Fostering group creativity through design thinking projects

Jeongmin Lee  
Ewha Womans University, Seoul, South Korea  
Yeonji Jung  
New York University, New York, USA  
Seonghye Yoon  
LET's Lab (Leading Educational Technologists' Lab), Seoul, South Korea

Recommended citation:  
Lee, J., Jung, Y., & Yoon, S. (2019). Fostering group creativity through design thinking projects. Knowledge Management & E-Learning, 11(3), 378–392. https://doi.org/10.34105/j.kmel.2019.11.020
Fostering group creativity through design thinking projects

Jeongmin Lee*
Department of Educational Technology
Ewha Womans University, Seoul, South Korea
E-mail: jeongmin@ewha.ac.kr

Yeonji Jung
Department of Educational Communication and Technology
New York University, New York, USA
E-mail: yeonji.jung@nyu.edu

Seonghye Yoon
LET’s Lab (Leading Educational Technologists’ Lab), Seoul, South Korea
E-mail: shyewha@gmail.com

*Corresponding author

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

Biographical notes: Dr. Jeongmin Lee (corresponding author) is an associate professor of Educational Technology at Ewha Womans University. Her expertise in the area of learning design for technology-integrated environment. Her current research interests include cognitive/emotional process in learning with emerging technologies and social networks.

Yeonji Jung is a doctoral student in Educational Communication and Technology Program at New York University. Her research interest involves enhancing learning experiences in higher education through learning design and learning analytics.

Dr. Seonghye Yoon is the CEO of LET’s Lab (Leading Educational Technologists’ Lab) and a lecturer at Ewha Womans University. Her main interests are entrepreneurship education, technology-based education, and
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 (Platner, 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.
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      | Analytical     | 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. |
| thinking         | thinking       |                                                                           |                                                                          |
| Strategic        | Identify        |                                                                           |                                                                           |
| thinking         | strategies for  |                                                                           |                                                                           |
| Area            | Code             | Definition                                                                 | Examples                                                                 |
|-----------------|------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Achieving high performance by considering various factors in problem solving and decision making, and systematically plan | 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 | 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 | 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 | 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 | 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 | 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 |
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

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                       |
| Integration 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               | Stage 2               | Stage 3               | Stage 4               | Stage 5               |
|-----------------------|---------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
|                       |               | Understanding knowledge | Empathizing          | Sharing perspectives | Generating ideas     | 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.

ORCID
Jeongmin Lee  https://orcid.org/0000-0002-1621-0657
Yeonji Jung  https://orcid.org/0000-0001-6269-5563
Seonghye Yoon  https://orcid.org/0000-0002-5266-1666

References
Amabile, T. M. (1996). Creativity in context. Boulder, CO: Westview Press.
Bielaczyc, K., & Ow, J. (2014). Multi-player epistemic games: Guiding the enactment of classroom knowledge-building communities. International Journal of Computer-
Supported Collaborative Learning, 9(1), 33–62.
Brennan, K., & Resnick, M. (2012). New frameworks for studying and assessing the development of computational thinking. Paper presented at the annual American Educational Research Association meeting, Vancouver, BC, Canada.
Brown, T. (2009). Change by design: How design thinking transforms organizations and inspires innovation. New York, NY: HarperCollins.
Byun, H. (2015). The influence of design thinking process to develop undergraduates’ creativity. The Journal of Creativity Education, 15(3), 378–392.

Brown, T. (2009). Change by design: How design thinking transforms organizations and inspires innovation. New York, NY: HarperCollins.

Byun, H. (2015). The influence of design thinking process to develop undergraduates’ creativity. The Journal of Creativity Education, 15(3), 33–62.

Carroll, M., Goldman, S., Britos, L., Koh, J., Royalty, A., & Hornstein, M. (2010). Destination, imagination and the fires within: Design thinking in a middle school classroom. International Journal of Art & Design Education, 29(1), 37–53.

Coursey, L. E., Williams, B. C., Kenworthy, J. B., Paulus, P. B., & Doboli, S. (2018). Divergent and convergent group creativity in an asynchronous online environment. The Journal of Creative Behavior. doi: 10.1002/jocb.363

Hargreaves, A. (2003). Teaching in the knowledge society: Education in the age of insecurity. New York, NY: Teachers College Press.

Harvey, S. (2014). Creative synthesis: Exploring the process of extraordinary group creativity. Academy of Management Review, 39(3), 324–343.

IDEO. (n.d.). Design thinking. Retrieved from https://www.ideou.com/pages/design-thinking

Jeon, J. H. (2013). An exploration of current state of collective intelligence in engineering colleges. The Korean Journal of Educational Psychology, 27(1), 1–34.

Joung, Y. J. (2014). Theoretical investigation on implications of community of inquiry for science education toward community of inquiry in science classroom. Journal of the Korean Association for Science Education, 34(3), 303–319.

