Utilising social networking services as a collective medium to support design communication in team collaboration

Mi Jeong Kim
School of Architecture, Hanyang University, Seoul, Korea
Yeon Sook Hwang
Department of Interior Architecture Design, Hanyang University, Seoul, Korea, and
Ha Sung Hwang
Department of Media and Communication, Dongguk University, Seoul, Korea

Abstract

Purpose – A variety of collaborative technologies have been developed to support design communication among members of design teams, and understanding the affordances of these technologies is critical to effective design collaboration. This research explores the potential of social networking as a collective medium that encourages design communication among student designers at the conceptual stage of design in a studio course.

Design/methodology/approach – For one semester, the student participants used different social networking services to communicate with their team members, and the authors analysed how they collaborated when solving a given problem using the collaborative tools.

Findings – The results show that various social networking platforms support students' communication of design and exploration of problems differently by affecting their clarification of ideas and information sharing. Collective discussion and online support are useful for framing problems and ideation in collaborative design.

Originality/value – This research proposes that social networking services appropriate to the activities needed to be chosen and provided to enable design communication to promote students' active learning through team collaboration.

Keywords Collaborative technology, Design ideation, Design communication, Team collaboration, Social networking, Collective medium

Paper type Research paper

1. Introduction

Designers use various computational design tools to create design models for visualization, analysis and simulation. When an individual design is scaled up to a collaborative design, designers additionally need collaborative tools for design communication and information sharing within a design team. A variety of collaborative technologies have been developed to support both synchronised and asynchronous interaction among designers in a team. An understanding of the affordances of collaborative technologies is critical to the effective use of these technologies in design collaboration.

Recently, the scaling up of individual intelligence to collective intelligence has emerged through social networking, as intelligence is increasingly located in the network of relationships that an individual has with the external environment and other individuals (Kim *et al.*, 2012). Networked collaboration is able to shift isolated "intelligences" into "collectives" (Hight and Perry, 2006). Collective design via networked intelligence forms the basis of the way in which collaborative technologies combined with social networking can support constructive participation in design environments. Furthermore, the use of social networking services (SNS) as communication tools is advancing rapidly, especially in university settings. Social networking through the internet has made it possible for students to interact and communicate with their friends and teachers about their progress and about the problems they encounter in learning (Magogwe *et al.*, 2015).

Many scholars argue for the purposeful integration of SNSs as an educational tool and have studied the pedagogical possibilities of SNSs (Kabilan *et al.*, 2010; Tess, 2013; Al-Ali, 2014; Magogwe *et al.*, 2015). However, few studies have examined the ways designers utilise SNSs as a collaborative tool for problem-solving in architectural design. This paper addresses this gap in empirical research by examining the potential role of SNSs as a collective medium for supporting design communication and information sharing for team collaboration, particularly, at the conceptual stage of design. The collaborative environments afforded by such SNSs can be used as mediums for collective problem-solving because users can share information and build on others' achievements by elaborating or providing alternatives to stored information.

We conducted an empirical study in a design studio to develop an understanding of how design communication is structured in SNSs for team collaboration, focussing on information sharing, problem exploration, interaction and engagement. Since we were interested in the potential of SNSs for design education rather than for design practice, we recruited student designers to complete the task. In engaging in non-threatening SNS environments, students can actively collaborate with team members, particularly, to frame problems – a critical activity in the conceptual stage of design. We hypothesized that the use of SNSs in the collaborative design process would allow students to communicate with the team members actively and to reflect collectively on design problems, leading to increased exploration of design alternatives. In addition, we expected that the three different platforms could facilitate different communicative and collaborative activities through design collaboration.

2. Related works

2.1 Problem framing and collaborative technologies

Design is a reflective practice to an exploration process (Schon, 1983). However, due to the complexity of design projects, in practice, most designers collaborate with other designers or professionals. Collaboration implies teamwork, negotiation and sharing representation (Gu *et al.*, 2010). During design collaboration, designers communicate dynamically and collectively arrange goals and navigate design problem spaces while constructing design solutions (Lahti *et al.*, 2004).

