A Case Study on Introducing the Design Thinking into PBL

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Abstract - In this paper, we describe a case study on introducing the Design Thinking as preparations for Project Based Learning (PBL). The purpose of introducing the Design Thinking is to improve students' skill in producing new added-value at the time of solving project problems and investigating PBL themes. In addition, we describe the results of the questionnaire carried out for evaluating the effect of this introduction.

Keywords: Design Thinking, Project Based Learning

1 Introduction

The curriculum of Kyushu University Information Communication Technology Architect Educational Program (QITO) [1], which is offered in cooperation with companies like Center for Future ICT Leaders (CeFIL) [2], has three educational approaches: "PBL (Project Based Learning)"[3], "ICT All-Round Education"[4], and "Long-Term Internship". These approaches are adopted for dealing with insufficiency in conventional education. In this paper, we focus on the PBL approach.

QITO aims at upbringing the pi-type engineers, as illustrated in Figure1, who are going to lead the next-generation information-oriented society. In particular, we aim for upbringing engineers who have "Design Ability" that connects "Technology Ability", the knowledge of computer science, and "Creative Ability", the utilization of ICT for profiting society. QITO introduces value-creation oriented PBL to raise "Design Ability".

In value-creation oriented PBL, students will learn "Technology Ability" (development skill, development technique, etc.) and "Creative Ability" (problem discovery and solution, etc.), and additionally, students are expected to design new added-value that raises society innovation, when they examine the theme of the PBL projects and the solutions of the problems.

To this end, we introduce a lecture and the practice of the Design Thinking before the start of value-creation oriented PBL, so as for the students to learn techniques to create new services and ideas, and to raise "Design Ability" necessary for a pi-type engineer.

In this paper, we describe the contents of the Design Thinking lecture that we carried out in PBL, its position in the PBL, and the effect of Design Thinking introduction. In section 2, we describe a summary of value-creation oriented PBL introduced in QITO. In Section 3, we describe the contents of the lecture and the practice of the Design Thinking that we carried out. In Section 4, we describe the effect of the Design Thinking introduction based on the results of questionnaires conducted after the lecture and the comments to the achievements of the practice. Finally, in Section 5, we summarize this paper and describe future prospects.

Figure1 Desired abilities for pi-type engineers

<table>
<thead>
<tr>
<th>Requested abilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Π-type engineers</strong></td>
</tr>
<tr>
<td>Connect “Creative” and “Technology”</td>
</tr>
<tr>
<td>Design Ability</td>
</tr>
<tr>
<td>How ICT could profit society</td>
</tr>
<tr>
<td>Knowledge of computer science</td>
</tr>
<tr>
<td>Creative Ability</td>
</tr>
<tr>
<td>Technology Ability</td>
</tr>
</tbody>
</table>
2 Project Based Learning

2.1 Summary

In the Fundamental PBL carried out in the first term of first-year master course, students are given a common problem of expanding an existing Web system for the purpose of acquiring basic software development and project management skills.

On the other hand, in the Practical PBL carried out in the second term of first-year master course and in the Advanced PBL carried out in first term of second-year master course (Practical and Advanced PBL are treated as value-creation oriented PBL), each student team start-ups a project on a different theme, where these themes could be society problems provided by teachers or companies, or students self-planned themes, etc. In addition to techniques necessary for completing a project theme, another purpose of such practice is to let students acquire abilities to discover problems and to think about means to solve the problems by students themselves based on teamwork.

2.2 Value–creation oriented PBL

In value-creation oriented PBL, each team works on a different theme as described follows. Because solutions are not prepared for these themes in advance, it is important that students could come up with solutions with higher added value when they solve the problems of the project.

- System development type (Company collaboration type)
  The purpose of this theme type is to develop systems according to requirement specifications provided by companies or teachers.

- Contest challenge type
  This project aims at winning the championship at ESS robot challenge [4]. Through using a vacuum cleaner type robot, students examined and developed algorithms for making the map of the competition field, as well as for arriving at the destination within specified time.

