TALKING TEAMS: INCREASED EQUITY IN PARTICIPATION IN ONLINE COMPARED TO FACE-TO-FACE TEAM DISCUSSIONS

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Abstract

The use of teams in undergraduate engineering is commonplace, but some students are disadvantaged in face-to-face team conversations. In this study, the effectiveness of computer-supported collaborative learning (CSCL) via Google Drawing tool with synchronous chat is considered as a way of increasing the opportunity for students to contribute to team meetings. The results suggest that teamwork in the online context is much less imbalanced, with far fewer students contributing at much less than expected levels. Pedagogical implications are discussed.

Introduction

Collaborative learning has become increasingly common in higher education, and it is particularly prevalent in the field of undergraduate engineering education. A strict definition of collaborative learning differentiates a collaborative project from one that merely requires cooperation. In collaborative learning, students work in groups to together develop a shared understanding of and solution for an ill-structured problem [1]. Teachers are redefined as “coaches” helping students to work towards a set of possible open-ended solutions, and students take some ownership of their own learning through reflection. Typically, students learn about team skills in addition to course content. Engeström [2] identified three stages that are characteristic of collaborative learning. In his view, for learning to be truly collaborative, students must work towards a shared problem definition, cooperate to “solve” the problem, and then engage in reflective communication, re-conceptualizing the process.

Team-based collaborative learning has increased in undergraduate engineering education worldwide [3]. The increased use of collaborative, problem-based learning allows instructors to more easily convince engineering students of the relevance of the theoretical knowledge they are learning in their math and science classes, leading to both enhanced motivation and increased student retention [4]. It encourages students to transfer knowledge across contexts and leads to the development of cooperative skills, which are valued by the profession [3].

Problems of Collaborative Learning in Undergraduate Engineering

However, there are also downsides to the increased use of collaborative learning in undergraduate engineering programs. If not carefully designed and monitored, group tasks can allow students to freeload, receiving credit for a team accomplishment without contributing substantially to it [3]. Other students may have low participation in groups because of production blocking, where another students’ more quick participation blocks other students from contributing [5]. More commonly, students may find in group work the opportunity to specialize in particular tasks and avoid others (e.g., CAD modeling, report writing), an issue when course outcomes are assessed at the team-level but skills are developed at the individual level.

Though students perceive participation on diverse teams as “real world” and therefore beneficial [6], their behaviors and experiences on diverse teams can be more problematic [7,8]. For example, students of different genders tend to take different roles on teams, with females more likely to complete project planning and communication work and males more likely to do technical planning and hands-on building [7,9]. It is unclear in the research whether students choose to take on gender-specific tasks or are pushed by teammates into those roles.

Team discussions tend to privilege some students at the expense of others. Women and under-represented minorities are more likely than other students to express dissatisfaction with teamwork in practice, reporting that they feel unheard or marginalized [10]. The speed of face-to-face group discussions may be a barrier to participation for some students. When students must jockey for a turn to speak, quick thinking is privileged. Students who are shy and/or reflecting on content may not be given opportunity to speak, leading to narrowing of expressed perspectives and perhaps decreasing the application of and reflection on engineering principles. The speed of face-to-face conversations may be especially difficult for some non-native speakers of English, who are wrestling with the same content as native English speakers, but with the additional cognitive load of doing so in a second language [11].

Additionally, students may be particularly concerned with social status and saving face. Research with high school and university students finds that students are less likely to provide constructive criticism of each other's ideas in face-to-face environments than online [10]. Face-to-face environments may decrease a potential benefit of collaborative learning, making individual knowledge explicit for the whole team to learn from.

Potential of CSCL to overcome some of the previously mentioned issues

Computer-supported collaborative learning (CSCL) has the potential to overcome some of the aforementioned problems with collaborative learning. A cognitive constructivist view of CSCL suggests that computer-supported environments for collaborative learning foster learning because they make individual knowledge elements explicit as a team works together to apply information to a problem [12]. Three characteristics of communication in CSCL are hypothesized to affect group processes: relaxed synchronicity requirements, text-based communication, and decreased social presence [8, 13].

Relaxed synchronicity requirements. The lowered synchronicity requirements of computer-mediated discussions may allow for increased student reflection and transfer of theoretical knowledge to the problem context. While face-to-face conversations necessarily happen in "real time," discussions in computer-mediated environments exist along a continuum of synchronicity. On one end are asynchronous discussion boards, which allow users to log in, read, and comment on their own time and without a conversational partner immediately present. Even chat spaces are less synchronous than face-to-face conversations, though, as more than one person can respond to a single comment and there is no jockeying to be the next speaker. Multiple team members can simultaneously respond to the same idea. The additional time and turn-taking opportunity can allow for more time to reflect, think, and search for information [12]. The relaxed synchronicity may foster more equal participation among team members who are disadvantaged by the speed of face-to-face conversations.

