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Article

Exploring Influence of Student Self-efficacy and Participation on Subject Integration through Design Competition

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Abstract: STEAM education uses the concept of subject integration to cultivate talents to solve complex problems. Design education also adopts project-based learning to integrate interdisciplinary knowledge and skills to enhance student's learning effectiveness. The purpose of this study is to explore the influence of student's self-efficacy on the ability of interdisciplinary learning and design integration and participation in the learning and integration through a design competition. This research is based on the performance in a short-term design competition in which teams of students from grades 1 to 3 work in groups to design and solve space problems. During the competition, teachers gave students lectures on subject knowledge and technology. Then, a questionnaire survey was conducted after the competition results were announced. A total of 152 valid questionnaires were collected. The research result confirmed that this competition increased student engagement and interest. Through the competition, students' knowledge and technical ability in various disciplines were promoted. In addition, the competition helped students enhance their design professional ability and improve the learning effect of integrated interdisciplinary teaching. The result also presented that self-efficacy and participation of students in different grades, and that the effects on professional learning effectiveness and interdisciplinary integration ability were different. This research provided an empirical and design-competition approach to the implementation of STEAM discipline integration.

Keywords: Design competition, STEAM, Interdisciplinary integration, Self-efficacy

1. Introduction

Design is about generating ideas and solving complex problems. For design, creativity and problem-solving require multiple knowledge and skills. Designer's role is to convey and present ideas or concepts in the form of works. There are various steps to solve problems during the design process. In turn, various technical capabilities are used to obtain the desired results and develop various products (Montalto, Graziosi, Bordegoni, and Di Landro, 2018). As the independence of professional subjects limits design education in universities, there was little research on how design integrates interdisciplinary knowledge and skills. However, under the current learning model that emphasizes problem-solving, complex issues must be solved by combining knowledge or skills in different subjects, and single-subject teaching no longer works in reality.

More attention has been paid to the concept of STEAM education in many countries. STEAM education integrates the learning of various subjects into the project design. Learners explore new knowledge or reflect on their previous knowledge, actively use it to solve problems, and then construct internalized knowledge (Han, Capraro, and Capraro, 2016). Technology and engineering in STEAM education are directly related to problem-solving, innovation, and design (Hernandez et al., 2014). As a result, STEAM education is recognized as a top educational focus in the world (Sergis et al., 2017). The application of multidisciplinary integration has also gradually developed in design teaching. Fan and Ye (2020) applied the concept of discipline integration and connection to fashion design. Various help is available for students' comprehensive learning and comprehensive application, enabling students to deal with difficult topics. Therefore, it is necessary to integrate learning across disciplines.

Many competitions are held not only to stimulate the creativity of students but also to find creative talents and teams as early as possible (Wang, Chang, and Huang, 2011). Numerous creative competitions examine the implications of planning and implementation activities to provide stimulated creativity and ability (Wang, Chang, and Liu, 2016). The competition is skill- or knowledge-oriented. When school students participate in competitions, it is easier for them to display different creativity and talents than in schools (Riley and Karnes, 2009; Riley, 2011). Design competitions assign a specific theme, goals, and problem context, allowing participants to solve real problems. During the competition, students participate in interesting practical activities. These activities create an environment for students to think, discuss, and negotiate with each other (Ye, 2007). Therefore, the design competition is regarded in this research as a thematic exploration activity that integrates the curriculum of various disciplines. The purpose of the competition is to cultivate students' integrated interdisciplinary professional knowledge and skills.

Learning effectiveness is often used to examine student learning outcomes. This research is to explore students' learning across disciplines and to understand how to improve the ability of various disciplines and achieve the goal of discipline integration through design competitions. Many factors affect students' learning outcomes. One of the important factors is self-efficacy. Self-efficacy is the degree of confidence of students in their abilities in subject learning or design tasks. Therefore, we use self-efficacy to explore the relationship that affects students' disciplinary integration ability. In addition, whether the circumstances of participating in the competition affect the student's assignment is also investigated. The purpose of the research is to explore the impact of student participation and engagement on the ability improvement of various disciplines as well as the relationship with the integration of discipline ability. Based on the above, we explore the impact of students' self-efficacy and participation on students' learning integration and subject ability in various subjects through a design competition, and also discuss the relationship between competition and learning effectiveness.

