How Shared Online Whiteboard Supports Online Collaborative Design Activities: A Social Interaction Perspective

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Abstract. The distance education and online learning have received increasing attention in recent years. However, due to the spatial separation and time differences brought by online learning spaces, the efficiency of the interaction be- tween peers and instructors can be significantly decreased, especially for online collaborative design activities. The online whiteboard was developed to provide users with a virtual whiteboard for visual creation and idea generation, but its effectiveness has not been adequately explored. This study aims to explore whether such an online whiteboard can adequately support users' communication and collaboration behavior during online collaborative design activities. An in-depth interview was conducted to investigate users' evaluations based on three social interaction aspects: affective expression, open communication, and group cohesion. The results reveal both the usefulness and drawbacks of the online whiteboard in facilitating participants' online collaborative design activities. Suggestions for future online collaborative tools are also discussed.

Keywords: Online whiteboard · Collaborative design activity · Online learning · Community of Inquiry · Social interaction

1 Introduction

In recent years, online learning has become a trend—especially in higher education institutes, as it can provide the latest educational resources and meet the diverse needs of students [1]. Due to the spatial separation and time differences brought by online learning spaces, the interaction between peers and instructors can become quite ambiguous [2]. Nevertheless, interaction and collaboration constitute a vital foundation for students to construct knowledge and to deliver learning outcomes within the learning community [3]. There still exists doubts in terms of the effectiveness of distance education and online learning [4].

The difficulties are more significant for online collaborative learning because the collaborative context requires people from a variety of fields to share ideas and work together effectively. During collaborative learning activities, knowledge is developed collectively, and group members are expected

to learn from one another and reflect on others' thoughts [2]. However, collaborative learning is usually expected to be less engaging [5], quite shallow [6], often disjointed [7], and divergent [8]. Taking the collaborative design process as an example, it typically comprises a series of collective activities to create artifacts or solve open-ended issues [9]. The design process commonly involves numerous project actors who are in separate locations, equipped with different design tools, and have various design experiences.

To overcome the possible obstacles, online collaborative learning tools should not only meet users' needs to deploy their professional skills but also increase users' social interaction and collaboration abilities. Some online tools have been developed to support project management, document collaboration, communication and information sharing, data collection, group discussion, and so on [10]. For instance, online collaborative whiteboards are attracting particular attention because they can provide multiple users with an integrated virtual whiteboard for visual creation, image and file adding and sharing, note writing and sticking, meeting arrangement, and so on. Online collaborative whiteboards such as Miro, Conceptboard, Twiddla, and Ziteboard have been found to be quite effective in supporting various collaborative learning activities, including laboratory learning [10], music education [11], and mathematics and physics learning [12] [13].

However, evaluation of the effectiveness of such online collaborative whiteboards for collaborative design activities has been limited investigated. Different from the science and technological problem solving, online collaborative design activities are characterized by their social and organizational dimensions—which require collective sharing, including continuous activity management and communication with team members [9]. Thus, it is necessary to investigate how online learning tools support users' collaborative design activities.

In this study, we focused mainly on the tools of online collaborative whiteboards. The purpose of this study is to explore whether online whiteboards can adequately support users' communication and collaboration behavior during online collaborative design activities. In particular, there are three questions proposed: (a) How do multiple users interact and communicate with their peers during online collaborative design activities? (b) How do multiple users develop interpersonal relationships and express their emotions using the online whiteboard? (c) How does the online whiteboard tool support users' collaboration behavior and develop group cohesion during online collaborative design activities?

2 Methodology

The method employed in this study was in-depth interviewing, which was conducted following an international online workshop organized by Harbin Institute of Technology, Shenzhen. The whole interview section lasted about 40 minutes for each participant.

2.1 Participants

Five participants (one male and four females) were recruited from each of the five groups in the online international online workshop. The participants included students (average age of 22.2 years) in their first year of graduate school who majored in product design and digital media design at the Harbin

Institute of Technology, Shenzhen. At the same time, this international online workshop was also joined by students from four international universities in Germany, the United Kingdom, Switzerland, and Brazil. It lasted for about one semester—from October 2020 to January 2021. Within a multidisciplinary team, the students were asked to create a healthy community by eliminating food waste and optimizing the consumption of nutritious food through the means of design. The participants needed to cooperate with other team members from a variety of educational backgrounds, including psychology, architecture, electronic engineering, and applied imagination.