Text-based communication. Text-based communication may allow for more equal participation of non-native English speakers. Researchers exploring the effect of text-based group communication on participation of non-native speakers of English have found mixed effects. Some students report that the ability to compose and edit contributions allows them to more accurately express meanings [6, 8]. However, some non-native English speaking students may express reticence at making their contributions "permanent" in case the contribution contains ungrammatical utterances [8, 14]. It is not known whether this same reticence would be evidenced in online chat, where native speakers of English often produce/allow nonstandard utterances themselves.

Decreased social presence. Decreased social presence may affect participation and increase student willingness to contribute constructively. Social presence is defined as the salience of other people in the interaction and the consequent salience of the interpersonal relationship [15]. Group discussions in face-to-face settings are necessarily high in social presence, but discussions in computer-mediated environments can exist along a continuum of social presence, with some settings making interlocutors more obvious (e.g., a video conversation shows a conversational partner and includes cues such as facial expressions, gestures, and vocal modulation) and others being much lower in terms of social presence (e.g., a chat can hide identifiers and allow for virtual anonymity). Social presence is affected by multiple message channels, including presence/absence of visual cues (video, photograph, avatar), presence/absence of audio cues (voice), knowledge of conversational partner, and actual message content (what the speakers choose to reveal, use of emoticons and other cues, etc.)

Research on the effect of social presence on team member participation has shown mixed results. High social presence may decrease participation. For example, Yoo and Alavi [16] found decreased participation in a laboratory-based experiment when college-aged participants completed a task using both video and audio inputs (compared to audio alone). In a similar study, however, Dennis and Valacich [17] found the opposite effect: Low social presence decreased participation by increasing social loafing. It is important to note that, in the latter study, "low social presence" was a truly anonymous condition in a laboratory-based experiment where the team would not interact as a group again.

Importantly, the comparative anonymity provided by communication channels with decreased social presence may actually facilitate teamwork by allowing introverted participants to contribute, democratizing participation. Additionally, minority students and/or students holding minority opinions may increase participation in communication media with lower social presence [18].

Given these characteristics of online chat that may promote more equal participation in student team conversations, this research project investigated the effect of conversation modality (face-to-face and online chat) on participation in student undergraduate engineering team discussions. There were four specific research questions.

1. How does communication modality affect total student participation?
2. How does communication modality affect the distribution of student participation?
3. How does communication modality affect participation of women, specifically?
4. How does communication modality affect participation of non-native-speakers of English, specifically?

Method

Site, Participants, and Project Context

Site. The study was conducted in the College of Engineering at a large, Midwestern University. The particular program is highly competitive (ranked in the top ten nationally).

Participants. Participants were consenting students (n=232; of these, 65 were women and 31 were non-native English speakers, as judged by the researcher. Of the non-native English speakers, nine were women.) from 16 sections of a required first-year course, "Introduction to Engineering," co-taught by the researcher between Fall 2011 and Winter 2013. Students were assigned to teams of about four or five for the course project (40 teams of four, 13 teams of 5, and 1 team of six).

Project/Class context. The "Introduction to Engineering" course introduces students to technical content such as physics and risk analysis as well as professional engineering topics such as technical communication and project planning. Each lecture section of the course is capped at 60 students, divided into three lab/discussion sections of 20. The course is a four-credit course with six contact hours per week (two 1.5-hour lectures, one 2-hour lab, and one 1-hour discussion). Students complete two collaborative learning cycles in the course, the first an introductory project that takes about two weeks and the second a larger project that requires about 2/3 of the semester to complete. See Figure 1 for images of students in one section of the course building an underwater vehicle and communicating about it at the end of the project.

Figure 1: Student team working on the structure of their underwater vehicle (left) and reporting about it after completion (right).

The team conversation analyzed in this study is one that happens about 1/3 of the way through the course, when students are assigned to final project teams and begin the larger collaborative learning project. The larger project is fairly open-ended, though size, weight, cost, and material constraints limit the design space. Students initially submit individual proposals, and the conversation investigated in this project is the first team conversation in which they brainstorm team objectives and constraints (developing a shared representation of the problem) and then determine a final design they will build and test in the remaining ~8 weeks of the course. The final design is typically a combination of one or more of the individually-proposed designs, but it could be something entirely different.

