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Construction of Curriculum System of Design Education

Under the Concept of STEAM

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Both design education and STEAM education pay attention to the cultivation of students' innovative consciousness and practical ability, and they are highly consistent in teaching objectives and educational ideas. Based on the analysis of the relevant educational practice, the current research situation and the basic concepts of design education, this paper puts forward the curriculum design principles of curriculum content and curriculum evaluation for the design education integrated with STEAM. This paper constructs the teaching link of design education under the concept of STEAM from three aspects: teachers' activities, teaching links and students' activities. finally, it discusses the new teaching methods of design education and the future development of design education.

Keywords: STEAM, design education, construction of curriculum system

Introduction

Innovation is the driving force for the sustainable development of the country. In order to cultivate innovative talents and enhance national competitiveness, National Science Board published the "Undergraduate Science, Mathematics and Engineering Education" report in 1986, which put forward the concept of STEM (Science, Technology, Engineering, Mathematics) education for the first time (National Science Board, 1986). However, researchers soon found that while paying attention to students' learning of scientific and technological knowledge, they should also establish a correct concept of scientific and technological application and humanistic literacy. Professor Georgette Yakman of Virginia Tech proposed in 2006 that Art be added to STEM, as a human factor to form STEAM education, which aims to increase students' interest in learning and encourage students to think creatively and critically through art (Yakman, 2019). At the same time, the American government, educational institutions and enterprises have injected a lot of human capital and economic support into the development of STEAM education. At present, the educational concept of STEAM has aroused widespread concern all over the world, and many educational researchers have carried out research on the localization of STEAM according to their own national conditions.

Interpretation of Art in STEAM

Many researchers believe that the integration of art into STEM education can effectively improve students' interest in learning and promote the improvement of innovative ability, criticism and imagination. However, there is no consensus on the definition of Art in STEAM. Different countries and different scholars have different understandings of Art in STEAM.

In "Using art education to build a stronger workforce", released in 2016, National Art Education Association proposed that art is divided into visual art, media art, architecture, environment and folk art. British National Science Foundation defines Art not only as art and painting, but also as humanities, history, art, design, science and technology, philosophy and social research. The "Art Curriculum Standard for Compulsory Education" issued by the Ministry of Education of the People's Republic of China in 2011 points out that art integrates dance, comedy, music and other categories, with classic, creative, comprehensive, humanistic, comprehensive and other connotations (Ministry of Education of the People's Republic of China, 2011).

The author believes that the concept of Art in STEAM should have the curriculum value of both "practical" and "aesthetic consciousness". In other words, in the process of teaching, we should practice and innovate through art to ensure the integration of interdisciplinary knowledge and enrich students' aesthetic literacy and ability on the basis of art. Finally, through "learning while doing", we can improve students' interest in learning and promote the absorption and transformation of knowledge in different disciplines. Thus it can be seen that the art discipline in STEAM education should have the following characteristics: first, the cultivation of humanistic quality. Second, the cultivation of practicality and innovation. Third, combine the knowledge of engineering, technology, science, mathematics and other disciplines.

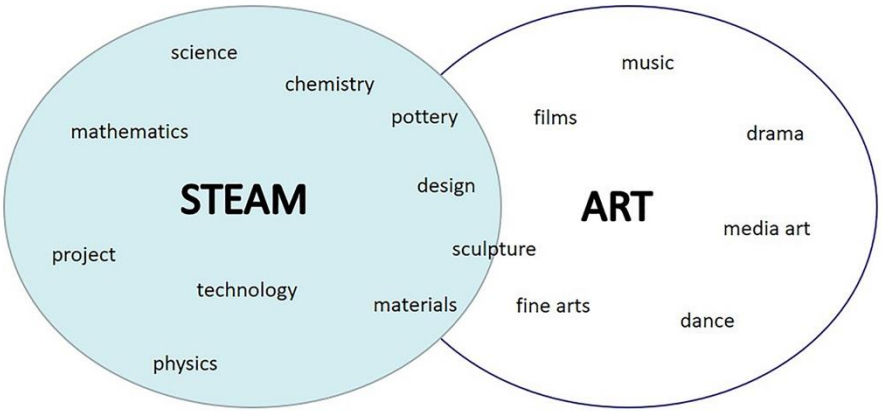

Figure 1. The relationship between STEAM Education and Art. Source: Self-made by the author