2.2 Online Whiteboard

The Miro online whiteboard (www.miro.com) was employed as a major collaborative platform in this online design workshop. This platform provides several functions for remote workshops. An infinite whiteboard allows users to collaborate the way they want on an infinite canvas. Users can use templates and frameworks to create mind maps, flowcharts, and tables. The Miro online whiteboard also provides smart drawing tools such as a freeform pen, shapes, arrows, and sticky notes. The online white- board is also embedded with video-chatting and commenting functions and integrated with numerous assistive applications such as Google Drive, Slack, Dropbox, OneDrive, YouTube, and Axure RP.

2.3 Workshop Sections

Similar to general design workshops, the online workshop contained the essential sections and components of a design project. It included the following: (a) a well- defined goal of the design workshop, (b) the workshop schedule and timeline, (c) ice- breaking activities, (d) literature review and user research, (e) idea generation and brainstorming, (f) the development of design solutions, and (g) evaluation and feed- back. The whole international workshop was conducted in both the synchronous way and the asynchronous way. For example, the ice-breaking activities and final evaluations were conducted involving the whole workshop team. The other activities, such as idea generation and solution development, were completed by each team.

2.4 Interview Questions

The present study particularly concerned whether and how the online whiteboard supports users' communication and interaction behavior during collaborative design activities. The Community of Inquiry (CoI) framework was referred to when developing the interview guidelines. Specifically, this study explored users' online collaborative design activities based on the aspect of social presence involved in CoI frame- work [14][15]. As shown in Table 1, nine structured questions were asked during the interviews, with each structured question elaborated by several follow-up open questions. These questions addressed the participants' experiences regarding the process of affective expression (Q1–Q3), open communication (Q4–Q6), and group cohesion (Q7–Q9).

Table 1. Interview questions on social presence during the online workshop.

Questions	Examples of the follow-up questions
Q1- Does getting to know other course participants give you a sense of belonging in the course?	Which kind of information can help you to know your group members?
Q2- Are you able to form distinct impressions of some course participants?	How did you form the impressions of your group members? Please give us some examples.
Q3- Do you think online or web-based communication is an excellent medium for social interaction?	If not, what are the drawbacks of online workshops, and do you have any idea as to how to improve the online tools in the future?
Q4- Do you feel comfortable when conversing through the online medium?	How did you converse with other group members? Please share the possible difficulties.
Q5- Do you feel comfortable when participating in the course discussions?	What kinds of tools have you used to discuss with your group members? Please share the possible difficulties.
Q6- Do you feel comfortable when interacting with other course participants?	How did you express your positive or negative feelings during the workshop? Please share the possible difficulties.
Q7- Do you feel comfortable when disagreeing with other course participants and still maintain a sense of trust?	How did you deal with these disagreements?
Q8- Do you feel your point of view was acknowledged by other course participants?	Have you met any difficulties or problems when expressing your own opinion?
Q9- Do you think online discussions can help you to develop a sense of collaboration?	Which functions or tools were the most helpful when developing the sense of collaboration?

3 Results

3.1 Experiences Related to Affective Expression

Participants were asked to discuss their experiences and perceptions when they were building interpersonal relationships within the groups and the difficulties and problems when they used the online whiteboard to express and share their affective feelings. Based on the analysis of the questions, most of them could get to know their group members and form distinct impressions of their group members quite well. Particularly, face-to-face video-chatting was preferred as the most efficient and vivid way for them to know and understand each other. For instance, some of the participants described their experiences as follows: "The way they were talking and their reaction from the face-to-face video-chatting could help me to form the impression quickly" and "If I could not see his or her face, I won't feel very close to them." Nevertheless, it was surprising that none of the workshop groups used Miro's built-in video-chatting functions. Instead, they utilized the video conferencing software Zoom (https://zoom.us) because of the loading problems. In addition, the ice-breaking activities conducted through video-chatting were reported to be more effective for knowing each other in the first place. The participants also claimed that detailed and subjective information (such as educational background, personal hobbies, expectations, and lifestyle) was more helpful in developing distinct impressions of other group members. They further stated, "The activities guided by questions and themes were more helpful than the general introduction in building an interpersonal relation- ship."