Problem framing is the initial step designers take when they are tasked with solving an ill-defined problem. Designers should manipulate "frames" of a given problem based on their understanding of key aspects of the design task because such manipulation can transform an ill-defined problem into a workable springboard for solution generation (Jay and Perkins, 1997; Kvan and Gao, 2006). Visser (2004) argued that analysing a design task by developing setting, formulation, structuring, framing and defining the ill-defined problem is a critical design activity. Schon (1983) demonstrated that framing is an initial activity that evokes other design actions in the framing-moving-reflecting model. More specifically, Kvan and Gao (2006) argued that problem framing can be a means of identifying whether digital technologies change the way designers engage in their work. That study compared the

pattern of problem framing in three design settings: an online remote setting, an online co-located setting and a paper-based co-located setting; it found that the online remote setting facilitated framing activities, particularly high level framing.

Collaborative technologies have become an essential aspect of design projects, and CSCW is an essential research area in the development of collaborative technologies for design. Most research in CSCW has focused on creating virtual "shared workspaces" in distributed computer environments (Ishii *et al.*, 1993). To support remote collaboration on tasks, awareness of other designers' activities is crucial since such awareness provides a context for each designer's own work and thereby assists in coordinating team activities (Dourish and Bellotti, 1992; Gutwin and Greenberg, 1996). To analyse the effects of collaborative technologies on design collaboration, Kim *et al.* (2012) developed an analytical framework that characterises CSCW in terms of representation, communication and human-computer interaction (HCI) and grouping types of technologies based on the time-place matrix.

To facilitate the adoption of collaborative technologies in design domains, many researchers have investigated the effects of collaborative tools on design communication. Kvan *et al.* (1997) found that designers engage in more high-level communication when using textual communication tools, and in a comparative study, Gabriel and Maher (1999) found that text better supported design collaboration. Paulini *et al.* (2013) explored the use of social networking and online participation in design and identified mechanisms by which collective innovation produce successful solutions from community engagement.

2.2 Social networking services as an educational tool

As teachers seek technology to catalyse their instruction and promote active student learning, SNSs are increasingly visible in higher education settings. Accordingly, studies on the educational value of SNSs have grown exponentially. Goman (2002) insisted that SNSs provide opportunities to build trust among participants who are otherwise uncomfortable sharing their knowledge with people. Tess (2013) studied how students and professionals utilise SNSs on their mobile phones as rich educational tools in informal learning contexts.

Since Facebook is a social utility that connects people with friends and others who work and study around world, its growth and popularity in educational settings has grown rapidly. Educators are quickly recognising that Facebook offers opportunities to bolster instruction and student learning experiences (Kent and Leaver, 2014; Bosch, 2009). For instance, Kabilan *et al.* (2010) suggested that using Facebook for class work can promote learner motivation, engagement and positive relationships among students. Facebook has also been found to foster students' communication skills by encouraging active participation and interaction (Ross *et al.*, 2009). Magogwe *et al.* (2015) examined whether university students are interested in using Facebook to facilitate group work in their courses and found that more than 80% of students preferred Facebook to a traditional group work methods. Students used Facebook to make suggestions on how they could organise their presentations, to arrange meetings and set up reminders, to ask for clarification and to congratulate and motivate one another for their successful presentations.

While Facebook is the most commonly used social media platform, Instagram's popularity has grown most rapidly since its launch in October 2010 (Lunden, 2014). Instagram is a mobile application that enables users to instantly turn their mobile snapshots into visually appealing images, which they can then share with others on the site. Although numerous studies have investigated the uses of various SNSs like Facebook and Twitter in classrooms, very few have discussed the use of Instagram in an educational setting (Al-Ali, 2014). Bell (2013) examined college student use Instagram on field trips in a library science course. Salomon (2013) and Tekulve and Kelly (Tekulve and Kelly, 2013) also discussed the experience of their institutions' libraries' in using Instagram, as compared to other social

media tools, to reach their young audience. Al-Ali (2014) examined how easily Instagram can be implemented in a language classroom to facilitate active learning. Students generally liked to use Instagram for learning purposes. Researchers reported that the unique function of the Instagram hashtag helped students create a more personalised learning experience by enabling them to share their content with people in different classes.

3. Methodology
To understand the practical implications of introducing SNSs as a collaborative tool in design courses, we developed an architectural design studio scenario and examined how student designers worked collaboratively using a closed-chat platform, Facebook and Instagram. We used the closed-chat application as a baseline for comparison with the SNSs. Our analysis was based on a protocol analysis and a questionnaire survey. Our study of team collaboration in these three settings provided empirical results regarding the online support provided by SNSs. Throughout the empirical study, we compared designer activities across the three different platforms.

