International Journal of Advanced Culture Technology Vol.6 No.3 1-11 (2018)
DOI https://doi.org /10.17703/IJACT2018.6.3.1

IJACT 18-9-1

Development and Effect of H-STEAM centering on Secondary Education of Korea

Yunkyung CHO

French Department , Ewha Womans University, Korea
lunecho@ewha.ac.kr

Abstract

The purpose of this study is to develop and analyze the meaning and contents of the "H-STEAM teaching & learning model" which combines Science, Technology, Engineering, Arts & Mathematics (STEAM) with the elements of Humanities. We developed this model based on the key competencies linked with career path for middle school students in Korea, with the recognition of two issues. First, the existing Korean STEAM education lacks the elements of humanities, thus failing to achieve an authentic convergence education. Second, it is necessary to develop a program that might correspond to the Free Semester Program that was first introduced in 2013, and implemented at full scale in 2016 for middle school students in Korea.

The advantages of H-STEAM are as follows: First, H-STEAM enables students to flexibly think while traversing the physical world and the symbolic world in the process of dealing with the daily problems. Second, it combines advanced technology with human sensibility and imagination, and enables students to derive creative outcomes that stimulate their minds. Third, it makes students feel and realize a point of contact between the subject that students learn, and jobs of the real world.

Keywords: *Key Competencies, Convergent Teaching & Learning Model, STEAM, H-STEAM, Secondary Education*

1. Introduction

The purpose of this study is to derive the key competencies linked with career paths in the middle school curriculum of Korea, to develop and apply the "H-STEAM teaching & learning model" which combines Science, Technology, Engineering, Arts & Mathematics (STEAM) with the elements of Humanities that focuses on experiences and participations, and to analyze the significance thereof. In a complicated and rapidly changing world, in order to cultivate the human resources needed in the 21st century, there is a growing awareness that students should move away from classes that merely focus on knowledge transfer. It is a global tendency to provide juveniles with opportunities to adapt to new environments, as well as explore career paths that fit their aptitudes and needs. In addition, it is further emphasized that key competency-centered education and convergence education are essential for students to actively cope with future society.

In this context, since the first introduction of the "Free Semester Program" in 2013, which operates one semester of the middle school curriculum as a free semester, Korea has been implementing it in all middle schools since 2016. Korea's free semester program, modeled after the Transition Year Program (Department of Education, 1993) in Ireland, is a program in which junior high school students are not tested during one semester, but receive career education, such as discussion and practice classes, or work experience activities. However, the educational programs that could substantively support this program are highly inadequate. In addition, except for some exceptional cases, including the free semester program, the overall school education

Manuscript received: July 9, 2018 / revised: July 20, 2018 / Accepted: August 1, 2018
Corresponding Author: lunecho@ewha.ac.kr
French Department, Ewha Womans University, Korea

in Korea is still unable to escape from overheated competition and cramming education centering on the college entrance examination.

In Korea, there have been attempts to improve students' integrated thinking, creativity, and problem solving ability through STEAM-type classes (Kim et al., 2012; Kwon et al., 2012; Park, 2014). However, Korean-style STEAM education has the limitation that it focuses too much on science and technology, rather than the true meaning of convergence education, and merely integrates some other elements of Liberal Arts. In addition, there is no link between curriculum and real life, and humanistic thinking for human, the world, and imagination is not accompanied, thus failing to substantially help students to explore their career.

Thus, this study suggests the "H-STEAM" program, which enables middle school students to develop creativity and career aptitude. In this study, precedent researches and domestic and foreign cases are investigated and analyzed, and STEAM education is restructured in accordance with the situation in Korea, and its appropriateness and feasibility reviewed, to secure the foundation of reflecting the model in the curriculum. In addition, the change of professional society according to the mega-trends of future society was researched to derive basic key competence that is common to the whole course of the STEAM field and human key competence related to the field of the humanities. By combining these key competencies, the H-STEAM Middle School Free Semester Program was developed. The emphasis in this process is laid on building experience and practice-oriented teaching and learning to discover and develop students' aptitudes and talents. In addition, it is an evaluation method that reflects the specificity of each class model, apart from the existing evaluation method, which merely measures the understanding degree of learned knowledge.

