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Put Students' Minds Together and their Hearts Will Follow: Building a Sense of Community in Large-Sized Classes via Peer- and Self-Assessment

Dwayne E. Paré, Lisa-Marie Collimore,
Steve Joordens, Carol Rolheiser, Robert Brym,
Garfield Gini-Newman, University of Toronto

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1 Yonge Street, Suite 2402
Toronto, ON Canada M5E 1E5

Phone: (416) 212-3893
Fax: (416) 212-3899
Web: www.heqco.ca
E-mail: info@heqco.ca

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Executive Summary

Many countries strive to make postsecondary education maximally accessible to their citizens under the assumption that educated citizens boost innovation and leadership, resulting in social and economic benefits. However, attempts to increase access, especially in contexts of stagnant or diminishing financial support, can result in ever-increasing class sizes. Two aspects of large classes are extremely worrisome. First, economic and logistical constraints have led many such classes to devolve into settings characterized by lectures, readings and multiple-choice tests, thereby denying students experience and exercise with important transferable skills (e.g., critical thought, creative thought, self-reflective thought, expressive and receptive communication). Second, such classes are depicted as cold and impersonal, with little sense of community among students.

Recently, a number of learning technologies have reported success in terms of addressing the first of these problems. For example, in a recent report, Joordens, Paré and Collimore (2014) demonstrated that a peer- and self-assessment system (*peerScholar*) used in large class settings was successful in enhancing indices they related to critical thinking and metacognition. Thus it seems that properly implemented technology can help address issues related to the depth of learning in large classes.

One interesting aspect of technologies that harness peer-assessment is that they essentially group a large class into much smaller, random subgroups of students who are trying to help one another improve. Given this, it is entirely possible that, even though they were not created for this purpose, these technologies may also enhance students' sense of community. This is the primary question addressed in this report.

Specifically, this report describes a large-scale study examining the effects of peer-assessment on students' perceptions of community in a 1,600-student Introductory Psychology course. Students in this course could choose to attend lectures or watch them online and all assessments except for the final exam were Web-based. Thus, the course fits the 'fully online' format that is becoming increasingly common across Ontario, albeit with a very high student-faculty ratio. Note that although this course could be taken in a fully online manner, students could also choose to attend the lectures as they were presented. Hence the course was simultaneously a fully online experience for some and more of a blended learning experience for others.

Students' perceptions of community were assessed using the *Community of Inquiry* (CoI) framework (Garrison, Anderson & Archer, 2000). This framework breaks sense of community down into three separate metrics: social presence (one's feelings of connectedness with the class and other students within it); cognitive presence (one's feelings of connectedness to the material presented in the class); and teaching presence (the extent to which the design, facilitation and direction of cognitive and social processes of the course make it possible for students to realize the intended learning outcomes). Thus it gives a broad sense of how connected students feel to their instructor, the course content and, most critically for present purposes, their fellow students in the course.

We evaluated the effects of peer-assessment on this measure of connectedness for two reasons. First, online tools supporting peer-assessment are becoming increasingly common and a growing research base suggests that peer-assessment provides an efficient and effective way to develop high-level cognitive skills such as critical thinking, creative thinking and communication (see Joordens, Paré & Collimore, 2014). Second, the core peer-assessment process asks students to comment on the work of their peers with the goal of helping them improve academically. The pro-social nature of these systems intuitively seems like something that could enhance one's sense of being in a community. In some ways, the student and the peers with whom they interact become a small, helpful subgroup in the larger class context.

We tested this possibility across two experiments. The first utilized a basic pre-post design to determine if engaging in a peer-assessment assignment would have an effect on students' sense of community. One group of students (PRE) completed the Community of Inquiry questionnaire prior to engaging in peer-assessment, while a different group (POST) completed it after engaging in peer-assessment. Sense of community was found to be significantly higher when measured after the peer-assessment activity was performed, suggesting a relationship between peer-assessment and enhanced sense of community.

To investigate this relationship further and to control for the fact that students in Experiment 1 completed self-assessments following each phase of the assignment *and* were part of the class for a longer period when completing the post CoI measure, the second experiment utilized a randomized control group design. The combined effects of peer- and self-assessment on sense of community were examined while also investigating the relevance of when the self-assessment was performed. Experiment 2 revealed that (1) students' sense of community is indeed enhanced by peer-assessment, and (2) the extent of enhancement is reduced when students self-assess *before* performing peer-assessment.

The primary worries associated with large classes are that they do not provide the rich learning experience of a smaller class and make students feel isolated. This study suggests that the same technologies that help maintain or enhance deep learning in large class contexts (peer-assessment-based technologies) can also enhance sense of community and connectedness. This convergence of positive outcomes is extremely powerful, adding to previous findings showing the positive effects of peer-assessment on the higher education learning experience of students.

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Introduction

Many countries, including Canada, strive to make postsecondary education maximally accessible to their citizens under the assumption that educated citizens boost innovation and leadership, resulting in social and economic benefits. However, attempts to increase access, especially in contexts of stagnant or diminishing financial support, can result in ever-increasing class sizes, which can potentially deny students of the rich learning experience a smaller class community would provide.

While many might argue that this trend of large classes is worrisome, there are different perceptions of exactly how large classes should be defined. Each definition is dependent on context: what constitutes 'large' at one department or institution might not hold at another department or institution. For the purpose of this study, we use the classification system established by the Council of Ontario Universities (2013), which defines a large first-year class as one that contains more than 251 students.

Over the past decade, several changes have occurred in Ontario's higher education sector that might affect student learning. At the University of Toronto, for example, the number of first-year undergraduate classes with 251 students or more rose from 67 classes in 2010 to 78 in 2013 (Council of Ontario Universities, 2013), and the use of electronic resources and e-learning technologies has increased (University of Toronto, 2014). But the effects of these changes on student learning are largely unconfirmed and thus warrant further investigation.