3.1 Studio composition and procedure
We selected one studio course, which ran for a single semester (sixteen weeks) in a university department of interior architecture. The study participants were second-year interior architecture students; they therefore had similar general educational backgrounds and experiences. We separated 47 students into three groups based on their preferences; 25 students used the closed-chat platform (Group K), eight students used Facebook (Group F) and 14 used Instagram (Group I). Teams were composed of three or four students from each group: Group K had seven teams, Group F had three teams and Group I had five teams. Students seem to be more familiar with the closed-chat platform than Facebook or Instagram for communication. One researcher joined the studio as a teacher, though the course included no specific lectures. The studio required students to develop designs based on their individual client-scenarios and to present their ideas as they developed every week.

3.2 The three collaborative settings
We used two popular SNSs – Facebook and Instagram – for this study, in addition to a closed-chat platform – the most popular one in Korea, where most students are familiar with the chat platform and use it frequently. In the closed-chat platform, users can chat and talk (over the voice service) one-on-one and in groups and share photos or files with their friends. In Facebook, users upload and provide access to photos, contact information and education and work backgrounds. Users can add others as "friends", which creates links between their profiles; such links between friends may vary based on individual privacy settings that control connections. Facebook and Instagram provide an open service that enables users to see other users' friends. Instagram provides additional functions. Users can create accounts, post content (pictures or 15-s videos), apply filters, add captions, tag users, add locations, add hashtags, like content, add comments, browse and follow other accounts, check feeds generated by followed accounts and explore hashtags/users (Table 1).

Feature	Closed-chat platform	Facebook	Instagram
Add comment	o	o	o
Upload photos	o	o	o
Open to public	x	o	o
The like button	x	o	o
Add captions/location	x	x	o
Tag users/hashtags	x	x	o

3.3 Design tasks and data collection
We gave them an abstract design task: to design a house where people could feel the flow of time and sustainability. We asked each team to choose a collaborative tool from chat applications or SNSs and to interact with team members using it to explore the given problem. We gave students no indication of the hypotheses we were testing. We captured the design communication that occurred in each setting for the data collection. At the end of the course, we interviewed the students to identify the strengths and shortcomings of the SNSs as team collaboration tools. Because Group F comprised only three teams, we included three teams each for Group K and Group I. Thus, data of nine teams were collected and analysed in the empirical study. Figure 1 shows the images captured from the three settings.

4. Protocol analysis
4.1 Coding scheme
We developed a customised coding scheme to examine students' collaborative ideation. The coding scheme consists of two levels: a design activity level and a communication level. The category 'information sharing' of the design activity level refers to what types of representation students used to share the information with others, and where they obtained information for exploring the design problem. We developed the category "problem exploration" from Schon's "framing", "moving", "reflecting" model in which these design activities together compose a cyclical design process. The category "interaction" of the communication level represents the mode and content of the interaction that occurred among students in the collaborative design process. The category "engagement" is related to the level of engagement in the communication; it investigates how students and visitors responded to posted content (see Table 2).

4.2 Segmentation and coding
We focused on three collaborative design environments: Group K, Group F and Group I with a detailed analysis of design communication. We selected nine teams – three from each group – because Group F had only three teams. This study is an explorative examination of design collaboration in SNSs. We analysed the protocols of five weeks of design communication in the conceptual stage of design based on a customised coding scheme. To assign codes, we segmented the protocols along each student utterance and uploaded information including

Figure 1.
Captured Images: (a) Closed-chat platform (b) Facebook and (c) Instagram

Design activity level			
Information Sharing	Type	Picture	Information in a form of picture
		Text	Information in a form of text
		File	Information in a form of file (i.e. movie file, word file)
		Link/hashtag	A link to other SNSs, websites or hashtag
	Sources	Internet	Obtain the information from the internet
		Snapshot	Take a snapshot using a mobile phone
		Scanned	Obtain the information from printed materials
		Handwritten/ sketch	Draw and scan their own sketch or handwritten ones
		Knowledge	Obtain the information from knowledge/experience
		Implicit	Provide the shared information that is implicit
Problem Exploration	Framing		Interpret further from design brief
	Moving		Propose a tentative solution with explanation
	Reflecting		Evaluate or judge the explanation in "moving"
Communication level			
Interaction	Mode	Synchronous	Communicate synchronously
		Asynchronous	Communicate asynchronously
	Content	Design-related	Talk about design-related issues
		Social relationship	Talk about general issues to build trust among members
		Encouragement	Encourage active participation and interaction
		Management	Arrange meeting schedule and allocate assignments
Engagement	Comment by visitors		Leave comments on the propose ideas
	The like		Push the button "The Like"
	No response		Not respond
	References		Mention about the shared information later

Table 2.
A coding scheme for a collaborative ideation in SNS

images and texts. As shown in Figure 1 above, the utterance patterns on Facebook and Instagram were different from those on the closed-chat platform in terms of clusters of pictures and length of text. For example, communication in Facebook and Instagram started with large or long posted information consisting of pictures or text, followed by members' feedbacks and discussion, whereas communication in the closed-chat platform was done through short utterances of information, ideas and feedback. The segmentation was completed by one researcher, the protocol coding was done by two researchers and the final protocol coding was achieved through a process of arbitration.

