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# A Developmental Research of Design Thinking-based Program for Optimal Learning Experience in University

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[Abstract]

The purpose of this study is to develop a design thinking-based program to enhance the core competencies of creative problem-solving, collaboration, and communication for college students and to verify its effectiveness. To this end, a design thinking-based program was developed according to the instructional systems design (ISD) model consisting of learning content analysis, class activity design, evaluation tool development, implementation, evaluation and revision. After applying to the target (88 college students), competencies in creative problem-solving, collaboration, and communication were tested to verify quantitative effectiveness and the collected data was analyzed by t-test. In order to verify the qualitative effectiveness, the reflective logs submitted by each group as a final project report were analyzed. The results of the t-test conducted to verify the change in students' means in the pre-post competency test, showed that there were statistically significant increase in creative problem solving skill (t=-4.955, p<.01), collaboration skill (t=-3.179, p<.01), and communication skills(t=- 4.293, p<.01). And the design thinking-based program enabled students to have optimal learning experiences. Especially, learners in the program positively appreciated the experience of sharing various ideas with other members, strengthening cognitive flexibility, and acquiring performance.

▸ **Key words**: Design Thinking, ISD, Creative Problem-Solving, Communication, Collaboration, Learning Experience

[요 약]

이 연구는 대학생의 창의성, 협업능력, 의사소통능력이라는 핵심역량 증진을 위한 디자인씽킹 기반 수업을 개발하고 그 효과성을 확인하고자 하는데 목적이 있다. 이를 위해 교육훈련프로그램 개발(ISD) 모형인 ADDIE를 기초로 설정한 모형(학습내용분석, 수업활동설계, 평가도구개발, 수업실행, 평가 및 수정)에 따라 디자인씽킹 수업을 개발하고 88명의 대학생을 대상으로 적용한 후, 양적 효과성 검증을 위해 창의성, 협업능력, 의사소통능력 검사를 실시하고 수집된 자료를 t-test 분석하였다. 또한 질적 효과성을 검증하기 위해서 모둠별 최종프로젝트에서 기술된 성찰일지내용을 분석하였다. 학생들의 사전-사후역량 변화를 검증하고자 실시한 t-test 결과, 창의적 문제해결(t=-4.955, p<.01), 협동력 (t=-3.179, p<.01), 의사소통력 (t=-4.293, p<.01) 측면에서 디자인씽킹 수업이 효과적인 것으로 밝혀졌다. 이러한 양적 성과뿐만 아니라 질적 성과 측면에서도 유익하였다. 구체적으로는 이 수업을 통해 학생들이 모둠원 협력을 통한 문제해결 참여경험, 학습경험, 가치경험을 증진시켜 최적의 학습경험을 할 수 있게 해 주었다. 수업에 참여했던 학습자들은 특히 다른 조원들과 다양한 아이디어 공유경험을 긍정적으로 평가하였다.

▸ **주제어**: 디자인씽킹, 교육훈련프로그램개발(ISD), 창의적 문제해결능력, 의사소통능력, 협업능력, 학습경험

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# I. Introduction

Entering the 21st century, the world is facing serious problems such as global warming, global infectious diseases, hunger, and environmental pollution. What role can education play in this global crisis? The 2022 revised national curriculum in Korea presents inclusive education for future competency development as the main task, and aims to prepare for a sustainable future by strengthening basic education which deals with ecological transformation, artificial intelligence and digital literacy, and democratic citizenship. University education also deals with social innovation (SI), environmental protection、social contribution、governance or ethical management (ESG), and sustainable development goals (SDGs) as important topics in the curriculum.

In the era of the Fourth Industrial Revolution the ability to find a problem and solve it creatively is becoming more important. In particular, design thinking has been attracting much attention as a human-centered and process-centered instructional method for developing creative problem-solving competency.

Design thinking became widely known with the establishment of IDEO, a design consulting company in 1991 and the Hasso Plattner Institute of Design at Stanford in 2005. A growing number of universities have opened the Hasso Plattner Institutes to help students acquire creative problem-solving and collaboration skills [1]. Now design thinking is recognized as a new paradigm that deals with problems in many specialized fields such as IT and business management [2].

Design thinking has been found to be helpful in enhancing competencies such as creative problem solving, collaboration, and communication. It was found that design thinking-based nursing classes improve daily creativity [3] and creative disposition [4]. As a result of applying design thinking to university undergraduate education, teamwork among group members increased considerably [5]. This is consistent with the result of a study [6] that design thinking was effective in improving collaboration competency for college students majoring in music. Lim & Ahn (2018) reported that the experiences of engineering students in design thinking-based classes was helpful in improving communication skills. It has also been reported that design thinking has a positive effect on college students' problem-solving ability [8] and communication ability [9]. Many students who studied at the School of Design Thinking at the Hasso Plattner Institute (HPI) at the University of Potsdam, Germany, were found to quickly acquire autonomy and creative initiative in the process of problem solving [1].

