Iyer, S. et al. (Eds.) (2022). Proceedings of the 30th International Conference on Computers in Education. Asia-Pacific Society for Computers in Education

Unpacking Emergent Creativity in Online Collaborative Making

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Abstract: Making encompasses creative problem solving and artistic self-expression. When makers work in groups by utilizing the available material resources, the creative process can be significantly influenced by social and material interactions. The article aims to contribute to the understanding of creativity as a distributed phenomenon, by discussing an empirical case study of how creative outcomes emerge from collaborative making. We specifically look at data from a graduate course run online, where novice makers collaboratively engage in solving design problems. Our analysis suggests that creativity arising from a collaborative making process cannot be reduced to individualistic traits, but spread across social and material worlds.

Keywords: Making, Collaboration, Distributed Creativity, Collaborative Emergence

1. Introduction

For the last few years, creativity has been discussed in tandem with the Maker movement and Maker culture. In general, making involves creation, collaboration, and sharing, gradually transforming the notion of DIY (Do-it-yourself) to DIT (Do-it-together) (Clapp, 2017). As makers come together in the collaborative making, resources are shared in the situated environment, and influence each other's ideas and design processes, resulting in a collective form of creative outcomes. At the group level, creativity cannot be reduced to individualistic mental processes but distributed across collaborative networks (Sawyer & Dezutter, 2009). As per this perspective, creative processes cannot be considered to be taking place only in isolated minds but also between people, objects, and over time. Such a distributed action considers creativity in terms of interactions, communication, and co-creation (Glăveanu, 2014; Sawyer & Dezutter, 2009). Creativity thus becomes the derivative of the flow of interdependent contextual interventions, and the mechanism of generation within the distributed process can be identified with the concept of collaborative emergence (Sawyer, 2014).

Collaborative emergence refers to the emergence of a new product or creative outcome resulting from collaborating groups that are less constrained (Sawyer & Dezutter, 2009). Collaborative emergence is characterized in group activities as having unpredictable outcomes, with moment-to-moment contingency and the interactional effect of any action can be altered by the subsequent actions of the participants. Collaborative making can also be argued to be distributive in nature, holding the potential for such emergent creative outcomes.

Often, making activities are used as interventions to enhance creativity among learners (Lille & Romero, 2017; Sullivan, 2011), but research studies exploring and documenting collective forms of creativity in making remain scarce (Schmoelz, 2017; Timotheou & Ioannou, 2019). Also, many research approaches have focused only on individual behavior, personality traits, and cognitive process (Kozbelt, Beghetto, & Runco, 2010; Smith & Ward, 2012), leaving out components of interaction with materials. Recent studies have acknowledged the collective and social dimension of creativity. (Aguilar & Turmo, 2019; Clapp, 2017).

In this article, we investigate how creative outcomes emerge out of collaborative making in an online setting, by conceptualizing creativity as distributed and materially-grounded activity, endemic to everyday life (Tangaard, 2013). The setting is that of a graduate course run online, where students work in groups and use maker tools and technologies to solve design problems collaboratively. We consider design as an integral part of the making process (Barniskis, 2014; Dougherty, 2012), and the students taking part in the course as novice makers.

2. Study Details

2.1 Setting

The data for the study is taken from the onscreen video recordings of a graduate course -Tools Lab- run by a leading engineering institute in India, where a series of maker tools-technologies and related activities were introduced to the graduate students. The participants for the course included Ph.D. students and master's students in an interdisciplinary programme, and were divided into six teams with four members each. For the study, we have considered a making activity: *A co-design activity to reimagine, redesign any of the daily encountered object/device, find pitfall(s) of the object/ device, and ideate for modifications and repurposing, with a stakeholder within the team*. Tinkercad was the recommended tool to engage in 3D modeling as it supported real-time online collaboration for designing. The activity was spread over 3 design sessions, with each session of 3 hours once in a week. Team selection and composition were done by facilitators to ensure balance in terms of disciplinary backgrounds, and prior experience with maker tools, in each team. Teams were directed to design or redesign objects or devices which are tangible and have a form so that 3D designs can be printed. Teams were advised to keep a design journal, but no format was given for the entries. The members engaged in the online making activity of design, through MS TEAMS. We looked for data set that covered teams' making actions from start to end of the activity, who have completed the task. Following these requirements, we have used the video recording of Team K, whose solution approach was found to be novel and addressed the particular design problem, as per the course instruction team. The team comprised of 4 participants, M1- first year Ph.D. student, M2-second year Ph.D. student, M3-first year Master's student, M-4 second year Master's student, and facilitators - F1, F2 as indicated in the excerpts. The members of Team K worked on solving a design problem with the problem statement*: Existing containers/ vessels are not well designed for carrying multiple beverages at the same time, especially in scenarios of meetings where attendees opt for different beverages*. The Team presented ideas and proposed solutions at the end of the design activity.