5. Analysis of design communication and user experience
5.1 Design communication by the protocol analysis
5.1.1 Design activity level. 5.1.1.1 Information sharing: type and source. We analysed representation types and sources for information sharing in terms of occurrence. Table 3 shows the occurrences of each type of representation throughout the five weeks. We noticed that students did not utilise Facebook and Instagram for file transfers to members as much as they did in the closed-chat platform. Judging from the protocols, students in Group F and Group I seem to use additional chat programs or emails for file transfers and management of their schedules and assignments. They shared specific information with pictures or text and discussed it in detail on Facebook and Instagram, whereas the Group K students instantaneously discussed their ideas using short sentences. The use of short utterances meant that Group K had a higher number of overall occurrences than the other groups. For example, the number "32" in picture format of Group K01 shows that students just uploaded

	Picture	Text	File	Link/hashtag
GK01	32.40	18.40	6.20	2.80
GK02	8.40	22.00	0.80	0.80
GK03	7.20	13.20	0.00	5.20
Mean (SD)	16.00(19.16)	16.47(11.57)	0.80(1.32)	2.93(3.59)
GF01	8.80	10.00	0.00	0.60
GF02	1.80	28.80	0.00	0.00
GF03	4.40	27.40	0.00	2.40
Mean (SD)	5.00(5.49)	22.07(10.06)	0.00(0.00)	1.00(1.65)
GI01	13.60	14.40	0.00	7.40
GI02	14.60	101.00	0.00	8.60
GI03	10.40	16.8	0.00	6.20
Mean (SD)	12.87(9.36)	17.13(6.15)	0.00(0.00)	7.40(6.50)

Table 3.
Representation types
(5 weeks)

images to share on the closed-chat platform, not to engage in detailed discussion. Interestingly, students in Group K also met face-to-face to further develop their design ideas and submitted captured notes to the instructor as proof of their discussions. It seems that students of Group K felt that their design communication through the closed-chat platform was insufficient for exploring the design problem and therefore needed additional offline meetings.

Table 4 shows the occurrence of each source from which the information was obtained throughout the five weeks. As expected, students used much information derived from the Internet and less scanned information of offline materials such as books and magazines. They often depended on their knowledge or previous experience for the information sharing and sometimes obtained snapshots using mobile phones for the site analysis. Interestingly, students in the closed-chat platform and Facebook produced several sketches or handwritten notes, whereas students in Instagram used no handwritten notes or sketches. Students seem to utilise Instagram as a collective medium for exploring abstract ideas for problem framing rather than posting individual solutions by each member.

5.1.1.2 Problem exploration. As shown in Figure 2, we analysed the problem exploration activities at the conceptual design stage in terms of framing, moving and reflecting. We focused on how students understood and defined "the flow of time" and "sustainability" in the given design problem. We excluded the design communication for week 1 because students' communication centred on housing designs trends after they visited a housing fair for the

	Internet	Snapshot	Scanned	Handwritten/sketch	Knowledge	Implicit
GK01	161	9	5	16	59	26
GK02	29	18	2	16	60	22
GK03	66	11	0	5	30	16
Mean (SD)	85.33(68.09)	12.67(4.73)	2.33(2.52)	12.33(6.35)	49.67(17.04)	21.33(5.03)
GF01	24	11	0	13	37	12
GF02	16	3	0	0	98	36
GF03	27	6	0	0	106	32
Mean (SD)	22.33(5.69)	6.67(4.04)	0.00(0.00)	4.33(7.51)	80.33(37.74)	26.67(12.86)
GI01	135	5	0	0	54	12
GI02	107	3	0	0	85	22
GI03	98	14	0	1	46	8
Mean (SD)	113.33(19.30)	7.33(5.86)	0.00(0.00)	0.33(0.58)	61.67(20.60)	14.00(7.21)

Table 4.
Information sources
(5 weeks)

first assignment. In order to identify the structure of the design communication with a focus on the framing, we put segments from all four weeks in a bar chart showing the cyclical process of the problem exploration. Figure 2 shows the representative patterns of the problem exploration in Group K01, Group F01 and Group I01.