2. Literature review

2.1. STEAM and Interdisciplinary Education

The National Science Foundation (NSF) of the United States had earlier advocated the development of STEM education. Later, arts were added to STEM education and engineering design education was strengthened to complement and enhance students' creativity and exploratory thinking (Ghanbari, 2015; Land, 2013; Maeda, 2013). STEAM education refers to cross-disciplinary courses and teaching including science, technology, engineering, arts, and mathematics. NSF added art to the original connotation of STEM education to strengthen its creativity and design. There were improved students' high-level creative thinking to be able to apply it to problem-solving in real situations (Maeda, 2013; Rolling, 2016).

The American education community hoped to use STEAM to enhance students' 21st-century knowledge, including problem-solving, self-management, self-development, systems thinking, interaction, and communication (Keefe, 2010; NRC, 2010). STEAM education is not limited to the fields of science and engineering. The practical application education of design is also closely related (Fan and Ye, 2020). Designing a product is a multifaceted and complex problem-solving activity involving various cognitive abilities such as creativity (Zeisel, 2006). Complex problems required different problem-solving skills and innovations. The courses that integrate subject training and creativity development improve college students' innovative cognitive abilities (Madden et al., 2013). STEAM education helps students improve higher-order thinking and technical skills and makes them better problem solvers and innovative inventors (Morrison, 2006; Stohlmann et al., 2012).

The important concept of STEAM education is to put learners at the center of integrating interdisciplinary knowledge and to help students develop characteristics such as problem-solving strategies, creative thinking, and innovative applications through the design of special courses such as exploration and practice (Chen, 2017; Land, 2013; Liao, 2016). In the STEAM teaching activity design, Rolling (2016) pointed out that many STEAM courses incorporate project-based learning (PBL). The main feature was designing problems in practice providing students with opportunities for creative choice and collaborative solutions. Quigley, Herro, and Jamil (2017) believed that the connection between life situations, problem-solving, and cooperative learning must be strengthened.

As STEAM develops, teaching across fields improves. The concept of an interdisciplinary aesthetic education curriculum is based on the integration of art activation, media, and other disciplines. Elements combined in interdisciplinary aesthetics are found in each discipline. There is a constructed interdisciplinary curriculum with art as the core (Lu, 2019). Aesthetic experience is made the common foundation of all disciplines and enhances students' aesthetic cognition and application ability through interdisciplinary study and practice (Yu, Chao, Lin, Li, 2015; Chao, 2016). The focus of STEAM and interdisciplinary aesthetic education instructional design connects core topics of aesthetic experience through artistic fusion, project-based learning models, exploratory practice activities, and technology fusion (Lu, 2019).

2.2. Factors that Affect Learning Effectiveness

2.2.1. Self-efficacy

Bandura (1977) believed that self-efficacy played an important role in influencing a person's motivation and behavior. Self-efficacy is the degree of self-confidence in one's ability to perform a particular task. The level of confidence affects the choices an individual makes in one's abilities, how much effort is put into a particular task, and how long one perseveres in the face of difficulties or setbacks (Bandura, 1991). Self-efficacy is an individual's assessment of an individual's ability to perform a specific job and was a belief in the ability to successfully perform a task (Ersanli, 2015). Bandura (1982) pointed out that people with high self-efficacy have higher confidence in doing or responding to a specific job, and this expected confidence is likely to lead to better performance. Gist and Mitchell (1992) believed that self-efficacy affects an individual's behavioral intentions and cognitive abilities for a specific job. People with higher self-efficacy have higher confidence in judging and accepting different challenges. Individuals who perceive themselves as having good abilities perform better (Antoncic, Antoncic, and Aaltonen, 2016).

