Evaluation of the Result and Benefit from international summer camp using CDIO framework

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ABSTRACT

In this study, we are going to display the result and evaluation of the 1st CDIO summer camp hosted by Feng Chia University in July 2018. Forty-five students from four countries and five different schools, Taiwan, Singapore, Vietnam and Malaysia, have worked together and completed the project of “i-Night Market”. The greatest challenge in this camp is that the students had to go through the process of “conceive, design, implement and operate” in just 1 week, and also, to make the actual product prototype. In order to evaluate the effectiveness of the camp, we’ve used the Kirkpatrick Model (1959) to design the questionnaire and asked the students to fill it out in the beginning and at the end of the camp. Post project appraisal has shown that the CDIO framework is very suitable for operating a camp and letting the students understand the learning objective of each phase. Seeing the actual performances from the students, we think the CDIO Summer Camp in the future could be adjusted to the “online and offline” framework. Students could then finish the C and D phases on the online platform and begin with the I and O phases right after forming the team.

KEYWORDS

Keywords: i-Night Market, Multinational, Multidisciplinary, CDIO, Active Learning, Standards: 1, 2, 3, 4, 5, 7, 8, 11.

INTRODUCTION

Background

In the year 2015, Feng Chia university had learnt and realized a way for innovative engineering education, the CDIO framework, and had first undergone a reformation to the engineering

related departments. Being a part of a comprehensive University as Feng Chia University, we have also tried to assimilate the CDIO framework into the PBL courses from the finance and humanities departments as we were promoting it. We have learnt that after the students went through the "conceive, design, implement and operate" phases in the seminar, the effectiveness of learning in classes has improved. Moreover, the process also assisted the learning effectiveness in other classes. With the positive results, Feng Chia University would like to promote the CDIO framework, allowing more students to get to know this kind of learning framework. At the same time, we hope to add some element of cross-country cooperation in the seminar, thus enhancing the opportunities of international communication for students.

Figures 1. Photograph of 2018 CDIO Summer Camp

July and August are summer vacation for students in Taiwan. Therefore, we hosted the 2018 CDIO Summer Camp during this period while the campus was empty, and turned the campus into a place for cross-country communication. We invited schools from Singapore, Malaysia and Vietnam, including Singapore University of Technology and Design, Singapore University of Social Sciences, National University of Malaysia, Thai Nguyen University, Ton Duc Thang University in total 32 students from 5 universities, along with 13 students from Feng Chia University, to go through a 10-day's journey to experience the full CDIO process.

In addition to the most crucial components of project, conceive, design, implement and operate, the Summer Camp also includes many other activities, like field exploration, lecture for cultural observation, introductory lecture, and group construction…etc. Students went through two major presentations, process examination and achievement display, and numerous minor oral presentations, sharing concepts, designs, prototypes with each other and having peer examination at the same time. We've specifically accommodated all students in the university dormitory, allowing them to discuss the seminar at night after their classes or activities. At the

end of the camp, students had to complete their final task by integrating what they've learnt in the camp and propose a solution to "how to make Feng Chia night market intellectual".

Feng Chia night market is located beside Feng Chia University and is the biggest night market in central Taiwan. The night market is full of delicious foods, it's very entertaining and is easy to shop through. Therefore, it is a must-go attraction for both local and foreign tourists when visiting Taichung city. According to the statistics from the Feng Chia University's statistical marketing research group on the night market, there are about 20,000 people visiting the night market per day during non-holiday and more than 50,000 people per day during holidays. The idea of University social responsibility has been brought up in recent years, and Feng Chia University is striving to improve and promote Feng Chia night market. The main theme, "i-Night Market", is set to respond to the mainstream of the current global trend, that is intellect. Students should design a plan or proposal to enhance the capability of the night market in facing such a huge flow of people. On the other hand, we also hope that our foreign students could get to know about Taiwanese night market culture while working through the project.

This study focuses on introducing how Feng Chia university designed the curriculum for the camp, allowing students to experience the 4 stages of "concept, design, implementation and operation", and to output the actual product prototype. In the end, we analyzed the questionnaires students filled out in the beginning and the end of the camp and discussed the result and advantages of applying CDIO in an international summer camp.

