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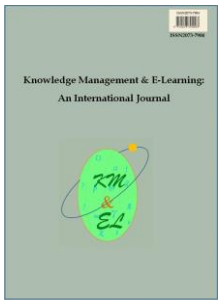

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Fostering group creativity through design thinking projects

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Abstract: The purpose of this study was to develop team projects in design thinking, for promotion and examination with the cultivation of group creativity. Research was conducted during the spring of 2017, with sixteen graduate students. Using artifact-based interviews, we analyzed the development of group creativity during the five stages of design thinking: understanding knowledge, empathizing, sharing perspectives, generating ideas, and prototyping. Results showed that analytical thinking was present throughout the overall project, while factors related to group creativity (such as learner orientation, interpersonal understanding, and flexibility) were observed at different rates as the project progressed. Results suggest that such pedagogical strategies as idea checking and training for applicability are necessary in order to foster group creativity.

Keywords: Group creativity; Design thinking; Team project; Artifact-based interview

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1. Introduction

The knowledge-based society of the 21st century is rapidly and continually changing in complex ways, and the ability to create values collaboratively by reconfiguring knowledge is emphasized over individual thoughts (Hargreaves, 2003; Lytras et al., 2015; Pook, Chong, & Yuen, 2017). The capacity to develop creative ideas through collaboration is expected to become more critical in the future, as sharing, connectivity, and interactivity are emphasized and based on sophisticated information communication systems (Sawyer, 2007). In this respect, group creativity has been considered a core competency necessary to adapt and survive in the context of diverse values, especially for adult learners (Lee, 2012; Van Ginkel & van Knippenberg, 2008).

Group creativity is present when group members work interdependently to achieve a shared goal, working toward a new and useful outcome (Harvey, 2014). Since group creativity is considered a significant part of an integrated educational experience by facilitating the capacity of group members through dynamic interactions (Sawyer, 2007), active educational efforts have focused on group creativity (Mesmer-Magnus & DeChurch, 2009).

However, group creativity is not exercised or learned simply by letting groups conduct collective tasks (Lee, Yoon, & Kang, 2015). Prior studies reported difficulties in the implementation of educational programs to develop group creativity (Mesmer-Magnus & DeChurch, 2009), suggesting the necessity of systematic instructional design to create synergetic effects between group members (Sawyer, 2007). In this context, pedagogical strategies that develop group creativity are needed to maximize the potential of both individual members and group synergy in collaborative learning.

Design thinking programs have been proposed to improve group creativity (Martin, 2009). Design thinking, as a reflective practice (Schon & DeSanctis, 1986), refers to a series of processes dedicated to creative problem-solving based on empathy and collaboration (Lee et al., 2015). Previous studies focused on connecting design thinking with group creativity since factors emphasized in design thinking (e.g., emotion, empathy, and sharing) can facilitate factors necessary for promoting group creativity (e.g., effective interactions, collective reflection, and sharing goals within teams). Byun (2015) developed a design thinking program for college students and observed significant effects on their group creativity. Similarly, Lee et al. (2015) designed and implemented a design thinking program for gifted science students and observed the development of their group creativity.

To facilitate group creativity among adult learners, it is necessary to provide educational opportunities such as design thinking projects as well as collaborative learning opportunities (Paulus & Nijstad, 2003). Therefore, this study focused on the use of design thinking projects as an educational tool to cultivate group creativity for graduate students. The purpose of this study was to analyze the development of group creativity during each stage of design thinking, based on the perceptions of the participants. The specific research questions were as follows: 1) How is group creativity developed during the overall process of design thinking? 2) How is group creativity

developed at each stage of design thinking? We explored the applicability of design thinking projects as educational tools and drew implications for effective design and implementation of design thinking team projects to develop group creativity.

2. Theoretical background

2.1. Group creativity

In general, creativity refers to the generation of new and useful ideas and solutions (Amabile, 1996). Creativity is one of the competencies that a learner must have to be successful, and it has been getting more attention because of the development of technologies such as artificial intelligence (Selamat, Alias, Hikmi, Puteh, & Tapsi, 2017). Moreover, group creativity is increasingly becoming more important than individual creativity, particularly as the creative activities needed for innovation in modern society are mostly collaborative (Sonnenburg, 2004). As a result, interest in group creativity is increasing. Group creativity is the result of the integration and interaction of the thinking and insights of each group member's experiences and characteristics (Sawyer, 2007). It is influenced by group composition, characteristics, processes, and contextual influences (Woodman, Sawyer, & Griffin, 1993). Therefore, group creativity differs from the arithmetical sum of individual creativity (Woodman et al., 1993), and thus research from a new perspective is needed.