In all sections, teams were assigned by instructors. Following departmental guidelines, geography is used as the primary team determinant, and attempts are made to form teams consisting of students who live on the same campus (central campus and north campus are about 20 minutes apart by bus). When possible, women and minority students are paired on teams, and students are sometimes intentionally paired or separated for a variety of reasons, such as pairing two students who were strong leaders on their initial project teams together to allow other students to step into leadership roles.

Experimental Conditions

Communication conditions (face-to-face or online) were assigned to intact 20-person lab/discussion sections, so that all teams within a section were assigned to the same condition. Assignments to conditions were managed such that semester, class topic, class day, and class time were approximately equally represented in the two conditions. Teams assigned the face-to-face condition met in a conference room for one class session (n=73 students on 17 teams). Students' interactions were audio-recorded, and the recordings were transcribed for analysis. Teams assigned the online chat condition met in a Google shared space (Google drawing tool) during the discussion class time (n=158 students on 37 teams). These students were required to log in at the appropriate time, but they could do so from anywhere with a reliable internet connection, and they did not attend class face-to-face that day. The running chat from the right side of the Google collaboration space was saved off as a transcript following each student meeting. More teams were assigned to the online condition because the transcription of audio files for teams in the face-to-face condition was time intensive and costly.

Unitization of Transcripts

Transcripts of the face-to-face sessions and the online chats were initially chunked into t-units, to better account for ideas contributed rather than simply turns taken. A t-unit, or “thematic unit," is an independent clause plus all of its dependent clauses [19]. Basically, it is a fairly reliable way to chunk a large body of text into ideas, and its application has wide acceptance in linguistics. These units provide only a gross measure of contribution (all ideas are given the same weight, regardless of complexity, creativity, etc.).

In practice, the chunking of the conversations into t-units required a certain level of judgment. In a conversation, there are many contributions that are not independent clauses (for example, there are lots of interjections, like the word "OK"). These were coded as t-units when they stood alone, but were combined into a more complex t-unit when they occurred with an independent clause.

Reliability of t-unit chunking. After the transcripts were divided into t-units by the author, a reliability check was carried out by having a colleague code the transcripts of two teams' interactions, containing 238 units, using the guidelines outlined by Gaies [19]. The coding was congruent for 237 of 238 units.

Preliminary Participation Analyses

For data processing purposes later, minor data manipulations were performed.

Team participation distribution. In order to quantify the imbalance of participation in a single team's conversation, the standard deviation and range of the individual participants' contributions (in t-units) were calculated. If every member of a team contributed exactly the same number of t-units, both the standard deviation and the range would be zero. In cases where a person or a couple of people spoke much more than others, and/or in cases where a person or multiple people spoke very little, both the standard deviation and the range are inflated. While it is not the case that an "ideal" team would have a standard deviation or a range of zero, it is the case that a high standard deviation and a high range indicate imbalance of participation on a team.

Standardized participation score. The number of t-units contributed is an imperfect measure of team contribution, both because it is affected by context (team size and condition may each influence the number) and because it is decontextualized (it is difficult for the reader to interpret whether "30 t-units contributed" indicates a strong or weak contribution). For this reason, a "standardized participation score" was computed for each student by dividing the number of t-units contributed by the average contribution for the individual's team. In this scheme, a standardized participation score of 1.0 indicates "average" contribution on a team. Scores lower than 1 indicate lower-than-average contribution (a 0.5, for example, indicates the student contributed half as much as an average member of the team), and scores higher than 1 indicate higher-than-average contribution (a score of 1.9, for example, indicates that the student contributed almost twice as much as an average team member).

Results

To investigate how condition affects overall participation, an ANOVA was performed using SPSS. The model considered the total number of t-units in the conversation, looking at group size (4 or 5 students) and condition (online or face-to-face) as fixed factors, and the single group of 6 was omitted from this statistical analysis. The group means and standard deviations can be found in Table 1.

Table 1: Mean (SD) Contributions (in t-units) per Group.

	# of speakers		All groups
	4	5	
Online	143.21 (16.1)	170.63 (16.4)	149.31 (19.7)
F2F	137.58 (29.0)	139.00 (34.9)	138.00 (29.7)
Both conditions	141.53 (20.6)	158.46 (28.6)	146.85 (25.0)

There was no main effect of either group size ($p=0.47$) or condition ($p=0.39$), but the interaction was marginally significant ($p=0.08$).

