Patterns of Interaction Emerging Creativity: A Case Study of a Communication on SNS in the EV Design Contest

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Abstract: An educational method based on interaction and cooperation among learners has been introduced into engineering and design education, but educational practices and articles based on this method present insufficient result regarding evolution of creativity, a core objective of design and engineering education. This study aims to identify the patterns of evolution of creativity from the analysis of a case study and presents the results from participants' interactions about exchanging product designs on a social networking service in the Association for the Promotion of Electric Vehicles EV Mobility Design Contest for International Students 2017. We observed three patterns of interaction spurring creativity based on the analysis: 1) creating a new artifact through interacting with the same or almost same artifact, 2) confirming strong originality rather than creating a new artifact, 3) combining an artifact presented by others to construct a new artifact. However, the result suggested 4) requiring a culture of exchanging opinions among participants for a learning environment.

Keywords: Creativity, Interaction, Design and Engineering Education, Cultural Psychology

INTRODUCTION

An educational method based on interaction and cooperation among learners has been introduced into engineering and design education. Coorey (2016) conducted a case study of peer learning in higher education. A peer-learning method aims to foster a collaborative learning community and increase leadership skills. In this study, first-year students taking a design course undertook one project with their small-group members and peer reviewing assignments with one pair learner. Based on field notes, Coorey found that the students created a team mentality that emphasized cooperative learning. Based on the post-survey results, 86% of respondents answered, "Ask a friend or peer in class," when they could not figure out an answer while completing a design assignment.

Savage, Vanasupa, and Stolk (2007) discussed the importance of project-based learning (PBL) and explained curriculum improvements at California Polytechnic State University. PBL can transform a curriculum from traditional instruction to alternative learning. In particular, PBL provides specific learning contexts for students. These contexts encourage students to apply their fundamental knowledge of science, mathematics, and technology to actual problems.

Silva and Neves Madeira (2010) evaluated a competitive and cooperative learning program in a programing course of a university-level engineering program. This case study conducted an individualized type of competitive learning in an intergroup competitive setting. Results of the post-survey that collected data from students who participated in the individualized type of learning indicated that the students feel pressure from others but were also highly motivated. In an intergroup setting, some students failed to actively participate in group activities, while others repeated the process of trial and error without reflective thinking; however, they finally produced outcomes.

Several educational methods are based on interaction and cooperation among learners, which commonly emphasize motivating students through cooperation and competition with others and encouraging acquiring knowledge of design concepts and skills. These examples in the literature have limitations regarding insufficient opportunities for creativity, a core objective of design and engineering education. Creativity is a skill that creates something new compared with existing artifacts or concepts. For example, using new materials, a new use of old materials, new ideas, and new combinations of common ideas (Zwirn and Zande 2015). Although cultivating motivation and acquiring skills for design through interactions among learners is important in

engineering and design education, they must show how interaction affects their creativity.

Next, this paper aims to identify how these interactions evolve learners' creativity from a case study. The literature has developed theoretical frameworks to reveal the effectiveness of interaction for creativity (Glăveanu 2010, Zwirn, and Zande 2015). The theoretical framework used in this study is explained in the next chapter.

THEORETICAL FRAMEWORK

To determine what types of interactions evolve, this study refers to the tetradic framework of creativity (Glăveanu 2010) as a theoretical framework. Glăveanu (2010) discussed a historical transition of the paradigms regarding creativity (i.e., the He-paradigm, I-paradigm, and We-paradigm) from reviewing the literature (Table.1).

Creativity had historically been considered a divine inspiration only possessed by lone geniuses (He-paradigm). In this paradigm, creativity is an innate ability; therefore, it takes the strongest individualistic stance in the conceptualization of creativity. The I-paradigm asserts that everyone is capable of creativity because this characteristic is not a capacity of the few chosen by God. This paradigm was intended to educate an average person with abilities linked to creativity (e.g., tolerance for ambiguity of and orientation toward the future, independence of judgment, preference for complexity, strong desire to create, deep motivation, strong intuitive nature, and patience). Researchers have developed these concepts and indicators to measure and develop curriculums to increase abilities.