In this context, the need for research on group creativity has been raised, but thus far most studies have been conducted in the corporate environment (Paulus & Nijstad, 2003). In recent years, however, researchers have begun to pay attention to group creativity in the context of higher education. Zhou, Kolmos, and Nielsen (2012) studied the environmental factors that enable college students majoring in engineering to demonstrate group creativity in a problem-based and project-based learning environment. Their results showed that factors such as formal and informal group discussions, regular supervisor meetings, sharing leadership, common goals, support of peers, and openness positively influence group creativity. Coursey, Williams, Kenworthy, Paulus, and Doboli (2018) divided undergraduate students into several groups and let them devise creative solutions using electronic discussion boards. This study indicated that group diversity can promote group creativity. Overall, previous studies have largely focused on identifying factors that promote or inhibit group creativity.

2.2. Design thinking

Design thinking refers to "a human-centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success" (IDEO, n.d.). Design thinking is a creative way to solve problems by thinking like a designer, and it has recently been given considerable attention in the fields of business and education (Brown, 2009; Leifer & Steinert, 2011; Scheer, Noweski, & Meinel, 2012).

Design thinking is based on several fundamental mindsets. First, design thinkers solve a problem with a human-centered process. Second, they empathize with others. Third, they use meta-cognition that is they know what they know. Fourth, they employ prototyping, experimentation, and flexibility. Fifth, they understand that it is more effective to show than to tell. Sixth, they move toward action rather than discussion. Seventh, they radically collaborate in multidisciplinary teams (Carroll et al., 2010).

There are several models that explain the process of design thinking. For example, Stanford's d.school model consists of five stages: empathize, define, ideate, prototype, and test (Plattner, 2009). IDEO (2013) defined five stages of design thinking: discovery, interpretation, ideation, experimentation, and evolution. Carroll et al. (2010) explained the process of design thinking through stages: understand, observe, point of view, ideate, prototype, and test. In this way, there have been many models that have suggested the process of design thinking so far, but their details are all similar.

2.3. Improving group creativity through design thinking

Design thinking can help creativity spread freely within a group (Brown, 2009). The process of group creativity requires convergent thinking as well as divergent thinking. Coursey et al. (2018) pointed out that research on group creativity has focused primarily on divergent processes and emphasized the importance of convergent processes for evaluating and refining ideas. Design thinking is the process of elaborating ideas through repetition of both divergent and convergent thinking (Leifer & Steinert, 2011). Therefore, it can be used as a methodology to improve group creativity since both design thinking and group creativity require divergent thinking and convergent thinking. In addition, empathizing and sharing, which are emphasized in design thinking, also contribute to group creativity (Lee et al., 2015; Sawyer, 2007).

Lee et al. (2015) developed an educational program applying design thinking processes to improve group creativity in the context of science education for high school students. They examined the various models of design thinking and developed a five-step process including understanding knowledge, empathizing, sharing perspective, generating ideas, and prototyping (Table 1). In addition, they developed a framework to identify the attributes of group creativity. Their framework consisted of four domains: collaboration, integrative thinking, human-centeredness, and multidisciplinary. They conducted research on design thinking for seven high school students and examined whether they expressed the core attributes of group creativity. The results showed that some attributes of group creativity appeared in stages. Through their research, they found that the process of group creativity could be experienced and learned through the design thinking process.

Table 1
The stage and activities for the design thinking (Lee et al., 2015)

Stage	Definition
1. Understanding knowledge	Explore, share, and understand the basic knowledge needed to achieve shared goals
2. Empathizing	Observe and understand the needs and requirements of the subjects in the group task
3. Sharing perspectives	Establish clear roles and discuss issues to be solved, team priorities, and direction of the project among team members
4. Generating ideas	Suggest a variety of ideas to solve the problems set by the group
5. Prototyping	Visualize the generated ideas and discuss whether the idea is possible or should be improved with the team members

3. Research methods

3.1. Research participants and procedure

The participants of this study included 16 graduate students in a Learning Motivation Analysis course at a university in Seoul, South Korea during the spring of 2017. The sample included seven doctoral students and nine master students, all of whom are female. Prior to the team project, five teams were formed with three to four students randomly assigned to each.

