Chapter 57
Effects of Implementing STEM-I Project-Based Learning Activities for Female High School Students

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ABSTRACT

This study aims to explore the application of STEM-I (STEM-Imagination) project-based learning activities and its effects on the effectiveness, processes, and characteristics of STEM integrative knowledge learning and imagination development for female high school students. A total of 72 female high school students were divided into 18 teams. Students were provided with a place to discuss, share, and integrate learning activities. A questionnaire and focus group interviews were conducted for data collection. The results show that STEM-I project-based learning activities can promote the development of diverse abilities and effectively expand STEM knowledge integration and learning for female high school students as well as enhance their imagination in the project-based activities. Additionally, the STEM-I instructional model with the process of initiation, development, expression, alternative, and links (IDEAL) is confirmed. Finally, some suggestions are proposed for future studies on STEM education and imagination integrative instruction.

1. RESEARCH MOTIVES

STEM education has become an international trend in integration across the sciences and in scientific education. The American Society for Engineering Education promotes STEM education in the K-12 (from kindergarten to Grade 12) curriculum, with "engineering design" as its focus, seeking to incorporate "know-how in mathematics, science, and technology," and promote the cultivation of "engineering thinking models" (Lou, Liu, Shih, & Tseng, 2011; ASEE, 2004). STEM

DOI: 10.4018/978-1-4666-7363-2.ch057

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education is the incorporation of interdisciplinary instruction in scientific inquiry, technology, engineering design, and mathematical analysis in instructional activities. It emphasizes the process of applied work in real contexts, so learners can evaluate and integrate their understanding and application of knowledge in science, technology, engineering, and mathematics and can be inspired by the potential of problem-solving and creative design (Lou, Tsai, & Tseng, 2011; Sanders, 2009). Tseng, Chang, Lou, and Chen (2011) incorporated the concept of STEM integrative education into project-based learning activities and found that STEM project-based learning activities can enhance learning effectiveness, leading to meaningful learning, influencing students' future occupation orientations, and helping them more actively explore engineering topics. This shows that STEM integrative instruction is one possible path to achieve the integration and promotion of technological education.

The knowledge economy trend includes the abilities of innovating, criticizing, and problem-solving, which are important in elevating citizens' competitiveness and for which training in creativity and innovation are prerequisites to maintaining citizen literacy and developing the knowledge economy. Based on this trend, in 2003, the Taiwanese government proposed the "White Paper on Creativity Education," which lists creativity education as a focal point in the education in the future (Ministry of Education Taiwan, 2003). Creativity is associated with imagination because imagination is the source and an implicit aspect of creativity, which can inspire the endless innovative energy of creators; creation or innovation are the external expressions of imagination (Liang & Hsu, 2011).

The exploration of imagination includes the two views of "personality theory" and "cognitive theory," where the former sees imagination as an innate personal quality, while the latter believes that imagination is an ability that can be cultivated through development and learning (Wang, Chu, Huang, & Kang, 2010). That is, imagination can be encouraged through suitable and open educational environments that provide specific stimulation and requirements, helping students extract, disseminate, and restructure mental images (Wang, Chu, Huang, & Kang, 2010). In addition, when applying imagination to instruction, learners reshape existing knowledge and experiences into new knowledge or findings, predict possibilities in learning results, and deepen the flexible usage of knowledge and abilities in life (Collins & Stevenson, 2004). Furthermore, imagination can be cultivated using the power of education, and in the process of cultivation by education, imagination has a positive promotional effect on instruction and learning. In light of this, this study seeks to use the IDEAL imagination training model, incorporating the concept of STEM integrative instruction, and to develop a set of instruction strategies in STEM-I (Science, Technology, Engineering, Mathematics, and Imagination) for female high school students in "the Amphibious Vehicle Imagination and Design Competition" to explore the effects, processes, and characteristics of the STEM-I knowledge application.

Based on these research interests, the purposes of this study are:

1. To analyze the effect of STEM-I project activity on female high school students' imagination and STEM knowledge development;
2. To understand the process of STEM-I project activity in female high school students' imagination and STEM knowledge development; and
3. To explore the characteristics of STEM-I project activity in female high school students' imagination and STEM knowledge development.

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