Through the above picture, we can find that although traditional arts such as poetry, opera and dance are important parts of people's all-round development, they lack the application of practical, innovative and interdisciplinary knowledge, and have a low degree of integration with the concepts emphasized by STEAM, such as project-based learning and interdisciplinary integration. On the other hand, the design majors such as industrial design, ceramic design and clothing design pay more attention to the cultivation of interdisciplinary, practical application and innovation ability. From the point of view of the combination of disciplines, design is the combination of art and technology. Technology, science and materials have a great impact on design, new materials and new technologies often profoundly change people's design and creation; at the same time, art will also have a counter-effect on science and technology. From the perspective of applied innovation, design education emphasizes innovative thinking and practical application, which is consistent with the educational goal of STEAM education to cultivate students' design thinking and innovative consciousness. To sum up, there is a close relationship between design education and STEAM education in curriculum objectives, teaching concepts, learning models, evaluation methods and so on. However, the combination of design and STEAM education is not a simple mechanical superposition, but should take design as the main line and integrate multi-disciplinary knowledge into practical activities, so as to stimulate students' thinking and application of other knowledge, and finally achieve the educational goal of cultivating students' humanistic and scientific literacy.

A Summary of the Research on the Relationship Between STEAM and Design

At present, the research on design in STEAM education is mainly focused on educational concept research, comparative research, educational resources research, curriculum design research and so on. To sum up, it mainly shows the neglect of design education, the reflection of the importance of design education and the cultivation of design thinking.

Neglect of design education

Design is often marginalized and its potential is not realized (Bell,2016). In England and Wales, design and technology are ignored in the English baccalaureate curriculum. This marginalization has led to inequalities in education, as reflected in the lack of time for the provision of design courses and the limited sources of funding for in-service training and professional development for teachers in specific disciplines. In today's educational environment, design education is an important way of cognition. Shrewd design educators should remind colleagues, school administrators, parents and other stakeholders that design education is indispensable in the practice of STEAM and the cultivation of students' all-round development.

Reflect on the importance of design

James believes that design should not be the introduction of STEAM learning, but the end point of interdisciplinary learning, so as to increase the effect of design learning (James,2012). Eisner (Eisner,2002), Hetland and his colleagues (Hetland, L., Winner, E., Veenema, S., & Sheridan, K., 2007) and other art education researchers refuse to use design as a tool to improve students' performance in other subjects. They believe that design and other disciplines can help each other, bringing creativity, beauty and appreciation, a high degree of spatial reasoning, sensory awareness and many other cultural values that are not easy to measure. Paul Thompson, dean of the Royal College of Arts, believes that Art represents design in STEAM, advocating the integration of design thinking into industry and manufacturing, as well as medical and technological research and development.

The cultivation of design thinking

The concept of design thinking can be first seen in Simon's book *The sciences of the artificial* published in 1969. Simon described that an important difference between artificial science and natural science is that artificial science is inseparable from human design and human thinking. In 2019, David Kelly founded the Stanford School of Design and formally introduced the course of design thinking into the field of education (Wang, youmei., Guo, jing., Wan, ping., 2019). Balkad pointed out that design thinking helps to cultivate students' metacognitive skills and improve their STEAM literacy (Balkad,2011). Design thinking can help teachers define their roles, guide teachers to better design and carry out STEAM teaching activities, help teachers better understand the nature of STEM innovative teaching, and pay attention to improving the connotation of students' innovative thinking.

To sum up, since the concept of STEAM education was put forward, there has been an upsurge of research on STEAM education all over the world. Britain, Australia, China, Japan and other countries have combined the concept of STEAM with the actual situation of their own countries, and promulgated a series of education policies. In addition, academia has also done a lot of research on the relationship between design and STEAM education, including educational concepts, educational resources, teacher-student relationship and so on, providing a lot of theoretical support for future research.

Research Content and Innovation

Design is closely related to human life, and design education is an effective way to cultivate people's innovative literacy. Design education can bring students rich interdisciplinary knowledge, which is very similar to STEAM education, which integrates nature, technology, science and other disciplines. At the same time, both of them have the teaching goal of cultivating people's innovative thinking and practical ability. Therefore, the author puts forward that the discipline of design is more in line with the concept of Art in STEAM. In recent years, some scholars around the world have studied the relationship between design and STEAM education, but there are relatively few studies on the integration of design education and STEAM education and curriculum design of design education. Therefore, this paper focuses on the construction of the curriculum system of design education under the concept of STEAM, and analyzes the curriculum objectives, teaching methods, learning content, teaching evaluation and other contents of the new design education.