The goal of the team project was to analyze the motivation of their chosen subjects and develop an educational prescription. During the six-week team project, groups used the design thinking process to select their topic of study, analyze the motivation of their subjects, and suggest a prescription for the problem under study. Each team selected a different topic and subjects as shown in Table 2. Prior to the team project, participants learned the key concepts of motivation (e.g., internal motivation, external motivation, self-regulated learning, ARCS model of motivational design theory, Maslow's hierarchy of needs theory, goal setting theory) and the processes of design thinking that were necessary to carry out the project (e.g., understanding knowledge, empathizing, sharing perspectives, generating ideas, prototyping). These learning experiences enabled participants to perceive the potential usefulness and value of the projects in developing group creativity.

Table 2
The topics and subjects selected by each team

Team	Topics and subjects
Team A	3rd grade elementary school students who were first to learn English as a second language in public education
Team B	3rd grade high school students with low academic motivation
Team C	College freshmen who had trouble adjusting to new environments
Team D	Foreign language learners who received advanced Korean language classes at the university language education center
Team E	Part-time graduate students who had difficulty in educational media production courses

Table 3
The stage and activities for the design thinking-based team project

Stage	Activity examples
1. Understanding knowledge	Learning in the field related to group tasks, learner analysis, environmental analysis
2. Empathizing	Observation, interview, survey
3. Sharing perspectives	Discussion to prepare for analysis of collected data
4. Generating ideas	Brainstorming with Post-its, six thinking hats technique
5. Prototyping	Proposal of the prescription strategy using a theoretical model

Each team conducted their project while following the stages of design thinking, as suggested by Lee et al. (2015). Unlike most design thinking processes proposed in the context of business management, this framework was developed with a focus on helping group creativity emerge in an educational setting. As previously described, Lee et al. (2015) verified that their framework for the design thinking process had the potential to help students identify group creativity. Based on their results, we adopted and modified the five stages to fit the research context of this study. As shown in Table 3, we defined the five stages of design thinking as follows: Understanding knowledge, Empathizing, Sharing perspectives, Generating ideas, and Prototyping.

3.2. Data collection

For this research, we applied an artifact-based interview method in which participants sat for interviews based on their authentic project experience. This approach has the advantage of producing more concrete experiences for data analysis (Brennan & Resnick, 2012). Based on the artifact-based interview method, interviews were conducted for 30 minutes by randomly selecting one student from each team after completion of the team project. During each interview, participants answered questions while looking at their team's final artifact, discussing their perceptions and experiences of group creativity in each stage of design thinking (Table 4). Interview questions were created based on a literature review focusing on the improvement of group creativity through design thinking team projects (Sawyer, 2007).

Table 4
Interview protocols

Categories		Interview questions
Design thinking process	1. Understanding related knowledge	- What team project activities took place at this stage?
	2. Empathizing	- Is there anything that you would like to supplement or improve at this stage?
	3. Sharing perspectives	- Are you satisfied at this stage?
	4. Generating ideas	- Was there any dissatisfaction or difficulty at this stage?
	5. Prototyping	- Are there any instructional interventions that you think you need at this stage? If so, why?
Overall perceptions	1. Differentiation of the project	- Did you think this team project is different from other team projects you have already done? If so, why?
	2. The need for group creativity competency	- Do you think it helps to do these projects to develop the group creativity competency of graduate students?

3.3. Data analysis

We analyzed the interview transcripts using a constant comparison method, which is a way to continuously revise and develop categories to conceptualize the collected data

(Lincoln & Guba, 1985). First, we repeatedly read transcripts of the recorded materials and generated common themes and keywords based on the group creativity analysis framework outlined by Lee et al. (2015). Their framework was identified and validated through the generic model overlay method, focus group interviews, and critical incident technique analysis from a previous study (Lee, Yoon, & Kang, 2014). Using Lee et al's process, three factors (self-control, persuasiveness, and information seeking) were deleted while two factors (applicability and initiative) were added using the open coding method. Next, we confirmed the revised group creativity analysis framework, consisting of 11 codes in four areas: collaboration, integrative thinking, activeness, and human-centeredness. Then, we conducted re-verification through repeated reviews of categorization. Finally, the framework of group creativity was confirmed in the context of four areas and eleven factors as follows: *Collaboration* (Organization, Communication), *Integrative thinking* (Analytical thinking, Strategic thinking, Applicability), *Activeness* (Achievement orientation, Initiative, Curiosity, Flexibility), and *Human-centeredness* (Learner orientation, Interpersonal understanding), as seen in Table 5. Then, the researchers coded whether each factor occurred or not, ranging from 0 (i.e. not occurred) to 1 (i.e. occurred), and calculated the sum of its frequency over the whole dataset (see Table 6); the frequency of occurrence of each code and its percentage over the whole frequency was also suggested. To verify inter-rater reliability, agreements among researchers for each code were calculated as Cohen's Kappa coefficients and found to be reasonable, ranging from 0.69 to 0.84 (see Table 6).

