Int J Technol Des Educ (2014) 24:473–491
DOI 10.1007/s10798-014-9265-0

Student perceptions and performance in online and offline collaboration in an interior design studio

Ji Young Cho · Moon-Heum Cho

Accepted: 20 January 2014 / Published online: 1 February 2014

Abstract Competence in collaboration is one of the critical abilities that interior design majors are expected to develop during the course of their education; however, few students are competent to collaborate with others online. The purposes of this study were to identify student perceptions and performance in online collaboration compared to those of offline collaboration and to explore the way students collaborate online. A total of 29 junior interior design students participated in the study. After finishing each online and offline collaborative project, they completed a survey. The findings show that students are more satisfied with offline collaboration and perceive offline collaboration as more effective than online collaboration; however, no significant difference was apparent in student performance online and offline. In addition, the findings show the need to provide appropriate online interface for design collaborations. This paper includes lessons learned and recommendations to promote both online and offline collaboration in a design studio.

Keywords Design education · Design studio · Discussion board · Interior design · Online collaboration

Design studio is a core component in design education as a pedagogical approach that emphasizes student-centered learning in design disciplines, such as interior design, architecture, and industrial design (Bunch 1993; Chen and You 2010; Cuff 1992). Different from lecture courses in which students depend heavily on textbooks containing concrete instructions, design studio offers students opportunities to learn by doing projects and solve ill-structured problems (Schön 1984). Because projects or problems in design studio are

J. Y. Cho (✉)
College of Architecture and Environmental Design, Kent State University, Kent, OH 44242, USA
e-mail: jcho4@kent.edu

M.-H. Cho
Department of Education, Sungkyunkwan University, Seoul, South Korea
e-mail: moonheum.cho@gmail.com

authentic, students can engage in professional practice in a unique environment that bridges academic and professional contexts (Brandt et al. 2011).

An aspect of professional practice in which students engage in an interior design studio is peer collaboration, a common practice in a real interior design professional community (Sagun and Demirkan 2009; Webb and Miller 2006). For example, in real practice, interior designers not only work by themselves but also with other professionals, such as architects, mechanical engineers, builders, and contractors as well as graphic, lighting, and furniture designers. Collaboration provides students with rich learning experiences, such as constructing knowledge with others, sharing resources or information, and providing and receiving feedback (Hennessy and Murphy 1999; Murphy and Hennessy 2001). Through collaborative projects in design studio, students learn how to negotiate meaning, how to deal with different opinions and viewpoints, how to lead the project in a constructive way, and how to coordinate schedules with team members (Hennessy and Murphy 1999). Collaboration in design studio is, therefore, a critical experience for students.

Moreover, the Council of Interior Design Accreditation (CIDA), an organization that accredits interior design degree program and oversees the quality of interior design education, outlines what interior design students are expected to learn from collaboration and how the program needs to support student collaboration. For example, Professional Standard 5 states that interior design students are expected to develop awareness of "(a) team work structures and dynamics, [and] (b) the nature and value of integrated design practices" (CIDA, 2011, II-16); and interior design programs are expected to include learning experiences in which students can engage, such as "(c) collaboration, consensus building, leadership, and teamwork, [and] (d) interaction with multiple disciplines representing a variety of points of view and perspectives" (CIDA, II-16). An interior design program must, therefore, provide opportunities in which students can enhance their understanding of collaboration and facilitate the skills they need to collaborate with others.

Currently, with the help of advanced technologies, including synchronous and asynchronous communication tools, a significant number of interior design firms conduct collaborative projects across the world; the expectation for interior design students to acquire collaboration experiences with technologies has thus increased. Although concepts of advanced technologies such as computer supported collaborative learning (CSCL) have been proposed in design studio in the past (Seitamaa-Hakkarainen et al. 2001), integrating technologies to enhance collaboration in interior design studio is still uncommon. Successful integration of technology for collaboration may be largely affected by students' perceptions about technologies (Pektas and Erkip 2006); therefore, investigating students' perceptions about online collaboration is significant to cultivate positive online collaboration experiences. In this study, we explored student perceptions and performance in online and offline collaboration.

Advantages of collaboration in interior design studio

Collaboration, working with others for a shared goal, has several advantages for student learning in an interior design studio. First of all, collaboration increases productivity and efficiency because more work can be accomplished by a group than by working alone (Haythornthwaite 2006). A team of students can handle more complex and challenging design projects than individuals (Webb and Miller 2006). By sharing the work load,

brainstorming, and exchanging ideas, students can generate design solutions more thoroughly and creatively through the mutual dependence of group members.

In addition, collaboration helps students learn to negotiate with other students. By working together, students are exposed to diverse perspectives and opinions. The professional practice of interior design commonly occurs in a team setting, and designers must discuss and arrive at agreed-upon design solutions. Learning to negotiate through collaboration can help students to prepare to become capable employees who can engage in complex teamwork in real-world practice (Webb and Miller 2006).

Collaboration also provides opportunities for students to enhance their interpersonal and communication skills. Interior design practice involves dealing with people, such as ascertaining clients' opinions and preferred design, and discussing projects with peer designers or related professionals. Through collaboration, students encounter frequent opportunities to elaborate opinions both verbally and graphically to deliver ideas effectively. Benefits from collaboration result in sophisticated learning outcomes.

Collaboration has several disadvantages as well, such as lack of individual control, unequal participation, and opportunities for miscommunication. For more effective collaboration, group members are required to improve communication and interpersonal skills, manage the egos of people with diverse perspectives and from different backgrounds, and balance individual strengths and weaknesses (Webb and Miller 2006). Collaborative problem solving requires designers to engage in a creative and critical approach.

