A Learning Model for an Innovative Live Design Project (ILDP) based on IC-PBL

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Abstract

Background In accordance with the new technological paradigm, an educational methodology to improve 'future capabilities' is necessary in the field of design education. The purpose of this study is to develop a learning model for innovation through industry-academia cooperation by grafting the concept of IC-PBL onto design methodologies and design processes. Another purpose is to evaluate the field applicability of the learning model by implementing the model-based project.

Methods First, as for the research method, a learning model for ILDP (Innovative Live Design Project) was derived by grafting the design process onto the concept of IC-PBL. Second, a syllabus based on the model was presented, and the live design project was in the actual course. Third, through a questionnaire with 11 students who participated in the course, data on the field suitability of the model were derived. Three corporate executives and professors evaluated the innovativeness of the students' design outcomes.

Results The level of understanding and the difficulty of activities were shown to be high, exceeding the average values. Positive factors included 'experience in actual company works' and 'experience in the feedback of persons in charge of actual work'. In addition, for the evaluation of innovativeness, there were opinions that the viewpoint of problem solutions was remarkable, and the design outcomes were judged to have innovativeness. However, time allocation caused by continuous feedback of clients showed as a factor of the problem, which should be improved as highly satisfactory through the refinement of time allocation of the decision-making process.

Conclusions The experiences gained from the practice based live project show that the learning model was appropriate in aspects of the field suitability. Also, the reflections through industry linked courses improve students not only to be more responsible future practitioners but also to produce innovative outcomes. Therefore, the ILDP based learning model can be regarded as a suitable application to the field of design education and useful in deriving innovative outcomes required by companies.

Keywords Innovative Live Design Project, Learning Model, Design Education, Higher Education

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1. Introduction

1. 1. Research Background

The South Korean government has been conducting the "LINC (Leaders in Industry-University Cooperation) Project" since 2012. This policy aims to promote R&D in relation to future convergent technology required in current enterprises, and is a leading model for fostering future capacities based on systematic interconnection between universities, industries, and research institutes. While LINC was one of the highly influential programs considering the fact that there are over 200 universities across the country, there is no industry-academic cooperation process model nor any manual that companies and universities with the same goals can implement step by step, conflicts often arise between professors and company clients(Nam et al., 2019). Especially, design education also aims to expand academic quality and experience through industrial-academic cooperation to foster practical skills for future industries. However, industry-academic cooperation has often promoted a focus on producing results and there were only cases for one-way learning models between companies and universities.

Therefore, the overall purpose of this study is to develop an innovative project model for industrial-academic cooperation that allows students to experience their future work ambiance, providing a practical process for professors-businesses-learners to achieve their goals. Above all, the aims of the model are for industry professionals to help students enhance their real-world design skills that include future capabilities required in the era of the Fourth Industrial Revolution. The learning model become beneficial for many educators and learners to conduct project based courses that leads to innovation in higher education.

1. 2. Research Objectives and Questions

This paper will detail the following objectives: First, we aim to develop an innovation model through industry-academia cooperation by grafting the concept of IC-PBL (a project learning method for solving problems of companies and social institutions) onto design methodologies and processes. And second, in order to provide a reliable learning model, we purpose to conduct an experimental research to evaluate the field applicability of the model by implementing a model-based design project. Third, we aim to justify the level of students' satisfaction and feedback. Final objective is to find out how the ILDP learning model is useful to provide idea innovation to solve the faced problems to create fluency and flexibility in the industry cooperation learning environment. These the research questions will achieve the following detailed objectives:

1) How do the design process and the concept of IC-PBL incorporate into the new ILDP model?
2) How is the field suitability of ILDP model in terms of motivation and usefulness of knowledge construction?
3) Why are students satisfied with this industry-coupled learning project?
   If students are not satisfied, what are the reasons and improvements?
4) In what ways does the idea innovation take place in the class based on the ILDP model?

