theoretical research and educational policy.

Since 2000, Prof. Yeping Li, a professor at Texas A&M University and editor-in-chief of the International Journal of STEM Education, has been engaged in researching the concept of STEM education. Prof. Lee has studied the trajectory of STEM education over the past 19 years, using a wealth of icons, detailed data, and clear, concise diagrams to illustrate the rapid development of STEM, the national circumstances of researchers, and the changes in research topics, as well as providing a series of specific interpretations of the results of the study.

In 2008, Chen Chao et al. analyzed the "National Comprehensive Strategy" of the U.S. federal government and studied the strategic plans such as the U.S. Higher Education Action Plan and the U.S. Competitiveness Plan in the article "The Strategy of the World-Class Universities in the United States and its Implications", and recognized the importance of STEM education for building world-class universities. He recognized the importance of STEM education for the construction of world-class universities, and thus opened a precedent of theoretical research on STEM education in China.

After that, Uyunqiqi's research on STEM education in Dynamics and Trends of Scientific and Technological Talent Resource Building in the United States, Japan, the European Union, and Australia (2010) has continued to deepen, and the theoretical and practical achievements have gradually increased.

In 2015, Professor Zhongjian Zhao, Ed.D., Ph.D., Professor of the Institute of International and Comparative Education at East China Normal University, published Progress in U.S. STEM Education Policies, which mainly includes U.S. federal government policy documents and reports from several national agencies on the development of STEM education in U.S. primary and secondary schools, aiming to show the U.S. government's policies on the promotion of the development of STEM education in a holistic way. Presentations. It focuses on analyzing the STEM education policies in the United States in recent years, and plays a leading role in the development of STEM education in China.

In 2016, the "13th Five-Year Plan for Education Informatization" clearly proposed that China should vigorously develop STEM education at this stage.

In 2017, Wang Su, director of the Institute of International and Comparative Education of the Chinese Academy of Educational Sciences and director of the STEM Education Research Center of the Chinese Academy of Educational Sciences, mentioned in "Interpretation of the 2017 White Paper on STEM Education in China" that from January 2001 to May 2017, with the keyword of "STEM education", a total of 682 records were found on the Knowledge Network. A total of 682 records were found, while the author found that the number of academic journals reached 365,900, dissertations 28,500, and more than 6,000 conferences in October 2023, showing an explosive growth in research on STEM and achieving certain theoretical and practical results. The 2017 White Paper on STEM Education in China also puts forward the "China STEM Education 2029 Action Plan", which proposes that there should be a top-level design for STEM education in China, to realize the coherent cultivation of universities, middle schools, and elementary school, to establish a STEM education ecosystem by utilizing social resources, to develop a batch of STEM navigating (Myint, 2018).

In June 2018, the Second China STEM Education Development Conference once again clearly pointed out that the core of STEM education is to cultivate problem awareness and innovation spirit, and its main line is inquiry practice. Over the past few years, the community has made efforts to play a leading role in scientific research and promote the development of STEM education in Chinese primary and secondary schools by establishing STEM Education Collaborative Innovation Centers, convening STEM Education Development Conferences, and carrying out research on related topics, and has achieved certain results (Li, 2019).

In October 2019, the China STEM Education Research Report released by the STEM Education Research Center of the Chinese Academy of Educational Sciences showed that 81.79% of teachers believe that carrying out STEM education can cultivate students' spirit of innovation, 75.42% believe that STEM education can cultivate students' practical ability, and 69.52% believe that through the implementation of STEM education, the students can master scientific research methods and develop the ability to comprehensively apply knowledge. In 2020, Chinese STEM education experts conducted a series of seminars and compiled the "China STEM Education 2029 Action Plan Series", which contains both theoretical expositions and operational success stories, and serves as a powerful assistant for teachers to carry out STEM education.

In 2021, Fan Wenxiang and Zhao Ruibin, doctoral students of the School of Educational Sciences of Nanjing Normal University, and Zhang Yichun, professor of the School of Educational Sciences of Nanjing Normal University, in the article "The Development Lineage, Characteristics and Main Experiences of STEAM Education in the U.S.A.", sorted out in detail the history and characteristics of the development of STEAM education, and at the same time put forward the relevant development of STEAM education for the actual situation in China. Suggestions (Fan, 2021).