Recently, a number of learning technologies have reported success in terms of addressing potential worries associated with large classes. For example, in a recent report, Joordens, Paré and Collimore (2014) demonstrated that a peer- and self-assessment system (peerScholar) used in large class settings was successful in enhancing indices they related to critical thinking and metacognition. Thus it seems that properly implemented technology can help address issues related to the depth of learning in large classes.

One interesting aspect of technologies that harness peer-assessment is that they essentially group a large class into much smaller, random subgroups of students who are trying to help one another improve. Given this, it is entirely possible that, even though they were not created for this purpose, these technologies may also enhance students' sense of community. This is the primary question addressed in this report.

Class Size and Student Learning

Most research on class size has been conducted in the K-12 sector and has looked at the effects of reducing class size on student experience. Past studies suggest that when teachers can adapt their teaching practices to a smaller class size to address the individual needs of learners, students feel a greater sense of community, they learn more, are more engaged and less disruptive (Bascia, 2010; Haughey, Snart & DaCosta, 2001). Smaller class size can result in better learning, improved peer interaction and positive social growth, some of which reflects students' sense of being part of a specific cohort of learners.

In the higher education sector, faculty members worry that increasing class size will have a negative impact on student learning. Yet few empirical studies have investigated the effects of class size on student learning in this context (Arias & Walker, 2004; Blatchford, Edmonds & Marin, 2003; Iaria & Hubball, 2008; Karakaya, Ainscough & Chopporian, 2001). Karakaya, Ainscough and Chopporian (2001) examined the effect of class size on students' test scores. They found no effect of class size on final grades when comparing students in a small class to those in a large class. In an examination of students' perceptions of their academic performance, Iaria and Hubball (2008) found that students reported similar perceived achievement scores in both small and large size classes. Together, these findings support the idea that student learning (as represented by test scores) need not differ between small and large classes in higher education contexts.

Research on class size has also shown that large classes tend to have lower rates of student motivation, satisfaction, attendance, participation, engagement and sense of community (Cooper, 1995; McKeachie, 1980). In an early meta-analysis, McKeachie (1980) found that, across all studies examined, faculty members and students preferred small classes. He argued that small classes are educationally more important for some students than they are for others and that the importance of class size depends on the educational goals of the class. After finding similar results about small-class preferences, Monks and Schmidt (2011) argued that "large classes (more students) may allow students to be more disruptive, allow them to 'hide' from participation, engagement, or even attendance, while small classes may more easily lend themselves to pedagogical activities that improve learning, such as hands on activities and student-faculty classroom interaction" (p. 7). In the current study, we argue that with the inclusion of pedagogical activities such as online peer-assessment assignments, students can feel engaged and connected to the community of learners despite class size.

Several studies have also noted that class size has a negative impact on student evaluations (Bedard & Kuhn, 2008; Cuseo, 2007; Feldman, 1984; Monks & Schmidt, 2011). Feldman (1984), for instance, found that large classes tend to have a significantly negative influence on student ratings of teaching, especially on ratings of the instructor's effectiveness and facilitative skills. Others have suggested that lower ratings of teaching may stem from the possibility that students' opportunities to receive feedback and interact with other students and teachers can be limited in a large class compared to the situation in a smaller class (Iaria & Hubball, 2008). A sense of community among learners may be the key to higher student evaluations of the instructor's effectiveness and, more importantly, to student learning.

The story suggested by the research conducted to date is complex. As class size increases, several factors apparently interact in ways that negatively affect the educational experience but not necessarily learning. One of the factors mentioned repeatedly is sense of community, and this factor is often highlighted in media reports that depict large classes as impersonal and cold. Given this situation, the remainder of this report will focus on sense of community and will ask whether the effective use of technology and collaborative assessment practices might be important means of establishing a sense of community even in very large classes.

Sense of Community and Student Learning

Past studies suggest that a strong sense of community may increase satisfaction among students, commitment to group goals and availability of support (Bruffee, 1993; Dede, 1996). Additionally, students who enjoy a strong sense of community are less likely to cut class, think about dropping out of school and suffer from burnout (Royal & Rossi, 1996). Studies have also shown that a sense of community can be created in online classes (Lambert & Fisher, 2013; Thompson & MacDonald, 2005) and that a sense of community is associated with student perceptions of learning (Shea, Li & Pickett, 2006). These findings suggest that examining the impact of students' sense of community in large classrooms is important to understanding how class size can affect student engagement and learning.

Several models exist in the literature for examining students' sense of community. However, given that the current study uses an online tool that focuses on student collaboration through peer-assessment, we utilized the *Community of Inquiry (CoI) framework* developed by Garrison, Anderson and Archer (2000) because it was designed as a theoretical model to explain and explore the pedagogy behind the online educational experience where students' work together rather than independently (Swan & Ice, 2010).

The CoI framework includes three interdependent elements – cognitive presence, social presence and teaching presence – and assumes that learning occurs in the community through the interaction of these three elements. Cognitive presence is the extent to which learners are able to construct meaning through continuous reflection and discourse (Garrison, Anderson & Archer, 2001). Social presence is the extent to which students identify with the community (i.e., all of the people involved in the course, including the professor, the teaching assistants (TAs) and other students), communicate with community members and develop relationships with them (Garrison, 2009). Finally, teaching presence is the extent to which the design, facilitation and direction of cognitive and social processes in the course make it possible for students to realize intended learning outcomes (Anderson, Rourke, Garrison & Archer, 2001). According to Garrison, Cleveland-Innes and Fung (2010), these three elements provide the structure to support higher levels of inquiry and meaningful collaboration in an online learning environment.