Asynchronous online collaboration

Online collaboration via asynchronous tools, such as a discussion board, has several advantages in design studio. First, an asynchronous tool offers participants the flexibility and convenience of communicating with one another without the constraint of time and geographical location (Hew and Cheung 2013). Students in design studio can communicate with other classmates at their convenience even after the class is over. Another benefit of using a discussion board for collaboration is that students have sufficient time to reflect on a topic and prepare a response to questions or issues raised by others during an asynchronous online discussion (Skylar 2009); however, time delay without active interaction may prevent the group from making quick decisions and frustrate some students because of the late responses of others (Girasoli and Hannafin 2008). Another benefit of using a discussion board for collaboration in design studio is that everyone has an equal opportunity to contribute to discussions instead of one or two students dominating the discussion. Because of these benefits, the current researchers adopted the Blackboard discussion board as a tool for collaboration in design studio.

Research questions

The overall purpose of this study was to investigate student perceptions of online collaboration. In order to improve understanding of student perceptions of online collaboration, we compared their perceptions of online and offline collaboration. Specific research questions follow:

1. Do student perceptions of online and offline collaboration differ significantly?
2. Does student performance in online and offline collaboration differ significantly?
3. How do students collaborate online?

Methods

Participants

The study was conducted in interior design studio course for juniors offered by a CIDA-accredited program in a Midwestern university in the USA. Among the 35 students enrolled in the studio course, 29 of them voluntarily participated in this research (82.86 %). The age of participants ranged from 21 to 24, and the average age was 22.55. The majority of the participants were female ($N = 27$); the dominance of females is representative of the current population of interior design students in the USA. According to Meneely and Portillo (2005), among students enrolling in accredited interior design program, 90 % were females in 2003; statistics at the time of this writing were similar. The participants' individual prior experience with either offline or online collaboration was identified. Fifteen of the 29 students had experience in online collaboration and 14 had none; in addition, 28 students had experience in offline collaboration, and one had none.

Research context

The interior design studio class met twice a week for 4 h per meeting. A total of two design projects were assigned to students in the studio during the course of the semester. The duration of the first design project was 9 weeks; the duration of the second, 7 weeks. In each design project, students engaged in collaboration for the first 2 weeks, then pursued design project individually based on the collaboration for the remaining weeks of each project.

The first design project was to design senior community housing for hypothetical clients–senior Ohio residents who had emigrated from one of the three countries: Japan, Chile, or Sweden. In this project, students were expected to design housing to accommodate both the cultural aspects and lifestyles the residents might have experienced in their home country. The second design project, which was to design a workplace for a fashion company in New York City, was for a design competition held by a professional interior design organization.

During the first 2 weeks of each project, students collaborated in teams of three to develop an understanding of the projects. The groups were determined by students voluntarily. In collaboration, students brainstormed ideas, shared resources, and conducted research on the topic. For example, for the first project, students in teams of three were asked to conduct collaborative research project online and present a summary of their findings. The content requirements were to (a) visit one senior housing facility and analyze it, using Christopher Alexander's pattern language theory, an environment–behavior theory; (b) analyze lifestyle and senior housing culture in Japan, Sweden, or Chile; and (c) examine architectural features of three senior housing facilities in the selected country. Students collaborated with group members asynchronously, for example, through group discussion on Blackboard by posting their research data with analysis, interacting with others, providing comments on others' postings, and receiving feedback from others. Once their online collaborative projects were finished, each team made a presentation during class. Then each student spent time completing an individual design project. As a means of facilitating participation and collaboration, requirements for using an online discussion board included a minimum number of postings per student.

The second assignment was to conduct another collaborative research project offline. Students were expected to make a presentation of their research after 2 weeks of

Table 1 Description of two collaboration projects

	1st collaboration project (online)	2nd collaboration project (offline)
Individual design project	Senior community housing design	Workplace design
Design project period	8 weeks	7 weeks
Collaboration period	2 weeks	2 weeks
Collaboration task	Analysis of one senior housing facility using Christopher Alexander's Pattern Language theory Analysis of lifestyle and senior housing culture in choice of country: Japan, Sweden, and Chile Analysis of architectural features of three senior housing facilities in the chosen country	Analysis of three offices in high-tech, media, entertainment industry in terms of organizational culture, branding, and incorporation of technology Analysis of strategies used in three design competition-winning projects in terms of concept statement, visual impact of project presentation, and quality of work
Final outcome	A presentation file of a summary of their research	A presentation file of a summary of their research
Collaboration requirement	Participation in group discussion in Blackboard Each member replies to the existing post at least ten times Each member makes a new post at least six times Each member adds hyperlink and image/pdf files at least six times Timely posting Comprehensiveness and thoroughness of the discussion Contribution to active discussions Quality of work Summarize findings in a single Power Point presentation Consider how you present your information in terms of visual impact Prepare images in color with clarity and legibility The layout and composition must be well thought out	Participation in group discussion Quality of work Summarize findings in a single Power Point presentation Consider how you present your information in terms of visual impact Prepare images in color with clarity and legibility The layout and composition must be well thought out

Table 1 continued

	1st collaboration project (online)	2nd collaboration project (offline)
Evaluation criteria	Quality of work Depth of research Depth of analysis and diagrammatic explanation Clarity of presentation Well-composed layout Quality of images Verbal delivery Participation to Group Discussion in Blackboard Timely posting Comprehensiveness of the discussion Thoroughness of the discussion Contribution to active discussions	Quality of work Depth of research Depth of analysis and diagrammatic explanation Clarity of presentation Well-composed layout Quality of images Verbal delivery
An example of collaborative project outcome		

collaboration offline with the same group members with whom they had worked online. With the same partners, students analyzed three creative office spaces and researched case studies of a few design competitions. Because their design project was a workplace design for a fashion company that was part of a design competition, students had to determine the branding strategy of the company as well as strategies for a successful design competition, such as visual impact and organization of project presentation. Table 1 presents a summary of contents, scope, and procedure of the two design projects and the corresponding collaborative projects.