The He-paradigm and I-paradigm emphasize creativity as individual abilities. Therefore, an individual's environment was not considered a primary factor affecting their performance. Although these individualistic stances take a main position in the research regarding creativity, the We-paradigm is based on cultural psychology and has been cited by researchers in this field. The We-paradigm asserts that "creativity takes place within, is constituted and influenced by, and has consequences for, a social context" (Westwood and Low 2003, p.236) and that it can be developed through interaction with others who do not share the context or in an environment that consistently changes.

Human development is achieved through activities mediated by various artifacts in communities, and the use of artifacts are affected by various cultural features that are specified by each community. In interactions between individuals who do not share social contexts or cultural backgrounds, they struggle to deconstruct the accustomed use of artifacts and concepts and construct new uses for artifacts and concepts to adjust to new activities. The We-paradigm assumes that creativity is an outcome of this interaction process. Thus, we should include these social contexts, cultural factors, and interaction processes when developing curriculums based on creative education.

Glăveanu (2010) presented a tetradic framework to understand manifesting creativity in the We-paradigm (figure 1):

> the new artifact (material or conceptual) is seen as emerging within the relation between self (creator) and others (broadly understood as a community), all three being immersed into and in dialogue with an existing body of cultural artifacts, symbols and established norms. (Glăveanu 2010, p.12)

Table 1. Definition of the He-, I-, and We-paradigms from Glăveanu (2010)

	He-paradigm	I-paradigm	We-paradigm
Definition	The few lone genius who were chosen by God or have innate abilities	Everyone is capable of being creative because it is no longer a capacity of the few chosen by God, biology, or unique psychological features	Assumed that creativity is the result of human interaction and collaboration
Theoretical background	Romanticism and enlightenment	Psychology	Cultural psychology
Relationship with social	Need nothing to link them to the world of others or existing knowledge	Just a factor of a myriad number of human development factors	Creativity occurs within, is constituted and influenced by, and has consequences for, a social context
Process of development	Excluding the role of co-creation or collaboration in the process of reaching great	Acquiring abilities such as tolerance for ambiguity and orientation towards the future,	

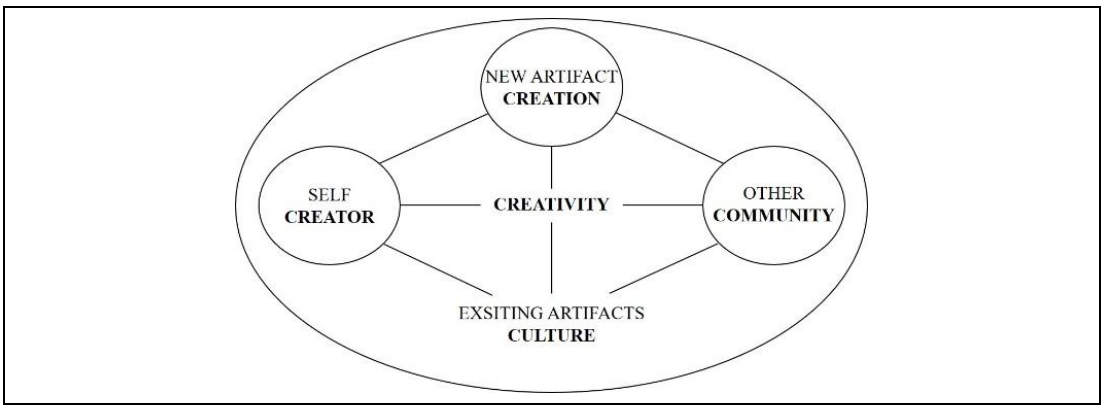


Figure 1. Tetradic framework of creativity (Glăveanu 2010, p.12)