The Present Situation of Relevant Educational Practice

This chapter mainly through the analysis of the integration of art and design of STEAM education practice, for the further construction of design education curriculum system based on the concept of STEAM to get some enlightenment.

STEAM Educational Practice of Integrated Design

Explorations in art

Explorations in Art is a primary school art education textbook published by Davis Publishing Company. Its purpose is to provide STEAM with a humanistic background and to cultivate students' interest in art and STEAM knowledge. At present, *Explorations in Art* has been used in 36 states in the United States, and it is one of the mainstream STEAM textbooks in the United States. The content of the textbook covers six grades of primary school, each grade includes six units, and each unit contains an integrated STEAM curriculum. Students can explore the importance of science, technology, engineering and mathematics in creating design works. Students are encouraged to cross discipline boundaries, view the world creatively in a new and open way, and improve their ability to solve practical problems from the perspective of comprehensive application. This teaching concept is mainly reflected in the following aspects: first, STEAM teaching based on design.

Second, STEAM courses around big concepts. Third, studio-based STEAM learning.
In addition, *Explorations in Art* takes design and art as the main course content, which provides teachers and students with thousands of works of art resources in recent years, enriches students' horizons, and integrates multi-disciplinary knowledge into the curriculum, so that students are good at thinking. It is a classic work of the integration of art and STEAM education.

Educational practice in schools

Every school offering STEAM education in the United States will integrate its own development history, characteristics and advantages to set curriculum goals. Although the form is slightly different, most of them emphasize students' participation and creativity, and exercise students' problem-solving ability and design thinking. For example, Drew Charter School in Atlanta focuses on the development of individual students. The educational goal of the school is to enable students to develop independent thinking and habits of observation, reflection, exploration, expression, production, understanding and participation.
Drew Charter School roots STEAM education in students' daily study and strives to fully integrate STEAM topics into core courses and elective courses. In this regard, the school employs professional STEAM teachers to improve materials, technology and equipment, and to provide students with STEAM course learning toolboxes and professional classroom space. Each learning space has tools and materials needed for product design, 3D printing and handicraft production, which are stored in red, black, blue and green toolboxes, which are beautiful and efficient, easy for students to find materials and develop the habit of timely collation and induction.
In addition, Drew Charter School has also carried out a series of STEAM educational activities such as STEAM Day, which enable students to understand and apply interdisciplinary knowledge and enhance their teamwork ability through interesting interactive activities, experiments, performances and games. Generally speaking, the STEAM classroom created by, Drew Charter School provides a good environment for students' hands-on production and practical production, and better arouses students' enthusiasm and creativity.

Educational practice outside the school

Out-of-school educational institutions play an important role in STEAM education practice and constitute an important part of STEAM education system. The analysis of out-of-school education practice in this section includes three aspects: PLTW (Project Lead to the Way), Change the Equation and STEAM laboratory.
1. "Project Lead to the Way"
PLTW is a major provider of STEAM courses in primary, junior high and high schools (Zhong bochang, Zhang lu, 2015) and the largest non-profit STEAM educational institution in the United States. The courses offered by PLTW are innovative and rigorous as a whole, which can not only cultivate students' enthusiasm for learning, but also improve their innovative ability, critical thinking ability and problem-solving ability to a certain extent. At present, more than 4000 schools in the United States offer PLTW courses, and more than 10000 teachers have participated in the advanced training of PLTW. PLTW has established partnerships with more than 100 well-known schools, large charities and leading companies, which have provided huge financial support for the development of PLTW, providing students with state-of-the-art STEAM educational technology, materials and facilities. Recruit teachers and managers with experience in the STEAM field to ensure that STEAM courses and teaching always maintain scientific contact with the real world, and prepare students for further study or employment in STEAM-related fields.

"Change the Equation"

A public welfare organization called "Change the Equation" has been jointly established by some American enterprises CEO, which aims to improve the quality of STEAM education, encourage educational reform and encourage young people to learn STEAM knowledge through the business community, and finally achieve the goal of promoting STEAM education in an all-round way. In order to facilitate the promotion of excellent STEAM education cases, "Change the Equation" has created a STEAM lesson database, where STEAM project developers can compare the relationship between existing projects and the projects they are studying in real time, prevent repetitive curriculum design, and maximize project investment benefits. At the same time, due to the continuous updating and improvement of the contents in the database, STEAM educators can find suitable and high-quality STEAM teaching projects for students in the database. At the same time, "Change the Equation" management members have pledged to invest more than US $600 million annually in supporting STEAM education and to provide a large number of STEAM training and learning opportunities, so that students in all states can enjoy the benefits of STEAM education.