Educational Technologies and Student Learning

The increasing use of digital technologies in the classroom has become tightly integrated with the desire to prepare students for the 21st century. Instructors are often encouraged to use digital tools found in their institutions' learning management system (LMS) to promote the development of skills such as oral and written communication, collaboration and critical thinking. It is thus not uncommon to hear of instructors using tools such as discussion boards and peer- and self-assessment assignments to increase student engagement in a range of class settings, including large classes.

Despite the popularity of educational technology in some circles, most college and university instructors continue to follow traditional lectures and students continue to use rote-memorization, including note-taking, writing exams and writing research papers (Sprau, 2001). One ubiquitous way in which educational technology has been incorporated into the traditional lecture format is through the use of multimedia

presentations. While time-consuming to prepare, multimedia presentations allow instructors to incorporate notes, videos, graphs and pictures into their lectures and they can also help students visualize complex ideas and grasp abstract concepts more easily than traditional oral lectures can (Brace & Roberts, 1996). Multimedia presentations can thus be used as teaching aids to illustrate meaningful examples (Hardaway & Will, 1997). Research by Karakaya, Ainscough and Chopporian (2001) suggests that the use of multimedia lecture presentations is a means of ensuring that large classes are as effective as smaller ones when it comes to student performance. The authors contend that the multimedia lecture format is a powerful pedagogical tool because it increases student involvement, and consequently student satisfaction, in learning. It is thus likely that the use of multimedia presentations can enhance the learning environment in higher education classrooms.

Another way in which educational technology has been incorporated into the college and university classroom is through the use of online peer- and self-assessment tools. This is the main educational technology of interest in the current study. Past research reveals that peer-and self-assessment tools increase student participation, satisfaction and engagement while also developing basic literacy skills and more advanced skills such as critical thinking, metacognition and digital citizenship (Gatfield, 1999; Topping, 1998; Wen & Tsai, 2006). Numerous studies have also found that the use of peer-assessment leads to improved student achievement (Cho & Schunn, 2007; Patchan, Charney & Schunn, 2009; San-Ju Lin, Zhi-Feng Liu & Yuan, 2001). Cho and Schunn (2007) found that students who participated in multi-peer feedback during peer-assessment showed significant improvement in writing quality from their first to second draft when compared to those students who received feedback from only a single peer or expert.

Most recently, Collimore, Paré and Joordens (in press) used a survey to ask Canadian high school students how they felt about engaging in peer-assessment. The students reported that they enjoyed participating in assignments that use peer-assessment and that these types of assignments were beneficial to their learning. Wen and Tsai (2006) investigated college students' perceptions about peer-assessment. The students believed that by engaging in peer-assessment they learned to develop high levels of responsibility and to focus more on their learning. Students also reported that they 'learned about learning'. Put another way, these students reported that peer-assessment enhanced their metacognitive understanding about their own learning process.

Student Learning (about learning)

Metacognitive understanding can further be amplified using self-assessment (e.g., asking students to assess their own work, especially by identifying strengths, challenges and areas for improvement). Studies indicate that when students engage in self-assessment they become more involved in the learning process, which results in higher levels of learner autonomy and motivation (Harris, 1997; Oscarson, 1989). Students like self-assessment because it clarifies expectations, it is fair and it gives them feedback they can use to improve the quality of their work (Ross, Rolheiser & Hogaboam-Gray, 1998a).

Positive effects of self-assessment on student performance have also been shown for difficult tasks (Arter et al., 1994; Maehr & Stallings, 1972), and although some studies have shown that students tend to

overestimate the grade their work deserves (Paré & Joordens, 2008b), students' propensity to inflate grades decreases when teachers share assessment responsibility and control (Ross, Rolheiser & Hogaboam-Gray, 1998b).

Self-assessment can also be beneficial to learning. Rolheiser (1996) provides a theoretical model describing how self-assessment plays a key role in fostering an upward cycle of learning. Specifically, when students evaluate their performance positively, self-assessments encourage students to set higher goals and commit more effort to them (Bandura, 1997; Schunk, 1995). Higher achievement is produced by combining goals and effort (Pajares, 1996) and results in students making self-judgments (e.g., "Were my goals met?"). Finally, students respond to those judgments with self-reaction (e.g., "How do I feel about that?"), thereby fostering self-confidence and forming the cycle that allows for positive evaluation of their performance. This upward cycle of learning results when students confidently set learning goals that are moderately challenging yet realistic, and then exert the effort, energy and resources needed to accomplish those goals (Rolheiser, Bower & Stevahn, 2000).

In the context of large classes, the implementation of online peer- and self-assessment can give students experience with critical thinking in a way that also reduces workload, manages grading delays and provides meaningful feedback (Davies, 2000; McGourty, 2000; Paré & Joordens, 2008). These assessments also allow students to interact more easily with one another and share their ideas and thoughts about each other's work confidentially and anonymously (Falchikov, 1995; Rubin, 2002; Topping, 1998). Thus, in many ways, online peer- and self-assessment tools are community-based techniques that can enhance the learning of deep cognitive skills, especially critical thinking as it is applies to peers and to self.

It is also important for us to define what we mean by critical thinking in the context of this report. Operationally defining critical thinking and how it might be enhanced is not easy (e.g., Browne & Freeman, 2000; Pithers & Soden, 2000). However, generally speaking, critical thinking reflects the use of a constellation of cognitive skills that underlie reasoned decision-making. For example, Harvey et al. (1997) describe critical thinkers as curious, critical, analytic and reflective. Thus, for the purpose of this report, a student who is thinking critically is assumed to be actively filtering information on the basis of its perceived quality with the goal of addressing a problem in a valid and justifiable manner.