Design thinking has been consistently proposed as a future instructional method for higher education based on learner-centered activities and group collaboration [10-12]. The design thinking-based class helps to play the role of a nudge that will naturally guide changes in a society. And design thinking has been widely noticed as a methodology for designing educational services [13].

However, the classes utilizing design thinking so far have been designed and developed mainly by the instructor's intuition. Although there are various instructional systems design (ISD) models that can systematically design and develop classes, the lack of instructional design capabilities of instructors and insufficient support for instruction by university authorities brought out such a phenomenon.

The purpose of this study is to develop and verify the effectiveness of design thinking-based class as a liberal arts subject at universities. The specific research questions set to achieve this research purpose were as follows.

First, what does the design thinking-based class look like?

Second, is the design thinking-based class effective in enhancing the core competencies (creativity, collaboration, communication) of college students quantitatively and qualitatively?

## II. Design for Solving Social Problems and Design Thinking

Education is basically requested to make an important contribution to making the current society a better one. Therefore, in order to have the capacity to design and innovate new society, acquiring the creative problem-solving methodology such as design thinking is considered very important. This design approach to solving social problems is expected to contribute greatly to creating a future-oriented and ideal new system, not staying at the level of the current system. Innovation is the ability to try something completely new [14], and the object of innovation is the system. Design Thinking takes a systems approach in the process of solving problems.

For example, to solve educational problems, it deals with all of system levels including organizational environment service system (e.g. nation, community), organizational service system (e.g. school), program service system (e.g. class), participant service system (e.g. instructor, student)[15].

Until now, when solving problems, a piecemeal approach has been preferred rather than a systems approach or an integrated ecological approach. As a result, it often came up against limitations that could not fundamentally solve the problem. In this respect, design thinking aims to design educational services based on a systemic approach.

In this study, system design and service design are discussed. System design deals with a system at a macro level for co-creation of value, and service design deals with services at a micro level for innovation. A design approach to problem solving is helpful in three aspects: value discovery, value creation, and value communication [16]. First of all, it is possible to preemptively discover various signals and trends that affect the expectations of learners, who are education consumers (value discovery). Second, effective and creative solutions can be prepared through the design process (value creation). Third, proper networking will teach everyone involved in the design process how to effectively deliver the product (value communication). In other words, through the process of designing educational services, education consumers can create and solve problems, and enhance communication and collaboration capabilities among design participants [17].

Problem-solving activities through design thinking vary depending on the institution. At d. School of Stanford University, design thinking process consists of empathize, define, ideate, prototype, and test [17]. Students will experience various learning experiences in this process. For example, empathy experience happens in the empathy and problem definition stages, creative experience in the idea generation and prototyping stages, and value experience in the testing stage. ‘Empathy experience’ refers to the experience of deeply understanding the needs of learners and finding fundamental problems based on it. ‘Creative experience’ refers to the experience in the process of deriving an idea to solve a fundamental problem and creating a prototype that shows it concretely. ‘Value experience’ refers to experiences including the sense of accomplishment that users feel in the process of modifying and supplementing (testing) the product presented as a prototype. In the end, it can be said that learners are highly likely to have an optimal experience through the design thinking process.

In design thinking-based college education, team collaboration [5-6] and communication competency [7][9] improved. Also it was found that design thinking in university education played an important role in increasing creativity [3], creative disposition [4], problem-solving ability [8][18], student autonomy & creative initiative [1], empathy [19], etc.

## III. Development of Design Thinking-based Class

This study applied the following model([Fig.1]) and procedure([Table 1]) by modifying and supplementing the existing instructional systems design (ISD) for developing a design thinking-based program that deals with creative problem-solving methodology.