STEAM Laboratory

STEAM labs in the United States have mature experience in the cohesion and application of social forces, the construction and updating of equipment resources, project staffing and training. According to the concept of STEAM, STEAM labs design learning situations based on projects, activities and problems, allowing students to carry out product research, design and development in the course of practical operation, and constantly improve students' STEAM literacy and ability to solve complex problems. According to different nature and different service groups such as students, teachers, families and the public, relatively clear educational goals are set, different project innovation practices are designed, and rich and colorful activities are organized. Labs allow students, teachers and parents to work together to imitate scientists, engineers or artists to design robots, create circuits and make handicrafts, and even explore problems with scientists, engineers and artists. American STEAM laboratory has become an important place for students to innovate, teachers to improve teaching skills, families to integrate into students' learning, and the public to improve their appreciation ability. The representative STEAM laboratories in the United States include the STEAM Laboratory of the Boston Institute of Art and the STEAM Laboratory of the Children's Museum in Manhattan.

STEAM education in the United States can be fully developed, on the one hand, because the US government has formulated a series of policies and regulations, on the other hand, many social institutions and enterprises are constantly engaged in STEAM education promotion activities, regard the promotion of STEAM education as their duty, and put a lot of manpower and material resources into STEAM education, such as, Gates Foundation to help students prepare for employment or further study. A total of $1.1 million in STEAM education funding was provided between 2010 and 2012. American Telephone and Telegraph Company has provided about 250 million US dollars for STEAM education, etc.

Enlightenment from Related Practice

Cultivate innovative talents

STEAM education advocates learning in practice, cultivating students' practical ability, cultivating students' core accomplishment, critical thinking, innovative ability and problem-solving ability. For design education, the teaching goal is not only to impart subject knowledge, but also to let students know how to use design in life, through design to make the current life and work more scientific.

Solve practical problems

The implementation of STEAM education focuses on students' solving practical problems in real life. Similarly, the design education integrated with the concept of STEAM needs to stimulate students' initiative and stimulate their enthusiasm and self-confidence in solving problems. Teachers should guide and encourage students to dare to face practical problems, be good at using interdisciplinary knowledge, solve their own problems through group cooperation, and cultivate students who are unique and innovative in the society.

Strengthen the construction of the contingent of teachers

Teachers are the key to the implementation of educational activities, and the training of design teachers should be strengthened through various channels. For example: encourage students who graduate from related fields to enter teaching posts; strengthen in-service teacher training to promote the deepening of design education in practice; support social education institutions to train design teachers.

Improve the compilation of relevant teaching materials

Professional teaching materials play a guiding role in curriculum teaching, which is basically accompanied by teachers' preparation and teaching, students' learning, practice and other stages. therefore, complete professional teaching materials is a key step in the development of innovative design education. Innovative design education teaching materials should incorporate multi-disciplinary knowledge into the curriculum content, cooperate with a variety of art, design works and cases, fully mobilize students' learning enthusiasm, and make students in design teaching activities. Enhance the thinking and application of multi-disciplinary knowledge.

Strengthen the cooperation between schools and enterprises

In today's society, the creativity and activity of enterprises are even greater than the research within the school. As mentioned earlier, PLTW and other out-of-school STEAM educational institutions provide advanced lessons for the development of STEAM education and apply them to the school STEAM classroom. Innovative design education should pay attention to strengthening the relationship between schools and enterprises, train more enterprises, institutions and companies that research and develop design education lessons, and

constantly inject vitality into the development of innovative design education in schools.

STEAM and the Basic Idea of Design Education

This chapter mainly discusses the basic concepts of STEAM education and design education, which lays the foundation for putting forward the curriculum system of design education based on STEAM concept.

Basic concept of STEAM education

STEAM education aims at students' current learning and future work needs, integrates multi-disciplinary knowledge, and enables students to complete project practice or solve problems encountered in life through teamwork. The main teaching goal is to cultivate students' problem-solving ability and innovative ability.

Project-based learning

Project-based learning is a process of carefully designing, exploring and implementing project tasks in order to solve real and responsible problems. Students can imagine, verify, improve, create, and enhance the level of innovation and practice. The content of STEAM education is often based on specific project scenarios and is closely related to people's daily life. Students use their knowledge in science, technology, mathematics and art to creatively solve meaningful problems in the real world. It is helpful for students to explore the objective external world and cultivate a sense of responsibility and team spirit.

