A STUDY ON CROSS-DOMAIN THEMATIC MAKER COURSE DESIGN AND PRACTICE

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ABSTRACT

In this study, freshmen to junior students of a high school in southern Taiwan participating in various invention training programs made good use of their club time to join in a maker and creative thinking course. In line with the Creative Thinking Instruction Model (CTIM) and Project-Based Learning (PBL), the course design takes a hands-on approach to demonstrate one's creativity. Centering on creative invention, the course aims to stimulate students' creative thinking in the learning process and encourage them to take the initiative to seek knowledge and resources for solving problems and to become one of the makers. After the course, a test is conducted upon students' problem-solving ability. The Problem-Solving Test is carried out in the form of paper and pencil for a group. Based on the results of one sample t-test, students' ability to understand problems, develop a certain plan, implement the plan, and review it all show a positive trend after this course.

Keywords: maker, creative teaching, cross-discipline, problem-solving ability

INTRODUCTION

As Maker Movement is becoming increasingly popular around the globe, innovation and practice are seen as the orientation of future talent development. The so-called Maker exhibits creative design, innovative thinking, cross-domain cooperation, proficiency in technology, and hands-on skills (Shen and Dai, 2016). Maker Movement is changing education, economy, and previous familiar manufacturing models (Chao, 2015).

Maker Movement emphasizes that all people can be creators, whether a scholar, farmer, artisan, or merchant. In Maker Movement, everyone can make self-improvement and implement fundamental values, ideas, and basis (Hatch, 2014). In addition to design with actions, creativity and innovation are two of the characteristics of the maker. Creativity is a significant educational goal in modern education (Ministry of Education, 2016) and is conducive to enhancing human civilization and scientific and technological progress. In previous studies, in terms of cultivation of creativity, creation and thinking training is the most widely used method for developing creativity, which not only can help promote diffuse thinking, but also improve the performance of problem solving (Cheng, Liu, and Chang, 2007).

This study therefore engaged freshmen to junior students of a high school in southern Taiwan who participated in various invention training programs and made good use of their club times to conduct Smart Life Cross-Domain Talent Training Course and the maker and creative thinking course. In line with the Creative Thinking Instruction Model (CTIM) and Project-Based Learning (PBL), the course design takes a hands-on approach as an expression

of creativity. Based on creative invention, the course centers on our daily life and environment, develops works or programs that may serve as solutions to relevant problems, and produces finished products or models. This course aimed to stimulate students' creative thinking in the learning process and encourage them to take the initiative to seek knowledge and resources for solving problems and become one of the makers.

In the form of group cooperation and learning, this course intends to promote the practical ability of students' scientific research, stimulate their potential creative thinking, and cultivate their scientific research and hands-on habits, paving the way for them to pursue independent creative research and development, so as to show multiple intelligences and to stimulate their own potential of scientific creation. After the course, a teaching examination was employed to verify the effectiveness of teaching and to understand students' current creative thinking and hands-on and problem-solving performance. Relevant personal teaching experience and recommendations are then put forward for future reference.

The purposes of this study are as follows.

1. Put forward an appropriate model of curriculum design and teaching of Smart Life Cross-Domain Talent Training Course for teachers in junior-high and high schools.
2. To understand students' creative thinking, hands-on ability, and problem-solving ability after the course.

LITERATURE REVIEW

Creatıve Teachıng And Creatıvıty Educatıon

What is creative teaching? It may be regarded as an expression of creativity. Sternberg (1999) proposed definitions of creativity from various scholars in the Handbook of Creativity and deemed that they all include the same standards of Originality and Usefulness though different in description.

Creativity teaching and creative teaching are distinctly different. Creative teaching is the product of teachers' thinking and the performance of their creativity. Hence, creative teaching embodies teachers' ideas, designs, and use of novel teaching orientations, methods, or activities to adapt to the mental development of students, stimulate their learning motivation, help them to produce meaningful learning, and achieve education goals in a more effective fashion.

Creativity teaching focuses on cultivating students' creativity, while creative teaching aims to achieve education goals through creative teaching methods (Starko, 2000). How can one cultivate students' creativity? First of all, in the process of cultivating creativity, students should be treated as creators (Lu, 2003). In recent years, the learner-centered approach in teaching and learning attaches great importance to regarding learners as creators. Amabile (1996) argued that creativity performance is the interaction result of domain-related skill, creativity-related skill, and task motivation.

