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Online class size, note reading, note writing and collaborative discourse

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Abstract Researchers have long recognized class size as affecting students' performance in face-to-face contexts. However, few studies have examined the effects of class size on exact reading and writing loads in online graduate-level courses. This mixed-methods study examined relationships among class size, note reading, note writing, and collaborative discourse by analyzing tracking logs from 25 graduate-level online courses (25 instructors and 341 students) and interviews with 10 instructors and 12 graduate students. The quantitative and qualitative data analyses were designed to complement each other. The findings from this study point to class size as a major factor affecting note reading and writing loads in online graduate-level courses. Class size was found positively correlated with total number of notes students and instructors read and wrote, but negatively correlated with the percentage of notes students read, their note size and note grade level score. In larger classes, participants were more likely to experience information overload and students were more selective in reading notes. The data also suggest that the overload effects of large classes can be minimized by dividing students into small groups for discussion purposes. Interviewees felt that the use of small groups in large classes benefited their collaborative discussions. Findings suggested 13 to 15 as an optimal class size. The paper concludes with a list of pedagogical recommendations and suggestions for new multimedia software features to enhance collaborative learning in online classes.

Keywords Class size · Note reading · Note writing · Collaborative discourse · Mixed methods study

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The study discussed here[1] examined the relationship between class size and note reading loads, note writing loads, and collaborative discussions in online graduate-level courses at a Canadian institute using software WebKF. Specifically, it investigated three questions: "How do different class sizes affect students' and instructors' participation in note reading and note writing?" "What are students' and instructors' opinions about note reading and writing loads related to class sizes?" "How do students and instructors make sense of online cooperation and collaboration across different class sizes?" The findings from this study point to class size as a major factor affecting note reading and writing loads in online graduate-level courses. Although the specific findings of this study are not individually surprising to people experienced with CSCL instruction, the discussion of their implication may contain a perspective that could usefully be made available to the CSCL research and practitioner community.

三个研究问题：
1.不同班级容量对学生和指导者参与笔记阅读和写作的不同影响
2.学生和指导者对班级容量对笔记阅读和写作负载的观点
3.学生和指导者是如何理解不同班级容量中的在线合作和协作

Class size has long been recognized as a factor affecting students' achievement in face-to-face instructional contexts, but has been little investigated in online courses. Some research has shown that online class size certainly has important effects on information overload in computer conferencing courses (Hewitt and Brett 2007; Lipponen and Lallimo 2004). However, few studies have examined the effects of online class size on exact note reading and writing loads and collaborative discourse, especially with mixed methods.

In face-to-face courses, students learn by attending class, listening to the instructors' lectures and participating in discussions with classmates. They contribute by talking to share ideas and opinions. In online courses, discussions are still primarily text-based. As a basic precondition, online learners have to read the messages, ask questions, comment on messages, and answer questions (Hron and Friedrich 2003). Students read instructors' and classmates' notes, and contribute by writing their own notes. Because note reading and writing are fundamental online activities (Davie 1988), we can analyze these operations to investigate how much students "listen" (read notes), and how much students contribute (write notes) in their online discussions. More importantly, we can investigate how class size correlated with students' and instructors' note reading and writing practices and their perspectives. However, "online teaching should not be expected to generate larger revenues by means of larger class sizes at the expense of effective instructional or faculty oversubscription" (Tomei 2006, p. 531). Online education will continue to shape the way some people learn in the 21st century (Wuensch et al. 2008). While e-learning systems have improved with time, they still have some problems that need to be resolved in order to achieve a truly stimulating and realistic learning experience (Monahan et al. 2008).

Class size and challenges in online learning

There is a growing tendency for instructors who previously taught face-to-face classes to teach online despite insufficient knowledge of online teaching. For example, Moore and Kearsley (1996) found that some "distance education courses were developed and delivered in a very piece-meal and unplanned fashion" (p. 6); a similar situation still exists. The present study's literature review found no set principles or detailed guidance for instructors and students about how to cope with different situations and workloads in different sizes of online classes. Educators need to build pedagogy or instructional strategies to enhance the online educational experience for instructors and students alike (Xu and Morris 2007).