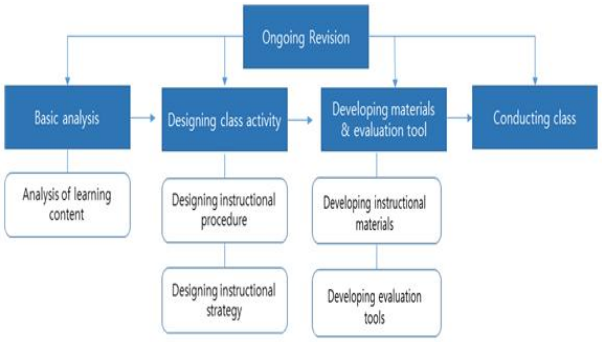



Fig. 1. Instructional systems design model for developing a design thinking-based class

Table 1. Course development procedure

| Stage | Activity | |
|---|---|---|
| Basic analysis | Analysis of learning content | hierarchical analysis, cluster analysis |
| Designing class activities | Designing for instructional procedure | Stages of design thinking |
| | Designing instructional strategies | Specific instructional plans for each learning stage: learning content presentation strategy, motivation strategy, interaction strategy |
| Designing materials & evaluation tool | Developing instructional materials | Development of class materials (PPT, etc.) |
| | Developing evaluation tools | Evaluation design plan |
| Conducting class | Implementing design thinking class | |

### 1. Analysis of learning content

The learning goal and sub-ordinate skill of design thinking-based class are as follows([Table 2]). The learning goal is “to design a better world by pursuing social innovation through creative problem-solving.”

Table 2. Analysis of learning content

| | Detail | |
|---|---|---|
| Learning Goal | Design a better world by pursuing social innovation through creative problem-solving. | |
| | Learn the mindset of design thinking and the process of design thinking | |
| | Knowledge | Understand the concept and necessity of design thinking |
| | Skill | Learn the mindset of design thinking, a creative problem-solving methodology |
| | Attitude | Learn the process of design thinking, a creative problem-solving methodology |

For the analysis of learning content, hierarchical analysis and cluster analysis were performed according to the type of learning goal. The results of sequencing the sub-ordinate skills of the design thinking class for creative problem-solving are as follows([Fig.2],[Table 3]).

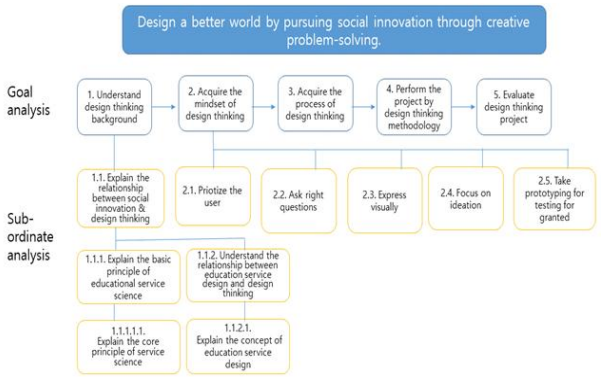



Fig. 2. Goal Analysis and Sub-ordinate Skills Analysis – Example

Table 3. Sub-ordinate Skills Analysis - Example

| 2. Acquiring the mindset of design thinking | |
|---|---|
| Stage | Sub-stage |
| 2.1 | Prioritize the user. |
| | 2.1.1. Identify potential user needs. |
| | 2.1.2. Determine what needs to be learned from users. |
| | 2.1.3. Summarize effective user interview methods. |
| | 2.1.4. Learn how to empathize with users. |
| 2.2 | Ask the right questions. |
| | 2.2.1. Explain the need for asking the right questions. |
| | 2.2.2. Identify the type of question. |
| | 2.2.3. Negotiations with stakeholders can be applied. |
| 2.3 | Express yourself visually. |
| | 2.3.1. Identify the characteristics of the object you want to express. |
| | 2.3.2. It can be drawn considering the characteristics of the object. |
| | 2.3.3. The result can be corrected and supplemented. |
| 2.4 | Focus on ideation. |
| | 2.4.1. Have an open attitude to various methodologies for generating ideas. |

| 2. Acquiring the mindset of design thinking | |
|---|---|
| Stage | Sub-stage |
| | 2.4.2. Can be flexible with the opinions of others. |
| | 2.4.3. Respect validity when prioritizing ideas. |
| 2.5 | Take prototyping for testing for granted. |
| | 2.5.1. Have a willingness to accept trial and error. |
| | 2.5.2. Have an understanding of prototypes. |
| | 2.5.3. Have an attitude of accepting feedback on prototypes. |

## 2. Designing class activity

### 2.1. Designing instructional procedure

The design thinking class for creative problem-solving consists of five steps: empathize, define, ideate, prototype, and test. 'Topic selection' step and 'sharing' are added as a pre-activity and a post-activity([Table 4]).