Instructional design

Instructional design refers to the work plan of educational and teaching activities in the future. In order to better apply teaching theory to teaching practice, it is often necessary to follow certain principles of teaching design in order to achieve good teaching results. In instructional design, STEAM education usually follows the following principles: 1. Principle based on real situation 2. Principle of subjectivity 3. Comprehensive principle 4. The principle of practicality. Principle of self-participation 6. Pay attention to the principle of process 7. Interdisciplinary principle.

In addition, STEAM education focuses on self-evaluation, classmate evaluation and teacher evaluation of the learning process and creative results according to students' performance in design activities. In terms of learning evaluation criteria, a wealth of evaluation methods are used to comprehensively evaluate the learning process of learners, such as the degree of understanding of knowledge, the degree of investment in activities, the effect of cooperation and the display of innovative consciousness, innovative thinking and creative products.

Basic Concept of Design Education

Curriculum objectives

The general goal of design education is to enable students to participate in design activities individually or collectively, stimulate their creativity, understand the design process and its expression, use various tools and media to express feelings and ideas, and beautify the environment and life. Use the methods of appreciation and criticism to improve the aesthetic ability and understand the unique role of design in cultural life and social development. Through observation, experience, conception, description, shaping, design, production and other teaching activities, we can guide students to pay attention to the natural environment and social life, and cultivate students' emotional attitudes and habits of being close to nature, integrating into society and caring for life. Gradually form their environmental awareness, social awareness and life awareness, so that students acquire a lasting interest in art learning, the formation of basic artistic literacy.

Instructional design

Design education emphasizes adhering to the teaching concept of facing all students, actively exploring effective teaching methods, creating a learning atmosphere conducive to stimulating the spirit of innovation, and guiding students to pay attention to the natural environment and social life. Explore lively and interesting teaching methods suitable for students' physical and mental development, cultivate students' healthy and optimistic attitude and persistent learning spirit, and pay attention to each student's performance and development in learning. Create a relaxed learning atmosphere, create problem situations, guide students to think independently, find problems, form creativity, and use design language and multi-media to creatively express and solve problems.

However, at present, the curriculum logic of design education mainly takes art and design as the learning object, and the teaching of knowledge of other disciplines is often ignored in the course content, which affects the cultivation of students' practical application ability and hinders the all-round development of students. At

the same time, the teaching evaluation content and evaluation subject of design education are not comprehensive enough. Compared with STEAM education, process evaluation and multiple evaluation subjects are neglected, resulting in incomplete and objective evaluation results. These are all problems that need to be considered urgently in design education which integrates the concept of STEAM.

Construction of Design Education Curriculum System Based on STEAM

In recent years, studies in the field of brain cognition have shown that design plays an active role in science and mathematics learning. Integrating design into the field of interdisciplinary knowledge not only enables students to explore a single knowledge, but also combines all different learning styles to form more neural pathways (Michelle,2013). In order to better realize the localization of STEAM education, there is an urgent need to strengthen the relationship between design and engineering, science and technology, and to find a design education and teaching model that integrates the concept of STEAM.

Principles of Curriculum Design

Principle of integrity and systematicness

Discipline integration curriculum not only includes interdisciplinary knowledge, but also pays attention to establishing the relationship between knowledge points of different disciplines and blurring the boundaries of disciplines. Design education teachers should pay attention to the teaching progress of other disciplines involved in the curriculum, and recognize which knowledge can be reflected in the curriculum, so as to better achieve the effect of curriculum integration and students' learning, reflection and consolidation of other disciplines. At the same time, other disciplines should also consider what knowledge can improve the cultivation of students' design, aesthetic and other humanistic qualities, so as to form a joint force between design and interdisciplinary, so as to better realize the integration of knowledge and the systematic development of courses. If we cannot clearly recognize the teaching progress of multi-disciplinary knowledge, it is easy to cause teachers of different disciplines to omit or repeat the knowledge of other disciplines in the classroom, which will adversely affect students' learning and waste valuable classroom time. Therefore, in the process of curriculum design, teachers of different disciplines should maintain active communication and have clear control over students' learning progress and teaching difficulties. Only in this way can we minimize the repeated narration of interdisciplinary knowledge in science, technology, engineering, programming and other interdisciplinary fields, and achieve the effect of reasonably replenishing the background of interdisciplinary knowledge.

