Intersections across Disciplines: The Case of a Learning Space Design in Interdisciplinary Collaborative Project-based Learning

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Abstract

This case study investigated how students from three disciplines (i.e., Architecture, Interior Design, and Instructional Design and Technology) developed design thinking and problem-solving skills over an interdisciplinary collaborative project aiming at designing a learning space for K12 schools. The findings revealed the benefits of interdisciplinary collaborative project-based learning (ICPBL) for learners from all the disciplines. Additionally, data revealed specific challenges encountered by the interdisciplinary teams, such as misunderstandings, miscommunications, and different approaches used by students from different disciplines. The study also demonstrated the role of technology in enhancing communications and collaboration, which are crucial to the success of developing designing thinking skills. Recommendations are provided regarding facilitating students’ design thinking and problem solving in ICPBL.

Keywords

Design thinking, interdisciplinary, collaborative project-based learning
Introduction

This chapter first opens with the importance and benefits of interdisciplinary collaborative project-based learning (ICPBL). Then it provides a literature review in the following areas: (1) defining ICPBL and discussing its benefits in enhancing design thinking and problem-solving skills (Ng, Yap, & Hoh, 2011; Skinner, Braunack-Mayer, & Winning, 2015), (2) design thinking and its relationship between design thinking and problem-solving (Brown & Wyatt, 2010; Dym, Agogino, Eris, Frey, & Leifer, 2005; Jonassen, 1997), and (3) general characteristics of design thinking across disciplines, and specific characteristics of design in different disciplines, such as instructional design, architecture and interior design, as well as the intersection of design thinking across the three disciplines (Klein, 2009; Ralph & Wand, 2009; Slotkis, 2017). The literature review provided us with the theoretical framework that guided us to analyze the data and explore students’ learning experiences and challenges while developing their design thinking in the ICPBL environment. The case study allowed us to examine how students’ design thinking was developed in the ICPBL environment and what issues were involved over time within individuals and among team members.

Theoretical Frameworks

Collaborative Problem-based Learning

Problem-based learning (PBL) has been used in medical education for decades (e.g., Barrows, 1986; Schmidt, 1983). It is an instructional approach designed to help learners generate problem solutions through conducting research, integrating theory and practice, and applying knowledge and skills. PBL has been proved to help students construct an extensive and flexible knowledge base, develop effective problem-solving skills and self-directed, lifelong learning skills, improve group task performance, become effective collaborators; and become intrinsically
motivated learners (Hmelo-Silver, 2004; Nargundkar et al., 2014; Savery, 2006). Project-based learning, which is specifically discussed in this article, falls in the category of problem-based learning (Savery, 2006).

In recent years, there has been a growing interest in studying interdisciplinary collaborative PBL. Interdisciplinary collaboration refers to an approach that consciously applies methodology and language from more than one discipline to examine a central theme or issue (Erkan, 2013). It is a process in which team members negotiate meaning, construct knowledge, and build consensus in a shared problem space (Roschelle & Teasley, 1995). Interdisciplinary collaborative PBL provides students with multiple perspectives, develops their critical thinking and innovative skills, fosters their self-confidence, and improves their communication skills with members of different disciplines (Erkan, 2013; Hmelo-Silver, 2004; Imafuku et al., 2014).

**Design Thinking**

Design thinking is an approach to learning that encompasses active problem solving by engaging with and changing the world (Goldman et al., 2012). The design thinking process consists of three spaces: inspiration, ideation, and implementation (Brown & Wyatt, 2010). The inspiration space motivates the search for solutions; the ideation space is the process when ideas are tested and solutions are developed and generated. The implementation space is the path that leads from the project stage into people’s lives. Design thinking reflects the complex processes of inquiry and learning in which designers perform in a systems context, making decisions as they proceed, often working collaboratively on teams in a social process, and “speaking” several languages with each other (and to themselves) (Dym, Agogino, Eris, Frey, & Leifer, 2005, pp.104).
In many ways design thinking shares similar characteristics with ill-structured problem solving (Jonassen, 1997). Owen (2007) argued that design thinking has characteristics of great value to teams dealing with complex, ill-formed problems. It consists of two problem-solving activities, that is, constructing mental models and simulating them in order to draw conclusions and make decisions (Richmond, 2001). The first requirement of design is to understand the situation to be changed, which is problem representation based on the problem-solving literature (Jonassen, 1997). Design thinking requires designers to tolerate ambiguity, handling uncertainty, maintaining systems thinking and systems design (Dym et al, 2005), which is consistent with ill-structured problem-solving (Jonassen, 1997). However, different from PBL, design thinking, as a mode of inquiry, puts doing and innovating at the center of problem-solving, and it promises to address future needs of the globe. It has the potential to engage students in ways that are inclusive of their diversity, makes school learning relevant and real, pressing local and global issues which can enhance one’s motivation to learn (Goldman et al., 2012). By improving students' design thinking skills, students will be more ready to face problems, think outside of the box, and come up with innovative solutions (Razzouk, & Shute, 2012). Because design is a collaborative effort where the design process is spread among diverse participating stakeholders and competences (Björgvinsson, Ehn, & Hillgren, 2012), and because design thinking requires designers to think as part of a team in a social process to engage in dialogues and communicate in several languages of design (Dym et al, 2005; Goldman et al., 2012), we believe that ICPBL intersects seamlessly with the design thinking approach to help students sharpen their problem solving skills that facilitates the development of design-thinking.