"Framing" is a critical activity for making ill-defined problems workable for design solutions; designers should therefore actively engage in "framing" at the initial stage of designing creative outputs. As Figure 2 shows, students using Instagram produced the most framing activities followed by students in Facebook. The cyclical process of "framing", "moving" and "reflecting" also occurred more frequently among students using Instagram, followed by those using Facebook. Students in Group F and Group I collaborated with team members to frame the problem by clarifying posed ideas and stored information, and then developed ideas collectively by building on team members' ideas. The result indicates that Instagram and Facebook supported active communication with team members and collective problem-solving and reflection on a design problem. On the other hand, fewer framing activities took place in the closed-chat platform. Students in Group K often used the closed-chat platform as a medium for sending information to team members without explanations. In other words, in the closed-chat platform students rarely engaged in the discussions of shared information that are crucial to the cyclical process of design.

5.1.2 Communication level. 5.1.2.1 Interaction: mode and content. Unlike other categories, we investigated interaction mode in terms of segmentation clusters to identify what portions of online communication occurred synchronously or asynchronously. Rather than seeking to determine time spent, we aimed to identify preferred modes of interaction in SNSs in terms of percentage. As Table 5 shows interaction in the closed-chat platform, and Instagram took place more synchronously compared to the more asynchronous interaction in Facebook. This result suggests that students in Facebook did not give feedbacks as fast as those in the other two groups. Students on Facebook sometimes appeared to upload information only to share it with other members, not to engage in synchronous interaction.

We analysed the interaction content as shown in Table 6. Interaction was predominately design-related. Interestingly, few interactions related to the arrangement of schedules or the

Figure 2.
Problem exploration:
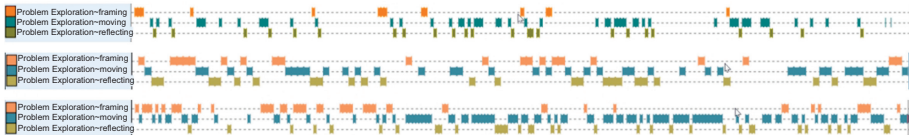(a) Group K01 (b)
Group F01 and (c)
Group I01

	Week 1		Week 2		Week 3		Week 4		Week 5	
	Syn%	Asyn%	Syn%	Asyn%	Syn%	Asyn%	Syn%	Asyn%	Syn%	Asyn%
GK01	70	30	60	40	50	50	75	25	30	70
GK02	100	0	95	5	90	10	90	10	85	15
GK03	100	0	100	0	70	30	100	0	100	0
GF01	50	50	25	75	30	70	25	75	20	80
GF02	60	40	70	30	100	0	100	0	100	0
GF03	70	30	80	20	80	20	90	10	100	0
GI01	45	55	75	25	100	0	80	20	50	50
GI02	35	65	60	40	85	15	90	10	80	20
GI03	40	60	55	45	80	20	75	25	50	50

Table 5.
Interaction mode

Note(s): Syn: Synchronus, Asyn: Asynchronous

	Design-related	Social relationship	Encouragement	Management
GK01	54.60	2.60	3.00	5.60
GK02	32.00	1.20	1.20	2.40
GK03	25.80	1.60	3.40	5.60
Mean(SD)	37.47(22.87)	1.80(1.70)	2.53(2.07)	4.53(3.66)
GF01	24.40	2.40	2.20	1.40
GF02	30.60	0.60	1.20	4.20
GF03	34.20	1.60	1.40	4.00
Mean(SD)	29.73(8.92)	1.53(2.29)	1.60(1.06)	3.20(2.21)
GI01	53.00	3.60	2.60	0.00
GI02	43.80	2.00	2.40	0.00
GI03	33.80	2.20	2.40	0.40
Mean(SD)	43.53(21.17)	2.60(3.02)	2.47(1.88)	0.13(0.35)

Table 6.
Interaction content

allocation of jobs took place via Instagram. This suggests that students utilised Instagram as a collective medium mainly for problem-solving and might use an additional communication tool for the management. The number of segmentations for design related communication on Instagram is much higher than those of the others groups. Students in Instagram not only shared design-related information with members but also engaged in active discussion and provided feedback on shared information.