Purpose of this Study

Given the potential of online peer- and self-assessment to enhance cognitive skills and create a community through student collaboration, the initial goal of the current study was to focus on educational technologies that support these types of assessment and to examine the impact these technologies have on both critical thinking and sense of community. Recently we have argued that a properly designed peer-assessment system may not only exercise many of the cognitive skills associated with our most valued learning outcomes, but that such a system may also allow those skills to be assessed quantitatively (Joordens, Paré & Collimore, 2014). For the current study we had hoped to assess the effects of peer- and self-assessment on critical thinking using the Cornell Critical Thinking test. Unfortunately, as will become apparent, we

encountered major difficulties employing this measure in both of our experiments and were unable to obtain a usable dataset.

Instead, we focus on the notion that because some educational technologies allow students to provide feedback to their peers, which can formatively enhance the quality of their own work (Cho & Schunn, 2007), these technologies could potentially foster a sense of community in large classes. The interactions occurring in the context of a peer-assessment activity can be described as encouraging prosocial behaviour. Prosocial behaviours are those that are performed for the primary reason of benefiting another individual (Eisenberg, Fabes & Spinrad, 2007). Although peer-assessment also benefits those providing the feedback when students participate in the process as expected, peer-assessment encourages prosocial behaviour because students make an effort to assist their peers by giving personalized feedback. This behaviour then is one means for the creation and maintenance of social groups (Barrett, 2002), and prosocial acts like the ones found during a round of peer-assessment may provide a sense of community to those in large classes.

To date, there has not been any research on the impact of peer- and self-assessment on students' sense of community in large classes within higher education. Thus, despite the challenges we encountered with respect to measuring critical thinking, which are outlined in more detail below, the Community of Inquiry questionnaire was employed without issue and, as such, became the focus of our analysis and report. To anticipate, we expected to see a change in social presence after the peer-assessment activity in our Community of Inquiry measure. Across two experiments we present data showing that course assignments using online peer- and self-assessment did in fact enhance students' sense of being part of a learning community, particularly with respect to social presence.

Experiment 1

Educators often worry about potential negative side effects when they bring new educational technologies into a classroom. An educator may, for instance, encounter technical issues that cause confusion and frustration. Similarly, students may be unhappy because their workload has increased. Despite such challenges, there may also be positive effects beyond those that motivated the inclusion of the technology. For example, implementing any digital educational technology gives students direct experience with online tools, which is a basic 21st-century skill. When the educational technology being implemented is one that uses peer-assessment, one wonders whether such a technology, which hopes to enhance thought and communication, also enhances critical thinking and a sense of community in the large classroom context. Experiment 1 was thus designed to assess the impact of peer- and self-assessment on students' sense of community and on critical thinking.

Method

Participants

Students enrolled in an Introductory Psychology class were invited to participate in this study. In total, 1,641 students completed the study assignment, with 1,158 (70.6%) giving consent to use their data. From the consenting sample, half of the students were randomly assigned to the PRE (peer-assessment) group and the other half to the POST (peer-assessment) group. Data were analyzed only for students who completed both the assignment and the additional measures. Thus, the final number of students in the PRE group was 370 and in the POST group was 421. Since all of the students were randomly assigned to the groups, we have no reason to suspect that the difference in sample size reflects anything other than random variation.

Digital Materials and Measures

peerScholar. Students used a peer- and self-assessment tool called peerScholar. peerScholar is an online tool that requires users to submit their work, assess the anonymously presented work of their peers and view the feedback that peers give regarding their work. When configured to do so, peerScholar also allows students to submit revisions informed by the feedback they received from their peers, as well as self-assess their own work after each phase mentioned above. In a typical peerScholar assignment, students are asked to respond to a particular question (i.e., the assignment) by a given due date (i.e., the CREATE phase). Students may be asked to self-assess the quality of their draft submission if that function is activated. Next, students anonymously see the work of a given number of their peers, who are randomly assigned. Here students can be asked to do several different types of peer-assessments (e.g., provide overall comments, give a rating and/or provide in-line commenting), but at least one type of assessment must be provided (i.e., the ASSESS phase). After assessing their peers, students can self-assess again (or for the first time) if that function is activated.

Finally, students see the peer feedback given to their draft assignment. Sometimes students are further required to analyze the constructive feedback that they received and to use helpful comments formatively to revise and submit their final assignment for grading. Again, students can be asked to self-assess after revising their submission if that function is activated (i.e., the REFLECT/REVISE phase).

In this experiment, students completed one peer-assessment assignment using peerScholar. To our knowledge, students had no prior experience using peerScholar and were introduced to it for the first time during the experiment. Students were asked to submit a written assignment by a given due date and then saw the work of six of their peers, anonymously presented and randomly assigned, as previous research has shown that an average of six peer ratings provided in the context of a peerScholar assignment is as reliable as a grade given by an expert instructor or teaching assistants (Paré & Joordens, 2008). Students completed self-assessments following the ASSESS phase of the assignment. Finally, students were also asked to reflect on the feedback that their work received and to revise and resubmit their work for final grading.

The Cornell Critical Thinking Test, Level X (2005). We chose to administer the Cornell Critical Thinking Test, Level X (Ennis & Millman, 2005) based on recommendations derived from the critical thinking literature. This test is a general-content, multi-aspect assessment that measures critical thinking ability by using content from a number of subject areas and/or life experiences and assesses several aspects of critical thinking. The 50-minute, timed, online version of this test was used in this study.

Upon implementation of this test, it became obvious that, although ostensibly usable online, the software supporting the administration of the test was not built to cope with the number of users simultaneously participating in this study. The server repeatedly crashed whenever the load was even slightly elevated and our attempts to distribute the load were unsuccessful. This test is intended to be timed and taken in a single sitting, but none of the participants had the intended experience due to the software crashes and thus, despite the cost and frustration involved, we ultimately chose not to use any data from this measure in our analyses. We report the use of the test here in the interest of full disclosure but we will not visit it further other than for archival reasons.