2. Theoretical Underpinnings of the Proposed Model

2.1 Theoretical Underpinnings of the Key Competency Class

Key competencies are the totality of knowledge, skills, and attitudes that are required for learners to solve various phenomena and problems. The Partnership for 21st Century Skills (www.21stcenturyskills.org), established in the United States in 2002, mentioned that the competencies requested of students in the 21st century are as follow: not only basic core curriculum knowledge, but also "life and job skills", "information, media, technology", and "learning and innovation technology – the 4Cs (Critical thinking, Communication, Collaboration, and Creativity)". Bellanca and Brandt (2010) asks, what are the most important skills in the 21st century, why are they important, and how can they be put into the school curriculum? Trilling et al. (2012) show that the key competences that are most requested in the 21st century to link learning, work, and life are 1) learning and innovations skills, 2) digital literacy skills, and 3) life and career skills, emphasizing education that can self-motivate the individual, and suggest ways to solve problems on their own.

Key competencies were introduced into the curriculum through the OECD's Definition and Selection of Competences (DeSeCo) project (2002). This project sets nine key competencies that are required for successful personal life and the development of society, namely, to act autonomously, to use tools interactively, and to interact with social heterogeneity groups. As a result, countries such as Canada, Germany, the UK, Australia and New Zealand began to reorganize their curricula based on competencies. In 2007, Korea proposed to retool its curriculum based on its key competencies, by moving away from a knowledge-based curriculum, through the "Vision and Strategy for Future Education" (Presidential Committee on Education Innovation).

The most important feature of the key competency-based curriculum is that the teacher does not construct a curriculum in reference to the contents to be taught, but instead constructs the contents of the curriculum, focusing on the level that the students must achieve. The learning goal of students is acquiring practical ability based on knowledge, not knowledge itself. In this context, the practice of knowledge and the linkage with

educational institutions out of school are emphasized. In the case of New Zealand (Rutherford, 2004), cross-curriculum convergence is important, in order to improve key competencies. Since key competencies are integrated with various kinds of knowledge, functions, and attitudes, various teaching and learning methods are deemed necessary, such as discussion, project learning, theme-based integrated curriculum approach, cooperative learning, and field learning.

2.2. Theoretical Underpinning of the Convergence Class

STEAM is an acronym for Science, Technology, Engineering, Arts, and Mathematics. STEAM education aims to enhance the interest and understanding of the convergent knowledge, process, and nature of various fields related to science and technology through creative design and emotional touch, to train human resources equipped with STEAM Literacy (Sousa, 2013) so as to solve problems in a creative and integrated manner.
Since STEAM education is structured to integrate other disciplines centering on science and technology, other academic elements, such as literature and art, have the limitation that they are used only as an additional device to educate science and technology in a new and interesting way. In order for STEAM to develop the proper convergent thinking that was originally intended, a complete convergence education program that combines imagination in humanities field and creativity in technology field is necessary.
This study conceived a class model that can naturally converge key competencies in the STEAM field and key competencies in the humanities, focusing on key competencies. In the process, the precedent research was analyzed. Ingram (1979), Fogarty (1991), and Drake & Burns (2004) have suggested the types that can be applied to the field based on solid rationale. By presenting an integrated education model, they laid the groundwork for convergence education.
Ingram (1979) distinguishes integrated education as structural integration that integrates subject contents, and functional integration that integrates learning methods. Structural integration has both quantitative integration and qualitative integration. Quantitative integration simplifies the placement of the components of the curriculum and the academic elements, while qualitative integration restructures the elements of the curriculum or the academic elements in a uniform way. This study develops the notion of qualitative integration among the integrated types proposed by Ingram (1979), and tries to reconstruct the curriculum based on overlapping principles and interests among the subjects, rather than simply integrating two or more subjects.
Fogarty (1991) presented in detail the types of integration, according to “Within a Single Discipline”, “Across Disciplines”, and “Within and Across Learners.” In this study, integration that is closer to convergent training in a more complete meaning, and applicable to the education field, was determined as an inter-disciplinary integration type, and integration within learners, or integration according to connection among learners, and a co-teaching type H-STEAM program was developed. On the other hand, Drake and Burns (2004) classified the types of integration as multidisciplinary, interdisciplinary, and transdisciplinary. Multidisciplinary integration indicates that the contents of several disciplines are combined and center on one theme. Interdisciplinary integration organizes a curriculum that centers on common content across disciplines. Transdisciplinary integration organizes a curriculum that centers on students’ questions and concerns, not in a specific curriculum, but in the context of real life.
If integrated education emphasizes a holistic view that encompasses the whole, convergence education emphasizes creative changes that produce the third different meaning and knowledge by gathering heterogeneities. This study aims to enhance the intensity of convergence through an interdisciplinary approach and transdisciplinary approach, from among the types defined by Drake and Burns (2004), and suggests a convergence type that improves convergence, and reinforces the student’s role in the context of real life. In