In addition, different age groups have different educational goals and curriculum design standards, but there is always an inherent logical relationship between them, such as curriculum content from easy to difficult, from simple to rich. The curriculum design of the new design education should have its inherent logic, the curriculum design of the lower grade should conform to the characteristics of the physical and mental development of the lower grade students, and the curriculum design of the higher grade should be based on what the lower grade has learned. it is a follow-up and in-depth supplement to the content of the lower grade, and a review of what has been learned in the past.

Project-based learning principle

The support of STEAM project teaching to independent development is to cultivate students' awareness of active learning in practice. In the process of research-based learning, students adopt reasonable procedures and methods to complete the design work according to the design propositions of the group, and the team members work together to solve problems and gain new experience in the process of questioning, planning, experiment, production, improvement and so on. Teachers guide students to reflect on curriculum experience and transform new growth experience into new knowledge and skills. In addition, to carry out the project, we should pay attention to the authenticity of the design project and design real customers. The dimension of the problem includes not only scientific and technological requirements, but also economic, environmental and social constraints. Students can develop a variety of solutions. This design practice pays attention to the needs of users and customers, uses technical and experimental evidence to make reasonable decisions, and considers technical, social and economic constraints and impacts. Solving problems is more complex and challenging.

Principles of practical application

The new design education needs to pay attention to the cultivation of students' practical ability and design thinking. In the process of curriculum design, teachers should adhere to the principle of combining hands-on operation with thinking development. Students are encouraged to initially master the basic skills of design and

production through hands-on practice, and to design and create creative works. Students can use general and simple information technology to solve practical problems and serve their study and life. Teachers should encourage students to use interdisciplinary knowledge to analyze and solve problems encountered in activities. In the process of activities, teachers should encourage students to use their hands and brains at the same time, guide them to apply what they have learned, analyze, think about and solve practical problems.

Learner-centered principle

The learner-centered classroom model mostly adopts the way of student-led projects. Teachers fully consider the differences of learners and formulate teaching strategies according to different background knowledge, interest preferences, acceptance and thinking habits. I hope that every student can give full play to his or her potential and encourage children to give full play to their imagination and try new ideas. Teaching methods are designed according to different students' learning styles. Students experience the fun of self-discovery and the sense of achievement in solving problems in learning activities, from which they can learn interdisciplinary knowledge.

Content of Courses

The choice of learning topics

Design education should take practical problems as the curriculum center, establish curriculum objectives, learning content, evaluation and feedback, and the determination of curriculum theme needs to consider the scientificalness and value of curriculum theme. Teachers need to do preliminary research and analysis, understand local educational resources, and analyze the characteristics of learners, such as students' existing knowledge and experience, knowledge of other subjects in the curriculum, and so on. The course theme of appropriate difficulty is determined according to the students' physical and mental development, learning ability, interest characteristics and so on.

Organization of course content

In order to guide the students to adapt to the society, it is suggested to choose the educational content and guide the students to adapt to the society from the perspective of students' growth process, living environment and society. Mobilize the students' existing experience, establish a connection with the curriculum content, through the process of experiencing curriculum activities, transform curriculum knowledge into life knowledge, and solve practical problems.

Curriculum Evaluation

Curriculum evaluation is an important index to test students' learning effect. In the traditional classroom, teachers often use a single teaching evaluation method and standard to evaluate students' learning effect, ignoring learners' learning process and individual differences, and limiting the objectivity of the evaluation results. The new curriculum evaluation of design education is based on the objective facts of students' learning, and pays attention to the coordination and unity of evaluation and teaching, especially to strengthen formative evaluation and summative evaluation. We should not only pay attention to students' mastery of design knowledge and skills, but also pay attention to the evaluation of learning ability, learning attitude, emotion and values. Students are encouraged to evaluate their learning progress and assignments by means of self-evaluation, mutual evaluation and teacher evaluation. The result of the evaluation can be a score, rating, or comment, or a combination of comments and ratings. The evaluation of students' homework is not only a full affirmation of students' progress and development, but also a clear direction for students' further development.

Teaching Process

This paper constructs the design education and teaching link under the concept of STEAM from three aspects: teachers' activities, teaching links and student activities, which is divided into seven stages: curriculum introduction, task analysis, student grouping, activity exploration, work display, teaching evaluation and curriculum development.

First, the stage of curriculum introduction. The teacher analyzes the curriculum objectives and the main points of knowledge learning to make the students clear about the curriculum objectives and design requirements.

Second, the stage of task analysis. Teachers are responsible for decomposing curriculum tasks, intuitive demonstration teaching, so that students have a preliminary understanding of the steps of design activities, clear curriculum tasks.