[1] The study is discussed in detail in Qiu 2009, on which this article is based.

Crucial to the success of online learning is active student participation and interaction with both peers and instructors (Sutton 2001). A common approach to encourage student participation is some overt reward or punishment system (Masters and Oberprieler 2004). However, such systems also create an authority structure which has a large impact on subsequent learning and collaborative learning activities (Hubscher-Younger and Narayanan 2003), and may not be effective in some online situations. For example, Bender (2003) found that one of the reported feelings in Computer Mediated Communication is being overwhelmed brought on by a large class size. Potentially, according to Hewitt and Brett (2007), the perception of information overload could have a number of negative consequences, such as heightened student anxiety, which can interfere with the amount of attention that participants dedicate to online learning. This leaves shy students, especially those who lack confidence or withdraw upon rejection of their initial ideas, with little chance to participate in discussions, a situation which may lead to depersonalization and deindividuation (Bordia 1997). Hewitt et al. (2007) also found that CMC students habitually engaged in practices like scanning, skimming, or reading new notes, and those larger classes had higher "scanning" rates due to an increased information load.

To overcome such problems, Hron and Friedrich (2003) argue, appropriate class sizes should be set in order to ensure for each class a minimum critical mass for participation without overload, to reach the goals associated with collaborative learning, and to make it easier to establish social presence and encourage greater interactivity (Aragon 2003). Studies of class size for online courses should examine the optimum class size for quality education and establish a discussion-board size that allows meaningful discourse (Frey and Wojnar 2004). Optimal class sizes "must be sufficiently large to encourage activity, but not so large that the sense of group connectedness is lost" (Colwell and Jenks 2004, p. 7).

Online conferencing usually takes more time (Clouder et al. 2006), and a major challenge in online learning settings is how to structure asynchronous online discussions in order to engage students in meaningful discourse (Gilbert and Dabbagh 2005). Educational researchers need to find technologies which best contribute to making collaborative online learning effective (Xu and Morris 2007). Hutchinson (2008) suggests that "the more effective deployment of existing technologies may be part of the solution" (p. 357). The majority of online education systems are still mainly text-based (Wuensch et al. 2008) with insufficient features to allow effective, interactive discourse. Dohn (2009) studied some discrepancies that lead to theoretical tensions and practical challenges when Web 2.0 practices are utilized for educational purposes. In addition, advanced multimedia applications, such as graphs, audio, and video are not much used, though some experts have suggested a movement "from e-learning to m-learning" using streaming synchronous audio and video technologies (e.g., Keegan 2002).

Constructivism, knowledge building, cooperation, collaboration and class size

Social constructivism, knowledge building, cooperative learning, and collaborative learning theories support the idea that students can learn from each other. They believe that explanation leads to deeper understanding and stress that the goal for students is to build knowledge and negotiate meaning in a learning community. How people learn is strongly influenced by social context, which in turn is the product of the interaction of individual differences (Bransford et al. 1999). Knowledge building can be considered as deep constructivism that involves making a collective inquiry into a specific topic, and coming to a deeper understanding through interactive questioning, dialogue, and continuing improvement of ideas. When learners are effectively motivated and actively try to achieve their learning goals, deeper levels of thinking and learning are promoted (Scardamalia and Bereiter 1994). This notion is consistent with Bruner's (1986) observation that learning is an active social process. Studies on teaching from a Vygotskian perspective (1978) emphasize creating more advanced social learning opportunities for students. Boettcher (1999) states that knowledge has the best chance of flourishing in an environment that is rich, supportive, encouraging, and enthusiastic.