When engaging in the cultivation of creativity, schools should place learners at the center and integrate and enhance their relevant areas of knowledge, thinking skills, and mental habits into the course so as to yield a long-term effect of creativity cultivation (Amabile, 1996; Csikszentmihalyi, 1996; Sternberg, 1999). In the cultivation of creativity, if coupled with several other fields, students will achieve all-around and outstanding creativity performance (Scott, Leritz and Mumford, 2004). Thus, the cultivation of creativity must be combined with domain-related skills - in other word, knowledge that students should learn in all areas.

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Maker Educatıon

Maker refers to a group of people who are willing to DIY (do-it-yourself), but is not limited to specific groups. It stresses that all people can be creators, whether a scholar, farmer, artisan, or merchant. In the Maker Movement, everyone can make self-improvement and implement fundamental values, ideas, and basis (Hatch, 2014).

In May 2012, following the implementation of maker education, Dale Dougherty, founder of Maker Media, officially launched the Maker Education Initiative, in which college students proficient in mathematics and young volunteers from all states can enter urban communities to implement workshops with students, teachers, and even community masses. The Maker Education Initiative model differs from the previous educational and learning model, while the maker education has greatly revolutionized the educational model.

The impact of Maker Movement on education may be illustrated from making, maker space, and maker (Halverson and Sheridan (2014)). Making refers to a process with a clear learning goal so as to construct design work and to focus on the content and procedures of learning. In this aspect, the teaching staff should make clear what students have learned and how to transform this into their professional knowledge and specialized areas. In the process of making, the teaching staff may directly observe their learning process to understand or assess whether students possess the core competencies (Executive desk of the President, 2014). As a community-based learning field, the maker space attaches great importance to its composition. Moreover, interaction and co-operation (co-working) between makers entail some activities that enable learning activities to naturally occur. Maker itself is a new type of self-learning identity recognition; more clearly, it offers students a chance and platform to enter into a professional field through the identity recognition of makers.

Sharing cross-domain characteristics, Maker Movement and design education pursue the same goal of innovation and creation and follow the goal-oriented teaching model. The education process of maker emphasizes the importance of creation. In such a process, students find problems independently or collaboratively, analyze the problems, and use multiple tools and resources to create products to solve them. Students are also self-driven in such a process to combine multidisciplinary knowledge to seek the best methods to solve the problems. Students in the context of maker education may select their own learning tasks. They learn to solve problems, which in turn engage them in in-depth learning, and this tends to produce new ideas. In this way, students not only develop the ability to identify problems, analyze problems, and solve problems, but also maintain the passion of learning and enhance the confidence of learning (Kurti, Kurti & Fleming, 2014).

COURSE STRUCTURE AND IMPLEMENTATION PLAN

Appropriate Model of Curriculum Design and Teaching of Smart Life Cross-Domain Talent Training Course For Teachers in Junior-High and High Schools

This course is designed and implemented according to the available teachers' resources, the course hours, and the teaching equipment. In line with the Creative Thinking Instruction Model (CTIM) and Project-Based Learning (PBL), the course design takes a hands-on approach to demonstrate one's creativity. In the form of group cooperation and learning, this course promotes the practical ability of students' scientific research, stimulates their potential creative thinking, and cultivates their scientific research and hands-on habits, paving the way for them to pursue independent creative research and development, in order to show multiple intelligences and to stimulate their own potential of scientific creation. Hence, the following

content is concluded in terms of the planning and design of the course, content, examination and correction, course planning review, and so on.

COURSE PLANNING AND DESIGN OBJECTIVES

1. Inspire students' spirit and cultivate their ability to create and think.
2. Cultivate students' attitudes to integrate creativity into life and hands-on ability.
3. Apply creative thinking principles and inventive techniques for research and development.
4. Learn to master skills such as expression, communication, observation, and analysis.
5. Provide students with chances to understand creative design industry to cultivate creative thinking and artistic virtue.

COURSE PLANNING PROCESS AND CONTENT

Table 1. Course Planning Process and Content Planning Table

Unit topics	*Learning content*
Exercise of creative skills	Exercise of creation and thinking process and creative techniques. The history and achievement of past works. Patent application and economic efficiency.
Smart family course module	Communication IOT - Interactive control between mobile phone and Arduino-Communication (1) _ Bluetooth Communication IOT - Security monitoring - Anti-theft communication (2) _ Zigbee Communication IOT - Security Monitoring - Access Control - Communication (3) _ RFID Cloud IOT - Cloud application - Current detection and WiFi settings. Cloud IOT - Cloud applications - Read and control using web commands. Big data management - Chart analysis and management _ Temperature and humidity chart analysis _ (Serial / Excel mapping) Big Data Management - Cloud database application with remote instant data writing, reading, and instant graph analysis.
First experience of creative invention	(1) Group discussion, information collection, respective creation. (2) Personal publication, peer rating, program consolidation.
Group R&D and design	(1) The group carries out the first review on the draft, makes revision, puts forward a work plan and material requirements, produces design briefing, publishes, and holds an open discussion. (2) Make models.