The 216th session of UNESCO's Executive Board, held in Paris, France, on May 22, 2023, announced an important resolution to establish a UNESCO category 1 institute for STEM education in Shanghai, China - the first UNESCO category 1 institute in China and the organization's first global category 1 institute outside of Europe. This is the first UNESCO category 1 institute in China and the organization's first global category 1 institute outside Europe.

The establishment of this institution demonstrates the global appreciation and gratitude for China's efforts and contributions in the field of education. It is of great significance not only to China but also to Asian countries, proving that the international community is concerned about China's development in science, education and culture, and it is also a kind of recognition of China's soft power.

(2) Problems and challenges

In 2017, a white paper on STEM education in China, published by the Chinese Academy of Educational Sciences, mentioned:

At present, China's talent structure is generally characterized by problems such as the hierarchical structure of talent training can not match the market demand, the lack of high-quality composite talents with strong comprehensive ability, and the large gap in the total number of talents. Cultivating a large number of talents with innovative thinking and strong hands-on ability to meet the needs of economic and social development is a fundamental problem that STEM education urgently needs to solve. Specifically:

Firstly, there is a lack of top-level design of national strategy of STEM education, which is of great significance for realizing the construction of an innovative country and the promotion of a strong manufacturing country in China, and STEM education should not be regarded only as a concept and method within education, but also be viewed from the perspective of fostering innovative talents for the construction of the country, and be considered in an integrated way from the perspectives of industrial development, talents' demand, and talents' training. It must be viewed from the height of cultivating innovative talents for national construction, from the perspective of industrial development, talent demand and talent cultivation, and integrate the resources of the whole society to promote the development of STEM education.

Secondly, the social linkage mechanism is not sound. STEM education is a systematic project with rich contents and wide coverage, which requires the integration of the strength of the whole society to promote it in a coordinated manner, not just the education sector. This requires the establishment of a social linkage mechanism, integrating various social resources, giving full play to their respective advantages, and forming a synergy under the same system. At present, China is basically working on its own when promoting STEM education. Although some professional organizations and school alliances have been formed, they are all loose organizations in the private sector, unable to form a joint force of the whole society, resulting in scattered strength, lack of strength, and uneven quality.

Thirdly, there is a lack of an overall design that bridges the academic segments. At present, China's STEM education has not formed a complete systematic program, and the contents and objectives of various school segments are not connected. In elementary school science education, there is STEM content, but in secondary school there is no corresponding continuation of the curriculum, which is entirely run by the school itself. Due to the different understanding of STEM, the content of STEM education is also varied, not standardized and unsystematic. There is no connection between higher education and basic education, nor between vocational education and general education. This state of fragmentation is not conducive to the systematic cultivation of talents and the creation of a superimposed effect.

Fourth, standards and evaluation mechanisms have not yet been established. STEM education in China is still in the early stage of development, and the corresponding standards are still blank. For example, what kind of courses can be introduced into schools, what kind of results these courses are expected to achieve, whether STEM education programs can achieve the expected results, and whether the STEM talents ultimately cultivated can match with the national needs, etc. All these problems need to be solved urgently, and only through the establishment of corresponding standards and evaluation mechanisms can we ensure the healthy and sustainable development of STEM education.

Fifth, the overall level of STEM teachers is not high, and the biggest bottleneck in the implementation of STEM education in schools is the problem of teachers. What is most lacking in China's STEM education is technology and engineering education, and there are no corresponding majors in the original teacher training colleges, so teachers of technology and engineering are in short supply in schools. At the elementary school level, the number of science teachers is insufficient, and the existing science teachers are not fully qualified to teach STEM education; at the secondary school level, how to carry out STEM education has not yet been solved, and even though some schools have already offered elective or compulsory courses in STEM, they are facing the problem of shortage of qualified teachers.