1. 3. Research Methodology

A mixed research approach is adopted in this paper because it allows collection, analysis and interpretation of quantitative and qualitative data. As methodologies of this paper, we first present literature review results that illustrate the importance of live projects in design education, and the notion of IC-PBL for higher education in order to better understand each concept. Second, in order to conduct developmental research, we explored the links between IC-PBL and design processes, we built a strong ongoing procedure within the combined model. Based on the model, we then described the syllabus of an ILDP learning Project's first simulation to help practitioners develop their innovative designs. Third, we gained quantitative results about field suitability of ILDP model through questionnaire from the learners of the project, and we obtained quantitative data for effective solutions from the encountered difficulties. Fourth, we proceeded expert's interviews in order to find out key factors that help students overcome new challenges and create innovative ways forward in uncertain circumstances. The evaluations of the learning project based on mixed research led to improvement and suggestions for further work through discussion.

2. Theoretical Research

2. 1. Importance of Live Project in Design Education

Live projects are one example of an innovative educational practice that is being explored in a number of settings in the existing education environment and have commonly served as an alternative approach by the design disciplines (Sara, 2006). The live project is defined as one that is distinct from a typical studio project in its engagement of real clients or users in real-time settings. Students are taken out of the studio and repositioned in the "real world". This external involvement tends to result in students producing something of value to the client/user group, which might range from ideas, feasibility reports, or research, to a completed design scheme, a construction, or other creation. Students learn to manage their time and the project in a real-world setting, which also introduces a contingent element to the work since unexpected and unpredictable occurrences influence and affect the work as it progresses (Sara, 2006). Increasingly, the government has recommended that higher educational institutions provide opportunities for their students to acquire and develop the skills and attributes required by industry. Through business and educational partnership, students perceive real-world problems and develop their critical thinking skills. In this way, students develop a greater understanding of the role of clients and users than in other design projects. In particular, live projects in the field of design education, ' are enhancing the curriculum and challenging students' with outside constraints and deliverables, furthering learners' professional knowledge. Design education at undergraduate level benefits from its practical, learn by doing nature. Programmes must expose students to a broad range of teaching and learning styles and approaches which mirror the design environments they are likely to work in and therefore has a stronger case than most for demonstrating positive impact by answering the demand from industry and in a wider context contributing to the growth of the economy (Hurn, 2013). For example, they put into practice not only interactive communication, but also presentation to individuals and a broad range of groups to achieve

design goals. Moreover, time management, effective planning, and strategic thinking with coworkers are some of the necessary abilities provided by higher education. This encourages a transition from learning dependence to independence, with the goal of producing self-confident, creative, autonomous, and adaptive individuals. Above all, the live project has the potential to provide a variety of outcomes, both in terms of learning, and of greater integration of the studio within the wider community. These methods will result in win-win outcomes for both private enterprise and higher education (Yasin et al., 2000). Hence, the live projects provide valuable experiences in both fields of education and industry. Business is able to gain fresh ideas and potential solutions to problem situations, while students enhance their portfolio of skills and their industrial knowledge as they build valued partnerships with industry.

2. 2. Relationship between IC–PBL model and Design Process

IC-PBL(Industry-Coupled Problem Based Learning) is a learner-centered educational model in which learners solve context-rich problems occurring in everyday fields, where industry, society, and university, dealing with real-world projects for businesses and social institutions. Through IC-PBL courses, social institutions and businesses can create innovative and professional problem-solving measures using the university's educational system and human resources, thus establishing networks with professional personnel (professors). In other words, IC-PBL classes create closer collaboration between society, business, and universities. The first goal of IC-PBL is a curriculum that develops cooperative human resources that have solid problem-solving skills reflecting current social demands. The second goal is to shift the educational paradigm in order to improve the quality of higher education and meet learners' satisfaction. The third aim is to create an innovative educational model that promotes seamless curricula with core competency from admission all the way to employment and/or business start-up. There are four specific IC-PBL concepts: Merge (Field Intervention Type) , Evaluate(Field Evaluation Type), Create(Problem Solving Type), and Anchor(Field Problem Type), (Oh, Yoon, & Lim, 2021).

IC-PBL classes focus on lectures developed by professors and company employees through a problem/project approach as recommended by the social institution and/or business. The university professors design customized classes for this kind of problem-solving. Class plans are provided by the social institution/business, including omnibus classes, field trips, and special lectures by field experts, among other activities. Students participate in solving the problem and creating the project through creative thinking. Clients support students with practical solutions that reflect a fresh perspective for the consumer. Finally, students create a provocative and creative solution for successful problem solving. At the same time, IC-PBL classes offer field workers opportunities for retraining as they educate and serve as mentors, co-workers, and field experts who perform evaluation activities. Professors assess learners' problem-solving ability and performance. Clients and field experts give feedback and perform an evaluation of the learner's final report. In addition, social institutions and business-related personnel decide on whether to apply the result to the project; if so, they incorporate the solutions within the industry.