Purpose
Despite numerous benefits about design thinking well documented in the literature, there is little empirical research about how design thinking skills can be facilitated and developed among students. On the other hand, there are challenges with the ICPBL. One of known challenges being the difficulty to communicate with other team members and explain it intelligibly due to different discipline background, as noted by Imafuku et al. (2014), which made it hard for students to make active contributions to discussions on topics that are foreign to them when in an interdisciplinary team (Imafuku et al., 2014). Therefore, a case study was conducted to explore the learning experiences of participants consisting of interdisciplinary teams in the ICPBL environment. The following questions were examined:

1. How does the interdisciplinary collaborative project-based learning (ICPBL) facilitate the development of students’ design thinking?

2. What challenges did the interdisciplinary teams encounter during ICPBL that inhibit the development of the design thinking?

3. What is the role of technology in supporting the development of students’ design thinking?

**Case Study**

Twenty-five students from three disciplines (i.e., 9 from Interior Design, 8 from Architecture, and 8 Instructional Design and Technology) participated in a design project called *Innovative Learning Environment for 2025*. This project was sponsored by a architecture design company, and it was intended to facilitate students’ development of design thinking, problem solving, and collaboration skills. Additionally, it was hoped that students could apply their expertise in making impact on education through the design of learning space.
The participating students were asked to create an innovative physical learning space for the year of 2025, named “2025 Schools”, which would support active learning. The project put a constraint on the students, that is, the learning space must have the capacity to accommodate 37 students. The students from the three disciplines self-selected into four multi-disciplinary teams (Group A, B, C, and D). Three of the teams had similar number of members from each discipline. The teams had six weeks to complete their projects, and they were required to present their solutions (i.e., the artifacts of the prototype design) to their clients in the last week. In addition, seven faculty members from the three disciplines participated in this project as facilitators of groups.

To understand how ICPBL help students develop design thinking, a case study was conducted (Creswell 2012). Data were drawn from five students’ interviews and their design documents. Each of the semi-structured interview lasted around 45 minutes and were transcribed verbatim. The student design documents included written design documents, final presentation posters, and weekly progress reports. The posters and presentation documents were visual representations of groups’ ideas on how learning space would look like in the year of 2025. The written design documents highlighted the features of their solutions and their rationales for the features. The individuals’ progress reports provided detailed accounts of team collaborative design thinking processes and documented challenges they had encountered.

This case study is mainly based on the interview data, with reference to the other data sources. The interview data were coded and analyzed using a deductive approach (Le Compte & Preissle, 1993). Two researchers worked together to conduct the initial open coding, during which initial coding categories were generated and subsequently applied to code the design document as well as observation notes. As new data were gathered, initial codes were confirmed
and modified. The researchers performed axial coding to draw relationships among the data. A quality check and data validation process were performed (Miles & Huberman, 1994).

**Findings and Discussions**

*“Priceless” Experience to Develop Design Thinking*

The students felt that ICPBL was a “priceless” and “knowledgeable” experience for them to develop designing thinking, problem solving, and collaboration skills. Students from different fields brought their expertise to the interdisciplinary groups, especially students from Instructional design and Technology who enabled the group members to see the importance of a sound theoretical foundation in design. For example, Jane from Group B said:

“I enjoyed working with both education students very much…they were always prepared and ready to work and really put forth a wonderful effort making our job as designers much easier. Evidence-and research-based design is crucial to the success of a project and without our education team, our design would have lacked clear direction.”

Through this experience, students had a better understanding of design thinking, i.e., exceptional designs do not just come from ideation, they need to have very solid theoretical bases.

Working with students from two different disciplines also enabled students to see different perspectives, which triggers new thoughts that lead to the development of design thinking and the successful completion of the project. Lei, a student from Group A stated:

“We shared our ideas to architecture and interior design students and they also gave us some ideas of what kind of space can meet the needs of high school learners that we seek to find out in this project…I think it’s a special experience for me. ‘Cause collaborating with the students from different colleges gave us lots of opportunities to reflect our study.
I have learned things like how to better understand their ideas from their perspective and how to explain my ideas in the language in which they can understand and how we can share our ideas under their specific condition to reach our shares goal. The better solution is to combine different prospective and collaborate. Students from other disciplines can help us have a better understanding of our area of study.’’