5.1.2.2 Engagement. As Table 7 shows, we analysed team member and visitor engagement based on responses to information or ideas through the like button, comments or references. Group I obtained more "Comments by visitors" and many more "Like" responses than Group F. Furthermore, there were always responses to the posted information or ideas on Instagram, whereas there were often "no responses" in the closed-chat platform. Students seemed to be more engaged in design ideation on the Instagram; their posted information also received more attention from visitors, which might have stimulated students to work more actively on the design task. Students on both Facebook and Instagram sometimes returned to and mentioned previously posted information later in design communication, which suggests that social networking acts as a collective medium for storing the information.

5.2 User experience of SNSs for team collaboration

At the end of the course, we asked students about the benefits of SNSs as team collaboration tools. The main benefit (listed by all students) was the ability to connect with group members seamlessly. Student comments are as follows: "we can communicate freely with no time or space restrictions when face-to-face meetings are not possible;" "Sharing and exchanging information related to the course is possible any time, whenever it is needed;" "Posting photos

	Comment by visitors	The like	No response	References
GK01	Not applicable	Not applicable	14	1
GK02	Not applicable	Not applicable	1	0
GK03	Not applicable	Not applicable	1	0
GF01	1	42	6	7
GF02	0	2	1	2
GF03	2	2	5	1
GI01	13	315	0	4
GI02	39	310	0	4
GI03	11	127	0	3

Table 7.
Engagement (5 weeks)

and opinions is easy and convenient." Students also highlighted SNS's capability to record posts. One student said, "I can see posts and content that group members upload anytime I want because they are stored on the site." SNSs also appeared to help students receive social support for team projects. On Instagram, in particular, students benefited from social support and integration with group members and other people. For instance, several students commented that when they posted their opinions on Instagram, their group members supported and praised them, which made them happy. Student comments include: "both group members and people who I do not know commented and expressed opinions on my posts. I felt that I received social support and it felt good;" "Sometimes third party feedback was helpful in developing design ideas." Students noted that they received fewer comments or responses when they posted class-related information. This is because, when it comes to class-related information, people tend to think more carefully before they comment or click "like."

Students also mentioned the disadvantages of SNSs as a tool for team collaboration. Some students felt frustrated by delays in feedback during discussions with team members using SNSs. One student commented that "compared with face-to-face, SNSs make sharing class information easy, but it is inconvenient for communicating instantly and making quick decisions because of slow feedback from team members." Another student described the difference between face-to-face and SNSs interactions for group activities as follows: "Face-to-face meetings are useful for discussing detailed design ideas and designing floor plans, while SNSs are useful for researching, and sharing and exchanging information and images with team members."

To sum up, users' responses indicated that students welcomed the use of SNSs for team collaboration. In most cases, students actively participated in design activities (e.g. finding, sharing and uploading class materials). It seemed that they perceived SNSs as collective spaces where they could share information and discuss ideas, opinions and comments to solve design problems. SNSs appeared to be more effective and appropriate venues for collaboration when groups needed outside ideas. This kind of online support from others occurred more effectively on Instagram because the platform is open to any user. Students welcomed the comments and support of others to their own posts, whereas such responses were less welcomed when they needed to make quick decisions or engage in in-depth discussion.

6. Conclusion and discussion

This empirical study explored the affordances of social networking as a collaborative tool to support design communication at the conceptual stage. As the use of social networking as an education tool increases, we need to better understand the dynamics of social networking for online support in design communication, emphasising social process of design. Through a study of team collaboration in a design studio, we investigated how design communication was structured in SNSs, focussing on collective problem-solving and information sharing. The results suggest that social networking acts as a collective medium by enabling students to clarify design ideas and share information effectively. Further, students' problem exploration and communication with team members across the three platforms because the affordances of each vary.

Students were generally satisfied with the use of SNSs for team collaboration and felt that SNSs are most helpful for exchanging and sharing the information with team members as well as for understanding the given design problem. While students using the closed-chat platform instantly and briefly shared ideas without fully exploring the problem; meanwhile, students using Facebook and Instagram shared information and then discussed it through Facebook and Instagram in detail. Furthermore, it appeared difficult for students using the

closed-chat platform to find and return later to specific previous conversations, while students using Facebook and Instagram had no difficulty finding their stored information whenever they needed it for further discussion. For example, students utilised Instagram primarily as a medium for exploring abstract ideas collectively; students using Instagram were more engaged in design ideation and produced active discussion. Moreover, students using Instagram received frequent feedback from visitors on the information they posted, which encouraged them to reflect on given problems collectively. The strength of SNSs that students emphasised included: "communication without time and space restrictions", "information storing for further discussion" and "social support and third party feedback"