Method

In the past 5 years of the annual conference held by the CDIO Initiative, the only article that shares a similar concept like in this study is "Capstone Bootcamp Concept Catalyzing Project-based Learning", published by University of Turku and Fudan University. Therefore, in this camp arrangement, we refer to the CDIO Standards method used by Capstone Bootcamp, focusing on Standard 1, 2, 3, 4, 7, 8, 11. In addition, since 2016, Feng Chia University participated in several CDIO Initiative CDIO Academy to observe how to handle transnational CDIO topics in a short time. Based on the two experiences mentioned above, the first edition of the structure for CDIO Summer Camp in Taiwan was created.

In order to evaluate the result and advantages of applying the CDIO framework on an international summer camp, this study is using the theory that Donald L. Kirkpatrick proposed in 1959, the four levels of evaluation model: reaction, learning, behavior, and result to design the questionnaires. The Kirkpatrick evaluation model emphasized observing the knowledge transfer and skill acquisition of the student after learning. And also made valuable contributions to training evaluation thinking and practice. It has helped focus on training evaluation practice on outcomes (Newstrom, 1995). In Kirkpatrick's model, the distinction between learning level (the second level of the theory) and behavior level (the third level of the theory) has drawn increased attention to the importance of the learning transfer process in making training truly effective. (Alliger & Janak, 1989). Therefore, this model underscored the importance of examining multiple measures of training effectiveness. (Wang, 2003). Furthermore, the model also emphasizes on the variation of the student's ability in the application and actual practices. This study believes that by implementing this evaluation system, we could understand student's level of outcomes in the four stages of "conceive, design, implement and operate" after completing the CDIO process, and then adjust the content of the camp accordingly.

Table 1. The pre-test questionnaires

SD: Strongly Disagree / D: Disagree / A: Agree / SA: Strongly Agree

Reaction Please base on your experience measure your satisfaction and reception of the curriculum planning.		**SD**	**D**	**A**	**SA**
1	From the past learning experiences, teachers taught or encouraged students to apply the design thinking tool in class.				
2	From the past learning experiences, teachers taught or encouraged students to think innovatively or distinctively in class.				
3	From the past learning experiences, teachers cultivated ability to discover the problems from surroundings and solve them with creative design in class.				
4	From the past learning experiences, teachers taught or encouraged students to share and integrate information in class.				
5	From the past learning experiences, teachers encouraged students to have teamwork in class.				
6	From the past learning experiences, teachers taught or encouraged students to communicate with interdisciplinary team members in class.				
7	From the past learning experiences, teachers taught or encouraged students to brainstorm the relative issues in class.				
8	From the past learning experiences, teachers taught or encouraged students to design the prototype in class.				
9	From the past learning experiences, teachers taught or encouraged students to produce the prototype in class.				
10	From the past learning experiences, teachers taught or encouraged students to present and promote the object in class.				
11	From the past learning experiences, teachers applied the project-learning strategies in class.				

Table 2. The post-test questionnaires

Behavior Please complete a self-evaluation of whether you can practically apply those previously learned strategies to the project in class after the learning stages.		**SD**	**D**	**A**	**SA**
1	In this lecture, I applied the design thinking tool in class.				
2	In this lecture, I tried to think innovatively or distinctively.				
3	In this lecture, I discovered the problems from the surroundings and solved them with creative design in class.				
4	In this lecture, I shared and integrated information with classmates in class.				
5	In this lecture, I had teamwork with my classmates in class.				
6	In this lecture, I communicated with my interdisciplinary team members in class.				
7	In this lecture, I brainstormed the issues in class.				
8	In this lecture, I designed a prototype in class.				
9	In this lecture, I produced a prototype in class.				
10	In this lecture, I presented and promoted an object in class.				
11	In this lecture, I executed a complete project in class.				

The questionnaire designed the experience of several stages of CDIO, teamwork, and project learning. The pre-test and post-test questionnaires are set in the same way. The pre-test is based on "from the past learning experiences" (Table 1.). We would like to know the learning experience of the students before joining the camp. The post-test starts with "in this lecture" (Table 2.) and want to know the students' effectiveness in four levels of reaction, learning, behavior, and results.