Most of the participants disagreed that online or web-based communication is an excellent medium for social interaction. First, four of the participants mentioned that there was a lack of individual initiative and project constraints during their online communication. Some of the comments are as follows:

"Some of the group members only attended the online discussion whenever they want; otherwise, they could just keep quiet," "I can just turn the camera off and take some rest. Nobody will notice that," and "We cannot supervise and urge each other just like what we did in offline discussions." Second, the participants believed that online communication could pro- duce a sense of distance and reduce the level of engagement to a certain degree. They reported, "The ambiance and context in the offline discussions were much stronger." Lastly, the participants mentioned the lower efficiency of online communication. They noted, "The efficiency of online communication was quite low; sometimes we were just hanging online and busy with something else," and "sometimes we dis- cussed for several hours without any significant progress."

3.2 Experiences Related to Open Communication

Regarding the platforms that support online open communication, the participants reported that Zoom was the major software they used for meetings and discussions. In most situations, they used Zoom to conduct oral discussions and employed the Miro board as a platform to organize their thoughts and ideas. The participants believed that face-to-face video-chatting was more suitable for brainstorming and idea generation. At the same time, the Miro board was especially helpful in providing a variety of functions to organize and record the ideas. The most frequently used tools on the Miro board included the Mind Map, flowchart, storyboard, stickers, PDF or link posting, YouTube video sharing, and free drawing (see Figure 1). In addition, two participants reported that the comments posted by other members on the Miro board were also quite useful, especially for those issues that did not need an urgent solution.

The participants also listed some other assistive applications they used during the online workshop. The most important ones are the instant messaging applications. Although the Miro board could remind the users once there was any information up- date and it was also integrated with some instant messengers, the students still needed some other applications to keep in contact after the online meeting and conferencing. Usually, they chose these instant messaging applications based on their habits and residence. Most of the groups used WhatsApp as the major platform to discuss and communicate offline, while two groups chose Slack and Discord as the major communicating software. Generally, they used these instant messaging applications mostly to schedule notifications, send links, and transfer documents.

Overall, most of the participants thought they were comfortable expressing their positive feelings. Mostly, they would directly communicate their praise and satisfaction using words or emojis. In particular, four participants said that the use of emojis was an effective way to express their emotional feelings. However, participants found it was much harder to express their negative feelings. Some of the comments are as follows: "I don't know how to express my dissatisfaction when some of my group members offend me" and "Sometimes I felt worried, but I didn't know how to push others to catch up with the progress through online platforms."

Fig. 1. Example of the frequently used tools on the Miro platform.

3.3 Experiences Related to Group Cohesion

Disagreement was a common situation within the group, but most of the participants felt free to express their opinions. In addition, they preferred to discuss the issues through video-chatting and thought this would not influence their sense of trust. Two of the participants expressed that online communications allowed them to better ex- press their real thoughts because they did not feel shy. Also, most of the participants could get clear feedback from their group members, and they believed the facial ex- pression helped a lot in delivering the feedback and acknowledgment. For example, some of them said, "I could see his or her face and felt that he or she was quite excited about my idea" and "I was pretty sure that my idea was acknowledged by the group members."

Although most of the participants thought they could develop a sense of collaboration during the online workshop, there was still a lack of interpersonal relationships during the process. Four of them reported that they built other kinds of social relation- ships with the group members by attending some extracurricular activities and eating together if possible. However, the online workshop was only held every one or two weeks, and all the topics were related to the course and workshop itself. It was very difficult to develop a closed interpersonal relationship with the group members, which diminished the sense of collaboration to a certain level.

In addition, the roles of instructors also became much more important during the online workshop. Some of the students made the following statements: "If the instructors could help us to cover the ideas and thoughts, it would be much more effective," "Sometimes the instructor would ask the students who were not actively participating in the discussion, which helped a lot," and "I expected my instructors could give more suggestions and guidance in detail."

4   Discussion and Conclusion

The purpose of this study was to investigate whether and how the online whiteboard supports users' communication and collaboration behavior in online collaborative design activities. We found that the

online whiteboard was employed as an important way of visual interaction—which could assist in the various design process aspects, including problem discovery and definition, idea generation and development, and solution evaluation. This is consistent with the findings of some previous studies [9] and [10]. We did not witness a scenario where any of the users abandoned the use of the Miro platform, and most of the users found it very useful and effective [11][12][13]. Their favorite Miro features included stickers, free drawing, flowchart, Mind Map, and storyboard. Some of the built-in and integrated features on the Miro board were also reported to be quite useful in design workshops, such as PDF and link posting, YouTube video inserting, and Google Drive document sharing.

The Miro board provided a vital way of visual communication, but it cannot fully support the online workshop without face-to-face communication. The participants expressed that they heavily depended on the video-chatting application to interact with other team members. Video-chatting could effectively help in impression development, emotion expression, online communication, and group cohesion. Nevertheless, the built-in video-chatting function on the Miro board was barely used because the participants mainly selected the video-chatting applications based on their usage habits and residence. At the same time, instant messaging applications were needed as a supplement and used to arrange schedules and requirements.