- International type / research type
  The purpose of this theme is to conduct research, in collaboration with an overseas university, on topics requested by teachers.

- Business planning type (Entrepreneurship)
  Students propose services and systems, which have the potentials to be developed into new business, and conduct the actual development. One example of past themes is "plan and development of a Web Service to visualize topic flow"[6], which was proposed and developed by students themselves in 2013.

3 Design Thinking

3.1 Summary

The Design Thinking is a technique to create new service and business causing innovation to bring the society a change[7]. The approach called "Co-creation" is important in uncertainty and diversifying society. "Co-creation" is to adopt the wisdom from every person like businessmen and customers as well as designers, and to create services.

The first step of service creation in the Design Thinking is to notice exiting problems by inspecting a field. Then, a prototype and a business model of the expected service are created by considering solutions to the problems by teamwork. Furthermore, the service and business model are brought into a close on-site examination in repeated cycles, during which new problems are extracted through inspecting the field by using the prototype developed.

3.2 Aims of the introduction

We introduced the Design Thinking lecture so as to let students learn how to solve project problems and to come up with more attractive ideas, which are necessary for value-creation oriented PBL.

Aim 1: Let students learn techniques and means of thinking to create new ideas for solving society problems, and to learn the process of reaching mutual agreement.

Aim 2: Let students deepen their understanding about the importance of "The Three Actuals" (actual place, actual part, and actual situation) for solving problems, rather than learning impractical theory.

3.3 Schedule

We carry out the lecture before the start of the Practical PBL in the second term of first year master course to utilize the Design Thinking when students examine the theme of business planning type and create ideas in PBL. In 2013, we carried out the Design Thinking lecture as part of a lecture called "Advanced Topics on Social Information Systems" to demonstrate examples of the social problem solutions and innovation essence using ICT.

The lecture of the Design Thinking was carried out in group work on July 4 and July 11, and an achievement presentation was conducted on July 19. The aim is to create new ICT services by using the Design Thinking, based on the lectures about the utilization of the ICT in real scenarios of social infrastructures (medical care and agriculture, etc.), which were carried out nine times from May 9 to June 20.

3.4 Practice contents

We set a virtual project in this lecture for the purpose of "Raising social innovation in Kyushu University Library".
Table 1: Time schedule of the group work

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Contents</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jul 4</td>
<td>50min</td>
<td>Field work</td>
<td>Pair</td>
</tr>
<tr>
<td></td>
<td>20min</td>
<td>Share of awareness</td>
<td>Pair</td>
</tr>
<tr>
<td></td>
<td>10min</td>
<td>Theme decision</td>
<td>Whole</td>
</tr>
<tr>
<td></td>
<td>20min</td>
<td>Pro-action cafe</td>
<td>Group</td>
</tr>
<tr>
<td></td>
<td>30min</td>
<td>Vision making</td>
<td>Group</td>
</tr>
<tr>
<td>Home</td>
<td></td>
<td>Personal worksheet</td>
<td>Individual</td>
</tr>
<tr>
<td>work</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jul 11</td>
<td>60min</td>
<td>Service environment brest</td>
<td>Group</td>
</tr>
<tr>
<td></td>
<td>60min</td>
<td>Simple persona</td>
<td>Group</td>
</tr>
<tr>
<td></td>
<td>60min</td>
<td>Service scenario</td>
<td>Group</td>
</tr>
</tbody>
</table>

3.5 Practice system

People who constitute this practice are shown in Figure 3. We invited lectures from Fujitsu and Fujitsu Design Limited because they have experience in examining new services in actual fields. In addition, as an important part in the Design Thinking, we carried out information gathering and problem hearing of the actual field in the Ito Library of Kyushu University. Furthermore, students of Kyushu University Graduate School of Design joined the practice as facilitator who made the discussions more activate and supported to visualize proposed ideas.