CDIO SUMMER CAMP IN FENG CHIA UNIVERSITY

How to design a camp based on the CDIO framework

CDIO is an innovative pattern of teaching. Apart from integrating the framework into engineering-related departments, Feng Chia university also applies it on business and humanities studies. We have discovered that the "conceive, design, implementation and operation" structure could complete the learning of a seminar. Therefore, we've imported the CDIO standards when designing the camp, hoping that the students from different countries could provide their specialties to the team and propose a plan for "How to make Feng Chia night market intellectual".

The camp preparation team has set a final learning goal based on the Learning outcome (standard 2), expecting the students to grasp the knowledge of terminologies related to intellectual city, and accustoming to new teaching and learning methods, for example: learning by doing, compound learning, peer learning, and abilities to communicate with groups and present on stage. After setting the learning goals mentioned above, we assisted the students with the integrated curriculum (standard 3) like: seminar lecture, introductory lecture, conceiving tool, questionnaire design and analyzation, team construction…etc. It allows students to strengthen their personal skills, social skills and other seminar constructive skills through an integrated learning experience and active way of teaching (standard 7, 8).

Before the camp started, we first introduced the process and core value of CDIO, according to standard 1 and 4. Then, we explained ways and methods for the final proposal, field background, design and implementation process in the process of proposal and moreover, the individual and social skills needed in the course. The entire period of the camp consists of 2 design-implement experience (standard 5), which are the design and implementation for questionnaire and proposal. Since this summer camp mainly emphasizes on international communication and the promotion of the CDIO framework, the learning assessment (standard 11) is based on student's self-value on their learning effectiveness.

Intended Learning Outcomes and Connections with PBL & CDIO

After a series of comparisons, Edstrom & Kolmos (2014) proposed that CDIO and PBL (project-based learning) are complementary. If the two are combined, a better curriculum could be designed and a more advanced learning outcome could be developed. In fact, Feng Chia University has been promoting PBL for quite some time already. The CDIO summer camp we organized has combined CDIO and PBL, hoping that students from all countries and schools could experience and understand the application of the CDIO framework. Xing Guo (2015) mentioned that if a short and intensive camp is to be held, it is necessary to arrange lectures and design the "practice" part, which must be alternated. For example, prototyping and team building can improve student learning effect. When Feng Chia University planned the camp, it integrated this idea.

The main content of the CDIO summer camp will be described in the following article followed by an explanation of the learning outcome set by the design team and its relevance to PBL and CDIO in Table 3:

- Lecture: We invited a specialist from abroad to lecture "Intellectual city and intellectual application in countries around the world". Other introductory lectures are mainly taught by teachers from Feng Chia University and industrial lecturers from industries related to

Taiwan's intellectual transportation. They introduce various AI identification systems for transportation, smart storage and parking lots.

- Field investigation: We combined field exploration with group activities and competitions, allowing students to enter Feng Chia night market with a layman's perspective. This assists them during the conceive stage of the project.
- Creative thinking: By teaching brainstorming 6-3-5, 5W2H and two-dimensional quadrant method, students could make the best use of their creativity and collect numerous ideas.
- Questionnaire: The principles and cognition of the questionnaire are taught to enable students to use a micro version of "design-implementation" to assist the overall proposal from the design phase to the implementation phase, and to approach and meet the user's needs.
- Prototype production: Through the various processes of divergence, convergence, and validation, students who have confirmed the content of the proposal must produce prototypes of the products, processes, or systems that drive their solutions.
- Result display: Students will have 8 to 10 minutes to elaborate the CDIO process they've experienced and to propose a plan of "How to make Feng Chia night market intellectual", with the key product, process or system that could perform the plan.