addition, when organizing a convergent subject, by clarifying the relation with existing subjects, a convergence program that can be used in the current classes is proposed.

3. Program Procedure and Description

This study analyzed the previous researches on Korea's curriculum, current and future social occupation group, key competencies, convergence education, creative experience activities, and career education. The key competencies of the STEAM and the key competencies of the humanities field, which are ranked highest in relation to career paths, were extracted, and the first and second delphi surveys were conducted for experts and field teachers. As a result, the basic key competencies of eight STEAM fields and the key competencies of seven humanities fields were confirmed.

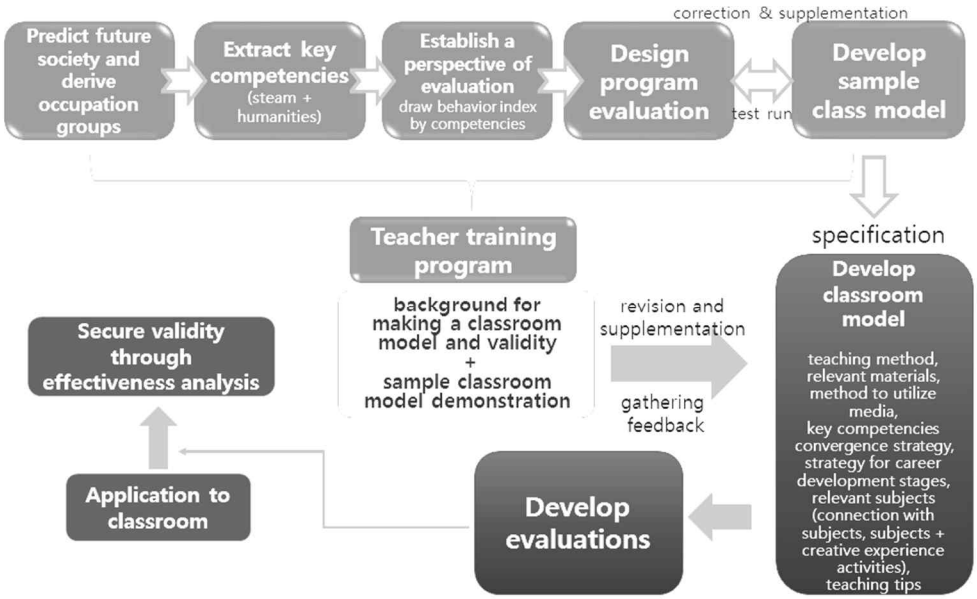

Figure 1. Process of Researches

The H-STEAM class model is created by converging basic key competencies in STEAM and key competencies in the humanities. The model is in a format of co-teaching classes between science and technology teachers and humanities teachers. Basic key competencies mean key competencies that are fundamental to the entire career path in the STEAM field, while key competencies in the humanities indicate key competencies that correspond to the career path in the humanities field.

Table 1. Basic Key Competencies in the STEAM Field and Operational Definition.

Basic Key Competencies in the STEAM Field: for the Entire Career Path	
Competencies	**Definition**
Self-understanding ability	Understand students' own interests, aptitudes, and values, identify students' own roles through various situations (home, school, social life, etc.) and relationships with others, and create positive self-concepts and attitudes

Self-managing ability	Ability to manage oneself through one's entire life by using behavioral learning principles as a way to change one's behavior
Creative problem-solving ability	Ability to discover problems with a new perspective, and to solve problems in various ways through convergent and divergent thinking
Information-utilizing ability	Ability to collect information through various routes, evaluate the reliability of the collected information, and comprehensively process and utilize the selected information
Communication ability	Ability to express what the individual wants to communicate in a way that allows listeners to understand it easily, and accurately using language or non-linguistic means
Ability of ethical performance	Ability to devote expertise and abilities of individuals in order to maintain a healthy society as a member of society, and to promote the interests of society as a whole with a sense of citizenship
Analytic/critical thinking ability	Ability to analyze problematic situations and handle them flexibly and systematically
Career development ability	Ability of the individual to establish career plans for their own academic studies and occupation, in consideration of the society-wide flow of occupations as a result of changes in social and economic systems, and to manage and implement career plans in accordance with rational decision-making principles