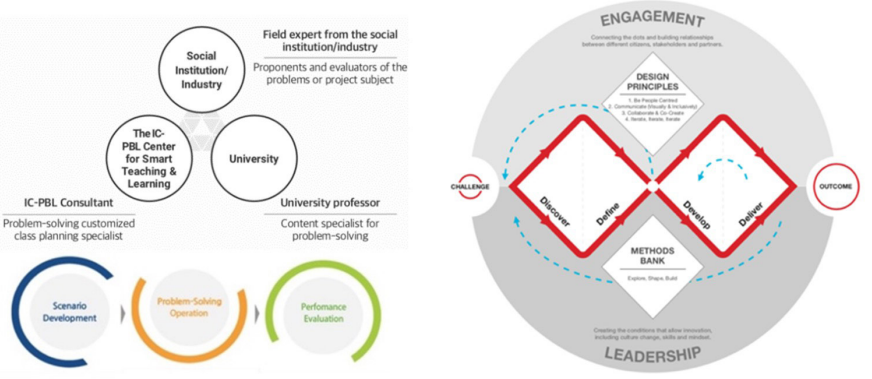


Figure 1 IC–PBL Learning model and Double Diamond Process
Retrieved from http://icpbl-eng.hanyang.ac.kr, http://www.designcouncil.org.uk

Every design specialism has a different approach and ways of innovative working, there are some commonalities to the IC-PBL process. Design discipline contains a range of concepts, techniques, and ideas that can be used, to good effect to create engaging real world problems and activities (Jackson & Buining, 2011). Especially, since design processes deal with the problems of industry sites and deriving specific outcomes and portfolios for industries, it shows how the principles of design are particularly suited to IC-PBL processes. Tim Brown, who is the CEO of IDEO company and researchers represented in the design process based on the Torrance's theory of creativity (Brown, 2008). He emphasizes that design processes not only involve a series of divergent and convergent thinking to solve complex interdisciplinary requirements, but also provide creative thinking process for innovation. Hence, we adopted 'Double Diamond Process' by British Design Council (2007) as the most representative design process related with the concept of IC-PBL. It is a framework for innovation has researched through in-depth study of the design processes used in eleven global brands gives real insights into the way design operates in these firms, and delivers usable lessons into the product and service development process. Specifically, the process is divided into four distinct phases; Discover, Define, Develop and Deliver, which is a simple visual map of the design process (Design Council, 2007).

3. Development of a leanring model for Innovative Live Design Project

3. 1. Suggestion of ILDP Learning Model based on IC–PBL

In order to propose an innovative live design project, we took the procedure for combining the conceptual characteristics of the double diamond process for innovation into the basis of the IC-PBL concept and process. The four process steps match the four phases: Discover, Define, Develop and Deliver; moreover, we reflect several featured keywords for innovation. The first feature is 'iteration'. This is not a linear process toward problem solving, which often sends participants back to the beginning. Rather, it constantly provides feedback on how products and services are working, and iteratively improves them. In the model for all creative processes a number of possible ideas are created, refined then narrowed down to the best

idea, and this procedure can be repeated. After development, testing, and refining a number of times, weak ideas are dropped. This cycle is an essential part of idea innovation and good design. The second feature of the process is 'people-centeredness', which is consideration for the end-user of these services and products. It is a creative approach to problem-solving that starts with people and ends with innovative solutions. The third feature is 'communication and collaboration'. A collaborative design process permits an entire team with varying skill sets to easily participate. Their interaction leads to good team communication, while this collaborative process brings together different ideas in which each individual team member plays a distinct part. We have synthesized these two processes by combining the semantic stage with characteristics of the design process based on the IC-PBL model.