It is possible to interpret these results as showing that the number of contributions scales with group size in the online condition, where multiple interlocutors can be contributing (typing) simultaneously. However, in the face-to-face condition, it seems the group is constrained by the time frame of the conversation, and with increasing group size, each individual team member has the opportunity to say less.

The second research question investigated how condition affected distribution of participation. The histogram shown in Figure 2 shows the distributions of standardized participation scores in the online and face-to-face conditions, respectively.

The histogram in Figure 2 shows a fairly normal distribution for participants in the online condition, with most students in the online condition contributing between 70% and 130% of the average team contribution (in general, most participants in online conversations seem to contribute an approximately average amount to team conversation). In contrast, Figure 2 shows a much flatter distribution for participants in the face-to-face condition, with many more participants at both tails, contributing either very much or very little to imbalanced team conversations. Note than none of the 158 students in the online condition provided less than 30% of an average contribution. In contrast, two of the 73 face-to-face participants contributed less than 10% of an average contribution— one providing only a greeting upon entering the room.

To test these distribution differences statistically, the standard deviations and ranges of participation were computed for each team individually and then were compared for online and face-to-face teams via independent samples t-test. Large standard deviations and ranges indicate an imbalance of participation within a group. Table 2 provides the range and standard deviations of group participation as well as the standard deviations of those numbers.

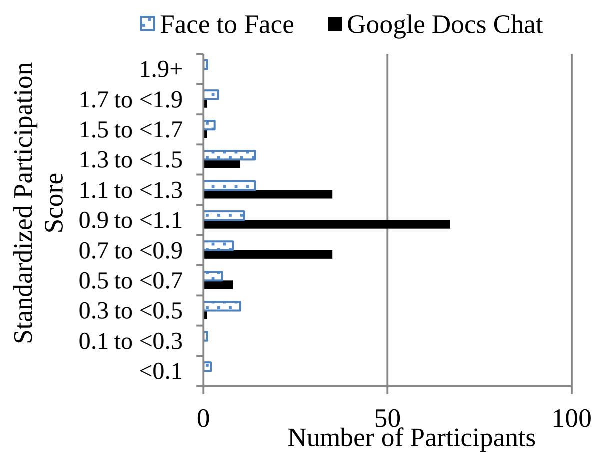

Figure 2: Histogram of standardized participation scores for participants. Participants in face-to-face team conversations (light dotted bars, n=73) show a flatter distribution, with more participants at the very-high and very-low ends of the distribution. Participants in online team conversations (black bars, n=168) show a more peaked distribution, with most participants contributing values near the mean contribution. There is much more imbalance among participation levels of students in the face-to-face condition. In fact, if we look just at students who contributed less than half of the expected contribution, we can see this characteristic is much more common for face-to-face participants. In the online group, less than 1% of students contributed less than half as much as expected. In the face-to-face group, almost 18% did.

Table 2: Measures of Variability Indicate F2F Groups Show More Imbalanced Participation.

	Online	F2F	$t(52)$	p
Mean (SD) Range	16.49 (7.92)	32.76 (9.73)	-6.53	<.001
Mean (SD) Standard Deviation	7.15 (3.29)	14.24 (4.55)	-6.50	<.001

The t-tests showed that both measures of variability (range and standard deviation of participation) were sensitive to this difference in participation ($p < 0.001$). The face-to-face condition had larger values both for ranges of participation and for standard deviations in participation, indicating greater imbalance in the contributions to face-to-face conversations as compared to online conversations.

The third research question investigated whether the online condition increased participation by female students. To test this statistically, male and female standardized participation scores by condition were compared using an ANOVA. Gender and condition were considered fixed factors. Means and standard deviations of participation scores by group are reported in Table 3. Statistically, there are no main effects of gender ($p = 0.99$) or condition ($p = 0.74$) on standardized participation scores, and there is no interaction of gender by condition ($p = 0.17$).

Table 3: Mean (and SD) Standardized Participation Scores for Men and Women.

	Online	F2F	Overall
Men	0.98 (0.20)	1.02 (0.40)	0.99 (0.28)
Women	1.05 (0.19)	0.96 (0.47)	1.02 (0.31)

My sense as an instructor that my female students were silenced in the face-to-face conversations, however, had been a reason that I investigated this research question in the first place. An examination of histograms of participation by women in online and face-to-face conditions (Figure 3) shows that the answer to whether the online chat increases participation is not appropriately tested by a statistical comparison of the means.