Table 3. The learning outcome relevance to PBL and CDIO

Program	**Intended Learning Outcomes**	**Connection with PBL Principles**	**Connection with CDIO systems**
Lecture	Master the application of the intellectual city and the relevant terminologies.	Cognitive Learning/ Content	C
Field investigation	Team construction, teamwork, to view the field of the seminar from different perspectives	Content	C&D
Creative thinking	Learn and apply skills for creative thinking, practice trying new and unique ideas	Cognitive Learning/ Content	C&D
Questionnaire	Have the ability to perform ideas through "design-implement", learn how to survey and analyze questionnaire	Collaborative Learning	D&I
Prototype production	Have the ability to perform ideas through "design-implement", strengthen personal and social skill through the process of making the prototype	All three principles above	I
Achievement report	By presenting their result, students show all the intended learning outcomes mentioned above	All three principles above	O

DATA ANALYSIS

Sample

The samples this study collected are from forty-five students who attended the CDIO Summer Camp. There are thirteen students from the Taiwan University of Feng Chia, six students from Singapore University of Technology and Design and University of Social Sciences, eight students from the National University of Malaysia, and eighteen students from Vietnam University of Thai Nguyen and Ton Duc Thang University. The questionnaire designed from the Kirkpatrick evaluation model was given twice in total. The first time was before classes began, and the second time was after all the classes ended. The overall response rate and validity of the questionnaires was 100%.

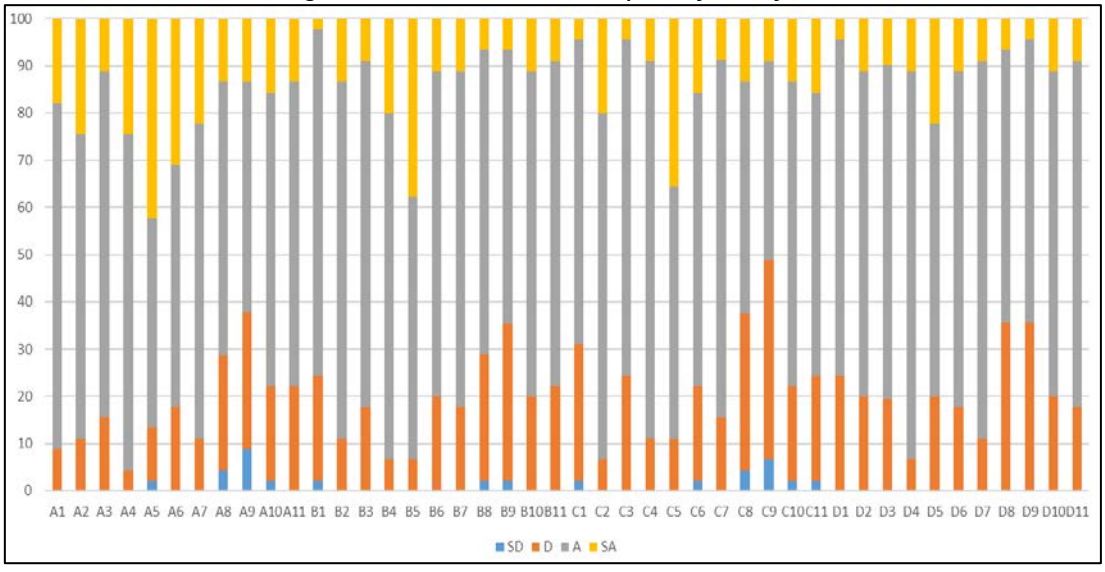
Process

The questionnaire is divided into four parts, the first part, personal information, the second part is about the satisfaction rate from former learning experiences and the overall learning experience of the camp; there are in total 5 questions in this section. The third part was designed based on Kirkpatrick's four levels of learning, which contains the level of reaction, learning, behavior and result. This part has a total of 16 questions. The first three levels each have 11 questions and are about the process, conception and teamwork of CDIO. The result level had 4 questions about comprehensive ability. The fourth part contains 3 short answer questions to help understand student's opinion on international communication, cross-field teamwork, integrating CDIO into classes and the activities. All scales were based on the four terms from Likert scale. It takes 15 to 20 minutes on average to finish each questionnaire.

Result

The study analysed the four levels of reaction, learning, behavior, and result. First, based on the analysis of the distribution of statistics (Figure 2.), students have experience in conceiving, DIY and teamwork before participating in the camp. The most lack of experience is "Design the Prototype", so the students' responses are falls in 1 or 2 scores.