2.2 Analysis

We analysed the data by content logging and segmenting the data into various phases of the design process such as ideating, information seeking, process planning and organizing, documenting, sketching, 3D modeling, refining ideas, and non-task related activities, to get an overall understanding of the making process in our context. We follow the case study methodology (Merriam, 2007) to examine the making activity of Team K. The online making sessions were recorded using screen recording. The authors were present during the making sessions and made observations to support the data analysis. We used the content logs to conduct interaction analysis (Jordan & Henderson, 1995) focusing on talk, use of artifacts, tools and technologies for communication, and making (Steier, & Davidsen, 2021). While replaying the video and parsing the transcripts iteratively, we focus on dialogic conversations and communications through MS TEAMS between participants along with their manipulation of available resources. We followed the team's making actions in Tinkercad, and actions on other shared artifacts like documents, 3D models, images etc. The idea units are considered for a unit of analysis where we look at episodes with the idea entry, evolution, and exit from the various making phases.

3. Findings

The study revealed evidence of collaborative emergence of ideas across multiple encounters of design sessions, where ideas get accumulated and modified on a moment-to-moment basis, affected by the interaction of or with human and material resources, which translate towards the conclusive proof of concept, capable of addressing the problem in hand. We found the emergence of two core ideas in the making sessions, where the makers attempted to address the previously mentioned problem statement. The two core ideas for the multiple beverage storage container are the idea for a structural unit of the container and the idea for a monitoring unit of the container. The creative making process is found to be entangled with: People - makers, facilitators, and Materials - 3D models in the Tinkercad shape library, product images from the internet, and sketches.

3.1 Representative episode of collaborative emergence of the idea for monitoring unit

The following episode represents an instance from the ideation phase in the first design session. Participants are using the brainwriting technique to note down ideas in spreadsheets, to solve the problem at hand. Here M3 introduced the idea of using the Internet of Things (IoT) for making the flask design under consideration, a smart device. The other participants are found to build on it and the accumulated ideas are parked for proposing an IOT-based vessel with multiple compartments.

M1 :	M3 turns out to be.. he has written IOT based thing [refers to idea written in spreadsheet]
M2 :	Oh.. but we will need sensors
M2 :	Some software installed in phone and.. then we can control.
M1 :	.. we can see the levels.
M3 :	Actually.. we have different compartments,. right?.. with different fluids of different temperature.. so helpful with sensing and heating
M1 :	Ok.. we keep battery based reheating then.. it can be taken to other places

The dialogic exchanges between the team members show the development of the core idea for smart technology integration in an incremental fashion. The spreadsheet becomes a shared artifact with a collection of ideas that can improve the functionality of the proposed container design. As the sensor-based monitoring is identified by team members, the thread for using IOT for the container is found to be expanding on a moment-by-moment basis. In the final presentation after the activity, the team proposed an IoT-based smart flask, for which a 3D model was created using Tinkercad collaboratively. Even though the model has little reference to IoT components, the final idea and proposed solution consisted of a smart device package and structural package. In the above excerpt, the idea of the monitoring unit cannot be attributed to a team member alone, but as a collectively shaped functionality.

3.2 Representative episode of collaborative emergence of the idea for structural unit

The following episode represents an instance from the 3D modeling phase in the third design session. The team used Tinkercad to realize the design ideas. Figure 1 shows the Tinkercad interface, using which multiple designs were generated. Team members are found to work on a single design at a time, by building on each other's input, refining for further changes, and then moving to a new model.

M1 :	.. Just check this M4.. in the chat [shares a link to 3D model, in the chat].. That's a 3d model, but it is cap and all is simple it seems.
M4 :	Yeah.. this is pretty good.. we cannot download it.. but can be created.
M1 :	mm.. try it. [imports a cylinder shape from Tinkercad Library] .. or can we design a different one.. with cylinder three compartment and common cap .. you got what i said?
M4 :	..not really
M1 :	[Moves pointer over the rectangular box model].. u know this hot box right?.. let me show u this picture..[searches images on the internet]. See.. like this..
M1 :	[Moves pointer over the cylindrical model] this idea we thought of.. then dropped

for.. some reason

M4 : I was just thinking.. one cylinder and. 3 triangular compartments.. the cap will be something like the one you said and when you rotate it, it changes the compartment

M1 : Initially, we thought about moving the compartment, but F1 said not to use a lot of rotation parts .. the stability issues

M1 : Here.. rotation can be only cap rotation right?

M4 : Yeah..