Instruments

A self-reported survey and open-ended questions were used to answer the research questions. The self-report survey consisted of four sets of questions in areas such as motivation, effectiveness, learning, and satisfaction. Responses were self-reported on 5-point Likert scales, where 1 denoted "totally disagree" and 5 denoted "totally agree." The data were collected through a 35-item survey.

For motivation, self-efficacy and task value were adopted from the motivated strategies for learning questionnaire (MSLQ) (Pintrich et al. 1993). The original number of items for self-efficacy and task value was eight and six, respectively. We used five items for self-efficacy and one item for task value. Self-regulation and coregulation were adopted from DiDonato (2013), who used 13 items for self-regulation and 19 items for coregulation. Among them, we adopted three items from each. We also created enjoyment items as well as questions for effectiveness, learning, and satisfaction.

To assess whether the 14 items that were summed to create the motivation score formed a reliability scale, Cronbach's alpha was computed. The alpha for the 14 motivation items was .73 online and .80 offline, respectively, indicating that the items formed a scale that has reasonable internal consistency reliability. Similarly, the alpha for the effectiveness scale (.87 in online and .81 in offline) and learning scale (.91 in online and .89 in offline) indicated good internal consistency, but the alpha for the overall satisfaction scale (.59 in online and .61 in offline) indicated minimally adequate reliability. Questionnaire definitions and subcategories under motivation, effectiveness, learning, and satisfaction are provided with sample questions in Table 2.

Two open-ended questions were used to investigate students' experience with online and offline collaboration; these questions were worded as follows: "please list three features of online collaboration you liked most" and "please list three features of online collaboration you liked least." The same survey and open-ended questions were administered to the students after each collaborative project was completed with minimal wording change, such as "online" to "offline."

Procedure

During the 15-week course, all students engaged in two projects. The first project was implemented during the first 8 weeks of the course. For the first 2 weeks (weeks 1 and 2) of the first project, students were engaged in online collaboration. The survey and open-ended questions about online collaboration were administered during the third week of the semester. The second project was implemented from weeks 9 to 15; during the first 2 weeks (weeks 9 and 10) of the second project, students were assigned to engage in offline collaboration with the same group members with whom they had collaborated online. The same survey and open-ended questions were administered during the 11th week of the

Table 2 Questionnaire categories and definitions

Learning experiences	Definitions	Examples of questions	No. of items
Motivation			
Self-efficacy for leaning and performance	Confidence about their learning	I'm confident I did an excellent job on the assignment	5
Coregulation	Group's use of strategies, such as setting goals, monitoring, and reflecting group's learning process	I knew what my other group members were working on during the collaboration	3
Self-regulation	Individuals' use of strategies, such as setting goals, monitoring, and reflecting individual learning process	I double-checked my work to make sure I was correctly completing the work during online collaboration	3
Enjoyment	Students' evaluation of the degree to which they enjoyed the format of collaboration	In general, I enjoyed online collaboration	2
Task value	Value of learned content when it comes to application in other courses	I think I will be able to use what I learned in this online collaboration in other courses	1
Effectiveness			
Communication	Students' evaluation of the degree to which the format of collaboration was effective for communication	Online collaboration was helpful in communicating with other team members	3
Organizing ideas	Students evaluation of the degree to which the format of collaboration was effective to organize their ideas	The online discussions worked well to organize my ideas	2
Brainstorming	Students' evaluation of the degree to which the format of collaboration was effective for group members' brainstorming	Online discussion worked well for the brainstorming stage between our group members	1
Summarizing research	Students' evaluation of the degree to which the format of collaboration was effective for summarizing research	Online discussion worked well for summarizing our research for the final presentation	1
Time management	Students' evaluation of the degree to which the format of collaboration was effective for their time management	In order to achieve the same level of quality in our research outcomes, I think we should spend less time doing online collaboration and more time in fact-to-fact collaboration	1
Equal contribution	Students' evaluation of the degree to which the format of collaboration was effective for each group member's equal contribution	Online discussion worked well for our team members' equal contribution to the research project	1
Learning			
Perceived learning through collaboration	The degree to which students perceived how much they learned through collaboration	Through the online collaboration, I feel that I gained a lot of new knowledge	3
Performance	Students' evaluation of the degree to which the format of collaboration was helpful for their performance	Online peer review motivated me to perform well in the collaborative project	3

Table 2 continued

Learning experiences	Definitions	Examples of questions	No. of items
Quality	Students' evaluation of the degree to which the format of collaboration was effective in achieving quality project outcomes	I believe that online collaboration allowed us to create quality project outcomes	1
Overall satisfaction			
Satisfaction	Students' satisfaction with the way they collaborated (online vs. offline)	I am satisfied with the online collaboration in regards to the other group members	3
Preference	Students' evaluation of the degree to which they liked the format of collaboration (online vs. offline)	I would willingly participate in online collaboration in future design studio classes	2
Total			35

semester. All the surveys and open-ended questions were administered before project grading was completed in order to avoid any possible impact of grades on students' perceptions of the two modes of collaboration. The research was approved by the Institutional Review Board and conducted ethically (IRB protocol number 12-399).