Although online tools can support collaborative design workshops to a large extent, the participants still believed online tools cannot replace offline collaboration and social interaction. For example, consistent with previous studies, it was difficult for the online design activities to foster interrelationship between the group members; thus, it may be less engaging and induce a sense of distance [5][7]. Accordingly, this study suggested instructional activities and opportunities that purposefully developing interpersonal relationships can enhance impression development and emotional engagement between peers. Another issue related to the online design activities was a lack of individual initiative and constraints, which largely decreased the efficiency of the online interaction. Therefore, it was suggested that more instruction and guidance should be made available for online collaborative design activities. The instructors should make a more detailed progress plan and actively join and guide the whole de- sign project process. Feedback on learners' problems and performance was also quite effective in facilitating their collaborative design activities.

Generally, this study found that users could effectively interact with their group members during online collaborative design activities using the online whiteboard and some assistive applications. Nevertheless, the online whiteboard needs to be improved in terms of its integration with some video-chatting and instant messaging applications. It should also consider the usage variance resulting from platforms, user habits, and cultural and regional differences. Online design activities should be carefully planned, and instructors should be required to perform more interventions. The results of the current study addressed the user experience of online learning tools from the perspective of design activities, and it is expected to assist the design and optimization of future online collaborative tools.

References

1. Zhou, M.: Chinese university students' acceptance of MOOCs: A self-determination perspec- tive. Comput. Educ. 92, 194-203 (2016)

2. Kent, C., Laslo, E., & Rafaeli, S.: Interactivity in online discussions and learning outcomes. Comput. Educ. 97, 116-128 (2016)

3. Anderson, T., & Dron, J.: Three generations of distance education pedagogy. Int. Rev. Res. Open. Dis. 12(3), 80-97 (2011)

4. Rai, L., & Chunrao, D.: Influencing factors of success and failure in MOOC and general analysis of learner behavior. Int. J. Inf. Educ. 6(4), 262 (2016)

5. Dennen, V. P.: Pedagogical lurking: Student engagement in non-posting discussion behavior. Comput. Hum. Behav. 24(4), 1624-1633 (2008)

6. Webb, E., Jones, A., Barker, P., Van Schaik, P.: Using e-learning dialogues in higher educa- tion. Innov. Educ. Teach. Int. 41(1), 93-103 (2004)

7. Zhu, E.: Interaction and cognitive engagement: An analysis of four asynchronous online discussions. Instr. Sci. 34(6), 451 (2006)

8. Hewitt, J.: Beyond threaded discourse. Int. J. Educ. Telecommun. 7(3), 207-221 (2001)

9. Metz, S. M. V., Marin, P., Vayre, E. The shared online whiteboard: An assistance tool to synchronous collaborative design. Eur. Rev. Appl. Psychol. 65(5), 253-265 (2015) 10.Rojanarata, T.: How Online Whiteboard Promotes Students' Collaborative Skills in Labora- tory Learning. In: 8th International Conference on Information and Education Technology, pp. 68-72. Association for Computing Machinery, New York (2020)

11.Lee, A., & Jen, Y. H.: Interactive whiteboard integration into music teaching and learning: Preschool children as a case study. Procedia. Soc. Behav. Sci. 177, 449-458 (2015)

12.Ng, O. L., Ting, F., Lam, W. H., Liu, M.: Active learning in undergraduate mathematics tutorials via cooperative problem-based learning and peer assessment with interactive online whiteboards. Asia-Pac. Educ. Res. 29(3), 285-294 (2020)

13.Stoica, D., Paragina, F., Paragina, S., Miron, C., Jipa, A.: The interactive whiteboard and the instructional design in teaching physics. Procedia. Soc. Behav. Sci. 15, 3316-3321 (2011) 14.Hsu, Y. C., Shiue, Y. M.: Exploring the influence of using collaborative tools on the com- munity of inquiry in an interdisciplinary project-based learning context. EURASIA Journal of Mathematics, Sci. Tech. Ed. 14(3), 933-945 (2017)

15.Garrison, D. R., Cleveland-Innes, M., Fung, T. S.: Exploring causal relationships among teaching, cognitive and social presence: Student perceptions of the community of inquiry framework. Internet. High. Educ. 13(1-2), 31-36 (2010)