

ABSTRACT

Research Summary

The purpose of this study is to foster students in Science High School and Gifted School by guiding direction to the STEAM educational development. To this end, the concept and the school system, training curriculum for implementation and development on STEAM education, teacher empowerment, administrative and financial support, physical facilities support, and specific methods regarding legal and institutional issues were researched to come up with suitable STEAM educational development for students in Science High Schools and Gifted School.

In order to carry out the research, analysis on previous studies, surveys and in-depth interviews, workshops with teachers at Gifted Schools were performed and based on these research results we came up with the suitable method for STEAM educational development in Science High Schools and Gifted School.

□ Theoretical background

The followings are the theoretical analysis on the previous studies to explore the appropriate characteristics of STEAM education targeting specialized students with talent in Science High Schools and Gifted School.

First, based on the reviews on science talents and the science and technology talent, the recent studies show ‘creativity’ is arising as an important factor and among people who has made many creative achievements possessed multiple ability (polymathy) which strongly defends the logic that ability in various fields promotes creative thinking. Especially the changes in today’s society to the creative based, requires fostering international creative science and

technology talents and such core competencies, ‘professionalism’, ‘thinking’, ‘ethics’, and ‘communication’ are required.

Second, the results on students’ characteristics of Gifted High School show that Science High School and Gifted School students have high ability in logical mathematical intelligence, understanding of personal intelligence, interpersonal intelligence and low in natural intelligence and also have high internal motivation and have strong creative ability to solve problems. There were almost no findings on other affective characteristics nor on their learning styles that the further research is needed to be carried out.

Third, the international trends and the related cases on STEAM education analysis show that the U.S. and the U.K. is implementing STEAM education to inflow outstanding talent and control the escape to improve national competitiveness in science and technology. It may seem different looking at the operation of STEAM education in Korea, however looking at the aspects that these countries have abundant base on humanities and arts education, the ultimate STEAM education contained similar education and training contents. In addition, analysis on STEAM related educational cases in the United States, Israel and Singapore did not explicitly advocate, however looking at the point of educational content aspect that combines science, technology, engineering, humanities, arts, and mathematics show that it has been operated through organically combined programs and educational curriculum.

Through the analysis of the these previous studies, this paper is to clarify the purpose of STEAM education on ‘Creative Science and Technology Human Resource Development’ for the students in Science High school and Gifted School, to be able to come up with the core competency where the term A is added on STEM in Korea which not only in the content itself but also through the amicable emphasis which should be put into, in order to pursue the need through variety range of resource supports.

□ The analysis of STEAM educational conditions in Science High School and Gifted School

In order to analyze the educational conditions in Science High Schools and Gifted Schools the survey and in-depth interviews were carried out.

The main results from the surveys and in-depth discussion are as follows.

First, the survey to find the appropriate characteristics of the STEAM education toward students in Science High schools and Gifted School, the research show that students in Science High school and Gifted School preferred subjects in the order of science, math, physical education, music, fine arts and liked to study alone, whereas for the tasks that requires creative ability development, students stated that they liked exchanging ideas among others through team-based projects and preferred the kind of research style. The students' awareness on STEAM education was quite low of 10%, however both students and teachers raised the need awareness on STEAM education (about 60%) and showed their participation interests as high as about 60% which means they have a positive view on the training implementation.

Second, the result on the survey about the state of educational conditions who that these schools established and operated basic courses and advanced curriculum for science field development and put effort to enable the operation of research activities and specialized activities. In most of the Gifted School the convergence related curriculum was provided, however the Science High school did not have these subjects and both types of schools were student-centered and there was the autonomous activity called R & E. In teachers' aspects, more than 80% of teachers responded they have difficulties and are burdened by the development of courses and operating of STEAM education curriculum and also the problems lies in the lack of knowledge and understanding in other field of studies. In terms of learning environment, it turned out that the need to secure

space and variety of physical facilities and financial support was mentioned.

Third, the survey result on the opinions about STEAM education promotion and operation plan, the students wanted the STEAM education in the regular education courses where they can choose the subjects and also teachers wanted to organize the STEAM content and operate flexibly with the existing courses. The method to strengthen the teachers' competencies, students mentioned the importance of teachers' qualification and abilities who can respect and assist them as a supporter, and teachers responded the need for continuous research and development supports. In regards of administrative and financial support, there were comments on urgent supports on environmental and municipal parts and other model operation and preparation on legal grounds.

The workshops on STEAM education targeting teacher educating the talented students was conducted twice and the results are as follows.

First, the first workshop was conducted in order to increase the understanding of basic knowledge of STEAM education and made teams to plan STEAM educational programs. Through the workshop, the result show that teachers were confused because of the absence of exact concept of STEAM causing conflicts among teachers where they could not come to a smooth cooperation.

Second, the second workshop was planned to focus specifically on the actual STEAM educational development. Teachers developed the curriculum by integrating art field focusing in math and science area and with the help of experts they were able to come up with the understanding of the aim and content of STEAM education, as a result modifying and supplementing the lesson plan, therefore enabling to develop teachers' abilities as the STEAM educators.

The study and analysis on STEAM education condition based on the above survey, in-depth interviews and workshops at the Science High school and Gifted School, these materials are important data to meet the ultimate goal on

STEAM education in order to develop specific plans and measures. The opinions on the characteristics of students from Science High School and Gifted School, the awareness of STEAM by the teachers and the expectations on supports and planning from the related agencies are to make STEAM education development to toward to more suitable real-world plan.