3.6 Practice contents of the first day (July 4)

3.6.1 Field work

Two students make a pair and perform the field work in the Ito Library of Kyushu University so as to understand the present conditions of the library. The explanation tour guided by the library staffs is carried out in the library and students receive the explanation of the functions of the library. Next, every pair observes the library and performs a hearing of the library staffs and users.
We use the "Viewpoint card" as a means to get awareness of the library. A name of the public facility, such as an exhibition, a hospital, a bar, or a restaurant (except the library) is written in a viewpoint card. The viewpoint card is distributed to each pair at random beforehand. When each pair performs the field work in the library, they carry out inspection and hearing in a viewpoint of similarities/differences between the library and the public facility written in the viewpoint card, and they take notes of the awareness about the characteristics and the function of the library.

### 3.6.2 Share of awareness / Theme decision

Each pair shares the awareness gotten in the library. Each pair shares the contents of the memo written in the card, and writes keyword on tags in a viewpoint of similarities/differences between the library and the viewpoint card, and puts it on the white board.

Then, further discussion themes are chosen from the keywords extracted by each pair. Each student votes for five keywords that he/she consider important from all the keywords extracted by other pairs. After that, keywords with the most votes are selected as discussion themes. In this lecture, five themes shown in table 3 are selected as discussion themes. For example, library users may use study hall and learning consultation in addition to the original borrowing books purpose; airport users may not only board an airplane but also buy souvenirs and eat meals. Therefore, the keyword "It is used other than its original purpose" was extracted, and selected as a discussion theme.

### 3.6.3 Pro-action cafe

While digging into the extracted themes, students construct groups to examine ideas for each of the new library themes. At first, each table is assigned a discussion theme, and one student is remained at last as a host for the theme. Then, other students who have interests in this theme may move to the table and further discuss about the theme. Students except the host may freely move to other tables/themes in the middle of the discussions. Students discuss themes at each table, and perform development and deepening of the themes. Japanese vellum is prepared at each table, and students write down new opinions extracted from the discussions. After having repeated movement several times, students choose the theme that they sympathize most, and form groups for the following practice.

### 3.6.4 Vision making

Each group investigates the concept of the selecting theme, and makes the cover catalogue of a new library. It is important that each group thinks about how they attractively convey the appealing point of the new library by using not only wording but also illustration. Concepts made by this practice are shown in Table. For example, as shown in Figure 4, as a result of digging into the theme "used other than its original purpose", a concept of "Library to feel" was made for the purpose of acquiring new constituencies through installing the theme parks, by which users can experience a world view of books.

### 3.6.5 Personal worksheet

As homework to be done before the practice of the second day, each student writes down on a worksheet his/her viewpoints of the theme, as the starting point of his/her ideas. By imaging an ideal operation state of the new library according to each theme, students summarize according to the following items.

- All "participants" who use the new library
- "The exchanges" that are carried out in the new library

![Figure 4: Examples of the concepts of a new library](image-url)
3.7 Practice contents of the second day (July 11)

3.7.1 Service environment

The worksheet contents of each student are shared within the group. From the worksheets, each group extracts keywords about the "information" concerning the library (books, users, floors, etc.), and about the "activity" which expresses the action of users, and then record these two information on tags. For example, as "information", keywords about users (such as "couple", "parent and child"), and about the characteristics of the library (such as "local oasis", "bad access", and "silent") were extracted. As "activity", keywords such as "search", "study", as well as "eat and drink" were extracted.

After that, each group thinks about the ideas of the new services by combining the "information" and "activity" extracted. Then, one idea should be summarized in one piece of A4 sheet. It is important that students think about combinations as much as possible within specified time. The quantity, rather than the quality, of the ideas are attached more importance.