Results

Differences in student perception of online and offline collaboration

The first analysis dealt with the mean differences in student perceptions of online and offline collaboration. Student perceptions of the two modes of collaboration were compared according to predefined categories, including motivation, effectiveness, learning, and overall satisfaction. We used a paired samples t test for our statistical data analysis because we used the same questionnaire for both collaboration conditions, based on repeated measures design (Meyers et al. 2006), and compared them. Our data met two assumptions for the paired samples t test (Morgan et al. 2004). First, the independent variable is dichotomous, and its levels are paired, such as online versus offline. Second, the dependent variable is normally distributed in the two conditions (online and offline). Most of the standard deviations in each variable between the two conditions are within absolute value one; therefore, normal distribution was assumed. Results of comparison are presented in Table 3.

With regard to motivation, a series of paired sample t tests showed a significant difference in enjoyment of online ($M = 3.07$, $SD = 1.04$) and offline collaboration ($M = 3.86$, $SD = 0.85$), with $t(27) = -3.11$, $p < 0.01$, $d = 0.83$. No significant differences were found among other motivational variables, including self-regulation, coregulation, task value, and self-efficacy. The results showed that students did not enjoy online collaboration as much as they did offline.

Another series of paired sample t tests on effectiveness demonstrated significant differences in student perceptions of communication (online $M = 3.39$, $SD = 0.88$; offline $M = 3.95$, $SD = 0.68$) with $t(27) = -2.53$, $p < 0.05$, $d = 0.71$; organizing ideas (online

Table 3 A paired sample t test between online and offline collaboration

Perceptions	Online		Offline		*t*	Sig. (2-tailed)
	M	SD	M	SD		
Motivation						
Self-efficacy	3.93	.53	3.94	0.64	−0.06	0.951
Co-regulation	3.62	.91	3.66	0.99	−0.13	0.899
Self-regulation	4.09	.67	4.14	0.67	−0.31	0.762
Enjoyment**	3.07	1.04	3.86	0.85	−3.11	0.004
Task value	3.24	1.15	3.52	0.91	−1.19	0.245
Effectiveness						
Communication*	3.39	.88	3.95	0.68	−2.53	0.018
Organizing ideas*	3.33	1.17	3.83	0.75	−2.17	0.038
Brainstorming	3.41	1.09	3.97	0.87	−1.95	0.062
Summarizing research	3.45	1.24	3.79	0.90	−1.38	0.178
Time management*	3.34	1.05	2.79	0.94	2.29	0.030
Equal contribution	3.31	1.14	3.72	0.88	−1.59	0.123
Learning						
Perceived learning**	3.03	0.91	3.54	0.77	−3.08	0.005
Performance*	3.43	0.87	3.91	0.78	−2.33	0.027
Quality*	3.31	0.97	3.83	0.89	−2.19	0.037
Overall satisfaction						
Satisfaction	3.44	0.95	3.78	0.77	−1.61	0.120
Preference**	3.07	1.11	4.00	0.69	−4.20	0.000

* $p < 0.05$; ** $p < 0.01$

$M = 3.33$, $SD = 1.17$; offline $M = 3.83$, $SD = 0.75$) with $t(27) = -2.17$, $p < 0.05$, $d = 0.50$; and time management (online $M = 3.34$, $SD = 1.05$; offline $M = 2.79$, $SD = 0.94$) with $t(27) = 2.29$, $p < 0.05$, $d = 0.53$. No significant differences were found in perceptions of brainstorming, summarizing research, and equal contribution in online and offline work. The results showed that students viewed online collaboration as less effective for communication and organizing ideas than offline collaboration but online collaboration more effective for time management than offline collaboration.

Another series of paired sample *t*-tests on learning indicated significant differences in perceived learning (online $M = 3.03$, $SD = 0.91$; offline $M = 3.54$, $SD = 0.77$) with $t(27) = -3.08$, $p < 0.01$, $d = 0.61$; performance (online $M = 3.43$, $SD = 0.87$; offline $M = 3.91$, $SD = 0.78$) with $t(27) = -2.34$, $p < 0.05$, $d = 0.57$; and quality (online $M = 3.31$, $SD = 0.97$; offline $M = 3.83$, $SD = 0.89$) with $t(27) = -2.19$, $p < 0.05$, $d = 0.56$. The results showed students perceived that they learned less, performed less efficiently, and produced fewer quality outcomes with online collaboration than offline collaboration.

The other series of paired sample *t* tests on overall satisfaction demonstrated a significant difference in preference (online $M = 3.07$, $SD = 1.11$; offline $M = 4.00$, $SD = 0.69$) with $t(27) = -4.20$, $p < 0.01$, $d = 1.00$, but no significant difference was found in satisfaction with the way they collaborated. The results showed students preferred offline collaboration over online.

Features students like best and least in online and offline collaboration

Open-ended questions were administered to students to investigate what they liked most and least about each collaboration mode (see Table 4). What students liked most about online collaboration were ease of use and access, followed by ease of sharing information and comments, convenience, organization of materials in one place, and references. Among the features of online collaboration, easy access and interaction with less limitation on time and place ranked as the top features students liked most. Another feature students liked most was that all the information and resources are stored in one place and easily referenced any time and any place.