Table 5
Group creativity analysis framework

Area	Code	Definition	Examples
Collaboration	Organization	Organize a team with others based on positive expectations	When we sort out individual learner characteristics, if I was alone, it would not have been so clear, but it had been done sooner because there were several people.
	Communication	Accept and understand the opinions of others and effectively express their opinions to others	I think we have talked a lot about the 'why is this happening,' 'the external motivation is good, but the intrinsic motivation is not good,' and 'what can come out like this.'
Integrative thinking	Analytical thinking	Systematically analyze data based on deductive reasoning and inductive reasoning, and draw conclusions	At first, we thought about elementary school students, but we also thought about foreign students and about all subjects that could have problems.
	Strategic thinking	Identify strategies for	I thought it was important what we could do right now. It is

Area	Code	Definition	Examples
		achieving high performance by considering various factors in problem solving and decision making, and systematically plan	important to have good intentions and to do what we want to do, but I think we should be able to get the research participants to observe and interview, and we should be able to do this with resources within a given period of time.
	Applicability	Practically apply existing knowledge, theory, and technology to new situations	The other is that the model and the actual learners rarely fall in perfect alignment when organizing the context, the individual, the internal factors, and the external factors.
Activeness	Achievement orientation	Gain satisfaction in the process of trying to achieve higher performance standards with a sense of challenge	I think that the steps at the previous stages seem to be meaningful because I thought that I could come to the arranged result through the process of arrangement in front stage and rearrangement and divergence through the design thinking process.
	Initiative	Obtain diverse information, predict future situations, and create new opportunities to improve the efficiency of the task	And if we question like this, I have a lot of thoughts about the expected question because there may be another problem in another part.
	Curiosity	Challenge with wide interest and curiosity in various fields	But when I interviewed, I had six questions, and I had a lot of other questions related to it. So, the original question may be very different from the actual question. And it was difficult to make them understand this question freely and easily. It's hard to answer it. So, I took a lot of examples.
	Flexibility	Have resilience to objectively understand and appropriately utilize different	Based on the survey, three people were members of the team, and the way they interpreted the question was all different. One member focused

Area	Code	Definition	Examples
		viewpoints	on amotivation, but I was interested in the overall motivation level.
Human-centeredness	Learner orientation	Empathize and create ideas based on the observation and understanding of others who will use new ideas	There was nothing particularly difficult, but it was awkward, which it would be better for the person to express how to communicate in the communication with participants. When we ask questions and the participants answer, we should consider a lot of things (communication).
	Interpersonal understanding	Listen to other people's stories and understand or sympathize with them	The reason I felt like that was that I already knew the participant very well. The reason why he acts like that is his relationship with the teacher at school, the problem that parents leave him alone, and the fact that some of his friends are troublemakers.

Table 6
Analysis and inter-rater reliability of the development of group creativity for the overall project

Area	Code	Frequency(%)	Cohen's Kappa Coefficients
Collaboration	Organization	13(7.6)	0.82
	Communication	13(7.6)	0.69
Integrative thinking	Analytical thinking	39(22.7)	0.85
	Strategic thinking	25(14.5)	0.83
	Applicability	6(3.5)	0.82
Activeness	Achievement orientation	8(4.7)	0.77
	Initiative	3(1.7)	0.75
	Curiosity	8(4.7)	0.84
	Flexibility	16(9.3)	0.79
Human-centeredness	Learner orientation	22(12.8)	0.77
	Interpersonal understanding	19(11.0)	0.82
Total		172(100)	0.77

Furthermore, we validated our data analysis by utilizing research methods involving member checks, peer debriefing, triangulation, and reflectivity, based on the conceptual framework of Lincoln and Guba (1985), as shown in Table 6. Moreover, to verify inter-rater reliability, agreements among researchers for each code were calculated as Cohen's Kappa coefficients and found to be reasonable, ranging from 0.69 to 0.84 (Table 6).

