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THE PROJECT DESIGN EDUCATION COLLABORATING WITH CITY GOVERNMENTS AND COMMUNITIES

Takao ITO, Masako SHIN, Keisuke MIYAZAKI, Setsuo IWATA and Eiichi SENTOKU
Kanazawa Institute of Technology, Nonoichi, 921-8501, Japan

ABSTRACT
Kanazawa Institute of Technology (KIT) applies Project-Based Learning (PBL) as a backbone of the curriculum and names it Project Design Program. The program combines its curriculum and extra-curricular activities to obtain innovation skills. Knowledge and skills are learned repeatedly, and used in order to tackle project problems. Although students usually solve their own familiar problems, a new approach to collaborate with city governments is suggested. Some of the city departments brought up their issues and students tackled these problems in teams. Some students continued their proposed projects as extra-curricular activities with the local community even after the curriculum course. In 2015, nine issues were identified from two cities and seventy-three projects were formed to work on those problems.. Project members were from 10 KIT departments. This paper presented three design projects, namely: "preserving historical cultural sites," "promoting tourism," and "supplying temporary housing." Students designed room arrangements, guidebooks and 3D CAD models of temporary housing. Level 1 and Level 2 evaluation of Kirkpatrick's four-level model was used to measure pedagogical effects of the collaboration approach. The growth degree of required skills and knowledge of 1,609 students was investigated using a survey questionnaire. The results of 1,447 respondents show statistical improvements of the students' innovation skills, including presentation skills, leadership, and idea creation.

Keywords: PBL, project design, collaboration, extra-curriculum, government.

1 INTRODUCTION

Project-Based Learning (PBL) is one of the key components to guarantee the quality of engineering design education and to satisfy ABET (Accreditation Board for Engineering and Technology) criteria set for the engineering education curriculum. ABET and JABEE (Japan Accreditation Board for Engineering Education) define engineering design as the process of devising a system, component, or the process to meet desired needs [1]. CDIO also sets standards for engineering education which includes design-implement experiences and active learning [2].

Kanazawa Institute of Technology (KIT) has applied Project-Based Learning (PBL) as a backbone of its curriculum, and names it Project Design Program (PD) [3-4]. The PD program is applied in 14 departments in four colleges of KIT: College of Engineering, College of Informatics and Human Communication, College of Environmental Engineering and Architecture, and College of Bioscience and Chemistry. The focus of this program is the use of the design process to solve the problems, and at the same time, to enhance students' innovation skills rather than specific engineering theories.

The PD program also pays attention to "Ba", a Japanese term for "a shared space for emerging relationships" [5-6]. "Ba" can be a physical meeting space, a virtual internet space, or a shared experience space. Individual and/or collective knowledge can be created through the spiral process of interactions. KIT has 24-hour available study rooms, team work spaces and facilities for designing and producing models/ prototypes.

In order to meet challenges in design engineering education, many attempts to collaborate with industries have been made. Working with experts who come from industries gives students deeper insights into the design process [7]. In sophomore Project Design course, some projects are implemented in collaboration with city governments and communities. Since staff members of city

governments are experts in their fields and have deep insights about the city problems, our students can get good feedbacks for their designs from them.
Kirkpatrick's four-level model has been widely used as the techniques for evaluating training programs [8]. Level 1 and Level 2 evaluations were used to measure pedagogical effects. Through these projects, meaningful pedagogical effects are observed.
The following parts of this paper are organized as follows: Section 2 will describe the pedagogical purpose and the program structure of the Project Design program with extra-curriculum activities. In Section 3, three examples of projects collaborating with city governments and communities will be shown. Pedagogical evaluation results will be discussed in Section 4. Section 5 will discuss the conclusion of the paper.

2 PROJECT DESIGN PROGRAM

KIT's pedagogical system considers high school students as inputs and nurtures them to become independently minded and actively engaged engineers [9]. These 'would be' engineers should be equipped with innovation skills and be able to create solutions to problems.
The system consists of a curriculum for grades and extracurricular activities. The curriculum is designed to realize a practical education required for global standard engineers. Extracurricular activities are reinforced to tackle the real-life problems.
PBL has been applied to Project Design program which is the backbone of KIT's curriculum. Within the program, the design process for problem-solving is emphasized; the innovation ability to work out is enhanced; and the best solution to a problem will be specified in a team.
Project Design program has 5 courses as shown in Table 1. Each course is held for 16 weeks in each semester. They are compulsory for freshmen, sophomores and seniors in all four KIT's colleges, which means more than 1,500 students take each course every year.
In Project Design 2 (PD2) course for sophomore, students set up the design theme from main topics related to their majors. They were required to find out their familiar problems connected with the main topic and create feasible ideas to solve the problems. They continued their proposed projects in another course, "Project Design Implementing & Operation" (PDIO) to embody and verify their ideas using experiments. PD2 and PDIO educational process is shown in Figure 1.