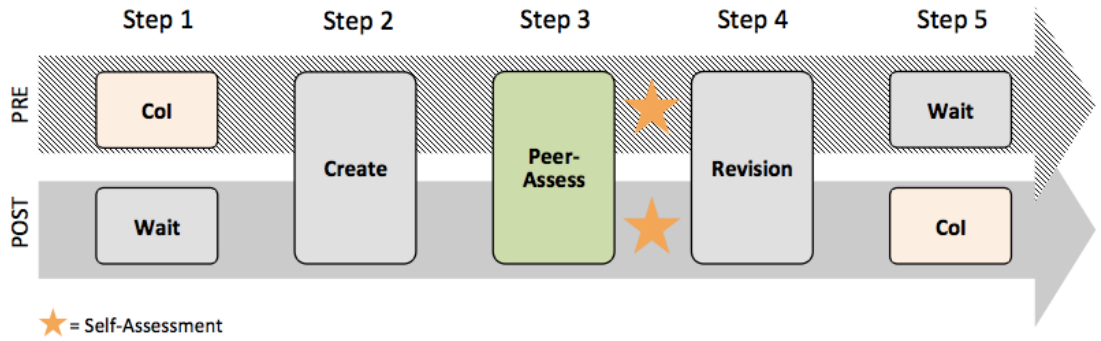
Community of Inquiry (CoI) Questionnaire. Students were also administered a modified version of the CoI Questionnaire (Arbaugh et al., 2008). The original questionnaire consisted of 34 items separated into statements reflecting teaching presence (13 items, e.g., "The instructor helped to keep course participants engaged and participating in productive dialogue"); social presence (9 items, e.g., "Getting to know the other course participants gave me a sense of belonging in the course"); and cognitive presence (12 items, e.g., "Course activities peaked my curiosity"). Our modified version consisted of 22 items (6 teaching presence items, 9 social presence items and 7 cognitive presence items; items presented in a fixed order); we removed items that were not applicable to our class context (see Appendix for a list of the items used, subheadings were included). Responses were scored using a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree) based on the work of Arbaugh (2007). This measure was delivered electronically. Although students completed all items on the modified questionnaire, our primary interest was to examine change in social presence as it related to peer-assessment.

Procedure

In this experiment we used a straightforward between-participant design. All students were given a peerScholar assignment about midway through the course. Half of the students were given the CoI questionnaire one week before the assignment (PRE group) and the other half received the CoI questionnaire one week following the assignment (POST group) as illustrated in Figure 1.

Students also completed a self-assessment following the ASSESS phase of the peer-assessment assignment. For the self-assessment, students rated their assignment on a 10-point scale. The self-assessment question was "Now that you've seen the work of your peers, consider your own composition again. What mark, out of 10, do you now think it deserves?"

Figure 1: Peer- and Self-Assessment Workflow for Experiment 1



Results and Interpretations

The Community of Inquiry (CoI) Questionnaire

Students' mean scores were calculated for the three elements of the CoI for the PRE and POST peer-assessment groups. Table 1 lists the group means, standard deviations and range of the three elements of the CoI (teaching, social and cognitive presence). Student means were computed using the 6 items forming the teaching dimension, 9 items forming the social dimension and 7 items for the cognitive dimension, and group means were computed from this score. As such, the metric of the group means can be interpreted along the same metric as the CoI Likert scale (1 = strongly disagree to 7 = strongly agree).

Table 1: Mean Scores (Standard Deviations) and Range of the Elements of the Community of Inquiry Scale

CoI Element	PRE (n = 370)		POST (n = 421)	
	Mean (SD)	Range	Mean (SD)	Range
Teaching presence	5.49 (1.13)	1.17 – 6.83	5.51 (1.05)	1.17 – 6.83
*Social presence	5.15 (1.11)	1.33 – 6.89	5.31 (0.98)	1.44 – 6.89
Cognitive presence	5.26 (1.09)	1.29 – 6.86	5.29 (0.97)	1.29 – 6.86

* sig. difference between PRE and POST, $p < .05$

An independent samples t-test was conducted for each element of the CoI questionnaire. There was no significant mean difference between the PRE and POST peer-assessment groups for teaching presence, t(789) = -0.11, n.s., nor were there any significant differences for cognitive presence, t(789) = -0.48, n.s. However, as predicted, mean differences between the PRE and POST groups were significant for social

presence, $t(789) = -2.17$, $p < .05$. The null finding of teaching presence is not surprising in this situation. Given that the same instructor was present for the entire course, one would expect the components that make up the instructors' teaching presence – direct instruction, design and organization, and facilitation of discourse – to remain constant across the PRE and POST groups. Similarly, no significant shift in cognitive presence was found across groups, which was not unexpected since there was no sustained communication between students during the one peer- and self-assessment assignment. Of greater implication are the mean differences in student perceptions of the social presence elements.

Compared to students who took the CoI prior to the peer-assessment assignment, those who took the CoI after completing the peer-assessment assignment reported higher levels of agreement with statements pertaining to social aspects (i.e., open communication, group cohesion and affective expression). This difference in perception about social presence suggests that, prior to participating in a peer-assessment assignment, students reported lower feelings of social presence in the course. That is, they reported lower incidences of identifying with the community, communicating with others in a trusting environment and forming interpersonal relationships with their peers. However, after participating in just one peer-assessment assignment, students reported higher incidences of identifying with the community. On average, they had a more positive outlook about being part of a community. It is possible that when exposed to an online environment such as peerScholar, where students are encouraged to collaborate with their peers anonymously, students have an added opportunity to feel more comfortable expressing their thoughts freely, which in turn increases their perception of a sense of community despite the large class size.