Regarding offline collaboration, what students like most was that it is good for brainstorming, followed by ease of communication and better understanding and less misunderstanding. Another aspect students liked most was that offline collaboration allows them to interact quickly with other group members in a physical place so that they can use other means of communication, such as sketches, gestures, or body language, for better communication. Students also indicated that face-to-face collaboration was more efficient.

With regard to what students like least about online collaboration, technological problems seem one of the important issues that must be addressed. Table 5 shows that many students commonly reported difficulty with Blackboard features and organization and technological problems. Students frequently reported that several cumbersome steps were required to read others' comments in a discussion thread, the difficulty in keeping track of each group member's postings because of the lack of a function to alert them to new postings, and trouble navigating postings as a result of the linear features of Blackboard discussion. Students also reported communication problems and the issue of online social presence.

Regarding what students like least about offline collaboration, students most frequently listed scheduling conflicts. Compared to online collaboration, offline collaboration can occur only when all members are in the same place at the same time. Another issue that many students frequently listed was conflict among group members. Students also reported an issue with lack of documentation; in other words, offline collaboration does not result in a record of their thought, opinions, and activities unless they keep a record of their activities during each meeting. Equal participation is yet another issue that needs to be addressed, explaining our intention to use an online discussion board for collaboration.

Difference in student performance in online and offline collaboration

Each group's achievement (grade) in online and offline collaboration was compared. Because total points available differed in the two collaborative modes, percentiles were used for the comparison. No significant differences in achievement were found in online and offline collaboration. This result shows a significant gap between perception and actual achievement. Although students significantly perceived offline collaboration more positively than online collaboration in terms of motivation, effectiveness, learning, and satisfaction (see Table 3 for more information), actual outcomes were the same in both types of collaboration.

How students collaborate online

Each group's activities online were downloaded for further analysis. The total number of postings, number of new threads and responses, and the number of posting days were compared (see Table 6). When looking at each group's collaboration occurring on the discussion board, we found that each group spent 6.33 days on average in online

Table 4 Summary of most liked aspects of each type of collaboration

Online	Student response examples	Frequency	Offline	Student response examples	Frequency
Ease of use/ access	"The program was extremely simple to use, making it easy to work without stress on the collaboration"	19	Good for brainstorming	"Brainstorming works much better when you put multiple minds together"	18
Ease of sharing info and comments	"Able to post and share information easily for everyone else to see as well"	14	Ease of communication	"I could easily communicate my thoughts and ideas on the topics at hand"	14
Convenience	"Collaboration could be done at any time, didn't require scheduling group meetings outside of class"	11	Better understanding/ less misunderstanding	"Online discussion made it much more clear for communication"	13
Organization of materials in one place	"Kept information in 1 place rather than scattered about"	9	Quick response time	"Instant answers/ responses"	8
References	"Could easily go back and reference information quickly"	8	Physical contact, use of sketches, body language	"Can read body language, tone, facial expressions"	7
Thoroughness of response	"No time limits, had a lot of time to think about responses"	4	Time efficiency	"Things get done more quickly"	7
Ease of communication	"The collaborations were nice to keep up-to-date conversations on topics and such"	4	Direct response	"Got responses more directly"	7
Blackboard features	"Shows if you have any new unread posts so you can stay up to date"	2	Effectiveness in problem solving	"Easier to solve problems"	5
Quick response time	"Can get information from group member faster"	2	Clear division of work	"Easier to designate assignments"	3

Table 4 continued

Online	Student response examples	Frequency	Offline	Student response examples	Frequency
Good for brainstorming	"You can get ideas from others"	1	Comfort	"The person being there is more comfortable to work with then you get to know them better; they aren't a stranger anymore"	3
Clarity	"Clarity between members"	1	Thoroughness/ preparation	"More research before meet"	2
Total		75	Total		87

collaboration during the 15 days of the collaboration period. In addition, a student participated in online collaboration for 3.86 days on average. Collaboration days that each student spent on the discussion board ranged from 1 to 6. The total number of postings ranged from 30 to 69 in each group. Readers need to be aware that Group 9 had only two students because of the odd number of total students in the interior design studio. The number of posting each student posted was 19.29 on average. Table 6 shows each group's posting patterns and grade for the online collaboration. Group 1 achieved the highest grade, and Group 8 earned the lowest grade.

In order to identify relationships between actual behaviors in online collaboration and group achievements, correlation analysis was conducted. No significant relationship was found among achievements and behavioral variables, including a total number of postings, posting dates, number of new postings, and number of responses. This means students' behaviors captured on the online discussion board are not related with achievements. The finding implies that actual collaboration behaviors, including posting messages on the discussion board or working together with others on certain days, did not explain students' achievements in online collaboration.

Further analysis showed that collaboration did not occur on a regular basis. More specifically, distribution of each group's participation on each day shows that collaboration occurred on specific dates, such as on the first day that the project was introduced, on the eighth day, and several days before the due date (see Fig. 1). On the eighth day students had a class in the interior design studio, and the instructors reminded them of the importance of time management and provided further guidance for online collaboration.

In addition, correlation analysis was conducted to investigate relationships between students' actual behaviors in online collaboration and their perceptions about online collaboration. A positive and moderate relationship was found between length of posting time and perceptions of effectiveness of online collaboration for communication ($r = 0.40$, $p < 0.05$) and summarizing research ($r = 0.44$, $p < 0.05$). This indicates that students who posted threads on the online discussion board over a greater number of days perceived online collaboration as effective for communication and summarizing research.