Sixthly, there is a lack of demonstration leadership by national-level programs. At present, the government advocates science and technology activities and programs, mainly the National Youth Innovation Competition and the National Future Engineers Expo. To a certain extent, these programs have enriched students' scientific and technological activities and played a role in advocating the concept of STEM education and promoting the practice of STEM education. However, these programs are organized by different departments and do not form a whole, especially lacking the demonstration and leadership of some national programs. These programs should not be limited to competitions, but should also include curriculum development, teacher training, and evaluation standards, so as to lead the STEM education practice to be systematized gradually.

Currently, China's STEM education has not completely imitated the practices of foreign countries, but has combined the needs of the country and the society, gathered the strength of all walks of life, and continuously explored the practical path of STEM education. Under the double background of China's demographic dividend disappearing and economic development entering the new normal, it is urgent to adjust the structure, transform and upgrade, and improve quality and efficiency.

Practice Patterns of STEAM Education in China

China has made remarkable progress in STEAM education. Many schools and educational institutions have begun to incorporate STEAM elements and have established comprehensive curricula that emphasize practical and applied teaching. Some schools have set up state-of-the-art STEAM laboratories, providing students with rich practical opportunities. In addition, China has organized various STEAM-related competitions nationwide to encourage students to participate in scientific and technological innovation and engineering design.

In addition, a number of universities and educational research institutes are working on research and training in STEAM education to enhance teachers' competence in STEAM education. Local industries and enterprises are also actively involved, cooperating with schools and providing practical opportunities to provide students with STEAM education experiences that are closer to practical applications.

In recent years, although China has made some achievements in the field of STEM education, there are still gaps that cannot be ignored in all aspects compared with developed countries. Whether it is the curriculum, or teachers, China's STEM education are just a beginning, in the Chinese Academy of Educational Sciences, Director of the Institute of International and Comparative Education, Wang Su, still "difficult", after all, STEM is currently the Ministry of Education of the informatization of the document put forward, if it can be used as a national strategy to promote the up to the possible It would be easier to promote it as a national strategy. Guangdong Provincial Institute of Education researcher Huang Zhihong believes that STEM education is not only for a certain subject or a section of the reform, but also an entry point, is likely to play a comprehensive reform of the field of education, "pull one hair and affect the whole body" role, basic education, vocational and technical education, higher education, continuing education and other fields will have a systematic impact, therefore, the need to improve the quality of education, and the need to improve the quality of education, and the need to improve the quality of education, and the need to improve the quality of education. It will have a systematic impact on basic education, vocational and technical education, higher education, continuing education and other fields.

Therefore, it is necessary to elevate the strategic position of STEM and integrate the resources of the whole society to promote the development of STEM education.

In 2017, Zheng Wei published a report on the development of STEAM education in China, in which she made a detailed analysis of three aspects, namely, system and environment, curriculum and teaching, and implementation guarantee, for the practice sample of STEAM education in China.

As the curriculum reforms carried out in China in recent years have been consistent with the concepts advocated by STEAM education in some of their concepts and practical practices, there also exist some relevant indirect policies to support them. For example, the Beijing Municipal Commission of Education's "Beijing Municipality's Curriculum Plan for Implementing the Ministry of Education's Experimental Program for Compulsory Education Curriculum (Revised)," released in July 2015, calls for the introduction of science (physics, chemistry, and biology) courses in junior high school, integrating multiple disciplines, and states in Article 2 that it is important to "pay attention to the overall nurturing function of the curriculum, as well as the linkages and integration of the subjects and between subjects, strengthen comprehensive practical activities, and promote the integration of the curriculum. In Article 2, it is especially pointed out that "attention should be paid to the overall nurturing function of the curriculum, as well as the connection and integration within and among disciplines, the development and implementation of comprehensive practical activity courses should be strengthened, and socialist core values should be vigorously cultivated and practiced. These are all in line with the concepts and characteristics of STEAM education. She also analyzed the survey data of the research sample schools, which showed that the schools have incorporated STEAM courses into the school curriculum system and curriculum settings, but because the TEAM courses appeared in the form of innovative school-based courses at the school level, and were not closely integrated with the national mandatory curriculum, the class time was relatively small, and the class time was concentrated in one to two class hours.