Experiment 2

In Experiment 1 we found that participating in a peer- and self-assessment assignment increased students' sense of social presence in a large class. While we believe that the engagement in peer-assessment enhanced students' sense of community, an alternative explanation for our findings is that students who wrote the POST CoI questionnaire were different in some other way. For example, students in the POST CoI condition were in the class longer (by approximately two weeks) than those who wrote the PRE questionnaire and therefore could have developed a greater sense of community due to other aspects of the course rather than through participation in a peer-and self-assessment activity. In this explanation, the timing of the CoI would account for our results in Experiment 1.

Additionally, students not only engaged in peer-assessment during Experiment 1 but also completed self-assessments after each phase of the assignment. Although we have outlined the benefits of self-assessment in general, we have previously found that asking students to self-assess prior to peer-assessment can anchor the peer-given ratings (Paré & Joordens, 2008b). Simply put, students assess quality of peer work relative to their own, so if they overestimate the quality of their work that can leave little room to give a higher ratings to their peers' work. With these findings in mind, we were interested in exploring whether the placement of self-assessment during peer-assessment had an effect on the sense of community. Given the potential confound mentioned earlier and our curiosity about self-assessment, we created a more complex design for Experiment 2 to address these questions.

In Experiment 2, we had five conditions wherein the timing/presence of the peer- and self-assessment varied and the administration of the CoI was static. Our study contrasted four experimental conditions with a control condition. In the control condition, students did not experience peer- or self-assessment before completing questionnaires related to community. In the four experimental conditions, students either performed only peer-assessment or they performed both peer- and self- assessment, with the self-assessment occurring in the CREATE, ASSESS or REFLECT/REVISE phase.

Method

Participants

Students enrolled in the Introductory Psychology class were invited to participate in this study. Of the 1,579 students who completed the course assignment, 1,092 (69.2%) consented to provide data for this experiment and completed both the assignment and the additional measures. As mentioned earlier, the design we employed involved a comparison of four experimental groups to a control group. The specifics of these groups will be described in the Results and Interpretations section that follows, but the basic breakdown of students into groups can be viewed in Table 2.

Table 2: Sample Size for Groups in Experiment 2

Group	n
Control	199
Peer-Assess Only	221
Peer + Self 1 (CREATE Phase)	226
Peer + Self 2 (ASSESS Phase)	220
Peer + Self 3 (REFLECT/REVISE Phase)	226
	1,092

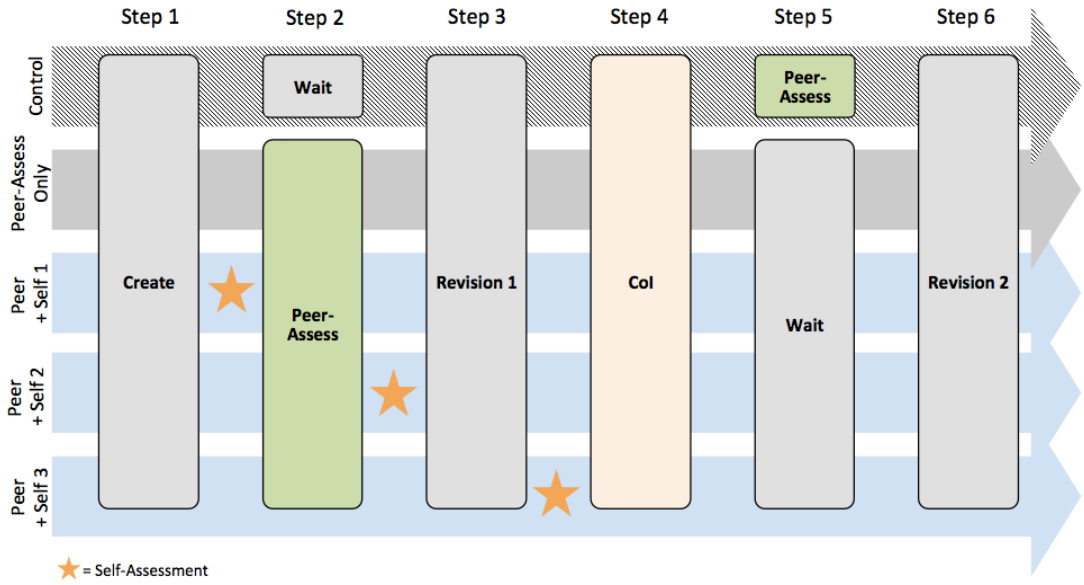
Digital Materials and Measures

As was the case in Experiment 1, peerScholar was the technology used to implement peer- and self-assessment for this study, and students' sense of community was quantified using the Community of Inquiry questionnaire (Arbaugh et al., 2008).

Procedure

Consenting students were randomly assigned to one of four experimental groups or to the control group. To ensure clarity, students in each group were given precise instructions regarding the workflow they would be expected to follow when they initially logged in to peerScholar. Moreover, in the introduction of this report, we described a typical peerScholar assignment as being composed of three phases: CREATE, ASSESS and REFLECT/REVISE. This typical workflow was lengthened in the current context to allow us to (1) have a valid control condition for comparison, and (2) ensure that those students assigned to the control condition were not disadvantaged, assuming that peer- and self-assessment have the positive effects we hoped to document. The addition of a second revision phase provided an opportunity for the control group to peer-assess later in the process and still gain potential benefits from the assignment. This resulted in a six-step workflow as illustrated in Figure 2.

Figure 2: Revised Peer- and Self-Assessment Workflow for Experiment 2



Perhaps the easiest way to think about Figure 2 is to first contrast the control group with the Peer-Assess Only group. The critical difference between these groups occurred in Steps 2 and 3; during these steps the Peer-Assess Only group assessed their peers (Step 2) and then performed a revision based on the comments peers provided about their work (Step 3). In contrast, the control group did not perform peer-assessment and did not receive any comments on their work. Thus, the first revision of the control group was based purely on the students' own thoughts about how they might improve their work, with no support from anything they might learn from assessing their peers or anything they might gain by seeing the comments of their peers. Note that we countered this lack of exposure to peer-assessment by giving students this experience in Step 5, before they submitted their second and final revision in Step 6. The other students were also allowed a second revision but they performed theirs without access to any additional peer-

assessment or peer comments. Thus all groups submitted a draft followed by two revisions, one of which was informed by peer-assessment, which for the control group did not occur until after we administered the critical research questionnaires.