Creative self-efficacy referred to an individual's self-judgment about one's ability to generate novel and appropriate ideas, solutions, and behaviors (Abbott, 2010; Yang and Cheng, 2009). According to Kaufman and Sternberg (2014), creative self-efficacy was self-judgment and belief in an individual's ability to imagine and generate novel and appropriate ideas, solutions, and behaviors. Carberry, Lee, and Ohland (2010) also mentioned that self-efficacy affected how individuals learn. Self-efficacy occupied an important and independent place in each task (Fryer, Ainley, and Thompson, 2016). Fan and Ye (2020) found that participants with a higher perception of design self-efficacy have a higher interest in design. Students with a higher sense of design interest show better performance in learning STEM. The research suggested that self-efficacy affected students' academic performance and explored the relationship between the two.

2.2.2. Participation Motivation and Interest

Wang, Chang, and Liu (2016) discussed the motivation and effectiveness of college student teams participating in the energy technology creative implementation competition. They found that the motivation of students to participate in the competition was the highest, followed by achievement motivation, and learning motivation was the lowest. Through task realization or competition, we further understand the reasons that affect learning or participation motivation. For example, internal motivation factors that influenced learning may include personal traits, attitudes, or experiences, while external motivation factors may include factors such as rewards, environment, or resources (Kreitler and Casakin, 2009). Interest was a learning function for specific content (Fryer and Ainley, 2017). There was a strong relationship between interest and learning (Rotgans and Schmidt, 2014). Interest is critical to successful learning (Lazarides, Gaspard, and Dicke, 2018). A person’s interest in a certain field is related to continuity, effort, learning ability, and actual achievement reflected in the learning process (Schiefele, 2009). Therefore, interest was one of the factors affecting learning achievement (Schnell and Loerwald, 2019). Interest has a positive effect on knowledge acquisition, and the higher the interest, the better the learning effect (Hong et al., 2016).

2.2.3. Grade

Zuo, Jiang, Lu, and Sun (2008) conducted an online questionnaire survey to explore learning attitudes and participation in online mathematics competitions of students at different stages in Taiwan. It was found that the higher the grade and the more experienced students, the better their learning attitude and motivation. Ye, Chang, Chu, and Huang (2007) studied high school students participating in the high temperature superconducting creative competition and found that there were significant differences in the motivation of participating in different grades, genders, and statuses (captain or team members).

Based on the above research, the factors related to learning effectiveness are found in this research. The independent variables are explored including self-efficacy, participation engagement, and grades of students. The impact on the learning and integration of various disciplines is discussed.

3. Research Method

3.1. Research Framework and Assumptions

The purpose of the research was to explore how students' self-efficacy and participation in design competitions affected knowledge and skill learning in various disciplines, in other words, how they influence the ability of students in various disciplines and the integration of design expertise through design competitions. At the same time, it is explored whether students' learning effectiveness of various subjects affected their satisfaction with the competition results.

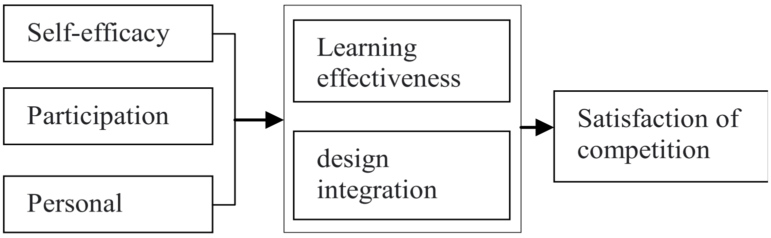

Fig. 1. Research framework.

The assumptions of this research are as follows:

H1: Students' self-efficacy, participation, and engagement were related to learning effectiveness across disciplines.

H2: Students' learning effectiveness in various disciplines have a positive impact on design profession and integration capabilities.

H3: There was a correlation between students' design integration ability and competition satisfaction.