Negative and moderate relationships were found between a total number of postings and self-regulation ($r = -0.55$, $p < 0.01$), effectiveness for time management ($r = -0.39$, $p < 0.05$), and summarizing research ($r = -.38$, $p < 0.05$). This indicates that students who posted more messages considered online collaboration less effective for self-

Table 5 Summary of least liked aspects of each type of collaboration

Online	Student response examples	Frequency	Offline	Student response examples	Frequency
Difficulty with Blackboard features/ organization	"I didn't like how in order to see the lists of posts you had to go completely back"	23	Schedule conflict	"It is hard to find available times for everyone in the group"	23
Difficulty with communication/ misunderstanding	"Can't communicate with group member very well"	11	Conflict between members	"Conflict between group members is likely to happen more often"	14
Technological problems	"Site was down sometimes"	9	Lack of documentation	"No documentation from everyone"	9
Lack of group connection; impersonal	"No personal contact"	8	Participation issue	"Members not showing up to meetings"	8
Many requirements in project	"Trying to meet the posts/reply requirements"	8	Difficulty in individual work (time management)	"Cannot do some aspects alone"	7
Participation issue	"Lack of responses"	4	Lack of thoroughness in response	"Less think before responses"	4
Felt unnecessary	"Shared the information online and did not feel necessary that we should have to post it"	4	Distraction	"Sometimes waste time to chat but not work"	3
Time consuming	"It required a decent amount of time"	3	Time-consuming	"Spend more time"	2
Long response time	"People not being prompt with responses"	3	Low comfort level	"Depends on who you have as a partner; this time I have good team members; other times not so much"	2
Not good for brainstorming	"Not a lot of brainstorming"	2	Difficulty in information sharing	"Still have to use electronics to transfer information"	1
Total		75	Total		73

regulation, time management, and summarizing research results. Although more research is necessary, students who had technical difficulties may have felt that online technology is not helpful for their self-regulation, time management, and summarizing results. No significant relationships were found among other variables.

Table 6 Summary of group posting patterns in online collaboration

Group	Total posting dates/ group	Average of posting date/ individual	Range of posting dates of individual	Total posting numbers/ group	Number of new posting/ group	Number of response posting/ group	Grade for online collaboration project (out of 100)
G1	7	4.667	4–6	52	21	31	94.67
G2	8	4.667	4–5	59	27	32	94
G3	11	5.333	4–7	69	28	41	91.33
G4	5	4	3–5	64	20	44	90.67
G5	4	1.66	1–2	49	18	31	92.67
G6	5	3.33	2–4	52	21	31	90.67
G7	4	3.33	3–4	65	32	33	90
G8	5	3	3	64	35	29	87.33
G9	7	5	5	30	11	19	90.33
G10	8	4.667	4–5	44	20	24	88.67
G11	6	3	2–4	69	38	31	94
G12	6	3.667	3–4	58	26	32	88.67
M	6.33	3.86	3.8	56.25	24.75	31.5	91.08
SD	2.02	1.06	NA	11.52	7.74	6.53	2.34

Group 9 had only two students. Group 1 achieved the highest grade, and Group 8 earned the lowest grade

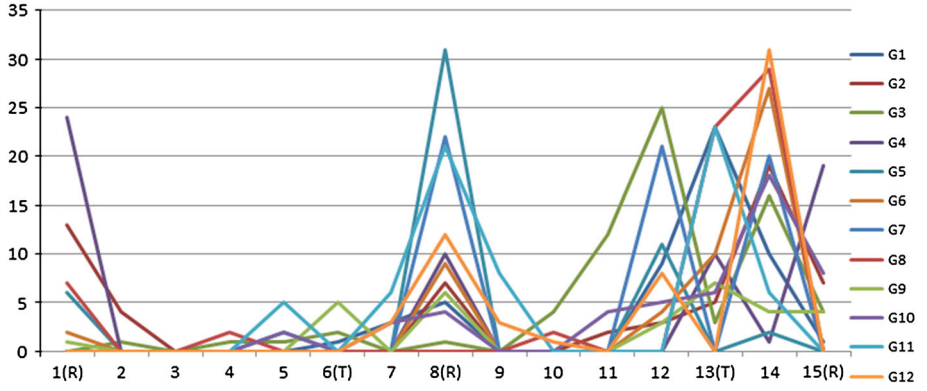

Fig. 1 Distribution of collaboration

Discussion

Why students perceived online collaboration as less favorable

In their responses students indicated that in general they favored offline collaboration over online collaboration in terms of motivation, effectiveness, learning, and overall satisfaction. Students viewed offline collaboration as more effective for quality of work, performance, organizing ideas, and communication; but no statistical difference was found in their actual achievements in the two types of collaboration.

The less favorable response toward online collaboration may be attributable to lack of online collaboration experience. The current study shows that students with past online experience had more positive reactions to both online and offline collaboration even though no statistical significance was found. Students with prior online collaboration experience rated both types of collaboration with high marks on the questionnaires. In addition, further observations of students' written comments revealed that those who had engaged in few previous online discussion activities tended to report more technical problems. For example, students with no online collaboration experience reported that the discussion board did not provide updates for new postings, forcing them to visit all postings each time. They also reported online collaboration sometime led to misunderstanding one another's intention, resulting in their posting of content similar to what was already on the discussion board, which they considered unproductive. Similar results were found in the literature with regard to an online nursing course, in which students reported they had to spend more time understanding the nature of the online course and discussion boards than learning content (Atack 2003).