Note that our strategy of including the extra revision phase was conceived primarily on the basis of the strong existing evidence supporting the pedagogical benefits of peer-assessment. In the absence of such evidence it might have seemed tolerable to have some students not experience peer-assessment at all, but once these benefits are known it seemed both fair and conscientious to ensure these benefits were not denied to a subset of the class.

As for the remaining three experimental groups, they followed the same procedure as the Peer-Assess Only group except that, in addition to assessing their peers, students in these groups also rated their own assignments either at the time of initial submission following the CREATE phase (Peer + Self 1), just after rating the work of their peers in the ASSESS phase (Peer + Self 2) or after revising their work in light of peer comments in the REFLECT/REVISE phase (Peer + Self 3).

The self-assessment question for Peer + Self 1 was "Given the points laid out in the rubric, what mark do you think your composition deserves (out of 10)?" The self-assessment question for Peer + Self 2 was "Now that you've seen the work of your peers, consider your own composition again. What mark, out of 10, do you now think it deserves?" The final self-assessment questions for Peer + Self 3 were twofold and included the questions "Once more I'd like you to think about your work, but this time both your initial draft and your final submission, and rate them as follows" and "What mark do you think you original draft deserves now that you've gone through this entire process? What mark do you think your final composition deserves?" Thus, a comparison of these groups relative to the Peer-Assess Only group allows for an assessment of the impact of self-assessment as well as the importance of when self-assessment occurs.

Results and Interpretations

The Community of Inquiry (CoI) Questionnaire

The relevant descriptive statistics are presented in Table 3. As is apparent, the results are encouraging. In all experimental conditions and for all three forms of presence, CoI scores are higher for students who engaged in peer-assessment than for those who did not.

Table 3: Mean Scores (standard deviations) across the Various Conditions by the Elements of the Community of Inquiry Scale

Col Element	Control [n = 199]	Peer-Assess Only [n = 221]	Peer + Self 1 [n = 226]	Peer + Self 2 [n = 220]	Peer + Self 3 [n = 226]
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Teaching presence	5.52 (1.27)	5.70 (1.15)	5.73 (1.12)	5.71 (1.25)	5.74 (1.18)
Social presence	5.08 (1.06)	5.42 (1.16)*	5.30 (1.08)	5.39 (1.18)*	5.41 (1.13)*
Cognitive presence	5.16 (1.11)	5.39 (1.15)	5.28 (1.10)	5.32 (1.14)	5.34 (1.15)

* sig. different than control group, $p < .005$

A one-way analysis of variance (ANOVA) showed that the effects were only reliable for the social presence element ($F[4, 1087] = 3.29$, $p < .02$) and, to some extent, that makes sense. As we have discussed, social presence refers to how connected students felt to their classmates, and that really is the sense of community we hoped peer-assessment might enhance. Dunnett's post-hoc analyses were conducted to compare the control group with the four experimental groups. The results revealed that three of the groups showed social presence scores that were significantly greater than those of the control group at the $p < .01$ level, with only the Peer + Self 1 group not being reliably different.

These results replicate our Experiment 1 findings and, more importantly, support our initial argument that the inclusion of the peerScholar peer- and self-assessment assignment did indeed enhance sense of community in our large class context. In addition, we have ruled out the possibility that the increased sense of community in this design was due to anything other than the peer-assessment assignment.

Note that this positive effect was smallest when students performed a self-assessment directly after submitting their work and before they assessed their peers. As mentioned previously, we found that when students are asked to do an early self-assessment, it "anchors" the scores they give to peers (Paré & Joordens, 2008b). That is, students tend to over-rate the quality of their own work, which then leaves them little room to appropriately assess peers who submit higher quality work than theirs. From the current data it appears that these early self-assessments also mitigate the positive effects of sense of community. Perhaps by directing a student's mind to their own work prior to the assessment of peers, the student has greater ego involvement, thereby reducing the feeling of connectedness. Further research is needed to establish this as a robust effect and explore causal mechanisms but this finding may support a "best practice" of not performing self-assessments until after peer-assessment is complete.

Although not statistically reliable, it is encouraging that elements of the scores for the cognitive presence, and even for the teaching presence, were also numerically higher for the experimental groups compared to the control group. Although social presence seems to be the element that shows the strongest sensitivity to peer-assessment, there are certainly no related costs to the other two elements and there may be small benefits.

Discussion

Research shows that when led by the right instructor, small classes of about 20 students or fewer can provide intimate and rich learning experiences (Bascia, 2010; Haughey, Snart & DaCosta, 2001). However, without making major changes to the way we offer our classes, those intimate and rich experiences will decrease in frequency as class sizes and student-faculty ratios increase. The potential for a poorer educational experience is magnified by the possibility that as class sizes grow, not only does it become harder for instructors and other instructional team members to create the same sense of community in their classes, but some of the assessment methods that work in small classes may become costly and unwieldy (Paré & Joordens, 2008). The result is often the impoverished though too common approach of reducing the educational experience to lecturing, reading and multiple-choice-style assessments.

Concerned educators have two options to consider if they wish to leave the path to impoverishment. First, they can choose to argue, beg, bargain or otherwise contrive to return to the days of smaller class sizes. Those who follow this path are valuable citizens because, whether they succeed or not, they at least ensure that we do not go quietly. Given current financial constraints, however, this option seems unlikely to succeed as it provides no alternatives for an education system striving to support increased student access.