COURSE IMPLEMENTATION RESULTS

The teaching activities are carried out based on the course design and students' performances are observed in order to produce an in-depth record. The detailed teaching results are as follows:

The Creatıve Desıgn of Students' Smart Lıfe

For the teaching activities of this study, the award-wining cases and models were provided to inspire students to some extent. Students held group discussion to decide their creative themes and were encouraged to share their ideas. Teachers and peers then made comments and suggestions. In the discovery stage, students were urged to propose different ideas and

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designs; for instance, using one's foot to pound one's back (as shown in Figure 1), Velcro storage box, love to drink (Figure 2), multi-function sun umbrella (creative award), and water hole cover.

Figure 1. Student's work No. 1 "Using one's foot to pound one's back" - With this tool, you can easily disassemble or assemble different chairs. Trampling your feet may enable you exercise in an appropriate manner and drive the massage equipment while at the same time not using power consumption, which is environmentally efficient.

Figure 2. Student's work No. 2 "Love to drink" - works description - The cap can be deformed. For instance, the beverage bottle can be sealed with the bottle and is flexible. Based on one's needs, they can use it in order to not finish the drink all at once.

Problem-Solvıng Abılıty

After the course, the Problem-Solving Test prepared by Pan (2002) after taking reference to that made by Lin (2000) was adopted to test students' problem-solving ability. The Problem-Solving Test was carried out in the form of paper and pencil for a group. In order to understand the impact of students' ability to solve their problems after this course, the contents of the test were divided into four parts: understand problems, develop a certain plan, implement the plan, and review.

According to the results of one sample t-test, as shown in Table 2, the t value of "understanding problems" is 5.25, developing a certain plan 6.36, implementing the plan 5.52, and reviewing 6.34. The four dimensions were evaluated with test value 3, which achieved an average of more than 3, indicating a significant difference. This shows that students, after the course, have higher enthusiasm in understanding problems, developing a certain plan, implementing the plan, and reviewing it.

Table 2. Problem-Solving Test - One Sample t-test

Variable (501)	*Nos*	*Average mean*	*SD*	*Test value = 3*	
				t	*p*
Understanding problems	28	3. 63	.63	5. 25	.00
Developing certain plan	28	3. 69	.58	6.36	.00
Implementing the plan	28	3. 54	.52	5. 52	.00
Reviewing	28	3. 64	.54	6.34	.00

COURSE IMPLEMENTATION, REVIEW, AND SUGGESTIONS

The teaching activities are carried out based on the course design and students' performances are observed in order to produce an in-depth record. The detailed teaching results are as follows:

COURSE REVIEW

1. In terms of finding problems, when students discuss with others or publish and feedback, they tend to be concentrated and creative.
2. In terms of practice, students are capable of putting forward a wide range of projects, but are limited by insufficient knowledge. Teachers also cannot meet the needs of various types of model production needs. Currently, the school provides woodworking machinery in creation base, laser carved machine in the life science and technology classroom, and a 3D printer and small CNC.
3. Briefing the preparation on published works greatly promotes the development of students. After certain guidance and practice, students are capable of preparing independently at a certain high level.
4. Publishing skills are also of great importance in this course. Through the guidance of teachers, feedback from peers, and multiple simulations, students who were helpless at first found that they were able to complete the briefing and answering questions in an orderly manner.

IMPACT

1. For students, a module course learning ranges from creative thinking training, design completion, making education, model completion, and briefing and expression, which undoubtedly encompass a cross-domain thematic course without any obvious distinction between Chinese, mathematics, nature, or biology.
2. For teachers, they learn from their teaching. As the cross-domain course is hard to distinguish different disciplines, only teachers and students learning together can render a smooth course and produce complete works. Thus, teachers of making education should at the same time strive to be a maker.

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SUGGESTIONS

In response to the student's wide range of proposals, in the production of models or works, a smaller range of topics should be carried out during the development period of the course; for instance, a furniture-related theme, which limits the works to digital manufacturing and carpentry; for smart a family-related theme, works may limited to Arduino. In this way, insufficient human and material resources may be efficiently employed.

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