Table 4. Major Activities and Outputs of Design Thinking

| Stage | | Main Activity | Main Output |
|---|---|---|---|
| Pre-activity | Select | Topic selection, Theme fair | Theme |
| Stage 1 | Empathize | Write challenge task<br>Draw user journey map<br>Draw emphathy map | Challenge task<br>User journey map<br>Empathy map<br>Categoring user's intention |
| Stage 2 | Define | Write 5Whys | Fundamental problem |
| Stage 3 | Ideate | Six thinking hats<br>Random word association<br>Categorize ideas<br>ERRC | Ideas<br>Final selected idea |
| Stage 4 | Prototype | Prototype | Prototype |
| Stage 5 | Test | Evaluation and revision | Improvement requirements |
| Post-activity | Share | Announcement of final deliverables and feedback | Final project report |

In the 'topic selection' stage, comprehensive issues to be solved are determined at each system level (organizational environment, organization, program, and people), and a final topic is selected through a theme fair. In the 'Empathize' stage, a user journey (experience) map and an empathy map are created to find out the true needs of users, and then the needs are analyzed to create a classification table of core user's needs. In the 'define' stage, the 5 whys activity is carried out to find the root cause. In the stage of 'ideate', six thinking hats methodology is used for brainstorming, and new ideas are derived using random word association technique. ERRC (Eliminate, Reduce, Raise, Create) is performed to refine the derived ideas. Afterwards, priorities are set among elaborated ideas, based on two evaluation factors, x-axis and y-axis. In the 'prototype' stage, simple implementation of ideas is carried out in the form of storyboarding, modeling, etc.. In the 'test' stage, opinions on the prototype are collected and the prototype is revised and supplemented. Afterwards, as a follow-up 'share' activity, the final product is shared with the entire class and time is given to receive feedback.

### 2.2. Designing instructional strategy

The designed instructional procedure was specified through instructional strategies([Table 5]) including strategy for presenting learning content, motivation strategy, and interaction strategy.

Table 5. Designing Instructional Strategies

| | | Details |
|---|---|---|
| Strategy for presenting learning content | | . Before starting a new session, summarize and present the contents of the previous session (prerequisite knowledge)<br>. When the step transits, the change is marked in color so that learners can clearly recognize it. |
| Motivational strategy | Attention | . Providing various types of information to learners through pictures, etc.<br>. Asking learners questions consistently and regularly |
| | Relevance | . Guidance to consider things that are closely related to students' real life in the process of selecting topics and problems<br>. When presenting examples, consider the level that can be understood from the point of view of college students. |
| | Confidence | . Opportunities for each group to adjust their learning tasks<br>. Accurate presentation of individual and group evaluation criteria |
| | Satisfaction | . Continuously and regularly encourage and praise the project<br>. Provide fair compensation to learners by creating and applying objective evaluation criteria of project product |

| | Details |
|---|---|
| Interaction strategy | . Monitor the learner's participation process and collect opinions through personal reflection diaries and feedback in each class<br>. After class, provide a space for in-depth exchange of opinions with other learners on class-related topics through discussion activities |

## 3. Developing instructional materials and evaluation tools

### 3.1. Developing instructional materials

To support the class instructional activities, instructional materials including PPT slides and 4 video clips which have summary of design thinking procedure and mindsets for flipped learning, were made.

### 3.2. Developing evaluation tools

The criteria for class evaluation was proposed as follows([Table 6]).

Table 6. Evaluation Criteria for Design Thinking Class

| Assessment Methods | Details of evaluation | Score | Rate |
|---|---|---|---|
| Attendance | 2 points minus per absence | 20 pts | 20% |
| Midterm exam | Check understandings of design thinking | 20 pts | 20% |
| Final project | Marshmallow Challenge | 1 pt | 50% |
| | Topic selection and prioritization | 5 pts | |
| | User Journey Map, Empathy Map | 10 points (5 points each) | |
| | 5 Whys | 5 pts | |
| | Six color thinking hats, Random word association, ERRC and prioritization | 15pts (5 points each) | |
| | Prototype | 10pts | |
| | Group presentations and feedback | 4pts | |
| Class Participation Activities | Reflection journal 8 times * 1 point | 8pts | 10% |
| | base score | 2pts | |
| Total | | 100 pts | 100% |

The structure of the tools [20-21] for evaluating the competencies (creative problem-solving, collaboration, communication) of the students in the design thinking class was shown in [Table 7].

As a result of analyzing the reliability of the tools with the data collected through the pre-competency test, the reliability of the tools (cronbach alpha) was .959, .751, and .829 respectively.