Table. 2 Process of EVDC 2017

Period	Event
April 2017	- Entry of EVDC
May	- SNS Exchange for brushing up the design product - The first screening (selected 23 teams from 96 teams)
June	- Workshop 1 for brushing up the design concept and styling
August	- Second screening (selected 10 teams from 23 teams)
September	- Workshop 2 for brushing up the design concept and styling
November	- Final screening

Conflict comes from the interaction between the Self (Creator) and the Other (Community), who does not share a common culture with the Self because of the different use of artifacts (i.e., material and conceptual). These different uses of the existing artifacts were constructed by each cultural background. To resolve this conflict, those that share a cultural background sometimes struggle to create a new artifact, find new uses of artifacts, expand concepts of artifacts, and re-evaluate existing artifacts. Thus, creativity is contained within the interaction by using various artifacts structured by each culture.

Though the tetradic framework of creativity presents a dynamic system that provides opportunities for creativity, it does not explain how creativity evolves through interaction and what principles of the learning environment are required for creativity to occur. This paper refers to this tetradic framework of creativity and discusses the patterns of evolution of creativity and the learning environment required.

Next, this study aims to identify the patterns of evolution of creativity from an analysis of a case study by presenting the results from the interaction among the participants regarding exchanging product designs on a social networking service (SNS) in the Association for the Promotion of Electric Vehicles (APEV) EV Mobility Design Contest for International Students 2017.

RESEARCH METHODS

Overview of the case study

As mentioned earlier, interactions observed during the APEV EV Mobility Design Contest for International Students 2017 (EVDC) were analyzed as a case study. In this contest, participants from various countries exchanged their design products to improve them for the screening. The tetradic framework of creativity emphasizes evolution of creativity through the interactions among individuals with different cultural backgrounds that use the same artifact differently. In this theoretical assumption, creativity is demonstrated through the interaction among individuals with different nationalities because each individual has a different cultural background. Notably, this study observed an interaction opportunity among participants from various countries to clearly show the result.

The APEV, which conducted the EVDC and was established in 2010 to promote the use of electric vehicles, has a stated mission: “leave the beautiful earth for our children in the future.” (APEV n.d.)

The EVDC was held from April until November in 2017 and has been held once every two years since 2013. The objective of this contest is to foster creativity in students predicted to lead the next generation of designs for electric vehicles; thus, they can include a broad range of possibilities (EVDC n.d.). EVDC 2017 hosted 255 participants in 96 teams from 16 countries. Each team could have a minimum of one member up to a maximum of six members.

The executive committee of EVDC conducted various events to brush up the design product during the contest (Table 2). Each participant submitted the design product before each screening at the end of May, middle of August, and end of October. Twenty-three out of the 96 teams passed the first screening, and 10 out of the 23 teams passed the second screening. These 10 teams joined the final screening wherein the first and other prizes were given.

Table 3 List of teams for the interviews

Team	Country	No. of members	SNS Group	Key concept	Final result
QF	Japan	4	#3	Automated bedroom mobility	Second Screening
Volcano	Uganda	1	#2	3D-printed electric rally vehicle	Final Screening
LAS	Japan	3	#1	House sharing with mobility	Final Screening
SOS	Japan	5	#2	Automated cruise dust bin	Second Screening
H2O	Japan	2	#3	Mobilized convenience store	Second Screening

Design of the interaction among the participants

The EVDC has an educational context compared to ordinal design competitions or contests; therefore, it aims to create an opportunity for interactions among the participants to improve their design product. Notably, we observed difficulties during the face-to-face interactions because the participants were residents of different areas. The EVDC introduced SNS as a communication space for the participants. Facebook was chosen because it is broadly used worldwide.

The communication was mainly activated in May, before the first screening. The executive committee established three groups on Facebook, and each team was randomly divided into the groups. To guide the interactions, the committee offered four topics.