M2 : [Rejoins after getting disconnected earlier] the problem with inside openers at top will be.. some mechanism required to make the fluid reach top

M1 : Yeah.. correct

M2 : ..But bottom one is helpful in that case

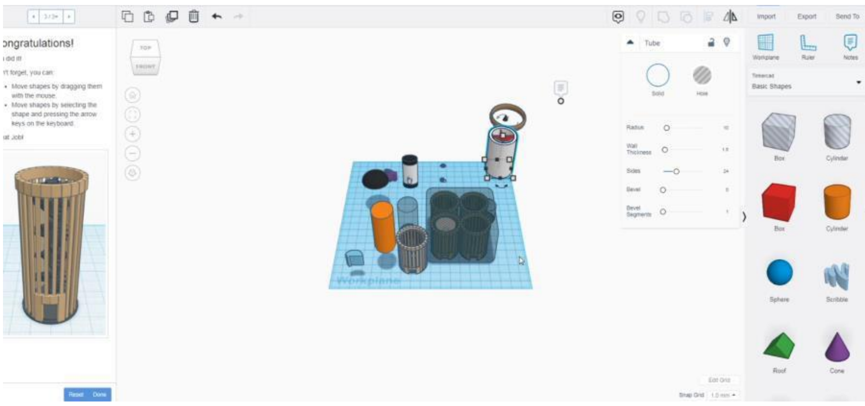

Figure 1. Multiple designs created by Team K during the modelling phase using Tinkercad.

The ideas and designs that are getting refined in the above excerpt are reflected in the collaboratively built 3D model and presented after the activity, as shown in Figure 2. The structural package is found to have 3 compartments, with 3 taps at the bottom and fewer moving parts. Here the dialogic interaction starts with M1 sharing a link via chat, and M4 getting inspired and responding to it. M1 and M4 then jointly decided to drop the rectangular box idea and follow the cylinder idea which is also used in the model shared previously. Also, M1 makes use of hot box product images from the internet, to convey the idea of moving compartments. M1 then points out the suggestions from F1, and are duly considered in the design decisions related to moving parts. It is also seen that M2 who got disconnected earlier due to network issues, rejoins and finds a problem with top opener ideas and suggests bottom ones. This episode of making is enriched by the elements: makers, facilitator, shared 3D model, Internet resources, contributing towards the emergence of the idea for a structural unit. These interactions suggest that making can be considered as a distributed process, with the scope for collaborative emergence of creativity.

Figure 2. 3D model presented by Team K as a final structural package.

4. Discussion

We have presented a case study of online collaborative making where team members worked on solving a design problem. Even though the team has followed established routines of problem-solving like brainwriting, we found instances in the making process where makers collectively contributed to developing the solution, one maker's action followed by the other in adding or refining the idea, facilitator inputs becoming instrumental in the making, material entities affording and mediating the making, thus underlining the distributed form of creativity. With the representative episodes, we have illustrated the emergence of two different core ideas for solving the design problem, from the less scripted collaborative making activity, distributed across the social and material spheres (Glăveanu, 2014; Sawyer & Dezutter, 2009). The first episode shows the interaction among makers taking up creative roles of synthesizers and analyzers, thus playing a vital part in arriving at the concept of using the IoT package for the proposed solution. The second episode showed the interaction of makers, between makers and online resources, and the influence of the facilitator in arriving at the final idea for the structural package, which is reflected in the 3D model created in the making activity. Here, the bidirectional connection between makers in which perspectives are exchanged, and differences are converted into creative expression, highlights the social dimension of creativity. The technological affordances of the tools, communication channels, directive nature of online resource materials, and the corresponding ways of utilization, point to the material line of distribution of creative online making (Literat & Glăveanu, 2018). Although the sociality and materiality aspects of creativity in the collaborative making are mentioned separately, these elements are found to be closely intertwined.

The findings from the study support the conjecture that the collaborative emergence of creative outcomes is shaped by not only social elements but also by the material elements of the situated-making context. The cases presented in the article bring in the materiality aspects of online collaborative making which are often overlooked in understanding creativity in online making contexts. With these initial findings, we suggest to factor materiality to expand the notion of collaborative emergence, which is rooted in sociality (Sawyer, 2014). The study also adds to the positioning of creativity in collaborative making as a distributed phenomenon where the creative process is constituted by the ecosystem of makers, facilitators, materials, and cannot be narrowed down only to individualistic processes. When compared to events of collaborative emergences in theatrical performances (Sawyer & Dezutter, 2009), design acts are of fragmentary in nature. Further studies are required to expand our understanding related to the socio-material entanglement in the creative making, especially that of online contexts, which can inform how the collective action of creativity can be fostered. Similar studies can be potentially helpful in getting insight into the distributed learning that takes place in various sites of collaborative making.

5. Implications & Limitations

Along with investigating creative making actions in online settings, the study also shows the potential of online making for learning. Researchers and educators should attend to design features of learning environments that can afford online collaboration and support tinkering. The materiality of online collaborative making needs to be studied deeper to enhance such distributed modes of learning.

The study focuses on limited data of an online making setting, where novice makers engage in groups to solve design problems. So, the findings cannot be generalized across other making settings and sites of collaboration. Analyses from several making contexts and among diverse makers would have given a wider perspective on collaborative emergence and distributed creativity. It would be also interesting to see how novice makers engage in creative making in physical and hybrid settings, using different modes of digital fabrication, physical materials, and computational units, which bring out more embodied interactions.

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