Table 2. Key Competencies in the Humanities and Operational Definition

Key Competencies in the Humanities: for Career Path in the Humanities	
Competencies	**Definition**
Creative understanding and expression	Ability to create creative products using various media based on language
Knowledge and thinking about humanities and society	Ability to understand and deeply reason the knowledge surrounding humans and the world
Language ability	Ability to communicate with other people in consideration of the value, culture, and situation of others through the effective use of Korean and foreign languages
Observation and overall understanding	Ability to read the global issues through observation, and to understand and predict the hidden context at the core and the underlying problem
Personal relations	Ability to communicate with others and work together based on attitudes to consider, sympathize, and listen to others
Ability for immersion and dealing with challenges	Ability to challenge the surrounding phenomena with curiosity through reading and experience, and overcome failure
Communication and sharing of feelings with other cultures	Ability to empathize through communicating and sharing with cultural heterogeneity groups

4. Results and analysis

4.1 Class The H-STEAM Program

Table 3. The H-STEAM Program

Title	Key Competency		Grade	Teaching method	Occupation groups
	Steam	Humanities			
Can I 'see' sound?	Communication ability	Knowledge and thinking about the humanities and society Language ability	3rd grade, Middle School	Humanities-science co-teaching Cooperative learning Problem-based learning (PBL)	Speech therapist, announcer, singer, theater actor, special-education school teacher, show host
I am an 'imagineer' who designs imagination!	Creative problem-solving ability	Creative understanding and expressions	2nd grade, Middle School	Humanities-science & technology co-teaching Problem-based learning (PBL) Discussion and debate	Inventor, Imagineer, emotion recognition developer, psychologist, emotional designer, emotional marketer, inventor

4.1.1 Program 1: Can I "see" sound?

Starting with the question "Can I "see" sound?," students created a scientific device for visualizing sound. This scientific device helped to explore the Korean language principle of phoneme fluctuation. At the end of the program, students explored various kinds of jobs that require accurate pronunciation. This program focused on "communication skills" in STEAM key competencies, and "humanities and social knowledge and thinking skills" and "language skills" in humanities key competencies.

People communicate with each other. Accuracy of speech when talking is very important in social life. Proper pronunciation is not only a means of accurately conveying thoughts to others, but also an important way to enhance creative expression in the careers. Sound is the science of vibration. As the air is pushed out of the vocal tract, it is converted into the desired word in the articulation organ through the resonance organ. However, even if the position of the tongue is slightly changed in the articulation organ, it is difficult to communicate smoothly. Students' pronunciation can be corrected by letting the students know whether their speech is correct. Also, if the sound is seen and checked through a computer-based sound program, the student can distinguish good pronunciation from bad pronunciation, and find their own unique pronunciation method.

Table 4. *Can I "see" sound?*: Class guide plans

	Contents	Activity, evaluations
1st~2nd class (Korean, Science)	- To know the concept of phoneme and draw a consonant and a vowel system diagrams - To find the difference between consonants and vowels while actually pronouncing phonemes	- Cooperative learning by groups - Formative evaluation using QR code
3rd classes (Science, Korean)	- To find differences in how phonemes sound - To make a device that can see sound with eyes	- Problem Based Learning (PBL) - Oral assessment by groups - Drafting an experimental observation report
4th classes (Korean, Science, Career)	- To find correct pronunciation using the speech mirror - To search for jobs that require accurate pronunciation	Completion report of career-linked activities STEAM key competency, humanities key competency evaluations

One middle school science teacher and one Korean language teacher applied this program to the class by co-teaching. In the 1st and 2nd class, the Korean language teacher taught the concept of phoneme, the difference of sounding method of consonant and vowel. A science teacher participating in this class took a picture of a shape of the mouth when a student pronounced a consonant and a vowel and showed the picture to the students, so that they can see the difference directly. Through this activity, students completed a consonant system and vowel system diagram by groups. Unlike when grammar is approached through the education of learning predetermined rules, H-STEAM through collaboration between the Korean and science teachers could make students hear themselves, and learn by themselves scientific, social, and symbolic rules of pronunciation.