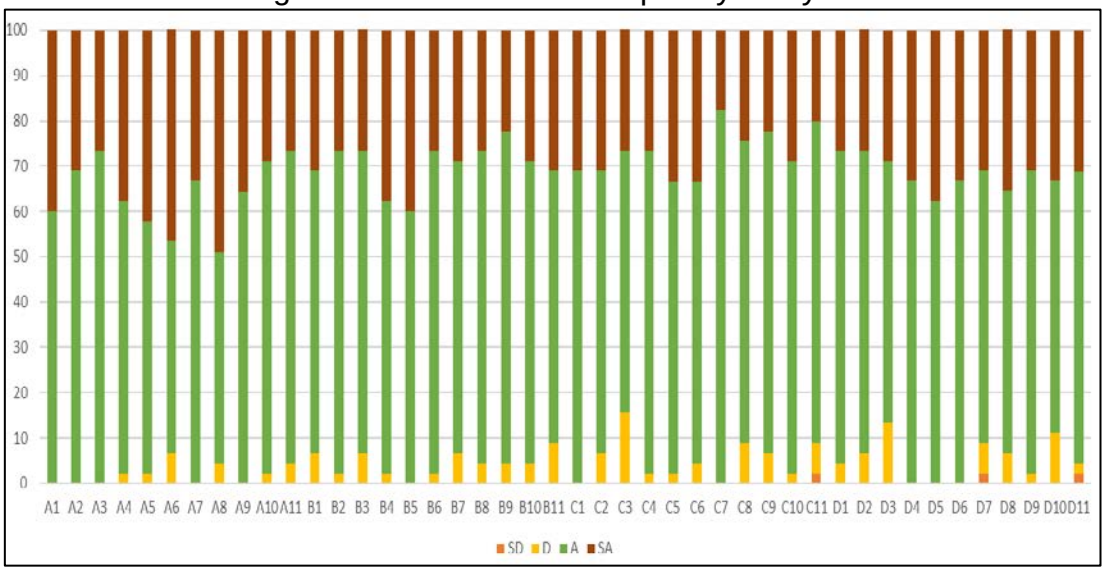
Figure 2. The Pre-test Frequency analysis



After training for the entire summer camp, the results of the post-test statistical analysis (Figure 3.) found that more than 80% students were satisfied with the reaction, learning, behavior and results of each level. There are 11 questions for all students to fill in the score is 3 or 4. Among

them, there are five questions focused on the reaction stage, showing that students are very satisfied with the procedure of the camp. Comparing Figure 2. and Figure 3.it can be observed that the learning outcomes of students' reaction, learning, behavior and result have significantly improved.

Figure 3. The Post-test Frequency analysis



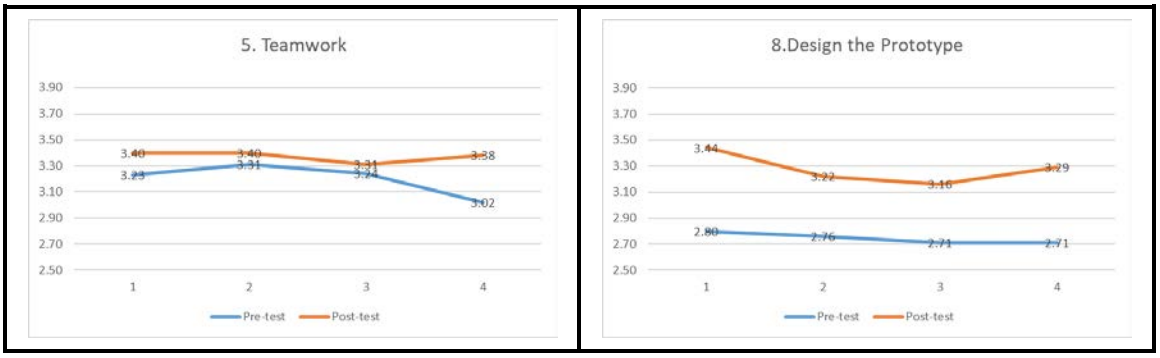
Next, with the paired sample t-test can be more objectively analyzed. The team members show their results in the four stages of the Kirkpatrick model (Table 4.). In the statistical analysis, $\rho < 0.05$ means a significant difference, and $\rho < 0.01$ means a very significant difference. In the t-test results of the camp, the reaction level has significant learning results, and the three levels of learning, behavior and results are very significant growth. Therefore, we believe that this summer camp is successful for CDIO procedure, teamwork, and project learning.