> Topic A) Upload the following things as an icebreaker: 1) a short team-introduction movie or a photo and text that includes a team profile (i.e., team name, members and their Facebook accounts, affiliate university/college/institution, and nationality), 2) their favorite car with a simple explanation (one car per team), and 3) a short message for the group members. *One team, one post
>
> Topic B) Share an initial concept with other participants and explain what daily life, social, cultural, ecological, and systemic backgrounds are linked. Post one picture or hand drawing (PDF) and explain it in 100–200 words. We strongly suggest uploading your concept to an SNS to enhance your products. *One team, one post
>
> Topic C) Compare other teams' concepts with your idea when you are inspired. Additionally, reply how you were inspired to view or respond to other group members' posts. *One person, one reply
>
> Topic D) Enjoy casual communication such as clicking "like" or making a "comment" to create friendships with others.

First, the committee created a set self-introduction to facilitate good relationships within each group (Topic A). Next, each team uploaded an initial design idea and an accompanying explanation to an SNS (Topic B), and other teams compared them with their own ideas and commented (Topic C). Lastly, casual communication among the participants produced recommendations to view similar topics (Topic D). After the first screening, the participants could access each SNS group, and the committee continued to encourage communication with other team members on the web.

Ikejiri, Isshiki, and Yamauchi (2014) evaluated the educational value of the EVDC in 2013 and observed that participants earned design views with features of EV from an analysis of the questionnaire. Additionally, their discussions and interactions on the SNS created the opportunity to promote these learning outcomes. In other words, creativity regarding EV design can evolve from interactions among participants. However, they did not examine the process of the interactions in detail. This study attempts to concretely identify that process from EVDC 2017.

Data collection and analysis

Fifteen participants from five teams, which passed the first screening and actively joined the SNS communication, were selected as interviewees (Table 3). The author conducted the interview session after workshop 1 in June for four teams from Japan. A team from Uganda was interviewed in August after the submission of their design product for the second screening. The session comprised the following five topics: 1) frequency of browsing the SNS and its purpose, 2) how the interactions on the SNS affected the design product, 3) how the interactions on the SNS affected the process of making the design product, 4) notable findings from the interactions, and 5) requests and improvements regarding the interactions. Two interviewers majoring in educational technology conducted each interview session, and the duration of each session was approximately 45 minutes. Japanese language was used for the four teams from Japan, and English was used for the team from Uganda. An IC recorder recorded all the sessions, and the transcripts were used for the analysis. We observed the typical language regarding evolution of creativity and described the episodes. Finally, the results were presented in a tetradic framework of creativity.

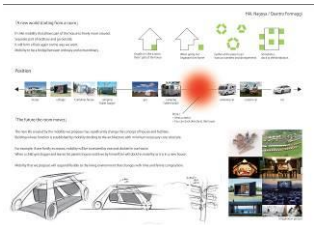
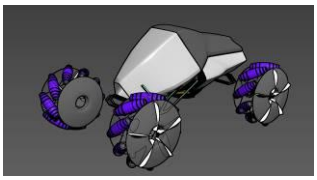
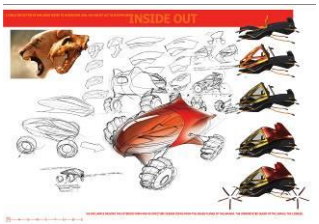
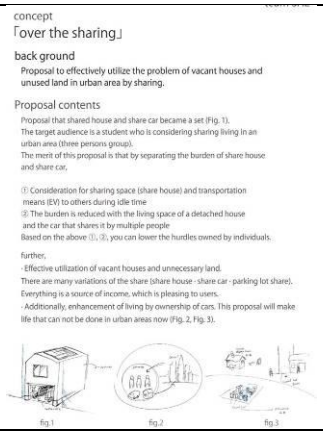
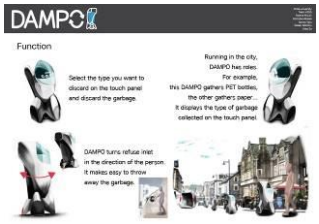
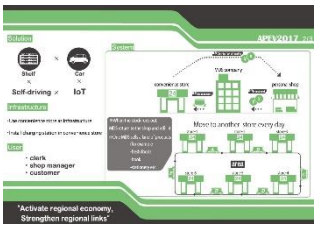
RESULT

Summary of the design products

Table 4 presents the design product of five teams before and after their interactions on the SNS. The initial ideas for the design products were posted to the SNS in the form of a rough sketch. The products submitted for the first screening were seen to have improved because the participants had to present their design concept and their styling in detail for the screening.