Table 1. Project Design Program Courses and Main Contents

Grade	Freshman		Sophomore		Senior
Course	Project Design Introduction	Project Design 1	Project Design 2	Project Design Implementing & Operation	Project Design 3
Main Contents	Experiment methods	Idea creation	Idea into shape	Verification experiments	Graduation thesis

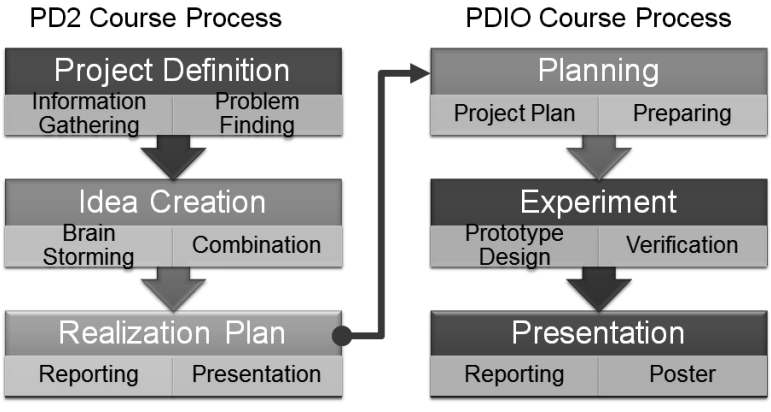

Figure 1. PD2 and PDIO Educational Process

In KIT's curriculum, extracurricular activities also play an important role. The expert performance is closely related to the assessed amount of deliberate practice [10]. 16-week course hours are not enough to develop engineering skills. The combination of formal education in classrooms and extracurricular experience helps students acquire engineering proficiency. KIT prepares programs in which students can set up objectives by themselves and work to achieve these objectives. For example, YUMEKOBO Projects (YUMEKOBO is a Japanese term which refers to the Factory for Dreams and Ideas) are self-directed projects to develop students' technical competence [11-12]. There are also many extracurricular projects collaborating with industries and communities.

3 PROJECTS COLLABORATING WITH CITY GOVERNMENTS AND COMMUNITIES

In PD2 course, other than discipline-related main topics, nine issues were brought up as main topics from Kanazawa City and Nonoichi City in 2015. During the phase of defining the PD2 Project, the staff from the nine city sections came to KIT and presented their issues and discussed their strategies.
The students who decided to tackle the city problems started working on the issues, gathered related information and defined their projects. Some students visited the city offices or conducted interviews with local people in related places. After creating ideas to solve the problems, they presented their ideas to the city staff and got their feedbacks.
1,609 students of 14 KIT departments took PD2 and PDIO in 2015. These students were divided into 291 project teams, out of which 73 project teams from 10 departments tackled problems of the city governments.
This section will show three key projects from the class of Department of Architectural Design. The first team of five members tackled Machiya project. The second team of six members worked on the project to enhance tourism. And the third team of six members dealt with temporary housing in emergency. These projects were good examples because they were closely related to the academic majors of the team members and students obtained the good results by collaborating with the city governments.

3.1 Machiya (Old Townhouses) Project

"Machiya" refers to Japanese traditional wooden townhouses built before 1950. A typical Machiya is shown in Figure 2 below. They add historical charm to Kanazawa City. However some of them were broken down because of higher maintenance cost. Therefore, Kanazawa City government called for initiatives from students to make plans to keep and use these old townhouses effectively.

Figure 2. Machiya Old Townhouses in Kanazawa City

In PD2 class, students learned how to explore customers' demands and create ideas. A team of five members decided to work on Machiya project. As extracurricular activities, they collected information from the city government staff members and found that there were many regulations. They also went to the Old Townhouse area and investigated the inner structure of these houses. They created an idea of using the townhouse as a shared house. Later, they designed plans for room arrangement.
In the continuing PDIO class, they learned the conjoint analysis from literatures by themselves and verified their designs using structured questionnaire methods. They set parameters of the questionnaire for the number of roommates, dimensions of a room, and rental cost. Figure 3 shows their verified room arrangement.

Figure 3. Verified room arrangement of Machiya

3.2 Traveller's Guidebook Project

More than eight million tourists visit Kanazawa in a year and nearly three million of them stay as hotel guests. It is expected that the number of tourists to Kanazawa continues to increase. The government requested enhancement plans of tourism. A team of six students decided to design new traveller's guidebooks for tourists.

To do this, they surveyed the traveller's guidebooks in markets, pamphlets of tourist agencies, and web pages of tourist spots. They particularly focused on the guidebook, information of tourist spots, and page design. They also studied colouring, paper materials, and the golden ratio for layout from literature.

Figure 4 shows the design of a new tour guidebook. Album area and checked box are added so that users can stick their photographs to keep the guidebook as a memory.

Figure 4. Design of tourist guidebook pages

3.3 Temporary Housing Project

After the Great East Japan Earthquake in 2011, every city in Japan has been required to make a disaster plan. Nonoichi City Government requested students make plans for supplying temporary housing, building temporary housing, and at the same time keeping the privacy.

After surveying government's and residents' needs, a team of six students had an idea of using transport containers as temporary housing. They presented their plan to the city staff and got good their feedbacks.