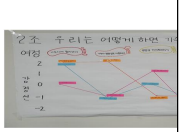
Table 7. Structure of tool for evaluating creative problem-solving, collaboration, and communication

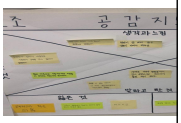
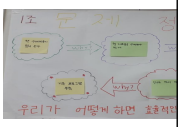
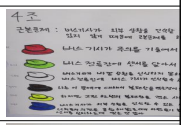
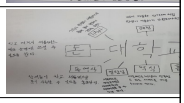
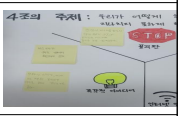
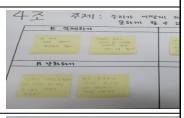
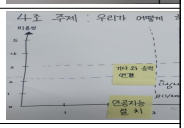
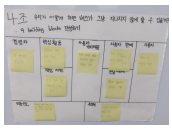
| Tool 1 | | No. of item | Tool 2 | No. of item | Tool 3 | No. of item |
|---|---|---|---|---|---|---|
| Creative problem-solving | A. discover & find problem | 9 | Collaboration | 6 | Communica-tion | 6 |
| | B. ideate | 8 | | | | |
| | C. plan actions | 10 | | | | |
| | D. conduct | 5 | | | | |
| | E. persuade & communicate | 7 | | | | |
| Cronbach's α | | .959 | Cronbach's α | .751 | Cronbach's α | .829 |

## 4. Conducting Design Thinking Class

The design thinking class is based on the d.school model (empathize, define, ideate, prototype, test) of Stanford University, adding topic selection as a pre-activity and sharing as a post-activity. It was conducted for a total of 15 weeks, including the presentation and sharing of the final project. Detailed weekly class activities are shown below ([Table 8]).

Table 8. Main class activities in design thinking class

| | Activity | | |
|---|---|---|---|
| Week 1 | Class orientation<br>Marshmallow challenge | |  |
| Week 2 | [Pre-Activity] Topic selection | . Writing topic and sharing<br>. Topic review & final selection of topic<br>. Writing reflective journal |  |
| Week 3 | [Stage 1] Empathize | . Writing challenge task<br>. Drawing user journey map<br>. Writing reflective journal |  |

| | Activity | | |
|---|---|---|---|
| Week 4 | [Stage 1] Empathize | . Drawing empathy map<br>. Categorizing user's requirements<br>. Writing reflective journal |  |
| Week 5 | [Stage 2] Define | . Conducting Root Cause Analysis :(5 Whys)<br>. Writing reflective journal |  |
| Week 6 | [Stage 3] Ideate | . Conducting six thinking hats<br>. Writing reflective journal |  |
| Week 7 | [Stage3] Ideate | . Conducting random word association |  |
| | | . Categorizing drawn ideas<br>. Writing reflective journal |  |
| Week 8 | Midterm Examination | | |
| Week 9 | [Stage 3] Ideate | . Conducting ERRC |  |
| | | . Priotizing ideas<br>. Writing reflective journal |  |
| Week 10 | [Stasge 4] Prototype | . Prototyping for bringing ideas to life<br>. Writing reflective journal |  |
| Week 11-12 | [Stage 4] Prototype | . Prototyping<br>. Writing mid project report & providing feedback | |
| Week 13 | [Stage 5] Test | . Giving feedback on prototye & revising<br>. Writing reflective journal |  |
| Week 14 | Writing ptoject report | Writing final project report & providing feedback | |
| Week 15 | [Post-Activity] Share | Sharing final product & providing feedback |  |

Through the class orientation in the first week, learners were guided to draw a blueprint for future instructional plans, and a marshmallow challenge was conducted to strengthen group ties and motivate learning.

In the 2nd week, each team's topics were explored considering system level (organization, program, individual). The topics were evaluated through topic review, but final topic is selected through a theme fair. After class, the task of writing a reflection journal was performed.

In the 3rd and 4th weeks covering empathy stage, user journey (experience) map and empathy map were drawn based on the interview with stakeholders in order to describe the challenge task and to understand what the user wants,

In the 5th week, it was the stage of defining the problem. 5 Whys, a root cause analysis method, was performed to find the root problem. In the 6th, 7th and 9th weeks, an attempt was made to derive ideas using a brainstorming method called six thinking hats and a random word association technique. In addition, ERRC (Eliminate, Reduce, Raise, Create) was carried out for elaborating derived ideas.

In the 10th and 11th weeks, the prototyping was carried out to easily implement the idea. To bring the idea to life, various types of prototypes were made, such as storyboards, modeling, diagrams, and 9 building blocks. In the 12th week, there was a time for supplementing the prototype and writing an interim project report and giving feedback on the results so far. In the 13th week, revision and supplement were done based on feedback on the prototype. In the 14th week, there was time for writing the final project report and feedback on it. And in the 15th week, activities were conducted to share and reflect on the final output of each group.