The participants were observed to understand various notions about design in the interactions on the SNS, and they expressed their design concept for the product with modifications. These improvements can be understood as evolution of creativity. The authors observed three patterns of interaction that spurred the evolution of creativity and the situations and environments required for this process. The episodes and their accompanying statements from the informants are subsequently described.

Table 4 Design products and their improvements

	Before (Posted on SNS)		After (Submitted for the First screening)	
QF		→		
Volcano		→		
LAS		→		
SOS		→		
H2O		→		

Patterns for evolution of creativity and the learning environment for that process

Episode 1: a pattern of creating a new artifact (concept) through interacting with the same artifact

The first pattern is creating a new artifact (concept) through interacting with the same or almost same artifact (concept). A member of team QR explained this pattern.

QR introduced an EV that includes a function of the accommodation; however, some teams also presented an EV with a function of the accommodation. Team QR had to express their originality in detail to differentiate their conception from the others.

"Maybe to teams Z and Y, our idea looked alike in a lot of components."
"When we looked at these design concepts, we discussed that we should go our way. This opportunity was a trigger to deeply reflect on what we want to produce."

QR member A

After this interaction, they deepened their ideas of their EV with accommodation to present a specific feature of their conception compared with the other teams.

"We kept developing our concept, and we should differentiate our idea from other teams."

QR member B

After this interaction, the design product submitted for the first screening expressed the EV with accommodation that emphasized relaxation. Thus, the participants had sharpened their idea through interactions on the SNS.

Episode 2: a pattern of confirming the originality of their concept from a comparison with an artifact (concept) presented by other teams

Episode 2 describes a pattern of confirming strong originality, rather than creating a new artifact (concept), through the interaction. LAS explained this pattern. In this pattern, LAS did not create a new artifact or conception after the interaction with others; however, they understood the creativeness of their design product through watching others.

LAS developed confidence after comparing their concept with the concepts posted on the SNS. This phenomenon occurred because although the initial design products of other teams had excellent layouts, the essential parts of the concepts were neither well defined nor logically well structured. Therefore, LAS kept their design concept for the first screening.

"Layout was excellent, I thought. Yes, they worked hard, but, this is just my opinion, the design concepts were not involved well."

LAS member A

"Some teams posted products after rendering, or sketches, but I couldn't understand what they would suggest. There are types of posts: these posts looked nice, and I thought it is really interesting."

LAS member B

Although the members in LAS found the value of their own concept, other teams did not even mention actively joining the interactions. Team SOS was highly motivated to exchange initial ideas for brushing up their design product and expected to earn feedback from other teams regarding their initial idea, but few comments were posted.

"We actively commented to other teams to encourage them to communicate, but almost all the teams did not follow uLASthough we posted a comment for others, the answer was not well defined. I was not sure what they did not fix yet, or maybe they were not motivated to interact with others."

SOS member A

Episode 3: a pattern of constructing a new artifact by combining different artifacts presented by other teams

The third pattern is featured actively: combining the artifact (concept) presented by others to construct a new artifact (concept). The Ugandan team, Member of Volcano, mentioned this episode.

Volcano structured an off-road EV composed of parts fabricated by 3D printer to manage the unique characteristics of Uganda; notably, this concept's visualization did not present well (Table 4). Next, Member of Volcano observed the initial ideas posted on the SNS and understood that their post did not clearly express the concept. Finally, Volcano included the context and location of the design product and submitted it for the first screening.