Table 4. The Result of the Paired Sample t-test

	N	M		SD	T	ρ
		Pre-test	Post-test			
Reaction	45	3.00	3.25	.360	2.222	.050
Learning	45	2.92	3.25	.121	8.827	.000
Behavior	45	2.88	3.20	.181	5.883	.000
Result	45	2.90	3.26	.142	8.219	.000

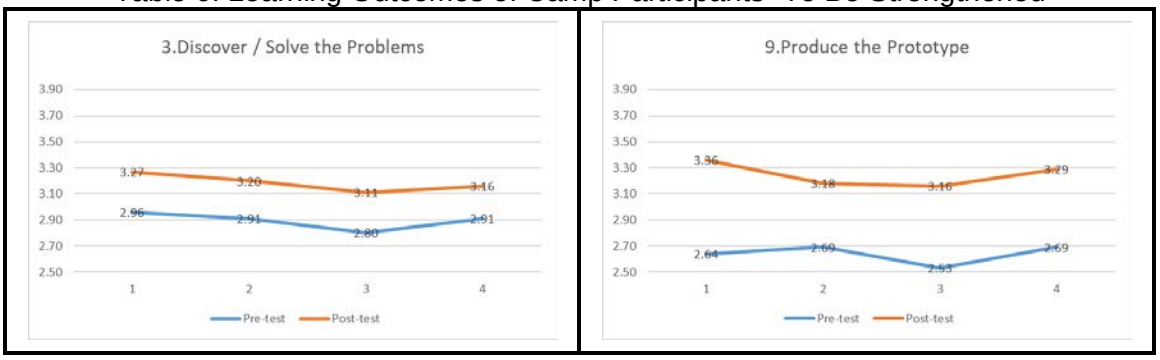
Finally, we make the average of the 11 questions answered by the students into a line graph, and compare the pre- and post-tests to observe the detail differences between the students' before and after learning. The best learning outcomes are "Teamwork" and "Design the Prototype". It is seen from the two line graphs that the students' "reaction" and "result" stages are quite close, indicating that the students have learned both skills.

Table 5. Learning Outcomes of Camp Participants-Positive



From the "Discover / Solve the Problems" and "Produce the Prototype" line graphs observations, the minimum value falls in the "behavior" stage, indicating that students are unable to apply these two skills smoothly during the course. This is the main points that we should expect ourselves to become better when we plan to design the team next year.

Table 6. Learning Outcomes of Camp Participants- To Be Strengthened



CONCLUSION

The CDIO Summer Camp is the first time that Feng Chia university integrated international communication with the CDIO framework. On one hand, the university hopes to promote the CDIO framework. On the other hand, it hopes to build and create different proposals for “i-Night Market” through the brainstorming from different countries and fields. In order to evaluate the result and advantages of integrating CDIO into the camp, we’ve performed questionnaire surveys at both the beginning and the end of the camp. The curriculum and activities designed based on the guidelines of concept, design, implementation and operation are truly helpful for the enhancement of student’s learning results. In terms of the proposals, products, processes or systems that each team proposed in the end, they all showed a good scale of feasibility.

From the analysis and observation of the questionnaire, we can understand that the learning outcomes of the self-assessment of the students are also doing well. In the comparison of the pre and post t-tests, it can be seen that after the participants have participated in the camp, the learning results of the CDIO at different stages, teamwork and project learning experience have been significantly improved. This shows that the CDIO framework is suitable to integrate into a camp and become the guideline for curriculum or activity design.

For the planning team of the camp, the most difficult part is to distribute CDIO into the curriculum and activities in proportion, allowing students to experience the process of CDIO in

a short amount of time. In fact, while we did self-evaluation, we all agreed that C and D are important phases, but they've also taken up too much time from the camp. This opinion is also consistent with the results we got from the questionnaire. Therefore, the CDIO Summer Camp in the future will be adjusted to the form of O2O, hoping to achieve the same thing as in the CDIO academy, letting students conduct the C and D phases through the online platform. In that case, when being face to face in the camp, students could immerse deeply in the phases of implementation and operation.

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