3.2. Competition Objectives and Design Areas

The purpose of the competition was to train students to explore real situations, find problems, and propose solutions in a known field. Students applied knowledge and skills to real situations. Therefore, the competition selected a certain space on the campus of University A as the design field. The space was a long corridor, where students entered and exited in their daily lives. Students were familiar with the environment. At present, the display space is used by various departments of the college for the announcement of information. This competition asked students to use environmentally friendly building materials and smart technology and improve the existing space.

3.3. Process and Content of Competition

It was intended to integrate the abilities of various disciplines through design competitions hoping that students cultivated the abilities of various disciplines by making the competition work. After determining the goals to be learned, three teachers formed a competition research group to discuss the implementation plan of the competition. Details such as course content were decided in the competition. The entire competition process was divided into the announcement of topics, group discussions, professional courses to increase student knowledge and skills, work production, result publication and evaluation, and a questionnaire survey.

The competition was held for a week at the beginning of the first semester of the 2021 academic year. After starting the competition, teachers arranged courses including technology and engineering respectively to reinforce students' knowledge of the subjects. Other subjects were matched with the content of the courses taught during the semester, including design principles, decoration engineering, valuation, and others. Students integrated the knowledge and skills of various disciplines during the competition and produced results through professional technology and practical skills. The purpose of the competition was to strengthen students' learning in various STEAM disciplines and integrate their knowledge and skills. The course plan for the competition was shown in Table 1.

Table 1. planning of STEAM subject content.

STEAM Item	Corresponding Subject Content	During Class
S Science (Principles)	Human factors engineering, color science	Mid-semester courses
T Technology	Smart technology is taught by professional teachers, and computer graphics skills are taught by computer teachers	3 hours lecture
E Engineering	Engineering knowledge and technology taught by material manufacturers and construction personnel	2 hours lecture
A Art	Art of Display, Decorative Aesthetics	Mid-semester courses
M Mathematics and Geometry	Engineering valuation	Mid-semester courses

3.4. Participants

Students from the Department of Interior Design of University A participated in the competition. Each team was formed across grades. Members of each team included students in grades 1 to 3. Each team had 7 to 10 people, and there were 20 teams in total. A questionnaire survey was conducted on students immediately after the design results were published. The questionnaire was conducted in the form of a google form, and a total of 152 forms were received.

3.5. Questionnaire Design

The purpose of this research was to explore the relationship between students' self-efficacy and participation in various STEAM disciplines, their impact on design integration ability, and their satisfaction with the competition. According to the relevant literature and the purpose of the research, teachers edited the questionnaire. The content of the questionnaire included several dimensions, namely: participation and engagement (3 questions), self-efficacy (3 questions), learning in various STEAM disciplines

(5 questions), design integration ability (3 questions), and competition satisfaction (3 questions). In the questionnaire, the Likert five-point scale and self-reporting method was used. Subjects were asked to rate questions with "strongly agree" (5 points), "agree" (4 points), "Neutral" (3 points), "Disagree" (2 points), and "Strongly disagree" (1 point). The student's basic information included their grade and the work in the competition.

3.6. Questionnaire Reliability and Validity Test

Data analysis was performed by using SPSS 22.0, and Cronbach's α was obtained to test the reliability of the questionnaire in each dimension. The reliability coefficient of the total scale was 0.95, and Cronbach's α coefficient of each dimension was between 0.79 and 0.90. This showed that the questionnaire was reliable with a reliability coefficient of over 0.80. Confirmatory factor analysis was used to check the validity of the five dimensions of the scale. The analysis results showed that the total variance of interpretation of all items was 72.11%. The factor loading KMO was 0.93. Considering that compliance with the recommendation that the standard value must be greater than 0.5, the questionnaire of this study was regarded to be feasible.

4. Analysis Results

4.1. Descriptive Statistics

The average number of 17 questions in the questionnaire was above 4 points. The average of the five dimensions was also above 4 (Table 2), indicating that the participants had a certain degree of recognition for the process and results of the competition.

Table 2. Questionnaire dimensions and averages of 17 items.