□ **The Direction and Reconceptualization of STEAM Education.**

Based on the previous studies on the direction of science education in the major foreign countries, these countries performed STEAM education in order to foster creative science and technology talent and the STEAM education aspects were quite similar to Korea. Moreover, surveys show that teachers, students and school vice-commissioner believe that the STEAM education allows the in-depth understanding and insight in science through the combination thinking. However, the effort to find out the possibility of the real-world implementation through the workshops, participants were confused between the two terms STEAM and STEM, and were not able to understand the concepts where every individual had their own definitions and opinions on the direction of the education making it difficult to implement in the real-world operation and development in the future. Therefore, this paper is to define the STEAM education concept and show the direction of the education as a result providing and establishing the basis on STEAM education to Science High school and Gifted School.

1. Establishing the concept of the STEAM education

In this study, STEAM education is defined as follows.

STEAM education is the combination of science, technology, engineering, humanities arts, and mathematics to enhance professional knowledge and versatility to promote creativity and expand convergence thinking and attitudes.

One of the elements ‘Arts’ of STEAM education includes not only general art (fine arts, music, etc.) but also liberal arts. This is the essential elements for scientific achievements in liberal arts which supplement thinking method in science, mathematics, engineering and technology that promotes reflective thinking and aesthetic thinking which makes creative thinking and insight possible.

2. The Direction of STEAM education

The summary of the direction of STEAM education are as follows.

- The aspect of students’ creative ability in science and technology: The goal of STEAM education is to foster creative science and technology talent by developing necessary competencies such as professional, creative thinking, ethical awareness, communication power through establishment of educational association.
- The aspects in teaching and learning methods: STEAM education should consider the characteristics of learners and draw the cooperation between educators and learners where educators should interact openly and freely.
- The aspects of education-based establishment: STEAM education should acquire appropriate facilities and equipment needed to operate and such institutional and administrative support must be equipped to work well in cooperation with external resources.
- The aspect of content-based linkage: In the linkage style the STEAM education of each curriculum (area), integration of content-based, application of integration and creativity-centered of the integration in various ways should be appropriately used.

□ STEAM Education Development Plan in the Science High School and Gifted School.

Based on the concept and direction of STEAM curriculum made for the Science High Schools and Gifted School were presented in terms of maintaining the five key points: organizing and operating the curriculum development plan; building

teachers' competencies; drawing administrative and financial support; supporting facilities and equipment; and organizing related regulations and the below shows the core elements for each points.

1. Organization and operation of STEAM curriculum

STEAM curriculum, in conjunction with R & E, should consist of several steps where the final stage should have two separate advanced courses of R&E and STEAM, depending on students' choice. R&E and STEAM activity consist of three steps and the features are as follows.

- **Step 1** :The 4 credit prerequisite course which all students should enroll that includes basic research methods and experimental survey studies necessary for both R&E and STEAM activities.
- **Step 2**: The elective course related to R&E and STEAM activities where students can select the STEAM research activities which refine the research activities and develop communication and collaboration technologies.
- **3 Steps**: Similar to Step 2, students may choose and participate in STEAM activities where they involve in the overall process and individually build leadership and independence to foster responsibility and ability to complete the STEAM project.

2. Empowering teachers for STEAM education development

This study suggests the type of teachers needed to operate STEAM education at the Science High School and Gifted school.

- **Type of teachers**: STEAM coordinator, STEAM mentor, team assistants, teachers and external experts in various fields.
- **Ways to strengthen teachers' competency**:
 - Teachers should know their roles and appropriate training opportunities should be provided.
 - Strengthen the on-site support through teacher association committee.
 - Provide opportunities to present excellent training program on STEAM education development.

3. Establishment on administrative and financial support in STEAM system

To present the administrative and financial support methods to promote STEAM education are categorized by the levels as follows.

- **The national level: The establishment of 「STEAM National Center」**
 - In charge of the role as a library, the role of STEAM community among education officials, the role of human resources poll.
- **The local level: Establishment of 「STEAM Resource Center」**
 - Build and operate resource center for personnel, facilities and materials support on STEAM educational development in Science High School and Gifted School at four Universities of Science and Technology.
- **The school level: 「Organizing STEAM Education Support and STEAM Training Operating Committee」**
 - Support more efficient operation of STEAM education in schools.

4. Facilities and equipment support in STEAM education activation

Measures for facilities and equipment support are as follows.

- **Operate 「STEAM Lab」:** Provide various options to foster students' creative inventions.
- **Utilize external resources:** Utilize local universities and research Institutes of Science and Technology

5. Regulations for real-world implantation of STEAM education

The legal (regulation) support measures are as follows.

- **Operation of class hours and relevant provisions on STEAM education courses:** Utilization of R & E operation optionally.
- **Formal management of course record on STEAM education courses:** With the conjunction with NEIS.

6. Suggestions for the future

With this, in addition to the STEAM education development planning in Science High School and Gifted School below are the future challenges for more progressive STEAM education promotion.

- **Secure funding for STEAM education**
- **Build cooperative relationship with the government for STEAM education development**
- **Increase social awareness on STEAM education**
- **Research on circular systematic on the effectiveness STEAM education**

Keywords: Creative Science and Technology Human Resource, STEAM Education