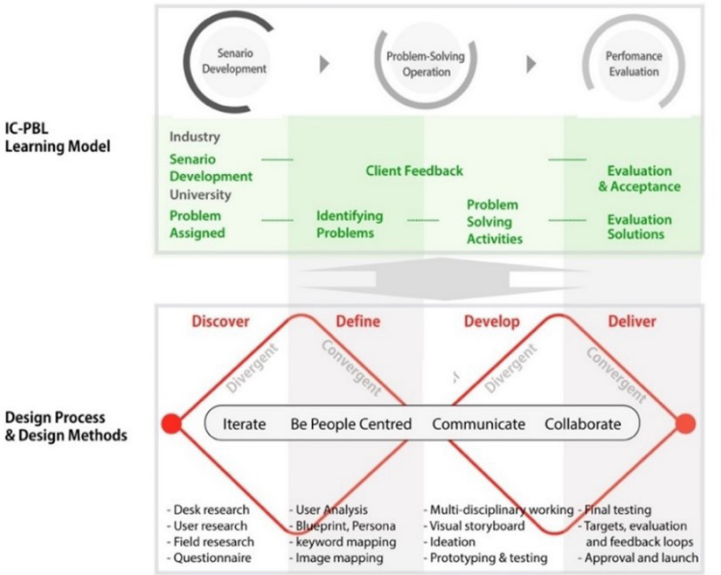


Figure 2 Combination of Design Process and IC–PBL Model

The following (figure 3) is a flow chart of the new learning stage which combines these two concepts: IC-PBL and the design process. Overall, there are six stages, the middle four of which belong to each of the design process' semantic elements. According to continuous client feedback, participants go through design activities and test repeatedly by discovering, identifying, and generating ideas, whose elements have a rotating, cyclical, and connected flow. We can visualize the process as follows:

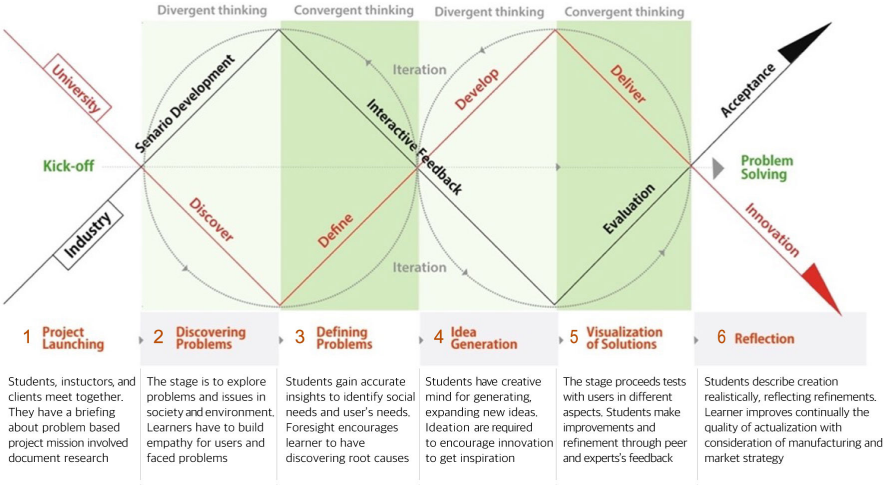


Figure 3 The Learning Model for Innovative Live Design Project (ILDP)

The procedure describes six stages, Project Launching, Discovering Problems, Defining Problems, Idea Generation, Visualization of Solutions, and Reflection, as a journey of diverging and converging phases. Above is a specific map of the six stages including each one's overall aims and flows. Originally there were four elements of a typical representative procedure that summarize the previous research. These have been rearranged to define a new live design project based on the IC-PBL model. It shows the assigned roles and aims in each step for refining one specific design. This allows participants to express unconstrained feedback and consider multiple developments in 'iterative, people-centered, collaborative, and communicative' atmospheres.

4. Evaluaton

4. 1. Suggestion of the ILDP based Syllabus

We presented a project course using the developed ILDP learning model, and suggested a syllabus in order to implement the live design project in actual education. Teaching teams have tried to focus on a clear and meaningful procedure according to the six-step process of the ILDP learning model. It consisted of 16 weeks of classes in accordance with the first semester of university education's regular curriculum, with one course subject being planned after prior discussion that selected an industry. The proposed syllabus was comprehensive enough that it could use any company wishing for industry-academia cooperation. Based on the six stages, a specific project scope was set by selecting a company called 'Livescape' that mainly designs landscapes and public spaces. According to the first step of the process, professors and the CEO of the industry set the subject through a pre-meeting, and discussed the mission of 'convergent planter design in the boarding school, Megastudy'. This procedure is the same as the scenario development stage of the class, and the subject design was written as follows:

Table 1 Suggestion of Syllabus based on ILDP

Course	Environment Design
Topic	Innovative Live Design Project for Convergent Planter Design
Course Outline	This course is a live design project implementing industry–academic cooperation for 'Convergent planter planningc and design' jointly with companies. The project briefing will be planned together with the corporate practitioner, and the identification process will be conducted from the beginning of the class. Design methodology will lead field research and innovative design. Afterwards, the final design will be produced through ongoing group tutorials and midterm evaluations. Classes are taught by collaborative teaching through professors, experts, and client feedback.
Learning Objectives	1) Under the guidance of company practitioners, to solve problems through live design projects. 2) To acquire the necessary skills to capture and reframe design briefings and problems that justify students' insights and generate well–grounded design concepts. 3) To focus on human–centered design through methodologies for sustainable innovation and vivid cultural discourse. 4) To provide the scope for the growth of personal design and innovation methodologies that expand and deepen core creative skills. 5) To produce convergent products that are useful for everyday life, taking into comprehensive consideration various social requirements and users' needs. 6) To explore new media and methods for creating thoughtful and responsible design solutions in an iterative, multi–disciplinary, and collaborative process
Learning Outcomes	1) Experience in collaboration between university and industry. 2) Problem solving ability in aspects of social design. 3) Revitalization to examine the innovative approach to UX development. 4) Co–design skills to manage social innovation in business organizations and the public sector. 5) Mind–challenging exercises for radical, innovative design concepts. 6) Functional approach that devolves into a true design capacity via strategic and real–world skills
Assignments & Evaluation	1) Creation: PPT for presentation, project reports, images with modelling, applicable prototypes. 2) Evaluation Criteria : Approach of experimental methodology for user research, Systematic analysis resulting in problem solving through logical progression, Good design ability incorporating the qualities of function and form and Application of innovative ideas reflecting user characteristics and environmental phenomena.

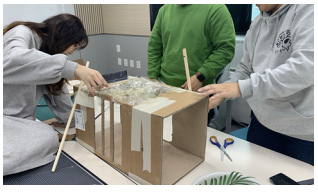
4. 2. Implement of the ILDP–Based Course

The course ran as weekly sessions over a fifteen-week period. Beginning with the 'project launching' stage, eleven students were introduced to the clients and attended a briefing about the project mission of 'convergent planter design in a boarding school'. This stage involved document and online investigation such as knowledge of and experience with boarding schools. Weeks 3 and 4 was dedicated to the stage of 'discovering problems', which involved group discussions and the exploration of users' needs and environmental issues using such methods as ethnography and shadowing. Students visited the boarding school and held user and stakeholder interviews conducted at the proposed sites. From the stage of 'defining problems' in weeks 5 and 6, students identified users' main concerns through the design methods of keyword and image mapping. During weeks 7 and 8 students experienced 'idea generation' which challenged their mindsets and gave them the opportunity to present their own ideas and key concepts to move forward into idea expansion. After midterm evaluations with the clients, students received insights from different perspectives; they also performed a case study for deep understanding about their planter ideas through a representative site visit. For 'solution production', students began to set up the development for solid ideas. During this stage, students produced 3D mock-ups and design prototypes to be refined and advanced toward final production through weeks 11, 12 and 13. For the stage of 'evaluation and reflection', students were required to produce the final design outcomes along with a concluding presentation. Once the final working prototype included technology design, the students gave the clients a final presentation at an industry site.

Table 2 Demographic Profile of the Research Participants

Type of Participant	Age		Gender		Education Level	
	Category	Frequency (%)	Category	Frequency (%)	Category	Frequency (%)
Students	21–25	11 (100%)	Male Female	1 (9.1%) 10 (90.9%)	High School Diploma	11 (100%)
University Professors	35–40 40–45	1 (50%) 1 (50%)	Male Female	1 (50%) 1 (50%)	Doctoral Degree	2 (100%)
Industry Experts	35–40 41–45	2 (66.7%) 1 (33.3%)	Male Female	2 (66.7%) 1 (33.3%)	Master's Degree	3 (100%)