Facet	Question content	Mean	Standard Deviation	Facet Mean
Participate in the investment situation	1. I am interested in this design competition.	4.18	0.758	4.27
	2. I am actively participating in this design competition.	4.30	0.772	
	3. During the competition, I am happy to work.	4.32	0.742	
Self-efficacy	4. I can handle my work efficiently.	4.17	0.795	4.20
	5. When I encounter difficulties at work, I have the confidence to overcome them.	4.18	0.798	
	6. I can get most of the work done when I'm on a mission.	4.25	0.730	
Learning outcomes by subject	7. This competition strengthens my knowledge and skills in the use of materials.	4.21	0.811	4.14
	8. This competition strengthens my skills in computer use.	3.84	1.030	
	9. This competition strengthens my knowledge and application of smart technology.	4.01	0.895	
	10. This competition deepens my feelings about art and aesthetics.	4.36	0.751	
	11. This competition strengthens my understanding of interior decoration engineering.	4.29	0.769	
Design integration professional ability	12. Participating in design competitions is useful for my study.	4.46	0.699	4.20
	13. This competition allows me to integrate and apply the knowledge and technology of design and construction.	4.05	0.916	
	14. This competition allows me to use my knowledge and skills to solve problems in space.	4.09	0.872	
Competition Satisfaction	15. I am satisfied with the process and content of the competition.	4.26	0.761	4.30
	16. I am satisfied with the results of this competition.	4.31	0.808	
	17. I am satisfied with the cooperation process of the cross-grade groups in this competition.	4.34	0.797	

4.2. Correlation Between Dimensions

Since the scale was an ordinal variable, the Pearson product-difference correlation was used for the analysis. The results show that, at a significant level of less than 0.01, the relationship between "participation and engagement" and "self-efficacy" ($r = 0.78$), "study effectiveness of various subjects" ($r = 0.64$), "design integration professional ability" ($r = 0.63$) and “competition satisfaction” ($r = 0.59$) showed a significant and positive correlation. Among them, the degree of correlation between "participation level" and "self-efficacy" was the highest. "Self-efficacy" and "learning effectiveness of various subjects" ($r = 0.66$, $p < 0.01$), "design integration ability" (r=0.65, p<0.01), and "competition satisfaction" ($r = 0.56$, $p < 0.01$) showed significant positive correlations with each other. "Each subject learning effectiveness" was significantly and positively correlated with "design integration ability" ($r = 0.86$, $p < 0.01$) and "competition satisfaction" ($r = 0.61$, $p < 0.01$). The highest degree of correlation was found between "learning effectiveness of each subject" and "design integration ability". "Competition satisfaction" and "design integration ability" ($r = 0.70$, $p < 0.01$) had the highest correlation.

The results of the correlation analysis confirmed the hypothesis of the research. Involvement in situations showed the highest correlation with self-efficacy. Participation engagement and self-efficacy positively and highly influenced the learning effectiveness of various subjects. Students learning effectiveness in various disciplines positively and highly influenced their ability to design and integrate majors. The students' design integration ability had a positive and high impact on competition satisfaction.

4.3. Analysis of Variance to Explore Differences

4.3.1. Grade

It was assumed that students of different grades had differences in self-efficacy, participation in competitions, learning effectiveness in various subjects, design integration ability, and different satisfaction with the competition. Therefore, one-way ANOVA tests for differences in facets between grades. The verification result showed that self-efficacy ($F = 3.57$, $p < 0.05$), learning effectiveness ($F = 7.25$, $p < 0.01$), and ability of design integration ($F = 4.52$, $p < 0.05$) showed significant differences in different grades. However, there was no significant difference in the dimensions of participation investment and competition satisfaction. The third-and second-grade students showed significantly higher differences in "self-efficacy" and "learning effectiveness of various subjects" than the first-grade students. The second-grade students also had significantly higher "design integration ability" than the first grade.