After making sufficient activities to understand the concept of phonemes and the way of sounding, a formative evaluation using QR code was performed. The purpose is to provide immediate feedback on the difficulties that students have. In other words, if the students enter the correct answer using a smartphone, they can see the answers through the teacher's computer in real time, and know the percentage of correct answers, so that it is possible to give instant feedback to the students.

In the third class, the search continued by the lead of the science teacher and collaboration of the Korean language teacher. Students created experimental devices that can visualize sound, with materials such as balloons, mirrors, and laser pointers. This allows students to explore how the movement of light depends on the consonants and vowels, and thus the waveforms are different. In the fourth period, the class "Can I "see" sound?" in connection with career education was completed. Using a speech mirror, students pronounced speech, and discussed why correct pronunciation is important in everyday life for their occupation. In addition, students explored the occupations where the importance of pronunciation is particularly emphasized, studied what qualities are necessary for those occupations and what kind of preparation is needed, and shared opinions.

Among the various fields of the Korean language, many students dislike grammar. However, by analyzing waveforms using various programs, such as sounding principle, sound wave, and speech mirror, students' interest increases, and understanding of phoneme and phoneme fluctuations increases. It is an advantage that students can understand and memorize more easily if they find out the reason for the fluctuation of the phonemes through the group activities, and the principle of phonetic variation. In addition, through this class, students can recognize the necessity to use Korean language with the correct pronunciation and grammar through this class, and improve their use of language. In this program, students can recognize many occupations requiring correct pronunciation and feel that there are many occupations they could not know. These students can relate what they learn during class with occupations, and search for their career in further detail.

4.1.2 Program 2: I am an Imagineer who designs the imagination!

The aim of this program is to write an idea plan for an invention that empowers students to become imagineers who can invent not function-centered inventions, but human-centered inventions. “Imagineer” is a combination of “imagine” and “engineer”, meaning a practitioner who imagines. It was created by Alcoa Corporation, and widely used by Walt Disney (Alex Wright, 2005).

In this class where students become imagineers, a poem creation process is introduced into the process of invention. A poet looks at the object in detail, creatively imagines it, and symbolizes it by literal means. This creation process of the poet is similar to the creation process of the invention. Inventions also begin by looking at things, and discovering them. Students will learn how to design “inventions for humans” through the creative process of “observation, discovery, expression and application”, which process is common to poets and inventors. This will lead to increase in “creative problem solving ability” from among the basic key competencies of STEAM, and “creative understanding and expressions” among the key competencies of the humanities. The world-renowned innovation group IDEO (2014) has proposed a creative process that suggests a concrete solution after observing and analyzing the real life scenes of people through human centerd design theory, and abstract thinking to discover design themes. IDEO’s case can be presented to students as a reference.

Table 5. ‘I am an Imagineer who designs imagination! ’: Class guide plans

	Contents	Activities and evaluation
1st class (Korean)	- Interesting videos: inventions with emotion technology - Try the sensory organs students have not used a lot: Mystery box (box unknown) experience, Express the situation in a mystery box	- Group activities - Experience in three stages : Observation, use of emotional terms, express in sentences
2nd class (Korean)	- Look at things and express feelings: Express emotions in objects as poetry, Find the emotional codes of things	- Group activities - find five emotional expressions, write creative poetry
3rd class (Korean and Technology)	- Conceive concrete ideas through the experience of writing poems - Think about ideas with emotional codes - Refine thoughts through idea conception technique	- Individual activities - Why-Why activity note - SCAMPER activity note using mind maps
4rd class (Korean and Technology)	- Draft an idea plan : Arrange specified ideas in a predefined form, and perform storytelling	- Individual activities - Draft an idea plan (search patent, think creativity, usability, storytelling) - Evaluate presentation

One middle school technology teacher and one Korean teacher applied this program to the class by co-teaching. In the first class out of four, three types of mystery boxes (box for stimulating sight + olfactory sense, box for stimulating hearing + tactile sensation, box for stimulating hearing + smell) were observed in three stages by groups. In the first stage, students observed in a scientific manner based on facts, and in the second stage, they expressed feelings about the objects in the box based on the results of the observations as words expressing emotions. In the third stage, students expressed their feelings with pictures and sentences. When the group activities were over, students presented the results of activities for the three kinds of mystery boxes.