Table 3 Implement of ILDP based Course

Course	Environment Design			
Topic	Convergent planter design			
Contents	ILDP Process	Weeks	Images	ILDP Activities
	Project Launching	1–2		Scenario development, Launching and Briefing of projec
	Discovering Problems	3–4		Document, Field research, User and Stakeholder interviews.
	Defining Problems	5–6		Keyword mapping, Image mapping, Affinity diagram
	Idea Generation	7–10		Brainstorming, Idea Sketch, Junk Prototyping
	Visualization of Solutions	11–13		Bodystorming Improvement, 3D Modeling and Rendering, Working Prototyping
	Reflection	14–15		Presentation and client evaluation, Acceptance of Innovative Solutions

4. 3. Evaluation Methodology

Through a questionnaire given to the eleven students who participated in the course, researchers derived data on the model's field suitability. For our research methodology we used a Likert scale, which is a psychometric measure used for responses in survey research, often interchangeable with a rating scale(Likert, 1932). The investigators prepared questionnaire criteria and interview protocols for quantitative and qualitative answers so that students could express their opinions about their experiences. We collected data using a Google survey that contained anonymous replies. Afterward, three students sat for in-depth interviews about how their interaction with the ILDP based course compared to standard university lectures.

Table 4 Questionnaire Sheet for Field Applicability

Criteria	Questions
Access and Motivation	At the beginning of this course, how did you feel (less burdened and motivated, more burdened and motivated) to make the project successful?
Understanding of the Process	Did you quickly grasp the ILDP concept and easily understand the whole process as well as each activity?
Usefulness of Knowledge Construction	Was this course useful for accumulating new knowledge?
Effectiveness of Learning Methods	Did you achieve your learning goals through cooperation and continuous communication through the given learning methods?
Difficulty of Activities	Were the activities that the professor suggested at each stage of the course easy or did they present difficulties?

Additionally, three corporate executives and two professors evaluated the innovation of the students' design outcomes compared to those of regular classes. The evaluation criteria were divided into process innovation and outcome innovation, and the evaluators responded to the researcher's questions while reviewing process-folios of the course's outcome images (videos, 3D mockups, etc.) using a retrospective technique.

Table 5 Interview Protocols for Satisfaction

Criteria	Questions
Learning Satisfaction	Compared to regular classes, were you satisfied with this course?
Achievement Satisfaction	Compared to regular classes, what competencies have been developed specifically through this course?
Dissatisfaction	Compared to regular classes, what are the difficulties or problems you faced during the ILDP course?
Improvements	What does the ILDP course need to improve and become better in the future?

4. 4. Findings from Students' Questionnaires

Table 5, shows students' responses in regards to the ILDP learning model's field adaptability. Although this survey targeted eleven students and did not include a large number of people quantitatively, generalizations apply because it showed less than one point when the standard deviation was calculated. As a result of this survey, when the median value of the 5-point scale was set as a standard of 2.5, ILDP was found to be suitable within the educational field due to the fact that all-sub factors are within three or more points. When interpreted according to specific sub-factors, 'Difficulty of activities' received the highest score with an average of 4.63, while 'Understanding of the process' received the second highest score with an average of 4.45. In other words, it was easy to understand the process and flow of this

educational model, and it can be concluded that the learning methodology set based on the design methods is applicable to undergraduate students' difficulty level. However, among the criteria within 'Field adaptability', the score for 'Access and motivation' is relatively low. In addition, since IDLP is a learning model that self-solves by stimulating field-oriented practical skills, students showed a low average in terms of' 'Knowledge construction'.

Table 6 Results in Aspect of Field Adaptability

Criteria	Average	Standard Deviation
Access and Motivation	3.27	0.79
Understanding of Process	4.45	0.69
Usefulness of Knowledge Construction	3.36	0.81
Relevance of Learning Methods	3.90	0.54
Difficulty of Activities	4.63	0.67