Third, the student grouping stage. Teachers create project situations to help students complete the grouping,

and group members communicate and discuss with each other and undertake the corresponding division of labor.
Fourth, the activity exploration stage. The teacher appropriately guides the students to complete the conception of the design plan and the creation of the design works in the group communication.
Fifth, the work display stage. After completing the production of the design works, the group selected commentators to display the works, and the rest of the students visited to evaluate the design works and the effect of the explanation.
Sixth, the stage of teaching evaluation. Through the combination of individual evaluation, group evaluation, group evaluation and teacher evaluation, the evaluation content is not only limited to the final design works, but also includes students' learning status, learning process and so on.
Seventh, the stage of curriculum development. Teachers lead students to summarize what they have learned, and put forward more expansive thinking in life, science and other aspects, so as to cultivate students' ability to combine theory with practice and think actively about problems.

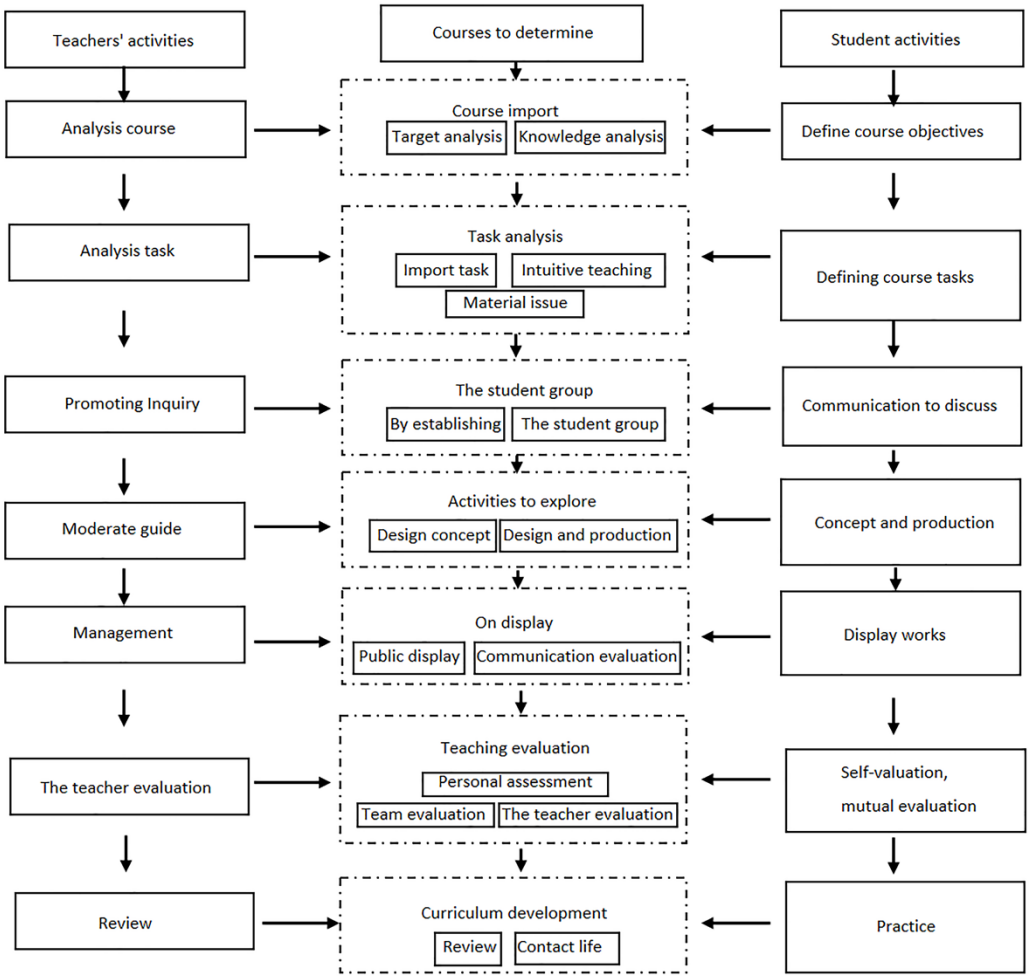

Figure 2. The Teaching process of Design Education based on the concept of STEAM. Source: Self-made by the author

To sum up, design activities and project situations are used to enhance the interest of the classroom. In the exchange and discussion, activity exploration and other links to gradually improve students' innovation and practical ability. Through the display of works and teaching evaluation, we can cultivate students' expression and aesthetic ability. Through teaching evaluation, teachers can optimize the future teaching links and teaching contents, so as to enable students to form a comprehensive understanding of themselves. finally, improve students' ability to use interdisciplinary knowledge, understand design, think about practical problems and so on.