Larey, T. S., & Paulus, P. B. (1999). Group preference and convergent tendencies in small groups: A content analysis of group brainstorming performance. Creativity Research Journal, 12(3), 175–184.

Lee, D., Yoon, J., & Kang, S. J. (2014). The introduction of design thinking to science education and exploration of its characterizations as a method for group creativity education. Journal of the Korean Association for Science Education, 34(2), 93–105.

Lee, D., Yoon, J., & Kang, S. J. (2015). The suggestion of design thinking process and its feasibility study for fostering group creativity of elementary-secondary school students in science education. Journal of the Korean Association for Science Education, 35(3), 443–453.

Lee, H., Choi, Y., & Ko, Y. (2014). Designing collective intelligence-based instructional models for teaching socioscientific issues. Journal of the Korean Association for Science Education, 34(6), 523–534.

Lee, S. S. (2012). New directions in educational innovation as a response to the networked society. Teacher Education Research, 51(2), 282–296.

Lee, Y. N., & Lee, S. S. (2009). Conceptual design principles of collective intelligence. Journal of Educational Technology, 25(4), 213–239.

Leifer, L. J., & Steinert, M. (2011). Dancing with ambiguity: Causality behavior, design thinking, and triple-loop-learning. Information Knowledge Systems Management, 10(1/4), 151–173.

Lincoln, Y. S., & Guba, E. G. (1985). Naturalistic inquiry. Beverly Hills, CA: Sage Publications.

Lytras, M. D., Mathkour, H. I., Abdalla, H., Al-Halabi, W., Yanez-Marquez, C., & Siqueira, S. W. M. (2015). An emerging – Social and emerging computing enabled
philosophical paradigm for collaborative learning systems: Toward high effective next generation learning systems for the knowledge society. Computers in Human Behavior, 51(Part B), 557–561.

Martin, R. L. (2009). The design of business: Why design thinking is the next competitive advantage. Boston, MA: Harvard Business Press.

Mesmer-Magnus, J., & DeChurch, L. (2009). Information sharing and team performance: A meta-analysis. Journal of Applied Psychology, 94(2), 535–546.

Paulus, P. B., & Nijstad, B. A. (Eds.). (2003). Group creativity: Innovation through collaboration. Oxford University Press.

Plattner, H. (2009). An introduction to design thinking: Process guide. Palo Alto, CA: Stanford Institute of Design.

Pook, A. S. Y., Chong, C. W., & Yuen, Y. Y. (2017). Effectiveness of cross-border knowledge transfer in Malaysian MSC status corporations. Knowledge Management & E-Learning, 9(1), 90–110.

Sawyer, K. (2007). Group genius: The creative power of collaboration. New York, NY: Basic Books Press.

Schon, D. A., & DeSanctis, V. (1986). The reflective practitioner: How professionals think in action. The Journal of Continuing Higher Education, 34(3), 29–30.

Selamat, A., Alias, R. A., Hikmi, S. N., Puteh, M., & Tapsi, S. M. (2017). Higher education 4.0: Current status and readiness in meeting the fourth industrial revolution challenges. Retrieved from https://www.moe.gov.my/muat-turun/teks-ucapan-dan-slide/2017/1527-redesign-he-4-0-higher-education-4-0-current-status-and-readiness-in-meeting-the-fourth-industrial-revolution-challenges/file

Shalley, C. E., Zhou, J., & Oldham, G. R. (2004). The effects of personal and contextual characteristics on creativity: Where should we go from here. Journal of Management, 30(6), 933–958.

Sonnenburg, S. (2004). Creativity in communication: A theoretical framework for collaborative product creation. Creativity and Innovation Management, 13(4), 254–262.

Valentine, S., Godkin, L., Fleischman, G. M., & Kidwell, R. (2011). Corporate ethical values, group creativity, job satisfaction and turnover intention: The impact of work context on work response. Journal of Business Ethics, 98(3), 353–372.

Van Ginkel, W. P., & van Knippenberg, D. (2008). Knowledge about the distribution of information and group decision making: When and why does it work? Organizational Behavior and Human Decision Processes, 108(2), 218–229.

Woodman, R. W., Sawyer, J. E., & Griffin, R. W. (1993). Toward a theory of organizational creativity. Academy of Management Review, 18(2), 293–321.

Wright, K. B. (2000). Social support satisfaction, on-line communication apprehension, and perceived life stress within computer-mediated support groups. Communication Research Reports, 17(2), 139–147.

Yang, M. (2011). Exploring the principles of collaborative learning for realization of collective intelligence. The Korean Journal of Educational Methodology Studies, 23(2), 457–483.

Zhou, C., Kolmos, A., & Nielsen, J. F. D. (2012). A problem and project-based learning (PBL) approach to motivate group creativity in engineering education. International Journal of Engineering Education, 28(1), 3–16.