Surely, face-to-face meetings are effective for in-depth discussions, especially in the design domain because in such situations people can make sketches to share directly with team members and receive feedback instantly. In addition, although chat applications such as the closed-chat platform are convenient for instant communication and quick decision making in collaboration, meeting with team members in person whenever needed can be difficult. Thus online communication tools that enable students to discuss their ideas with team members remotely are needed regardless synchronous or asynchronous mode. As the results indicate, SNSs like Facebook and Instagram serve as useful mediums for sharing information and communication with team members and for getting feedback on design ideas remotely. Students were able explore the design problem and develop their ideas deeply in SNSs because the posted content include sufficient information sources to stimulate discussion. The inclusion of drawing functions in SNSs would facilitate further in-depth design discussion. However, if students become familiar with using SNSs for design activities, they could utilise the snapshot function effectively to exchange handwritten notes or sketches with team members.

The results of this research highlight a number of important considerations in relation to promoting the use of SNSs in the design domain. Above all, the research contributes to more effective utilisation of SNSs for design studios, emphasising collectivism and online support in collaborative design. Collective information sharing and discussion and online support and interaction are particularly useful for problem framing and ideation in collaborative design. In addition, teachers could use our findings to improve their instruction as well as promote students' active learning by emphasising engagement through SNSs. However, this study has certain limitations in terms of the application of it results to design practice because we recruited student designers and conducted the study within a design studio setting. In addition, we considered only students when studying the effective use of SNSs as a collective medium in a design studio, disregarding the role of teachers in the process. We believe future research should empirically examine the active engagement of teachers in student design communication through SNSs in order to determine how teacher participation in SNSs influences student design activities and learning processes in design courses. Further study could be undertaken on design practice to identify the potential of SNSs as a collective medium to support design communication in team collaboration.

References

Al-Ali, S. (2014), "Embracing the selfie craze: exploring the possible use of instagram as a language mLearning tool", *Issues and Trends in Educational Technology*, Vol. 2 No. 2, pp. 1-16.

Bell, M.A. (2013), "Picture this! Using instagram with students", *Internet@Schools*, Vol. 20 No. 4, pp. 23-25.

Bosch, T.E. (2009), "Using online social networking for teaching and learning; Facebook use at the university of capetown", *South African Journal for Communication Theory and Research*, Vol. 35 No. 2, pp. 185-200.

Dourish, P. and Bellotti, V. (1992), "Awareness and coordination in shared workspaces", *Proceedings of the 1992 ACM Conference on Computer-Supported Cooperative Work*, Association for Computing MachineryNew York, NY, pp. 107-114.

Gabriel, G. and Maher, M.L. (1999), "Coding and modeling communication in architectural collaborative design" in Bermudez, J. (Ed.), *ACADIA99*, Association for Computing Machinery, New York, NY.

Goman, C. (2002), "What leaders can do to foster knowledge sharing knowledge", *Management Review*, Vol. 5 No. 4, pp. 10-11.

Gu, N., Kim, M.J. and Maher, M.L. (2010), "Technological advancements in synchronous collaboration: the effect of 3D virtual worlds and tangible user interfaces on architectural design", *Automation in Construction*, Vol. 20, pp. 270-278.

Gutwin, C. and Greenberg, S. (1996), "Workspace awareness for groupware", *Proceedings of the Conference Companion on Human Factors in Computing Systems: Common Ground*, Vancouver, British Columbia, pp. 208-209.

Hight, C. and Perry, C. (2006), *Collective Intelligence in Design (Architectural Design)*, Academy Press.

Ishii, H., Kobayashi, M. and Grudin, J. (1993), "Integration of interpersonal space and shared workspace: ClearBoard design and experiments", *ACM Transactions on Information Systems*, Vol. 11 No. 4, pp. 349-375.

Jay, E. and Perkins, D.N. (Eds), (1997), *Problem Finding: The Search for Mechanism*, Cresskill, New Jersey, NJ, Hampton.

Kabilan, M.K., Ahmad, N. and Abidin, M.J.Z. (2010), "Facebook: an online environment for learning of English in institutions of higher education?", *Internet and Higher Education,* Vol. 13 No. 4, pp. 179 -187.

Kent, M. and Leaver, T. (2014), *An Education in Facebook?: Higher Education and the World's Largest Social Network*, Routledge, MY.