Table 7 Results in Aspect of Satisfaction

Criteria	ILDP course	Regular course
Learning Satisfaction	I was able to gain practical experience by taking this course with the feedback of persons in charge of actual work, and I am satisfied with experiential learning in actual company works.	I am a little satisfied with the convenience of the learning method, but I am always anxious and worried about how to deal with to faced problems properly in the future.
Satisfaction of Achievement	I most needed the ability to spread ideas and the ability to make my thoughts come true. We trained the ability to present ideas boldly and freely. Also, it is very satisfied that I was able to develop the ability to visualize and realize the ideas presented.	General practical classes cultivate the ability for computer techniques rather than thinking activities. We have taught passively related knowledge and have memorized them. It is not necessary in the higher grade.
Dissatisfaction	In each class, the professor's feedback was given, and new feedback was given during the expert evaluation. As a result, a lot of time have spent on editing and improvement. It was also difficult to coordinate opinions between different team members.	Regular courses are rarely chosen by themselves because we have to perform a given task manually. In addition, because we have to focus on individual learning, they become more competitive and are wary of their peers.
Tips for Improvement	I would like to experience more active corporate connections with industry members. Since corrections are likely to occur in the final evaluation stage, the early evaluation time is accelerated and refinement through continuous with expert intervention is necessary for improvement. It would be great if seminars related to new technologies in specialized fields are also provided. In the elaboration stage, it is necessary for enough time and experts who can cooperate to overcome modifications from different perspectives.	

Overall, students were satisfied with the course content and with achieving practical abilities; moreover, their greatest satisfaction was with the quality of ILDP education in that it solves problems with the help of field experts. However, in regard to dissatisfaction, students' progress and time allocation should be improved and made more efficient. The goal is to achieve highly satisfactory procedures and course flow.

4. 5. Findings from Experts' Interviews

The experts including industry clients evaluated qualitatively student's final outcomes and they have revealed innovativeness of the ILDP. In aspects of the innovativeness of the process, they pointed 1)whether students themselves try new ways to grow ideas repeated risk-taking with failure and success. Also, they judged 2)how the design activities provide various idea solutions to solve the faced problems to create fluency and flexibility in innovation options 3) how they have tried reflect the most innovative ideas they have come up with in their work.

Table 8 Results in Aspect of Process Innovation

Criteria	Team 1	Team 2	Team 3
Process innovation	1) Team 1 came up with a wealth of ideas by repeating idea sketches to look at space from a new perspective and reinterpret it. 2) In particular, they attempted to look at the problem from various perspectives and approach it by combining two existing new ideas at the stage of definition. 3) It was difficult to narrow down various ideas and apply the best ideas to transform them into realistic ones, but overcame that.	1) Team 2 carried out the idea development step by step throughout the process. 2) In particular, to actualize the working model, several attempts have been made with various materials and tools. 3) The final result was complete with the best ideas that came out in the beginning, which was consistent and not confusing. An excellent idea was derived in terms of marketability.	1) Team 3 struggled to improve the idea until the last step, but through repeated attempts and expert help, an excellent idea came out. 2) In consideration of solutions from various perspectives, appropriate ideas were derived in terms of aesthetics, affordance, and economics. 3) Several ideas were tested through a bodystorming a number of times, and the most innovative and practical ideas were applied to the final results.

When it comes to innovativeness of final prototypes, experts defined 4)how team's the design outcomes solve the problem, increasing the innovation potential of solution 5) whether the design outcomes are innovative creations that doesn't exist in the world to uncover unexpected areas of exploration. Also, they judged 6)how the design results have important effects when the solutions apply to the field's markets to get obvious solutions beyond stereotype views. As to the results of the evaluation for innovativeness, professors and clients opined that the aspect of problem solutions was notable, and the design outcomes were judged to demonstrate innovativeness. Each team's outcome may not have had the same degree of innovation, but in terms of the sub-factors that we refer to as innovation, students' challenges and risk-taking sparked new ideas and generated novel solutions. Therefore, we are able to demonstrate that the ILDP is suitable for the innovative project design process and useful in formulating innovative outcomes according to the clients' requirements.