In terms of teaching styles, Zheng Wei analyzed the survey data and found that for project-based learning, problem-based learning and design-based learning, which are commonly used in international STEAM education, the percentage of teachers using them was low, especially the percentage of teachers using design-based learning was only 25%. It can be seen that teachers' knowledge of these teaching methods is obviously insufficient. This can also reflect the fact that there is also a lack of understanding of STEAM education itself, which does not allow for the use of teaching methods suitable for STEAM education to be implemented.

There is still a lot of ambiguous understanding of the core concepts and ways of realizing STEM in and outside of the Chinese education sector. There exists a lot of ambiguous understanding, and there are still four general problems at the practical level: first, the lack of clear educational goals and the lack of understanding of how STEAM education is closely related to the cultivation of students' future-oriented core literacy; second, the emphasis on hardware and the lack of software. Many schools are keen on purchasing equipment and building various "studios", but neglect the research and development of "curriculum" and project library, and lack of systematic teaching content and corresponding evaluation system; thirdly, lack of high-quality resources suitable for carrying out STEAM education; Fourth, there is a lack of specialized teachers. Therefore, studying the current situation of STEAM education research and the practice pattern of STEAM education in China, and organizing and analyzing the existing results can help to better grasp the whole STEM development and provide ideas for the future development of STEM education.

Integration of STEAM Education Concepts and Piano Teaching

1) The Application of STEAM Education Concepts in Piano Teaching

Educators apply the teaching method of "tailor-made teaching", which conforms to the connotation of STEAM concept, to the piano performance majors of comprehensive universities, which is not only a necessity for the teaching reform of the piano majors' curriculum but also a necessity for the cultivation of comprehensive quality talents according to the development needs of the times. It is the need to cultivate compound quality talents according to the development needs of the times. The article puts forward feasible individualized teaching strategies for piano performance majors in comprehensive universities, which will lead to the sustainable development of piano performance teaching in comprehensive universities. Chen Lu discusses the application of the STEAM concept of individualized teaching in the teaching of piano performance majors in comprehensive universities in four aspects: students, teaching materials, teachers, and class schedules. A series of application strategies are formulated: firstly, emphasize the individual differences of students and adhere to the basic concept of teaching according to students' abilities; secondly, apply diversified teaching methods to enrich the form of students' piano performance; thirdly, improve the teachers' own quality and accumulate teaching reform experience scientifically. The article also mentions that by enriching the form of piano performance, piano students not only play solo, but also create more opportunities for them to cooperate and provide occasions for cooperation, so as to cultivate students' teamwork and cooperation spirit (Zhang, 2022).

The Application Value of STEAM Education Concept in Piano Teaching

In teaching, when students apply integration in their thinking to link the arts (visual arts, drama, music, rhythm, media) with cross-disciplinary knowledge, they will think deeply about the possibilities of various ways of solving problems and strive for breakthroughs in creativity, and that the learning experience of integrating disciplines is the cornerstone of quality education, promoting criticality, and fostering creative thinking (Yang, 2003).

Piano can be taught with the help of technology, such as digital pianos and electronic pianos, to enable students to acquire basic skills more quickly and further improve their learning. Learning piano includes many engineering elements, such as tuning, repair and maintenance. The teaching process can guide students to understand and apply this knowledge and develop their engineering thinking and practical skills. Piano playing itself requires artistic innovation and expression (He, 2023). Through the STEAM education concept, students can be encouraged to find new ways of expression and creativity in music composition and performance. Music theory and rhythm mastery are closely related to mathematics, and through piano teaching, students can be helped to apply their mathematical knowledge to practice and enhance their understanding and ability in the field of mathematics. Piano teaching can be combined with other subjects, such as history (to understand the development of music) and physics (to understand the principles of sound production), to promote the integration of multi-disciplinary knowledge (Chen, 2021). In the course of piano study, students encounter various technical difficulties and difficulties in analyzing music. By solving these problems, students develop problem-solving skills and logical thinking. In ensemble or orchestra performances, students need to work closely with other members to create beautiful musical pieces. This fosters teamwork and collaboration.

Conclusion

Overall, integrating STEAM education concepts into piano teaching allows students to develop more well-rounded qualities while learning music, expands their cognitive domains, enhances creativity and problem-solving skills, and helps to cultivate talents that may be involved in technology, engineering, or other fields in the future.

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