Since we intended to explore whether students' learning effectiveness in various disciplines was improved through design competitions and understand whether students of different grades had differences in the improvement of their professional subjects through design competitions, the one-way variance was used to analyze the differences in each subject. The test results showed that the learning effectiveness of students in different grades was significantly different in “Material Knowledge” ($F = 3.81$, $p < 0.05$), “Computer Technology” ($F = 21.76$, $p < 0.001$), and “Smart Technology Application”($F = 5.55$, $p < 0.01$). Through multiple comparisons, it was found that the third-grade students had significantly higher material knowledge improvement than the first-grade students. The third and second grades showed significantly higher improvement of computer technology and the use of smart technology than the first-grade students. However, in the improvement of subjects such as "Aesthetic Feeling" and "Engineering Understanding", there was no significant difference between students in different grades.

For whether students in different grades had different integrated professional abilities through design competitions, the result showed that students with different grades had significant differences in “using knowledge and skills to solve spatial problems” ($F = 6.72$, $p < 0.01$). Multiple comparisons showed that more third- and second-grade students thought that the competition helped them use knowledge and solve problems than the first-grade students. Students had a high degree of recognition that "the design competition was useful for their learning integration". Therefore, there was no significant difference between students in different grades in learning integration. All students were satisfied with the process and content of the competition, the results of the work, and the cooperation process of the group. Therefore, there were no significant differences in satisfaction with the competition between students in different grades.

4.3.2. Main Work that Students Were Responsible for

The completion of work included many tasks in the competition. Team members were responsible for different tasks that required different knowledge, technology, and computer software. If students performed different tasks, there might be differences in the learning effectiveness of each subject and the integration ability of the design major. Therefore, the competition design work was divided into three categories: (1) 2D or 3D drawings, (2) post-processing of drawings, layouts, and presentations, and (3) models or other work.

Single-factor variance analysis was used for testing the difference between learning effectiveness and different tasks. The test results showed that there were significant differences in the learning of subjects such as “computer technology”($F = 12.77$, $p < 0.001$) and “smart technology application” ($F = 3.89$, $p < 0.05$). Further multiple comparisons found that students working on “2D or 3D drawing” and “making layouts and presentations” showed significantly better results than those who perform other tasks. In addition, students working on “making layouts and presentations" used smart technology more than those working on other tasks. The results of the analysis showed that there were significant differences in "using knowledge and skills to solve spatial problems" ($F = 3.62$, $p < 0.05$) when performing different work contents. Students working on "2D or 3D drawing" showed a higher ability to use knowledge and skills to solve problems than those working on other tasks.

5. Discussions

5.1. Correlation between Variables

In the questionnaire survey, the average score of each dimension was above 4 points. This indicates that students had a high degree of recognition for participation in design competitions and learning. Among them, satisfaction with the competition was higher than satisfaction with group cooperation, competition process, and results. However, the recognition of learning effectiveness was low in subjects, especially in the use of computer technology. Overall, students agreed that design competitions were helpful for subject learning, strengthening the integrated application of knowledge and technology, and solving spatial problems.

Students' participation in the competition was highly correlated with students' self-efficacy. These two variables represented students' initiative to participate in the competition and their confidence in completing the design task. Students who actively participated in the competition had higher confidence in their ability to complete their assignments. The correlation between self-efficacy and learning effectiveness in various disciplines and the professional ability of design integration was more significant than that with the participant’s situation. In other words, when students felt confident that they could complete the design tasks, they showed better results in the learning of various disciplines and technologies, as well as a high degree of recognition of the integration ability of design. Therefore, the research confirmed the importance of self-efficacy for learning effectiveness and design integration across disciplines. The learning effectiveness of students' knowledge and technology was highly correlated with the design integration ability in various disciplines. This implies that in the process of design competition, the knowledge and technology of various disciplines need to be used, and the completion of works also needs to integrate the knowledge and technology of various disciplines. Therefore, students need to be based on the knowledge and technology of various disciplines. When students study well in various disciplines, their design integration ability becomes better. The research result confirmed that the knowledge and technology of various disciplines influenced the integration ability of design.