"One of the teams that I saw, I commented on the way that they approached something and how they visually described it; I think it was the dust bin? I was very amazed with their breakdown. Yeah, I actually said, I really appreciate how clear and simple your concept was defined in the context to the location planned for. It has made me reanalyze my approach to the visual presentation of my concept. I remember that. It was pretty impressive."

Volcano member A

Episode 4: learning environment for evolution of creativity

As mentioned earlier, creativity does not automatically evolve. Sometimes the initial ideas of the design products were not well defined or too abstract to evaluate. Therefore, the participants found it difficult to create ideas to improve their design products.

> *"In most of the ideas, there were insufficient considerations, so I couldn't comment. It was very hard to comment for them."*
>
> *H2O member A*

This comment expresses that even if the opportunity for interaction is organized, the interaction expected to evolve creativity might not automatically occur and requires the culture of exchanging opinions among the participants. Additionally, the participants have difficulty in communicating when there are substantial differences regarding the quality of the design product. The tetradic framework of creativity does not describe the context or environment that encourages the interaction. To develop an educational program that cultivates creativity, educators should include the perspective of designing a learning environment.

DISCUSSION AND CONCLUSION

We demonstrated three patterns regarding the interactions that spur the evolution of creativity from the analysis of the case study. Creating a new artifact through interacting with the same or almost same artifact was the first pattern generated by the interaction among the participants from the same country. The tetradic framework of creativity indicates that creativity occurs through encountering new artifacts. In the design contest, the participants were evaluated based on their creativity. We conclude that encountering the same or almost same artifacts can trigger the creation of a new artifact.

The second pattern explains confirming strong originality rather than creating a new artifact. We confirmed what is new or original by performing a comparison with other artifacts. Members of LAS had compared their design concept with other teams and increased their understanding of their concepts value and originality. This interaction can be observed as evolution of creativity.

The third pattern is featured actively: combining the artifact presented by others to construct a new artifact. The team from Uganda learned the importance of the context and situation in which the EV is used, and developed a design product involving these notions. This is an example of creativity that incorporates the features that others have suggested.

Although the authors found these productive interactions from the case study, some of the participants did not actively join the interactions. In addition, sometimes the quality of the interactions was low because some of the ideas posted to SNS were not well defined. Additionally, some of the participants did not achieve evolution of creativity through the interaction. To develop an educational program to cultivate creativity, educators should include the perspective of designing a learning environment.

Finally, the authors discuss and evaluate the quality of creativity for future educational practices. Episodes 1 and 2 were observed to reflect at the concept level and brush up their design production from the posted considerations. For example, QF reflected on their concept that emphasized including an accommodation function and inspired them to further differentiate their concept from others. The reflection or brushing up at the concept level was not observed for Episode 3; in summary, the participants learned design skills.

To invoke concept-level reflection and brushing up, construction of the appropriate learning environment is critical. This is one of the methods to encourage active participation. For example, controlling the quality of initial design ideas for posting to the SNS is necessary to involve the participants in the interactions. In addition, instructions should be provided regarding the best attitudes to have when reading and posting ideas to the SNS. SOS passively waited for comments from others, but QF and LAS actively collected information from fewer messages and engaged in less communication to improve their products.

Therefore, educators should provide guidance on how to assess the posts on the SNS. Moreover, the authors suggest intentionally selecting groups with different features by, for example, discussing the participants' concept, styling, and skills. In this case study, the executive committee randomly distributed the teams into the three groups, and each had different challenges and emphases.

The authors observed three patterns and a learning environment that facilitates the evolution of creativity. Although the interaction evolves a variety of creativity, it is not automatically invoked. Educators should consider the type of creativity to evolve in the educational practice and construct learning environments to encourage active interaction. As a future direction, we are developing models to be embedded in the notions that this article suggested. The author must continue to investigate other patterns of interaction evolution of creativity.

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