3.7.2 Simple persona

To concretize the usage scenario of the proposed service ideas, simple personas of different usage styles are made. For each persona, a concrete profile such as hometown, hobby, character, and sense of values is set. In addition, each group thinks about how a persona uses a service idea in a chronological order. The image of each persona should be summarized in one piece of A4 sheet by using not only words but also illustrations.

3.7.3 Service Scenario

Each group realizes services by considering concrete scenarios through combining service ideas and personas, and summarizes the design of the new library. Each group builds up concrete service scenarios with sympathy, while using illustration on one piece of sheet by putting together the combination of "information" and "activity". Such combination becomes the starting point of the service, the use scene, the scenario that related with the scene, and the persona concerning with the scene.

One example of the service in the "Library to feel" is shown in Figure5. The service is to start a restaurant in the library that serves foods. It is expected that persons, who don't usually read books and are only interested in eating, may come to visit the library for using the restaurant, and then may become interested in books which dishes offered by the restaurant appear.

3.8 Achievement presentation (July 19)

Each group presents its design, and conveys the concept of a new library to participants. In this practice, the presentation documents were made by utilizing illustrations and images, and the presentation time was set to 25 minutes per group, including question and answer time.

Each group presented the concrete suggested service scenarios. The presentation explains how a "persona" (which was set with concrete profile) used the "service" (which took into account the combination of "information" and "activity") in the new concept library. Examples of suggested services by each group are shown in Table3.

Students’ fieldwork reveals that there were few users of the Ito library. To deal with this fact, students proposed services for increasing user numbers of the library. The service category is as follows.

- Enhancement of students’ will to use the library
  For the purpose of raising students’ will of using the library, new services are proposed, which include, e.g., visualizing students’ efforts and providing better services according to usage frequency; and recommending research laboratories according to book rental history.

- Expansion of the constituencies of the library
  To attract users who do not usually use the library, it is proposed to set up theme parks and hold events such as quiz contest or lottery. It is expected that such means can attract new non-student users like children and housewives.

- New encounter / interchange
  Through setting up places for task display or hobbies, and photograph galleries, the proposed services are expected to be able to deepen interchange among not only students who use the library but also local inhabitants.

Figure5 Example of a service scenario provided in a new library
Table 3 Examples of suggested themes provided in a new library

<table>
<thead>
<tr>
<th>Concept</th>
<th>Information</th>
<th>Activity</th>
<th>Persona</th>
<th>Contents of service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enjoyable learning</td>
<td>indifference</td>
<td>go to library</td>
<td>family, child</td>
<td>holding a contest to look for the answer to a problem from books</td>
</tr>
<tr>
<td></td>
<td>grandchild</td>
<td>use PC</td>
<td>child, old person</td>
<td>promoting local interchange through teaching the operation methods of PCs and smartphones by a child</td>
</tr>
<tr>
<td>Appealing that something is there</td>
<td>everyone</td>
<td>search books</td>
<td>foreign student</td>
<td>searching and displaying the route to a book using tablet terminal</td>
</tr>
<tr>
<td></td>
<td>advanced</td>
<td>somehow</td>
<td>student of varied hobbies</td>
<td>increasing friends with a common hobby by setting up places for free talks</td>
</tr>
<tr>
<td>Height of floor shows height of will</td>
<td>books</td>
<td>public lottery</td>
<td>students, housewives</td>
<td>performing a lottery using the ISBN of books among people who borrowed the books in the past</td>
</tr>
<tr>
<td></td>
<td>library</td>
<td>use facilities</td>
<td>students, professors</td>
<td>making comfortable rooms available for people who use the library more times</td>
</tr>
<tr>
<td>Handbill operation</td>
<td>teachers, students</td>
<td>rental history</td>
<td>Students</td>
<td>recommending a suitable laboratory to a user based on his/her book rental history</td>
</tr>
<tr>
<td>Library to feel</td>
<td>physical science</td>
<td>introduce products</td>
<td>student for the encounter</td>
<td>providing places for persons who have interests in the same fields through displaying student themes</td>
</tr>
<tr>
<td></td>
<td>infants</td>
<td>experience</td>
<td>mother with children</td>
<td>not only making comfortable usage available for housewives, but also attracting children’s interests to the library</td>
</tr>
</tbody>
</table>

The ideas created by this practice received the following comments from lecturers and participants.