Furthermore, in this study we validated our data analysis by utilizing research methods involving member checks, peer debriefing, triangulation, and reflectivity, based on the conceptual framework of Lincoln and Guba (1985), as shown in Table 7.

Table 7
Ensuring the validity of qualitative data analysis

Strategy	Application in this study
Member checks	In the interpreted research results, the accuracy of the research was improved through member checks of the research participants to eliminate personal preferences and tendencies of the researchers (Creswell, 2007, 2009; Yoo et al., 2012).
	For those areas where it is difficult to clearly understand the opinions of the research subjects, or where there are discrepancies between the researchers' interpretations, additional reviews were conducted until 95% agreement was reached among the researchers.
Peer debriefing	The researcher who oversaw data collection shared the data collection and analysis procedures with the co-researcher and conducted continuous and regular discussions to objectify and describe tacit knowledge related to the context of the class.
Triangulation method	In addition to the interview material, which formed the main research data of this study, applying the triangulation method, the team project outcomes, the class observation notes taken by the researcher, the Learner Profile that deals with previous course and learning motivation, the syllabus, and the instructor's lecture handouts were collected.
	We conducted comparisons with interview analysis and crossover analysis among researchers.
Reflectivity technique	We kept notes regarding the data analysis process to reduce subjectivity and minimize mistakes made by individual researchers while analyzing the data.

4. Results and discussion

4.1. The development of group creativity in the overall project

The frequency of each factor's occurrence varied from 3 to 39 (see Table 6). As described, each code was also calculated as its percentage over the whole frequency in total. Results showed that *analytical thinking* appeared the most (22.7%), followed by *strategic thinking* (14.5%), *learner orientation* (12.8%), and *interpersonal understanding*

(11%), while *initiative* (1.7%), *applicability* (3.5%), *achievement orientation* (4.7%), and *curiosity* (4.7%) were less often identified. This suggests that learners utilize the various factors of group creativity, focusing on the areas of integrative thinking and human-centeredness, during design thinking projects.

4.2. The development of group creativity during each stage of design thinking

The factors of group creativity emerged differently in each stage of design thinking (Table 8). The frequency of each factor's occurrence per stage of design thinking was calculated as its percentage over the 100 percent; the value for each cell in Table 8 was calculated by dividing the frequency occurring in each cell by the total number of results (i.e. 172) and multiply by 100. In this table, the highest values were highlighted in grey.

Table 8
Analysis of the development of group creativity in each stage of design thinking (%)

Area	Code	Stage 1 Understanding knowledge	Stage 2 Empathizing	Stage 3 Sharing perspectives	Stage 4 Generating ideas	Stage 5 Prototyping
Collaboration	Organization	2.33	2.33	2.33	0.58	0.00
	Communication	1.74	1.74	0.58	1.74	1.74
Integrative thinking	Analytical thinking	4.65	5.81	5.81	3.49	2.91
	Strategic thinking	5.81	3.49	2.91	1.16	1.16
	Applicability	1.74	0.00	0.58	0.58	0.58
Activeness	Achievement orientation	0.00	0.58	1.16	0.58	2.33
	Initiative	0.00	1.16	0.58	0.00	0.00
	Curiosity	0.00	1.16	0.58	1.74	1.16
	Flexibility	0.58	2.91	1.16	2.33	2.33
Human-centeredness	Learner orientation	2.33	4.07	2.33	1.74	2.33
	Interpersonal understanding	1.16	4.65	1.74	1.74	1.74
Total		20.35	27.91	19.77	15.70	16.28

Integrative thinking factors such as *strategic thinking* (5.81%) and *analytical thinking* (4.65%) appeared most during the first stage of understanding knowledge. This showed that, in the process of exploring the basic knowledge necessary to deal with the issues for each team, group creativity often emerged in the cognitive aspect as students considered factors surrounding the issues and planned the project. In addition, group creativity was developed in the area of *collaboration* (4.07%), which could emerge through the process of sharing information and opinions within the team (Lee et al., 2015; Wright, 2000). However, at this stage, the participants experienced difficulty regarding *applicability* while searching for and applying the appropriate theories to solve the team

task, although they had already learned related theories. Instructional strategies including providing clear guidelines and training exercises that allow students to practice inductive thinking can help address this issue (Lee et al., 2015).