Kim, M.J., Maher, M.L. and Gu, N. (2012), "Mobile and pervasive computing: the future for design collaboration", in Anumba, C.J. and Wang, X. (Eds), *Mobile and Pervasive Computing in Construction*, Wiley-Blackwell Publisher, Oxford.

Kvan, T. and Gao, S. (2006), "The comparative study of problem framing in multiple setting", in Gero, J.S. (Ed.), *Design Computing and Cognition '06*, pp. 245-263.

Kvan, T., Vera, A. and West, R. (1997), "Expert and situated actions in collaborative design" in Barthes, J.P. (Ed.), *The 2nd International Wrokshop on CSCW in Design*, International Academic Publishers, Beijing, pp. 400-405.

Lahti, H., Seitamaa-Hakkariner, P. and Hakkarinen, K. (2004), "Collaboration patterns in computer supported collaborative designing", *Design Studies*, Vol. 25 No. 4, pp. 351-371.

Lunden, I. (2014), *Instagram Is the Fastest-Growing Social Site Globally, Mobile Devices Rule over PCs for Access*, available at: https://techcrunch.com/2014/01/21/instagram-is-the-fastest-growing-social-site-globally-mobile-devices-rule-over-pcs-for-social-access/#:~:text=According%20to%20research%20published%20today,in%20the%20last%20six%20months.

Magogwe, J.M., Ntereke, B. and Phetlhe, K.R. (2015), "Facebook and classroom group work: a trial study involving University of Botswana Advanced Oral Presentation students", *British Journal of Educational Technology*, Vol. 46 No. 6, pp. 1312-1323.

Paulini, M., Murty, P. and Maher, M.L. (2013), "Design processes in collective innovation communities: a study of communication", *International Journal of CoCreation in Design and the Arts*, Vol. 9 No. 2, pp. 90-112.

Ross, C., Orr, E.S. and Sisic, M. (2009), "Personality and motivations associated with Facebook use", *Computers in Human Behavior*, Vol. 25 No. 2, pp. 578-586.

Salomon, D. (2013), "Moving on from Facebook Using Instagram to connect with undergraduates and engage in teaching and learning", *College and Research Libraries News*, Vol. 74 No. 8, pp. 408-412.

Schon, D.A. (1983), *The Reflective Practitionaer: How Professionals Think in Action*, Basic Books, New York, NY.

Tekulve, N. and Kelly, K. (2013), "Worth 1,000 words: using Instagram to engage library users", *Brick and Click Libraries Symposium*, pp. 1-8.

Tess, P.A. (2013), "The role of social media in higher education classes (real and virtual) - a literature review", *Computers in Human Behavior,* Vol. 29 No. 5, pp. A60-A68.

Visser, W. (2004), "Dynamic aspect of design cognition: element for a cognitive model of design", *Theme3A-databaseds Knowledge Based and Cognitive System*, pp. 72-79.

About the authors
Dr. Mi Jeong Kim is a professor of School of Architecture at Hanyang University in Korea. She received her bachelor and master degree from Yonsei University, and her Ph.D at the University of Sydney. She worked as a postdoc fellowship in UC Berkeley before joining Kyung Hee University. Her current research interest includes convergence issues such as sensing architecture, human-computer interaction for spatial design, virtual reality and augmented reality and design education and strategies for creativity. She has published many international papers and books in the field and a committee member of editorial boards in known international journals.

Dr. Yeon Sook Hwang is a Professor of Interior Architecture Design at Hanyang University in Korea. She received her Bachelor and Ph.D from the Department of Housing and Interior Design at Yonsei University, Korea. She completed a Master at the Department of Interior Design of Pratt Institute, USA. Her research areas are user-focused design and space regeneration design. She has presented her design works at exhibition. She is a former president of the Korean Institute of Interior Design.

Dr. Ha Sung Hwang is a professor in the Department of Media and Communication at Dongguk University. She earned her PhD in mass media and communication from Temple University. Dr. Hwang teaches introductory courses in media theory and research methodologies, with emphasis on survey analytic method. Her research interest centres on effects of social medial, with a particular focus on individual's adoption of Social Networking Services (SNS). Dr. Hwang's research work has been appeared in journals including, *Information, Communication and Society, Social Behavior and Personality, The Social Science Journal and Transactions on Internet and Information Systems*. Ha Sung Hwang is the corresponding author and can be contacted at: hhwang@dongguk.edu