Table 9 Results in Aspect of Final Prototype Innovation

Team 1–1	Team 1–2	Team 2	Team 3
Responsive corridor for relaxing experience	Ceiling planter with adjustable mood	Interactive lighting desk set for my own planter	Wall types of recycling bin
			
4) This outcome solves students 'problems which feel tired of preparing for exam can experience the five senses while walking. 5) The result is the first new concept corridor that have never seen before. 6) Experts that when the result was applied in practice, it could create synergy with a spatial solution that satisfies users.	4) This result is a good design to purify the classroom with poor indoor air through the participation of students. 5)This is the first method that can adjust the illuminance with an automatic motion. determined 6) In particular, it has the potential to generate synergy when applied to a lobby or rest area.	4) The result gives students psychological satisfaction for solving emotional problems of students who are living in same time and same place. 5) This is the first desk that helps planting affectionately by interactive action to grow the plants. 6) It has excellent marketability because it can be used not only in boarding academies, but also in general homes and commercial spaces.	4) It's a great solution that makes the trash throwing fun and provides students with environmental messages. 5) The combination of planting and ideas that induce recycling through participation is novel. 6) The construction cost may be higher than that of the existing wall, but it is a potential and valuable idea in aspects of sustainability.

5. Discussion

Our research has led to the development of an innovative learning model for design education, one that is different from traditional educational methods, and which allows students to experience their future work ambiance. The ILDP learning model's procedure comprised six stages were a journey of diverging and converging phases. These elements all had a rotating, cyclical, and connected flow. The process was considered with multiple concepts in 'iterative, people-centered, collaborative, and communicative' atmospheres. We presented ILDP based project by developing a syllabus that utilized an actual design in the real world. We derived data on the model's field suitability through a questionnaire with the eleven students who participated in the course. The data demonstrated that ILDP is suitable for education because all the sub-factors are within 3 or more points. 'Difficulty of activities' received the highest score and 'understanding of the process' received the second highest score, which had an average of 4.4. In other words, students found it easy to understand the process and the flow of this educational model. Also the learning methodology set based on the design methods shows that the level of difficulty is not beyond undergraduate students' abilities. However, the surveys showed only an adequate score for field adaptability because of 'access and motivation' and 'knowledge construction', which had relatively low scores. In addition, we conducted an in-depth interview to get detailed answers on the learning satisfaction level of the project. Overall, students were satisfied with the content and process with achieving practical ability; at the same time they showed the greatest satisfaction with the quality of IDLP education in that it uses field experts' help to solve problems. However, as for dissatisfaction, time allocation should be made more efficient to achieve highly satisfactory course flow and procedures. Additionally, three corporate executives and professors evaluated the innovativeness of the students' design outcomes compared to outcomes from regular classes. In regard to the results of the evaluation for innovativeness, some opined that the viewpoint of each solution was remarkable, while the design outcomes were judged to demonstrate innovativeness. Each team's outcome may not have had the same degree of innovation, but in terms of the sub-factors that we refer to as innovation, students' challenges and risk-takings sparked new ideas and created novel solutions. As a result of combining these various opinions, we concluded that the ILDP learning model needed some improvements.

- In the first stage of the process, ice-breaking activities are needed to motivate students to increase their familiarity and lessen their uncertainty about the company-related projects.
- Students are encouraged to learn on their own as they solve problems in the field, but they need a knowledge acquisition process and activities to learn related knowledge. Thus business associates and experts should provide relevant lectures and seminars along with the process activities.
- Since instructors and experts' feedback at the final stage of the project limits re-editing opportunities, this stage of expert and client feedback should occur sooner in order to allow sufficient time for revision.
- Each stage of the course process should include tutors so that there is a clear pathway of content for better activities that lead to every team's customized solution.

6. Conclusion

Therefore, we are able to demonstrate that the ILDP model is suitable for an innovative process to design projects; also, it is useful for generating the innovative outcomes that companies require. Moreover, it is defined that the ILDP model brings the advantages of learning to enhance real-world design skills. Reflecting on the above, we hope to plan and carry out more complete projects based on the educational model, thereby improving its effectiveness. The limitation of the study is that it obtained qualitative feedback by executing only one project to verify the model's validity. In the future, it will be necessary to design and evaluate more projects based on the ILDP learning model to find even more improvements. Improved this way, the project model will allow students to experience their future work ambiance while providing a practical process for the academic-business-student axis to achieve different goals. Above all, the model aims for industry professionals to help students enhance their real-world design skills that include future capabilities required in the Fourth Industrial Revolution. Students will become highly competitive in the global job market by learning industry related skills from members of global companies. Furthermore, we will obtain effective solutions from the difficulties they encounter using this model, thus enhancing both learning and the quality of education. The ILDP learning model will be intellectually challenging and extremely enriching to the world of academia through an environment that facilitates new perspectives on design, education, management, society, and life.

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