Group creativity emerged the most frequently during the empathizing stage (27.91%), with *analytical thinking* (5.81%) appearing most frequently in this stage. Each learner utilized interviews or questionnaires to understand the demands of the research subjects as selected by each team, and they analyzed data systematically. Furthermore, *interpersonal understanding* (4.65%) and *learner orientation* (4.07%) appeared in this stage, as the participants noted that they could understand the learning motivations and problems of the subjects through this process. Therefore, meaningful activities should be created to effectively encourage group creativity by allowing students to grasp the needs of others and facilitate the generation of new team ideas (Lee, Choi, & Ko, 2014; Joung, 2014).

Analytical thinking (5.81%) and *strategic thinking* (2.91%) appeared most often during the sharing perspectives stage. The participants clearly identified the subjects' motivation based on the data collected during the empathizing stage, and they determined the direction of the resulting prescription through discussion. Moreover, *organization* (2.33%) appeared in this stage, as students came to consensus on which artifacts they were going to make. This indicates the necessity of mutual collaboration through continuous sharing to facilitate group creativity (Lee & Lee, 2009; Jeon, 2013).

Analytical thinking (3.49%) was often identified during the generating ideas stage, as each team created and classified ideas using the Post-it brainstorming technique. *Flexibility* (2.33%) appeared as well since activities necessary to objectively understand and classify different viewpoints frequently occurred. Group creativity can, therefore, be strengthened through the implementation of instructional interventions such as idea checks to monitor ideas rather than monitoring project progress (Bielaczyc & Ow, 2014).

Finally, during the prototyping stage in which each group visualized their generated ideas, *analytical thinking* (2.91%) appeared the most frequently, followed by *achievement orientation* (2.33%), *flexibility* (2.33%), and *learner orientation* (2.33%). These factors were observed as the participants shared and obtained satisfaction sharing different viewpoints. This suggests a need to design a mutual exchange process, beyond the simple exchange of information, which is different from collaboration itself (Lee et al., 2015; Yang, 2011).

5. Conclusions

In recent years, creativity has been actively studied at the group level rather than the individual level since collaborations among diverse people facilitate creative thinking and better performance (Shalley, Zhou, & Oldham, 2004). For adult learners, group creativity is considered a core competency necessary for adaptation in modern society, which is characterized by complexity and diversity (Lee, 2012). In this study, we investigated the development of group creativity by designing and implementing a design thinking project with the intention of applying the project as an educational method that can be used elsewhere.

According to our results, analytical thinking emerged the most frequently during the overall process, while different factors of group creativity were expressed to differing degrees during each stage of design thinking. First, during the stage of understanding related knowledge, factors such as strategic thinking, analytical thinking, team

organization, and learner orientation emerged most frequently, suggesting the necessity of applying theory to practice through training in inductive thinking. Second, during the stage of empathizing, analytical thinking, interpersonal understanding, and learner orientation appeared in addition to strategic thinking and analytical thinking. Third, during the stage of sharing perspectives, analytical thinking, strategic thinking, and team organization emerged. Fourth, during the idea generation stage, the emergence of analytical thinking and flexibility were confirmed through methods such as idea checks. Finally, during the prototyping stage, analytical thinking, achievement orientation, flexibility, and learner orientation were identified, demonstrating a mutual exchange process of sharing information.

The pattern we observed was similar to that of Lee et al. (2015), although there were some differences. We observed higher frequencies of achievement orientation and flexibility during the prototyping stage. This appears to be due to the differences in the context of design thinking education between our study and that of Lee et al. (2015). In contrast to their research, where design thinking was applied as an additional activity in a high school, our study applied design thinking in a regular credit course at a graduate school, which can explain why our study observed higher frequencies of achievement orientation. In this study, more flexibility was observed because the form of prototype (i.e., motivational strategy) allowed for more flexibility than a physical prototype.

The significance of this study is summarized as follows. First, we confirmed that the use of design thinking projects as educational treatments can facilitate the emergence of factors related to group creativity among adult learners. Second, we analyzed qualitative data including learners' perceptions to examine the emergence of group creativity in detail, unlike previous studies that analyzed group creativity using quantitative scales (Larey, & Paulus, 1999; Valentine, Godkin, Fleischman, & Kidwell, 2011).

Results of this research confirmed the feasibility and implications of design thinking-based programs for fostering group creativity among adult learners. However, this study had several limitations. First, we used a small sample size and therefore limited the potential for external validity. Second, we did not utilize a control group, which therefore raised the need for an experimental study to verify our treatment. We propose that follow-up studies should use quantitative research methods such as pre-post data comparisons, extend the sample of research subjects, and test the applicability of design thinking projects and group creativity analysis frameworks such as those utilized in this study.

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