## IV. Educational Effectiveness of Design Thinking Class

### 1. Quantitative effectiveness of design thinking class

In order to confirm the effectiveness of the design thinking class for creative problem-solving,

data were collected from the online survey for creative problem-solving ability, collaboration ability, and communication ability (5-point scale). The data from 82 students[1] were analyzed using t-test. The results of t-test were as follows([Table 9-11]).

The means of creative problem-solving ability, collaboration ability, and communication ability were 3.84, 4.28, and 4.43, respectively.

The results from the pre-test (M=3.47, SD=.592) and post-test (M=3.84, SD=.670) in creative problem-solving ability indicate that the design thinking resulted in an improvement in creative problem-solving ability (t=-4.955, p=.000)([Table 9]).

Collaboration ability (t=-3.179, p=.002) and communication ability (t=-4.293, p=.000) were also analyzed to have statistically significant differences at the significance level of .01([Table 10-11]).

Table 9. Means difference between pre- and post-test for creative problem-solving ability

| | N[2] | M | SD | t | p |
|---|---|---|---|---|---|
| pre-test | 80 | 3.47 | .592 | -4.955* | .000 |
| post-test | 80 | 3.84 | .670 | | |

p*<.01

Table 10. Means difference between pre- and post-test for collaboration ability

| | N | M | SD | t | p |
|---|---|---|---|---|---|
| pre-test | 82 | 4.10 | .526 | -3.179* | .002 |
| post-test | 82 | 4.32 | .525 | | |

p*<.01

Table 11. Means difference between pre- and post-test for communication ability

| | N | M | SD | t | p |
|---|---|---|---|---|---|
| pre-test | 82 | 4.15 | .541 | -4.293* | .000 |
| post-test | 82 | 4.43 | .560 | | |

p*<.01

## 2. The qualitative effectiveness of design thinking class

In order to understand the qualitative effectiveness of design thinking class, the reflective journals and final group project reports were analyzed. The results may be summarized below.

First, the learners positively evaluated the experience of sharing various ideas with other team members as part of the experience of participation in the problem-solving process. It was recognized that they had experiences of creating value with other learners. It was confirmed that the participation experience through collaboration and communication among team members in the problem-solving process was beneficial. In design thinking class, instructors must build free learning environments so that learner-centered activities can proceed.

"It was good to share various ideas with the team members through the systemic design thinking method. It was nice to be able to think deeply about issues related to education once again.."(Learner 1)

"If I hadn't done design thinking, I would have finished the class without knowing other classmates'names. It was nice to get to know them."(Learner 2)

"It seems that the activity itself to find a problem with people and to think of various ways to solve the problem is what I learned."(Learner 3)

"I learned about the design thinking approach for the first time and had time to practice it through group activities. Based on what I have learned, I think I can use this method in solving problems in future."(Learner 4)

"At first It was very difficult to be with unfamiliar people. However, it became to form a rapport by sharing ideas with the team members. I think it was good to form relationships with new people and create new ideas."(Learner 5)

"It was good to have an opportunity to put design thinking into practice. I think the most important thing in

1) The 82 pre-service teachers were from five universities which were located in Chungnam (69 students) and Seoul (13 students). They participated in the design thinking-based classes (instructional method & educational technology). They had the basic understandings of education. The participants were composed of 23 males (28%) and 59 females (72%),

2) Since two students responded insincerely in the post-test for creative problem-solving ability, 80 students' response data were analyzed.

utilizing the design thinking is to 'directly' experience the process of solving problems."(Learner 6)

Second, the active learning experience in the design thinking process is expected to improve cognitive flexibility by promoting the development of creative thinking and various perspectives. In other words, it can be said that the flexible thinking behavior of attempting various approaches has been strengthened, breaking away from the 'psychological inertia' that only insisted on one direction within the existing thinking frame.

"When looking for problems and devising solutions, I had the opportunity to think through completely unfamiliar words like random words. So I think I was able to break my way of thinking frame. Also, I believe I dealt with more fundamental issues because I could speak freely without thinking about any budget. Through this, I was able to develop my thoughts on the root rather than a superficial problem."(Learner 7)

"It was a valuable time because I learned 'how to catch a fish' rather than 'getting a fish from someone' through a way to create various solutions with a different perspective and an educational methodological approach." (Learner 8)

"I was able to develop various thinking skills, such as selecting a topic, making a prototype, and finding an alternative to a problem."(Learner 9)

"I felt that it was helpful to come up with a solution by going to the site, observing directly, and empathizing with the problem in the position of the user or the person concerned. In particular, drawing a 'user journey map' was helpful a lot in drawing problem situations in my head, and I was able to come up with unexpected good alternatives while doing ERRC."(Learner 10)

"I learned a lot about dealing with a problem in various ways, thinking from a variety of perspectives, sharing opinions, cooperating effectively in the process of problem-solving." (Learner 11)

Third, the learners in the design thinking class highly valued the acquisition of performance experience. They experienced making valuable outputs as self-regulated learners.