- More library services are concretized than expected, and the services are considered to be feasible with respect to realization. However, since the fieldwork was conducted only in a short time, it is necessary to further dig into demands from actual situations.

- Because it has been shown that problem solving abilities are improved by repeating the cycle of idea creation, such techniques learned from this practice should be continuously utilized in the future.

- The created ideas were slightly felt insufficient from the viewpoint of innovation. At the initial stage of idea creation, it is expected that students could catch more the operation mechanism of the library.

4 Effect of introducing the Design Thinking

4.1 Summary

We carried out a questionnaire to students after the achievement presentation with the purpose to evaluate the effect of introducing the Design thinking and hence to improve the lecture contents for the next fiscal year. The questionnaire is in a free description form and students can describe their impression and thought experienced during the Design Thinking.

4.2 Effect

The results of the questionnaire are shown in Table 4. About thinking techniques, because the students could realize the effect of introducing the Design Thinking, we obtained the result that there was constant effect for future PBL practice. About the structure and process of the practice, there was the opinion that argument was active in the PBL practice. About thinking techniques, there were indications about motivation and time designation of the practice, which are considered as future tasks.

Furthermore, about the contents of the achievement presentation and the process of the lecture, the comments as described below were obtained from the people related to Kyushu University Library.

- The services were very unique and interesting. In the future, students are expected to be able to think about things by innovative approaches like used in this practice, without narrowing a range from the beginning.

- Because students only visited the library at the time of fieldwork of the first day, they should investigate the services already provided by the library and collect demands from actual situations other than pure lecture time.

- There were many public library oriented services, and few ideas targeted at university libraries.
Table 4 Questionnaire results about the practice of the Design Thinking

<table>
<thead>
<tr>
<th>Classification</th>
<th>Good points</th>
<th>Points to be improved</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of responses</td>
<td>Contents</td>
</tr>
<tr>
<td>thinking techniques</td>
<td>17</td>
<td>Because more opinion exchange was conducted than conventional discussions, many new ideas were able to be created.</td>
</tr>
<tr>
<td>process of the practice</td>
<td>8</td>
<td>The visualization method and the way of thinking of the students from Kyushu University Graduate School of Design were very useful for reference purposes.</td>
</tr>
</tbody>
</table>

5 Conclusion

We introduced the lecture of the Design Thinking as a preparation for value-creation oriented PBL. The purpose is to let students learn the thinking methods and the process of reaching agreement for creating added value when they solve problems, and let students understand the importance of solving problems based on opinions from actual situations, rather than based on impracticable theories.

As the results of the questionnaire after the Design Thinking lecture, we understood the effect of such PBL practice including "Through the methods of the Design Thinking and the way of thinking of students from Kyushu University Graduate School of Design, more ideas could be created than convention discussions" and "the importance of making clear what is happening in actual situations could be understood better".

On the other hand, some issues for improving the lecture contents were pointed out, such as "lectures about the process of putting the ideas into practical use are necessary" and "the investigation of actual situations was short". Furthermore, the refinements about the accomplishment degree of the practice were also pointed out, such as "the ideas for solving the problems of university libraries were insufficient". Therefore, we will feed back the comments for the process of in future lectures.

6 Acknowledgement

This research is carried out in the programs of "Project for Establishing a Nationwide Practical Education Network for IT Human Resources Development (Education Network for Practical Information Technologies)" and "IT Specialist Program Initiative for Reality-based Advanced Learning" supported by Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan. Furthermore, this research received the cooperation of the Ito Library (Kyushu University Library) at the time of the field work and the evaluation of the practice results.

7 References