In the architectural specialized course, they learned how to use 3D CAD design tool [13]. By using this tool, they not only made models of cardboards, but also applied the knowledge of making 3D models to verify the living environments.

This project is a good example of collaborating design education because PD2 and PDIO act intermediately between knowledge learned in a specialized course and real-life community problems. Students developed their knowledge learned from specialized courses through PD courses.

4 PEDAGOGICAL EFFECTS

To measure pedagogical effects of the collaboration approach, Kirkpatrick's four-level model was used. Level 1 (Reaction) measured customers' satisfaction. The knowledge acquired and skills improved were measured by Level 2 (Learning). Level 3 (Behaviour) measured the behaviour change. Level 4 (Results) measured the outcome. Among 4 levels, Level 1 and Level 2 evaluations were used to measure pedagogical effects of the collaboration projects with the city governments.

In Kirkpatrick's Level 1 evaluation, 1,609 students who took PD2 class were asked to complete feedback survey sheets in the final class of the course. The survey included students' satisfaction and enthusiasm for the course. More than 90 % students answered they were enthusiastic and satisfied with PD2 class.

For Level 2 evaluation, questionnaire-based evaluation was carried out three times during week 1, week 8, and week 12 in order to measure the growth of students' skills. The questionnaires of 28 questions were designed to evaluate students' self-confidence in the objectives of the courses. Questions are listed on Table 2. They are on a 5-point scale; 5-OK, 4-possible, 3-uncertain, 2-not good at, and 1-cannot. Questions A to E asked about their skills required to work as an engineer: oral presentation, reporting, team working, ethics, and gathering information. Questions F to I asked about their understanding of the design process: finding problems, specifying requirements, idea creation, and embodying ideas.

Table 2. Questions

No.	Skills relating questions
A1-A4	Oral presentation
B1-B2	Writing a report
C1-C6	Teamwork & Leadership
D1-D2	Ethic of an engineer
E1-E4	Gathering information
F1-F2	Finding problems
G1-G2	Required specifications
H1-H3	Idea creation
I1-I3	Embodying Ideas

1,447 students answered questionnaires on both 1st week and 12th week. 361 responses collected were from students who tackled topics of the city governments, while 1086 responses were from students of other projects. Figure 5 shows the average score of each question for the 1st week (C_W1 & W1) and the 12th week (C_W12 & W12) of PD2. C_W1 and C_W12 are results of team members who tackled topics of the city governments, whereas W1 and W12 are results of team members of other projects. Orange marks and red marks indicate meaningful higher scores of "C_" teams to other teams.

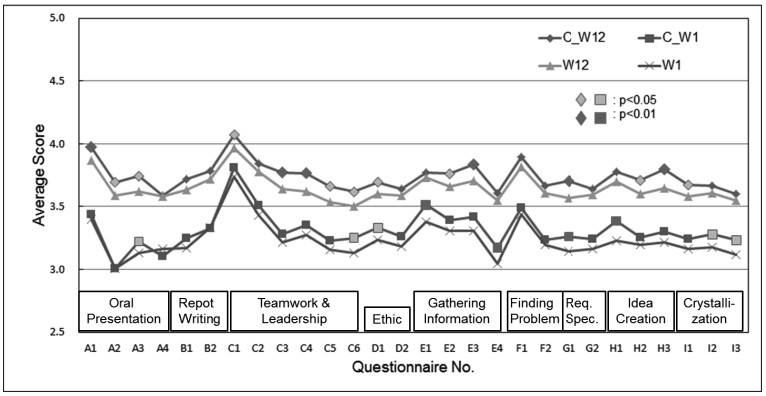

Figure 5. The average score of each question comparing city topic projects and others

The responses from C_ teams who worked on the collaboration projects show higher average scores in most questions for both 1st week and 12th week results. That means highly skilled teams tackled the governments' topics.
The results of C_ teams on A1, C3, C4, E3 and H3 show statistically meaningful higher improvements in the 12th week ($p < 0.01$) although they are not meaningfully high in the 1st week. These results indicate that the collaboration with city governments and communities can help students improve their skills of oral presentation, team working and utilizing information. The scores of the members of the three projects shown in Sec.3 are much higher; 4.3 on A1 and 4.1 on C4 show students' high confidence in presentation and teamwork accomplishments.
On the other hand, although results from C_ teams show meaningful high scores in the 1st week for E1 and H1, they are not highly confident after 12th week. E1 asked about skills of voluntary information gathering and H1 asked about multiple idea creation. As having given a great deal of information from governments and found many restrictions, they felt somewhat powerless for information gathering and free idea creation, which might reduce their efforts of finding deeper insights of the design activities.

5 CONCLUSION

This paper has presented a collaborating approach with the local city governments and communities in KIT Project Design Program. 73 teams out of 291 project teams tackled problems proposed by the city governments. Three project examples from the class of Department of Architectural Design were discussed. The teams did not only create and design solutions, but also got feedbacks and redesigned their ideas.
Results of the questionnaire based pedagogical survey were discussed and the collaboration approach was statistically confirmed to be useful in improving students' skills of oral presentation, team working, and utilizing information.

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