"I was proud and happy to have outputs through design thinking."(Learner 12)

"I was able to create great outputs not only by myself, but also by coming up with ideas and cooperating well with my team members."(Learner 13)

"Every class, I had the desire to do better, and it was so nice to see the results and feel the sense of accomplishment."(Learner 14)

"Design thinking seemed to be a good guide for me to produce any output. I felt a great sense of accomplishment and pride."(Learner 15)

## Ⅴ. Conclusions

Even in the era of the Fourth Industrial Revolution, which requires creative problem-solving capabilities, most of the problems in university classes are still described in structured language, But there are many limitations in expressing the complexity and integration of real problems. It is almost difficult to transfer what is learned in class to reality. Accordingly, as the need to enhance the ability to directly deal with and solve social problems increases, interests in design thinking are also increasing in university education. The purpose of this study was to develop a design thinking-based class by utilizing an instructional systems design (ISD) model and to verify its quantitative and qualitative effectiveness.

The results of the study were as follows. First, based on the ISD model consisting of basic analysis (analyzing learning content), designing class activity design (designing instructional procedure, designing instructional strategy), designing instructional material & evaluation, conducting class, and ongoing revision, the design thinking-based program was developed for the learning goal of 'designing a better world by pursuing social innovation through creative problem-solving'. The design thinking-based program consisted of a total of 15 weeks, including midterm exams and final project presentations. This program was basically carried out in stages

such as selecting a topic, empathizing, defining a problem, deriving ideas, prototyping, testing, and sharing.

Second, the developed design thinking-based class is judged to be effective in enhancing creative problem-solving ability, collaboration ability, and communication ability of college students quantitatively and qualitatively. The means of creative problem-solving ability, collaboration ability, and communication ability of the students in the design thinking class were 3.84, 4.28, and 4.43 respectively. The results of the t-test conducted to verify the change in the pre-post competency of these students indicated that there was effective in creative problem solving skill ($t=-4.955$, $p<.01$), collaboration skill ($t=-3.179$, $p<.01$), and communication skills ($t=-4.293$, $p<.01$). These results are supported by the results of previous studies: improvement in problem-solving ability [22-23], improvement in collaboration ability [5-7] and communication ability improvement [9] in design thinking classes.

The design thinking-based program was found to be beneficial not only for these quantitative outcomes, but also for qualitative outcomes. First, rather than individual learning in the form of listening to lectures, it was recognized that students had the experience of creating value directly in the process of performing problem-solving activities with other learners. This can be interpreted that design thinking-based program can bring co-creation of value. It is also in line with the argument that efforts to reinterpret and reconstruct the current phenomenon should go hand in hand with value creation activities [13]. Second, due to the active learning experience in the design thinking learning process, it was found that cognitive flexibility was promoted by improving the development of creative thinking and diversity of perspectives of learners. This result is consistent with the previous one that university classes utilizing design thinking strengthen creativity [3] and creative propensity [4]. Third, in the design thinking-based program, learners were recognized as helping to become self-regulated learners who take responsibility in the learning process. This is supported by research results [1] that design thinking-based classes strengthen creative initiative.

Specifically, this program allowed students to have optimal learning experiences by enhancing their problem-solving experience, learning experience, and value experience through learners' collaboration. The learners who participated in the program positively evaluated the experience of sharing various ideas with other members.

This study has one limitation in the aspect of research design. In order to verify the quantitative effectiveness of the design thinking-based program, this study adopted a research design method that compares the results of the pre- and post-competence tests of the experimental group on average. In the future, it is necessary to re-verify the results of this study through an experimental design consisting of an experimental group and a control group.

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## REFERENCES

[1] Von Thienen, J.P.A., Royalty, A. & Meinel, C., "Design thinking in higher education: education (pp. 306-328)," Hershey: IGI Global, 2017.