Another possible reason for the less favorable response toward online collaboration is the nature of actual participation in online collaboration. In order to participate in online collaboration, students must log into Blackboard and post messages. In addition, they must read others' messages and provide feedback and comments; however, in offline collaboration, students simply met and discussed the topic. The nature of online collaboration necessitates accessing the internet and interacting with others via typing, which may be perceived as demanding and overwhelming for students with insufficient online experience. This will be discussed further in the next section. Results imply that in order to help interior design students perceive online collaboration positively, instructors must provide many opportunities for them to develop competence in online collaboration (Feichtner and Davis 1984; Webb and Miller 2006).

Yet another possible reason for more favorable response to offline collaboration may be students' familiarity with one another. Students might have become more familiar with collaboration activities and grown accustomed to each member's style and thus rated the second collaboration (offline) more highly.

Merely exposing students to multiple collaboration opportunities is insufficient to help them improve their experience with online collaboration. Students need to understand why they are assigned to engage in online collaboration for projects (Haythornthwaite 2006). When they perceive the benefits of online collaboration, such as the acquisition of a competence necessary in the current job market or the ability to produce a quality product, their collaboration will be more productive and positive. Another strategy to facilitate online collaboration is training. Webb and Miller (2006) reported that collaboration training and preparation have a positive relationship with perceptions and attitudes about teamwork behavior. Demonstrating a clear process and expectations through training is an important step toward successful collaboration.

Appropriateness of the interface of blackboard discussion for design collaboration

In this study, Blackboard was adopted as an online collaboration tool for two reasons. First, it was the system available at the university where the current study was conducted. Second, the discussion board in Blackboard is a common computer-supported collaborative learning (CSCL) tool, widely used to foster students' online collaboration.

We found several limitations in using Blackboard to support interior design students' online collaboration. First, the interface of Blackboard caused students difficulty in

uploading images and diagrams on the discussion board. For example, in the task in which students were to analyze the architectural features of three senior housing facilities in Japan, Sweden, or Chile, they had to post photos they had taken themselves or images scanned from books in order to collaborate. Because of the difficulty in uploading files of such images, many students attached zipped files to their postings instead of posting small files frequently. In addition, when website links were posted, Blackboard did not present website images; consequently, students may not have been motivated to click on the website links. An explanation may be that discussion boards were originally developed to support text-oriented communication.

Second, the interface of Blackboard was not supportive of sharing opinions and providing feedback to visual images. The nature of this collaboration project required students to share opinions about characteristics of spaces represented with images; however, in order to see the images, students had to complete several additional steps, including downloading zipped files, unzipping the files, looking at the images, and providing feedback. In addition, when students wanted to read other students' reviews of certain threads or wanted to revisit a certain posting, they had to click every post to locate the particular content because no function was available to show all posts at once. The lack of such a function caused miscommunication: sometimes students uploaded the same content without realizing it. Because additional steps were necessary to see images and providing feedback while looking at the images was difficult, the interactions represented with the number of postings were fewer and the quality of feedback was lower on discussion boards than expected. Students also mentioned that using Blackboard was time consuming and ineffective for collaboration.

Third, discussion boards on Blackboard are unappealing and failed to foster designers' creativity, engagement, and excitement during collaboration. Students said the background color and its organization were not exciting. They wanted a more visually attractive and interactive environment than the traditional page-based linear environment.

Because of these limitations we suggest that future researchers consider using alternative collaboration tools that support both image sharing and interactions. Possible tools include social media, such as Facebook and Pinterest. Dunn (2013) reported that he used three social media—Facebook, Pinterest, and Twitter—to enhance students' engagement in the design studio project. He also stated that regular interaction via social media among students as well as between students and instructor provided informal learning opportunities resulting in a more secure learning environment and better prepared final projects. In addition, newly developed collaboration tools specifically for designers can be considered for online collaboration. These tools include Mural.ly and GoVisually. Additional research is necessary to investigate the way these alternative collaboration tools support design students' online collaboration.

Recommendations

Several recommendations for interior design educators who want to use online collaboration emerged from this study. First, interior design educators need to be aware of the strengths and weaknesses of online and offline formats of collaboration. Each format tends to work better at a certain stage in the design process. For example, offline collaboration worked better for brainstorming and organizing ideas, but online collaboration worked better for organizing materials, sharing sources and data, and managing time. A wise selection of the more appropriate mode of collaboration with understanding of the benefits of each will enhance students' online experience.

Second, educators should provide diverse opportunities for online collaboration to help students prepare for their careers and transfer the knowledge they gain to real practice in the future. Students with past online experience gave positive responses to both types of collaboration even though no statistical difference was found. This implies that experience in online collaboration is important in determining their perceptions of both types of collaboration. Therefore, interior design educators should provide more opportunities for online collaboration.

Third, when planning collaborative projects, educators should develop methods for facilitating collaboration. They can be actively involved in the collaborative process by prompting, monitoring, and providing comments (Correia and Baran 2010). In addition, educators can encourage students to take an active role in group work by giving them roles like facilitator and summarizer; however, expectations for each role should be clarified.

Fourth, educators should evaluate not only the quantity of participation but also the quality. We evaluated students' collaboration in terms of the number of initial postings and responses as well as whether or not they met deadlines; however, as the research findings indicate, posting a minimum number of comments and meeting deadlines do not guarantee full engagement in online collaboration. We required a minimum number of postings as a means of facilitating discussion; however, in reality motivation for in-depth discussion was lacking, and students met only the minimum requirement. Students must also be introduced to examples of thorough and thoughtful discussion. Instructors can model quality postings (Haythornthwaite 2006), and peer evaluation with guidance can promote quality in online collaboration.