Discussion

The design education under the concept of STEAM is different from the traditional art education. The most

important feature of design education based on STEAM concept is the change of learning style. The learning content is connected with the project-based situation, which connects the learning of knowledge with daily practice, and transforms knowledge into learners' inner feelings and into a real understanding of the external world. Design education based on the concept of STEAM provides students with a variety of opportunities suitable for autonomous learning, allowing students to learn autonomous learning and change passive acceptance into active thinking. Fully stimulate students' curiosity and motivation for subject knowledge and develop the habit of lifelong learning. Teachers not only pay attention to students' learning results, but also pay attention to the long-term impact of the learning process and curriculum on students' development.

The new design education attaches importance to the connection and connection between disciplines, helps students to understand a discipline from multiple angles, encourages students' ability to identify, analyze, synthesize and integrate knowledge, transcends discipline boundaries and stimulates creativity. The new teaching ideas it provides can promote the healthy development of students' critical thinking, decision-making ability and values, and promote opportunities for cooperation among students to improve the effectiveness of students' understanding of knowledge.

The research on design education not only carries the thinking of current educational problems, but also lies in the groundwork and construction of design education in the future. The author believes that the future design education should be closely related to real life. Design will show a trend of diversification and extensiveness in people's daily life, and the public will have a clearer understanding of design education. The design will also continuously improve the aesthetic ability of the public in the way of "home-school cooperation".

References

Bell, D. (2016). The reality of STEM education, design and technology teachers' perceptions: A phenomenon graphic study. International Journal of Technology and Design Education, 26(1), 61–79. doi:10.1007/s10798-015-9300-9.

Balkad. (2011). Standards of mathematical practice and STEM. Math-science connector newsletter.

Eisner Elliot. (2002). The Arts and the Creation of Mind. Yale University Press.

Hetland, L., Winner, E. Veenema, S., & Sheridan, K. (2007). Studio thinking: The real benefits of visual arts education. New York: Teachers College Press.

James W. Bequette & Marjorie Bullitt Bequette. (2012). A Place for Art and Design Education in the STEM Conversation. Art Education (2). doi:10.1080/00043125.2012.11519167.

James Haywood Rolling. (2016).Reinventing the STEAM Engine for Art + Design Education. Art Education(4),. doi:10.1080/00043125.2016.1176848.

Li Wangwei & Xu Xiaodong. (2018). The Art of Integration and the cultivation of Innovation in STEM practice--Enlightenment from eight STEAM Education cases in the United States. Foreign primary and secondary education, (12),9-17. doi:CNKI:SUN:WGZX.0.2018-12-002.

Michelle H. Land.(2013).Full STEAM Ahead: The Benefits of Integrating the Arts Into STEM. Procedia Computer Science. doi:10.1016/j.procs.2013.09.317.

Ministry of Education of the People's Republic of China. (18 Dec 2011). Art curriculum standard of compulsory education. http://www.moe.gov.cn/srcsite/A26/s8001/201112/t20111228_167340.html

National Science Board. (1986). Undergraduate Science, Mathematics and Engineering Education. [EB/OL] Retrieved from https://arteducatorsprod.s3.amazonaws.com/documents/535/ff8bfae5-6b4f-4352b900-4fc1182ad2b1.pdf?1455134278

The Congressional STEAM Caucus. (7 February 2013). Americans for the Arts Action Fund. Retrieved from www.artsactionfund.org/news/entry/ the-congressional-steam-caucus

Wang Youmei, Guo Jing, Wan ping & Zhao Wenzhu. (2019). Design thinking: promoting the Deep Integration of STEM Education and Creator Education. Research on audio-visual education, (03),34-41. doi:10.13811/j.cnki.eer.2019.03.005.

Yakman G. (9 Mar 2019). STE@M Education: An Overview of Creating a Model of Integrative Education[EB/OL]. Retrieved from http://steamedu.com/wp-content/uploads/2014/12/2008-PATT-Publication-STEAM.pdf.

Zhong Bochang & Zhang Lu. (2015). The emergence and Development of Project Guide (PLTW) Organization and its Enlightenment to China. Educational scientific research, (05),63-69. doi: CNKI:SUN:JYKY.0.2015-05-015.

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