Through this project, students from different disciplines were able to reflect on their own thinking, elaborate their thoughts, and incorporate ideas from other disciplines, which ultimately contributed to the development of design thinking, communication, and problem-solving skills.

Challenges Due to Disciplinary Differences

Although, students agreed this experience was beneficial, all students participated in the interviews indicated domain differences with different terminologies and understandings undermined interdisciplinary collaboration and effective communication. When asking about the challenges, Yun, a student in Group C responded,

“They talk about things we are not really familiar with, and we talk about things, sometimes we use some educational terms, so they’re kind of confused about what we are talking about. So we need to explain what this term really mean and they need time to figure out what we are talking about and sometimes I’m confused about what they are talking. We spent a lot of time trying to understand each other.”

Like Yun, Jane thought the communication was unsuccessful in her group due to domain differences and lack of understanding of each other, “There were issues in communication from the beginning that should have been resolved but rather exploded over the course of the project in an unnecessary manner.” From participants’ responses, it showed that domain differences impaired interdisciplinary groups’ effective communication and collaboration.
Additionally, students also experienced differences representing design thinking due to different disciplines. Architecture and Interior Design students were more “practical”, focusing more on the physical and structural aspects of the project, while the students from IDT were more “theoretical”. Wen from Group D said,

“They [Architecture and Interior Design] are more practical. They focused on the functions of the learning space while we focused more on theoretical things, such as background information, problems, goals, target learners and context in order to conduct needs analysis.”

Yun shared the similar view. She indicated,

“We focused on totally different things and second I felt like they’d like to have the design idea because they don’t have any educational theory background, so they like to have are big picture about their design without any educational support. But for us we’d like to provide the background of what happened to current education and it gives them some support to have them develop their ideas. So we are the first part, they are the second part. so it’s hard for us to compromise.”

It seemed that initially students from different disciplines used different design approaches to deal with the same problem, which made it challenging for them to understand and work together with each other.

Technologies in Supporting Design Thinking

Three main types of technologies were found to support interdisciplinary groups in the development of Design Thinking: communication tools (synchronous and asynchronous), visualization tools (static and dynamic), and socially sharing tools. The communication tools
were tools (e.g., emails and instant messages) used for communication purposes, such as scheduling team meetings and exchanging ideas among members. For example, Yun said:

“Emails, I mean the function for the e-mails in our group communication is, either we found something or we put add more materials in Dropbox, we emailed the other team members to let them know there is some new information in the Dropbox, please check and we’ll also send an e-mail to others to remind them don’t forget today we are going to have our meeting at what time.”

Similarly, Qing from Group D articulated: “We used an instant message app called GroupMe to communicate ideas if we can’t meet. Emails were used for [sharing] documents.” Like other teams, Group A used emails to share ideas. Additionally, they used emails to inform the team members their progress.

The visualization tools, such as SketchUp, were used by all four teams to visually represent individuals’ ideas, which facilitate knowledge co-construction and the development of design thinking. Lei told the researchers,

“The architecture and interior design students used Sketchup to make visualization of the design, which helped us a lot to understand their design cause, at the beginning if you haven’t studied like, like the engineering parts, you have no idea what they are talking about. This visualization tools helped us a lot when we have meeting and discussion.”

The socially sharing tools, such as Google Drive and Dropbox, were used by team members to store and share files and co-author documents. Wen stated: “We used Dropbox where we submitted our individual work and if we have our own ideas or something like that, we will write them down and submit to Dropbox for sharing.” Based on students’ responses, it seemed that technologies played a larger role in facilitating students in problem representation,
ideation, and meaning negotiation, which were critical to the development of students’ design thinking and problem solving skills.

**Conclusion**

This case study shows interesting intersections between design thinking and ICPBL across three different design disciplines. Although the three design disciplines share numerous similarities, such as critical and creative thinking, communication skills, needs analysis, planning and designing, they also possess specific features that are unique to a discipline. The commonalities among the three disciplines helped to enhance students’ design thinking and creative problem-solving while the differences allowed them to see multiple perspectives from different aspects of design. However, the disciplinary differences also presented challenges when the team members tried to reach understanding to create a shared problem space. As such, scaffolding strategies and tools are essential to facilitate a successful and productive ICPBL experience to promote the development of design thinking. In the ICPBL environment, students designed to learn, and they learned to design, which added value to the ICPBL.
References