In the second class, students became an object, and expressed their feelings in poetry. In the process, “Emotional Code Search Activity” was conducted. When a teacher showed a real object, the students observed

the object, and performed the activity to become the object. In Gordon's (1961) Synectics technique, which combines irrelevant elements, the "Personal Analogy" was used to gain new insights by thinking that the person who solves the problem has become a part of the problem themselves. Students used a smart device to enter the words for expressing feelings they felt during the process of becoming an object. The teacher showed the emotion codes found by all of the students to the students through the tag cloud. Students shaped and presented emotions found in the object in a short poem. In this way, students could use the five senses to feel the objects, and to find emotional codes in the objects. In past use, students creatively expressed themselves by using synesthesia more proficiently than when simply doing poetry activities. As a result, students showed that they were enjoying and immersing themselves in writing poetry, avoiding the stress of writing poetry.

In the third and fourth classes, the class performed "configuration of invention idea and drafting an idea plan". Led by the technology teacher, the creative activity in the Korean language class was linked with the creative activity in the invention class, and it was embodied as the idea of invention with emotion. In order to overcome the difficulty of creative thinking, students were taught how to use SCAMPER, and what are the 5 Why's, and they tried various exercises. They had time to think about how this class could be utilized for occupations, and opportunities to present their thoughts. In applying the H-STEAM programs to a middle school class, students who engaged in invention activities after writing poetry could think more deeply about not only the functional aspect of the invention, but also the emotional aspect, the user's psychology, characteristics of the object itself, and the social significance of the invention.

5. CONCLUSIONS AND RECOMMENDATIONS

The results of developing and applying the H-STEAM programs in practice confirm that these programs are effective in enhancing students' creativity, ability to think about convergence, and deepen their understanding of diverse occupations. Designed to be closely linked to real life, the classroom programs help students gain a better understanding of future career education in formal education, find out what they want to do, and grow their dreams.

The advantages of the H-STEAM classroom programs are: First, students are able to flexibly think through the physical and symbolic world, i.e. the empirical world and the abstract world, in solving the real life problems. Second, it combines advanced technology with human sensibility and imagination, and enables students to derive creative outcomes that move people's minds. Third, it makes students feel and realize what kind of contact they have with occupations in the real world.

As a result of applying the H-STEAM programs to the middle school class, it was found that the students participated in the class more happily and dynamically than the general class. The students' immersion and problem-solving ability have been improved through the curriculum which is to create a tool for students to directly observe sound through vibration and waveform, departing from the phoneme education that focuses merely on knowledge acquisition. In addition, the invention class in which the poetry writing process was involved made it possible for students to make an invention that includes not only functional superiority, but also poetic sensibility. The co-teaching type class applying the H-STEAM programs could expand students' thinking to be deep and wide by making them experience the point where the humanities and scientific views are connected and converged. The teachers strengthened the career capacity of the students through the use of professional terminology and concepts related to the subject of disciplines, and the curiosity and the immersion of the students were increased through the cases of everyday life videos attracting attention.

The matters requiring attention for an effective H-STEAM class are as shown below:

First, in terms of class management, forming a group is important. It is necessary for the teacher to intervene appropriately and activate teamwork. Even if a class guidance plan is proposed by dividing classes, such as first class and second class, if the classes are operated by block times, it may be effective for group activities. Then, students can be easily immersed, and it has the advantage that the class flow is not cut off when making an output.

Second, when students are introduced to the convergence class, if they are given description of the convergence class in advance, they can be more immersed in the class.

Third, the convergence class can be much more burdensome for students, so the class should be much more leisurely. For completeness of output, a lot of feedback is needed.

Fourth, an overly detailed assessment blocks the opportunity for students to naturally shift to other topics. This study suggests a compromised evaluation method that can be used in the present curriculum of Korea. However, it is considered that in the future, the evaluation of the convergence class needs to be more flexible and diversified.