The design competition was to integrate various knowledge and skills of design and then produced design results. If the abilities of the design are integrated and used, the student's satisfaction with the competition becomes higher. Students' satisfaction with the competition results in integrating and utilizing their design expertise. In other words, the better the students' integration ability, the better their satisfaction with the competition outcomes.

5.2. Differences in Grades

The competition for the research was combined with the participation of first- to third-grade students. Therefore, the opinions of students in different grades on the design competition were analyzed. Statistics showed that the first to third-grade students' satisfaction score with the competition was about 4.3, showing that the students were satisfied with the process and results of the competition. In terms of participation, the students scored above 4 points. The participation level of the third-grade students was higher than that of the second-grade students who showed a higher level than the first-grade students. The reason for this was that the third-grade students took a role of a leader in the team. Therefore, they must actively participate in the design competition. The second-grade students did their tasks by assisting the senior. As the first-grade students were novices, they worked on assigned tasks from the senior, so their participation level was relatively low.

In terms of self-efficacy, the third-grade students had at least two years of professional training and abilities and experience in participating in competitions. Therefore, the self-efficacy of third-grade students was significantly higher than that of first-grade students. Although the second-grade students studied for a year, they still needed to strengthen their professional knowledge and technology. Through the participation process of the design competition, they could learn knowledge from the instructors and design methods from the third-grade students. They learned to integrate knowledge and skills and use them to solve spatial problems. The results of the research showed that the second-grade students had the most significant improvement in their professional knowledge of various subjects and the integration ability of design. Therefore, we concluded that design competition was more helpful for second-grade students in subject-integrated learning.

5.3. Compare Differences in Learning Across Disciplines

In this research, we required students to use specific materials which were created according to the curriculum during the competition process. The third-grade students had learned the relevant material knowledge in the previous semester and had a basic understanding of the material. Based on their existing knowledge, they used the materials to solve design problems. Therefore, after the competition process, the ability of the third-grade students to know and use the material was improved significantly more than that of the second-and the first-grade students. On the other hand, in the competition, the second and third-grade students played the role of main computer illustrators and work producers. Therefore, their improvement in computer technical ability was significantly higher than the first-grade student's ability. The second and third-grade students were also more aware of smart technology. The competition enhanced their use of smart technology in solving space problems. The result showed that the design competition had obvious differences in the learning situation of students of different grades, and the higher grades, the higher degree of ability enhancement was observed.

6. Conclusions

The purpose of this research was to explore the impact of students' self-efficacy and participation on subject learning and design integration through design competitions. The research results showed that short-term design competition could grasp the enthusiasm of students' participation and increase their interest in learning. Through the competition, students improved their knowledge and technical ability in various disciplines. Moreover, competitions helped students integrate their professional abilities and improve the learning effect of integrating interdisciplinary majors. Design competitions were used as an implementation method for STEAM education. The results showed that different grades of students had different levels of self-efficacy and participation. There were also differences in the ability of professional learning effectiveness and interdisciplinary integration. Third-grade students had been trained for two years for their intellectual skills and creative aesthetics. Therefore, they had higher self-efficacy, which made them more confident in completing design tasks, and their learning effectiveness in the subjects was better.

Although the second-grade students have been taught basic learning, they needed more ability to solve professional problems. In the competition, the second-grade students learned and completed the design tasks through discussion and teamwork with the seniors. Thus, the second-grade students achieved good results in the integration of learning and design abilities in various subjects. Because the first-grade students were novices, they were not familiar with knowledge and technologies. The design competition provided them with an overview of design fundamentals and design processes for a short period. Therefore, formal courses were still required for the development of various disciplines and majors for first-grade students. The research results revealed that aesthetics and artistic ability were not improved through a design competition, because aesthetics was the long-term accumulation and self-cultivation of students. Therefore, there were other ways to improve students' aesthetic ability in this regard. On the other hand, engineering skills need to be trained and implemented through field practice. Therefore, it is impossible to enhance students' engineering skills in a short period. In this research, we only discussed the design integration of disciplines and learning effectiveness in terms of participation and self-efficacy in a design competition. Many factors that affect student learning will be discussed in subsequent research.

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