In the second option, educators can consider which aspects of a small class allow for a rich experience and then search for alternative ways to capture those aspects in large classes. While we sympathize with those who follow the first option and completely agree with them in terms of the need especially for higher-level, senior classes to remain small, we simultaneously feel that it is wise and necessary to explore new methods that can replace some of the educational opportunities that become lost as student-faculty ratios grow.

One solution for deepening the learning in large class contexts involves the use of online peer-assessment technologies. As argued by Joordens, Paré and Collimore (2014) and others in previous research (Ruben, 2002; Topping, 1998), these technologies can develop and perhaps even assess critical thinking, creative thinking, self-reflective thought, receptive communication and expressive communication. As such, online peer-assessment tools have great potential for bringing experience with deep cognitive skills back into classrooms of any size. These tools can also enhance skills that are transferable to other life contexts and that go well beyond the specific content of a course.

Given that the core process of peer-assessment encourages prosocial behaviour (i.e., the provision of helpful feedback), we reasoned that in addition to the direct pedagogical benefits of peer-assessment, students might also feel a greater sense of community with their course after experiencing a peer-

assessment assignment like the one offered through peerScholar. If so, then the use of online peer-assessment might simultaneously address, at least to some extent, two of the main concerns associated with larger class sizes: the reduced educational experience and the reduced sense of community.

Our primary results suggest that this is indeed the case. After engaging in a peer-assessment assignment using peerScholar, students felt more connected to each other (greater social presence) as measured by the Community of Inquiry measure. Given that this measure is a validated and widely used tool for assessing students' sense of belonging (Lambert & Fisher, 2013), our findings suggest that even brief student interactions performed with the online peer-assessment tool in a large class can make a student feel less isolated.

Of course, we do not take these results to imply that the use of peer-assessment in a large and/or online course suddenly makes it as good as a smaller, traditionally run course. Nonetheless, our numbers did fall in the positive agreement range of the scale and despite the extremely large size of our class, our numbers are also similar to those reported for much smaller and more traditional courses. Our data, however, provide no means of direct comparison with a traditional small class and we expect that if such a comparison were made, the smaller class in the hands of a good instructor would still be preferable. In fact, in upper-year classes where the content and relevant thought processes become deeper and more complex (e.g., seminar courses focusing on original research), significant increases in student-faculty ratios could cause irreparable damage to the educational experience. But in introductory-level courses, where the student-faculty ratios have long been high in many institutions, the use of peer-assessment at least mitigates the most obvious problems associated with large class size.

As a final point related to peer-assessment, one author of this paper – Steve Joordens – sometimes equates large online classes to our exploration of space. Space is a cold, inhospitable place. But as we explore it we devise processes and technologies that allow us to function, if not thrive, despite the constraints of the environment. Sometimes the solutions at which we arrive have applicability in other, less extreme environments. With this analogy in mind, the sense of community fostered by peer-assessment practices need not be confined to the extreme learning environments provided by large and/or online courses. If the use of peer-assessment can make a large online course feel richer and warmer, imagine a small seminar course in which students see and comment on the ideas of others, and see comments on their ideas, before they all come together for discussion (see Collimore & Paré, 2009, for examples). In such contexts it may function less as a way of bringing back what is lost and more as a method for making a deep learning experience deeper yet.

Conclusion

The primary finding of this study is simple but important. Those who argue that big classes are ineffective typically point to two central problems: (1) as classes grow, the educational experience becomes focused mainly on content rather than transferable skills, and (2) students feel less connected to their peers and to the course itself. Technologies that harness the power of peer- and self-assessment have already been

successful in bringing transferable skills training to large classes. In this report we show that those technologies also enhance sense of community.

There is perhaps a larger point here. Yes, large classes have disadvantages when considered solely from a traditional education perspective but they also may allow for new ways of achieving the same educational goals. In the case of peer-assessment, for example, a group of more than 1,500 students can be effectively reduced to a subgroup of six students who are tasked with helping each other improve – and suddenly students feel connected and supported in their learning goals. In a sense, this massive class can temporarily be transformed into 250 small classes, at least within the context of the assignment. Effective use of technology is required to make this happen. The technology must solve logistical constraints while also supporting deep learning. Clearly this is an obtainable goal and may represent our best solution for providing a high-quality educational experience in the widely accessible yet economically viable way that society demands.

At the very least, these technologies may allow us to support learning and community in the first few years of postsecondary education, during which classes tend to be the largest, thereby providing students with a good foundation of critical thought, creative thought, self-reflective thought and both expressive and receptive communication skills. From there, two possibilities exist for upper-year courses. One involves returning to more traditional methods, thereby transitioning from a technology-based solution to a more traditional human-based solution (e.g., where the instructor and classmates are expected to provoke and support exercises with these skills). But another intriguing solution is to consider whether these technologies also have a place in smaller class contexts, thereby combining technology and human solutions to create an even richer experience.

We have been more informally exploring this 'combined' approach in our upper-year seminar courses with what we view as great, although currently anecdotal, success. Traditionally, students come to a seminar, listen to the presentation of other students and are expected to come up with interesting ideas and put those ideas into words, all on the fly. We have been asking students to write thought papers and then assess the papers submitted by a subset of their peers prior to the seminar itself. Students come into the seminar having (a) read the relevant readings, (b) come up with ideas about those papers themselves, (c) seen the ideas that their peers submitted and (d) thought about those ideas deeply enough to provide feedback. Now they come into the seminar armed with ideas and potential reactions to the ideas of others when they arise. Our experience is that this procedure has resulted in much deeper and more distributed conversations in the seminars in exactly the way we want it to happen.

The implication of this example is the following: Technologies that support deep learning and community formation in large courses may also be useful in small courses. In the latter case, they may combine with the more traditional, human approach in ways that make the traditional approach even better. If so, then large classes may become the engine of educational innovation more generally, which would be beneficial for all students at all levels.

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