Fifth, it is absolutely necessary to improve teachers' understanding and competence for successful convergence classes. Convergence classes require background knowledge of teachers about the convergence. The teachers are required to have the ability to synthesize their perspectives in the field while they are interested in various fields. Therefore, training of teachers should be more dynamic, and enable teachers to explore various teaching methods with their own convergent minds, rather than one-sided top-down training focused on class demonstrations.

6. Acknowledgement

This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government(The CORE project of the Ministry of Education)

References

[1] J. Bellanca & R. Brandt, 21st century skills: Rethinking how students learn, Bloomington, IN: Solution Tree Press, 2010.
[2] Department of Education, Transition Year Programme, Guidelines for Schools, Dublin: Department of Education, 1993.
[3] S. M., Drake & R. C. Burns, Integrated Curriculum, Meeting Standards Through, Virginia USA: Association for Supervision and Curriculum Development, 2004.
[4] Eberle, Bob, Scamper: Games for Imagination Development. Waco, TX: Prufrock Press, 1996.
[5] Fogarty, R, "Ten ways to integrate curriculum", Educational Leadership. 49(2), 61-65, 1991.
[6] Gordon, J.J., Synectics: The Development of Creative Capacity, London: Collier-MacMillan, 1961.
[7] Heil, D.R., Pearson, G., & Burger, S.E., Understanding Integrated STEM Education: Report on a National Study, Paper presented at 2013 ASEE Annual Conference & Exposition, Atlanta: Georgia, 2013.
[8] IDEO, Human Centered Design Toolkit. Ideo.org, 2014.
[9] Ingram, J. B., Curriculum integration and lifelong education: A contribution to the improvement of school curricula, Oxford: Pergamon Press, 1979.
[10] Ishikawa, K., Guide to quality control, Tokyo: Asian Productivity Organization, 1998.
[11] Jeffers, G., "The Transition Year programme in Ireland, Embracing and resisting a curriculum innovation", Curriculum Journal, 22(1), 61-76, 2011.
[12] Kim, D., Ko. D. G., Han, M., & Hong. S., "The Effects of Science Lessons Applying STEAM Education Program on the Creativity and Interest levels of Elementary Students", Journal of The Korean Association For Research In Science Education, 34(1), 43-54, 2014. doi:10.14697/jkase.2014.34.1.1.00043
[13] Kim, S., Chung, Y., Woo, A., & Lee, H., "Development of a Theoretical Model for STEAM Education", Journal of the Korean Association for Science Education, 32(2), 388-401, 2012. doi:10.14697/jkase.2012.32.2.388
[14] Kwon, S., Nam, D., & Lee, T., "The Effects of STEAM-Based Integrated Subject Study on Elementary School Students Creative Personality", Journal of the Korea Society of Computer and Information, 17(2),

79-86, 2012. doi:10.9708/jksci.2012.17.2.079
[15] McIntosh, J., & Meacham, A., Creative problem solving in the classroom: The educators handbook for teaching effective problem solving skills, Waco, TX: Prufrock Press, 1992.
[16] Park, B., & Lee, H., "Development and Application of Systems Thinking-based STEAM Education Program to Improve Secondary Science Gifted and Talented Students Systems Thinking Skill", Journal of Gifted/Talented Education, 24(3), 2014, 421-444. doi:10.9722/jgte.2014.24.3.421
[17] Rutherford, J., Key Competencies in the New Zealand Curriculum: A snapshot of consultation, December 2004, 2004. Retrieved 18, November, 2017 from http://www.tki.org.nz/r/nzcurriculum/docs/consult-snapshot.doc
[18] Rychen, D., & Salganik, L., Definition and selection of competences (DeSeCo): theoretical and conceptual foundations: strategy paper, [Swiss Federal Statistical Office], [Neuchatel], 2002.
[19] Osborn, A., Applied Imagination: Principles and Procedures of Creative Problem Solving. New York, NY: Charles Scribner's Sons, 1953.
[20] Sousa, D. A., & Pilecki, T., From STEM to STEAM: Using brain-compatible strategies to integrate the arts, Thousand Oaks, CA: Corwin publishers, 2013.
[21] Trilling, B., & Fadel, C., 21st century skills: Learning for life in our times, Hoboken, NJ: John Wiley & Sons, 2012.
[22] Wright, A., Imagineers: The Imagineering Field Guide to Magic Kingdom at Walt Disney World, New York: Disney Editions, 2005.