As a comparison of the histograms in Figure 3 shows, there is a marked difference in the contributions of female participants in the two conditions. Some female participants contribute a lot and others contribute very little in face-to-face groups. One third of the women participating in face-to-face conversations contribute either less than 50% as much as an average team member or more than 170% of an average team member. In contrast, in online groups, none of the women exhibit such extreme behavior. While the mean contribution does not show up as statistically different in the ANOVA analysis, it does seem

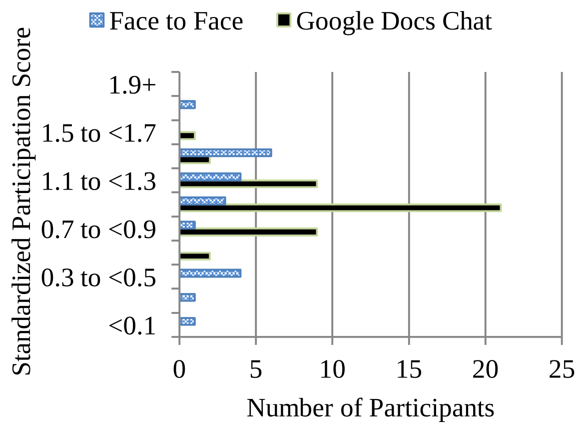

Figure 3: Histogram of female participants' standardized participation scores by condition. Women in the face-to-face condition (light dotted bars, n=21) show a fairly flat distribution, with 1/3 of the women scoring outside of the range 0.5 to 1.7. Women in the online condition (black bars, n=44) show a fairly normal distribution of participation, with none of the women scoring outside of the range 0.5 to 1.7. There is much more imbalance in face-to-face participation: some women contribute a lot, and others contribute very little, compared to participation in the Google Docs chat.

to be the case that at least some women are less likely to contribute in the face-to-face condition, perhaps for the reasons outlined in the introduction. We need a deeper understanding of the differences in the groups or of the women to understand what conditions lead to these extreme patterns of participation.

The final research question investigated whether the online condition increased participation of non-native speakers of English. The statistical test done for this question was the same as the one done to explore the effect of gender. An ANOVA model was created, with speaker-status as a fixed effect and condition as a random effect, and the standardized participation score was the variable of interest. The means and standard deviations of this score by group are reported in Table 4.

Table 4: Mean (and SD) Standardized Participation Scores for Native (NS) and Non-native Speakers (NNS) of English.

	Online	F2F	Overall
NS	1.00	1.02	1.01
	(0.20)	(0.19)	(0.29)
NNS	1.03	0.64	0.96
	(0.42)	(0.21)	(0.24)

Note. Main effects of native-speaker status and of condition are not significant, but the interaction is significant (p = .005).

In this analysis, there is no main effect of native language (p = 0.54) or condition (p = 0.55). The interaction between the two, however, is highly significant (p = 0.005). Non-native speakers of English, but not native speakers of English, contribute more in online team conversations than they do in face-to-face team conversations.

Limitations

A major limitation of this research is that it investigates group dynamics on the basis of only a single one-hour meeting, in order to have truly comparable groups within the constraints of an already-existing class. However, assignment to groups within a course for a single one-hour group activity is a common practice in classrooms, so it is believed that these results generalize to at least that real-world context.

An additional limitation of the analysis is the consideration of participation as simple contribution of t-units, a gross measure of participation. A finer analysis at the level of the discourse would shed further light on the actual team dynamics.

Discussion and Implications for Teaching

While overall participation was similar between the two conditions, there was a marginally significant trend for amount of participation to increase for five-person groups only in online chat. This finding makes sense, as groups meeting face-to-face are constrained temporally (only one person can productively speak at a time). In contrast, when a group meets in an online chat, multiple people can plan and contribute utterances simultaneously, so amount of participation should increase with group size. This finding indicates that instructors should consider online chat-based meeting options for larger groups to allow for greater participation.

Though overall participation was similar between the two conditions, there were major differences in the distribution of the participation. Face-to-face groups had many more students with either very high or very low participation. In face-to-face groups, women were over-represented at both high and low participation extremes, and non-native speakers of English were over-represented at the low end. The online groups had much more balanced participation, with fewer instances of students taking over or of students remaining virtually silent in team conversations. This finding suggests that the online environment may allow students whose voices are not heard in face-to-face discussions to more fully participate. That women and non-native speakers of English are over-represented at the low participation end in face-to-face conversations but not in online conversations suggests the value of using online environments to promote equity on undergraduate engineering teams.

Finally, from the instructor's point of view, having a written record of student discussions from the online chat allows the instructor to review the record of interaction, give feedback to the teams and individuals in the teams in ways that are not possible when the discussions take place in face-to-face settings.

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