[2] Dorst, K., "The core of design thinking and its application," Design Studies, 32(6), 521-532, 2011. DOI:10.1016/j.destud.2011.07.006

[3] Kim J.S., "The Effect of Design Thinking-based Nursing Learning Program in Students," Journal of The Society of Convergence Knowledge, 8(4), 1-9, 2020. DOI:10.22716/sckt.2020.8.4.030

[4] Han, S.M., "Effectiveness of Design Thinking-based Team Projects on Empathy and Creative Personality of Nursing Students. The Journal of Humanities and Social science, 11(1), 1645-1658, 2020.

DOI:10.22143/HSS21.11.1.120

[5] Yi, S., Kim, D.M., Kim, M.H., Kim, S,C, Kim, H,J, Park, K.M., & Lee, I.S., "Case Study of Interdisciplinary Studio Class with Design Thinking Method -Focusing on the Perspective of Instructional Design-," Design convergence study, 14(1), 63-81, 2015. UCI:G704-SER000008947.2015.14.1.003

[6] Han S.J,. "Exploring the Relationship between Student Satisfaction, Team Cooperation, and Self-Directed Learning Ability by Applying Design Thinking Process," Culture and Convergence, 42(11), 237-268, 2020.

[7] Lim, J.H., & Ahn, & M.L., "Analysis of Learning Experience for Collaborative Communication in Design Thinking Activities with Engineering Students," Proceedings of the KACE conference, 23(1), 27-30, 2018.

[8] Suh, E.K., & Shin, Y.H.. "Development and Effect Analysis of Flipped Learning-Based Coding Education Course," Proceedings of the KACE conference, 24(1),29-32, 2020.

[9] Woo, Y.J., Park, B.J., Lee, H.J., & Choi, M. S., "Class Utilizing Design Thinking," Seoul: Sigong Media, 2018.

[10] Choi, H.A., & Park, J.W., "Developing the Design Process in Education to Improve Creativity Based on Design Thinking," Journal of Digital Design, 14(4), 677-686, 2014.

[11] Chon,E.H. & Jung, H.J., "Development and Effect Analysis of College Students' Career Curriculum Based on Career Constructivism and Design Thinking," The Journal of Humanities and Social science, 10(6), 767-782, 2019.

[12] Lee, A,Y.. "A study on transformative learning and sociality experience in college students' design thinking," Unpublished Thesis. Graduate School of Hanyang Univ., 2021.

[13] Jang, H.Y., Baek, P.J., Kim, S.W., Hong, J.S., "A Theoretical Exploration for Establishing the Discipline of Education Service Science," Journal of Corporate Education and Talent Research, 20(4), 125-147, 2018.

[14] Roos, J., Roos, G., Dragonetti, N. C., & Edvinsson, L. "Intellectual capital: Navigating the new business landscape," 1998.

[15] Kim, S.W., Baek, P.G., Hong, J.S., & Jang, H.Y., "Can Education Service Consulting Open a New Way for Educational Innovation?," Journal of Corporate Education and Talent Research, 21(4), 1-17, 2019. http://doi: 10.46260/KSLP.21.4.1, 2019.

[16] Hong, J.S., & Jang, H.Y., "Combining Education Service and Design for the Improvement of Educational Activities: Exploring the Methodologies of Education Service Design. Journal of Corporate Education and Talent Research, 21(3), 53-70, 2019.

[17] Kim, S.W., "Design thinking for creatively solving problems. Seoul: Dongmoonsa, 2021.

[18] Seo, I.M., "Effects of Design Thinking Teaching Method Applied to Nursing Leadership Course. The Journal of Learner-Centered Curriculum and Instruction, 20(17), 707-725, 2020.

[19] Lim, J,M,. "The effects of design thinking on college students' empathy ability. Unpublished Thesis. Graduate School of Hanyang Univ.. 2010.

[20] Lee, H.S., Pyo, J.M., & Choi, I.S., "Development and Validity of Creative Problem Solving Profile Inventory (CPSPI)." Journal of Gifted/Talented Education, 24(5), 733-755, 2014.

[21] Kim, C.H., et al., "Development of Korea's Educational Indicator ، Index (RR 2014-21)," Seoul: KEDI, 2014.

[22] Alcivar, I., Caicedo, G., Contreras D., Guaman-Quintanilla, S., & Tapia, C., "Design Thinking: a problem-solving approach for first-year undergrad students," 17th LACCEI International Multi-Conference for Engineering, Education, and Technology: "Industry, Innovation, And Infrastructure for Sustainable Cities and Communities", 24-26 July 2019, Jamaica.10.18687/LACCEI 2019.1.1.389, 2019.

[23] Plumb, J.,"Design thinking: a strategic approach to the problem solving," 2024. https://www.cambridge-dt.com/design-thinking/

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