Finally, educators must be familiar with available social media or web-based collaborative platform tools that can support designerly thinking and interaction for online collaboration. The basic media of communication for designers are graphics and visual images; therefore, the tool selected should support easy sharing of images and feedback. Designers also tend to be sensitive to the visual organization of the online working environment, so the tool should support their creativity and reflect their styles.

As recommended by the CIDA, providing students collaborative opportunities is essential in interior design education. Design studio must accommodate real practices in which students can engage in "multi-disciplinary collaborations and consensus" (CIDA 2011, II-16). With the aid of appropriate tools and mode of collaboration fit to its purpose and phase, supported by the proper training and facilitation, the design studio will allow students to learn leadership and negotiation and improve communication and critical thinking skills. Well-prepared and well-planned collaboration experiences will improve students' perception of collaboration and will be transferred to the real practice of future interior designers.

References

Atack, L. (2003). Becoming a web-based learner: Registered nurses' experiences. *Journal of Advanced Nursing, 44*(3), 289–297.

Brandt, C. B., Cennamo, K., Douglas, S., Vernon, M., & McGrath, M. (2011). A theoretical framework for the studio as a learning environment. *International Journal of Technology and Design Education,*. doi:10.1007/s10798-011-9181-5.

Bunch, M. A. (1993). *Core curriculum in architectural education*. San Francisco, CA: Mellen Research University Press.

Chen, W., & You, M. (2010). Student response to an internet-mediated industrial design studio course. *International Journal of Technology and Design Education, 20*, 151–174.

Correia, A. P., & Baran, E. (2010). Lessons learned on facilitating asynchronous discussions for online learning. *Educação, Formação & Tecnologias-ISSN 1646-933X, 3*(1), 59–67.
Council for Interior Design Accreditation (CIDA). (2011). *Professional standards 2011*. Retrieved April 13, 2013. http://accredit-id.org/wp-content/uploads/Policy/Professional%20Standards%202011.pdf.
Cuff, D. (1992). *Architecture: The story of practice*. Cambridge, MA: Massachusetts Institute of Technology Press.
DiDonato, N. C. (2013). Effective self- and co-regulation in collaborative learning groups: An analysis of how students regulate problem solving of authentic interdisciplinary tasks. *Instructional Science, 41*(1), 25–47.
Dunn, M. (2013). *Embracing social media technology in the design studio.* Paper presented at the IDEC Annual Conference. Retrieved October 30, 2013, http://2013.idec.org/2012/05/01/embracing-social-media-technology-in-the-desi/.
Facebook. Retrieved from https://www.facebook.com/.
Feichtner, S. B., & Davis, E. A. (1984). Why some groups fail: A survey of students' experiences with learning groups. *Journal of Management Education, 9*(4), 58–73.
Girasoli, A. J., & Hannafin, R. D. (2008). Using asynchronous AV communication tools to increase academic self-efficacy. *Computers & Education, 51*(4), 1676–1682.
GoVisually. Retrieved from http://www.govisually.com/.
Haythornthwaite, C. (2006). Facilitating collaboration in online learning. *Journal of Asynchronous Learning Networks, 10*(1), 7–24.
Hennessy, S., & Murphy, P. (1999). The potential for collaborative problem solving in design and technology. *International Journal of Technology and Design Education, 9*(1), 1–36.
Hew, K. F., & Cheung, W. S. (2013). Audio-based versus text-based asynchronous online discussion: Two case studies. *Instructional Sciences, 41*(2), 365–380. doi:10.1007/s11251-012-9232-7.
Meneely, J., & Portillo, M. (2005). The adaptable mind in design: Relating personality, cognitive style, and creative performance. *Creativity Research Journal, 17*(2–3), 155–166.
Meyers, L. S., Gamst, G., & Guarino, A. J. (2006). *Applied multivariate research: Design and interpretation*. Thousand Oaks, CA: Sage.
Morgan, G. A., Leech, N. L., Gloeckner, G. W., & Barrett, K. C. (2004). *SPSS for introductory statistics: Use and interpretation* (2nd ed.). Mahwah, NJ: LEA.
Mural.ly. Retrieved from https://mural.ly.
Murphy, P., & Hennessy, S. (2001). Realising the potential—and lost opportunities—for peer collaboration in a D&T setting. *International Journal of Technology and Design Education, 11*(3), 203–237.
Pektas, S. T., & Erkip, F. (2006). Attitudes of design students toward computer usage in design. *International Journal of Technology and Design Education, 16*(1), 79–95.
Pinterest. Retrieved from https://www.pinterest.com/.
Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the motivated strategies for learning questions (MSLQ). *Educational and Psychological Measurement, 53*(3), 801–813.
Sagun, A., & Demirkan, H. (2009). On-line critiques in collaborative design studio. *International Journal of Technology and Design Education, 19*(1), 79–99.
Schön, D. A. (1984). The architectural studio as an exemplar of education for reflection-in-action. *Journal of Architectural Education, 38*(1), 2–9.
Seitamaa-Hakkarainen, P., Raunio, A.-M., Raami, A., Muukkonen, H., & Hakkarainen, K. (2001). Computer-support for collaborative designing. *International Journal of Technology and Design Education, 11*(2), 181–202.
Skylar, A. A. (2009). A comparison of asynchronous online text-based lectures with synchronous interactive web conferencing lectures. *Issues in Teacher education, 18*(2), 69–84.
Webb, J., & Miller, N. (2006). Some preparation required: The journey to successful studio collaboration. *Journal of Interior Design, 31*(2), 1–9.