Cohen (1994) stresses that cooperative learning can stimulate the development of higher-order thinking skills and that cooperative groups are particularly beneficial "in developing harmonious interracial relations in desegregated classrooms." (p. 17) Students receiving individual feedback on cooperative group mates obviously increase their cooperation rate in comparison to those receiving no feedback (Kimmerle and Cress 2008). However, cooperative groups differ from collaborative groups; the former tend to have a "divide and conquer" mentality, where the group divides the work into chunks that can be done 合作和协作的区别 independently (Graham and Misanchuk 2004). By contrast, collaboration involves the mutual engagement of participants in a coordinated effort to solve the problem together (Roschelle and Teasley 1995).

The commonsense starting point in Computer-Supported Collaborative Learning is that learning is social in nature (Jones et al. 2006). Collaboration is especially important in online learning (Pena 2004), where the learners tend to be isolated without the usual social support systems found in on-campus or classroom-based instruction. Since the purpose of collaborative groups is to achieve consensus and shared classroom authority (Bruffee 1999), individual accountability becomes central to ensuring that all the participants in the group develop by learning collaboratively (Hutchinson 2008). In classrooms that adopt a collaborative approach, the basic challenge shifts from learning in the conventional sense to the construction of collective knowledge (Scardamalia and Bereiter 2006; 2003). Hakkaranen (2009) argued that "knowledge advancement is not just about putting students' ideas into the centre but depends on corresponding transformation of social practices of working with knowledge." (p. 213) With collaborative learning, the control of learning is turned over to the students and the learning environment is student-centric. Learning takes place in a meaningful, authentic context and is a social, collaborative activity, in which peers play an important role in encouraging (Neo 2003). In order to establish and maintain an online learning community, the learning environment needs to be effectively designed to provide students with opportunities to practice collaboration, critical thinking, and teamwork skills that are increasingly valuable in the information age (Kerka 1996). Though its benefits are widely known, collaborative learning remains rarely practiced, particularly at the university level (Roberts 2004).

Proper online instructional strategies could guide meaningful online discussion between or among peers who co-construct knowledge; allowing learners to share and refine meaning with peers in a social context (Tao and Gunstone 1999). Some writers (e.g., Weigel 2002) have argued that combining traditional courses with online collaboration represents a significant step forward in higher education. Laurillard (2008) argued that "New technologies invariably excite a creative explosion of new ideas for ways of doing teaching and learning, although the technologies themselves are rarely designed with teaching and learning in mind." (p. 5) Online technology enables the transfer of content and feedback (Neo 2003). Properly deployed, the technology can support and enhance learning, the acquisition of knowledge, and the development of intellectual analysis and skills in the information age (Collins and Halverson 2009), rather than serving merely as an added medium for transmitting information. It can be very productive to marry appropriate instructional strategies with online technology (Ingram and Hathorn 2004).

Researchers have proposed a number of different optimal sizes for online classes. Based on their own online teaching experience, Aragon (2003) proposed 30 as an upper limit on class size. This matches Bi's (2000) suggestion that to optimize and allow for effective feedback, fewer than 30 students should be enrolled in each class. Roberts and Hopewell (2003) suggested that faculty keep the size of the class to 20 students, to allow for more "workable" loads. This size is manageable without overwhelming the instructor or minimizing his effectiveness. Rovai (2002) argued that to guarantee effective online engagement and interactions, 8–10 students were required. However, in general, students in smaller classes tended to learn more (Glass and Smith 1979).

Method

Creswell (2005) states that "Mixed methods designs are procedures for collecting, analyzing, and linking both quantitative and qualitative data in a single study or in a multiphase series of studies" (p. 53). He points out that all research methods have limitations that in mixed-methods research the biases inherent in any single method could neutralize or cancel the biases of other methods. Morse (2003) argues that the major strength of mixed methods research is that it allows research to develop as "comprehensively and completely as possible" (p. 189). In other words, the fundamental principle of mixed method research is to collect multiple sets of data using different research methods in such a way that the resulting mixture or combination has complementary strengths and non-overlapping weaknesses (Johnson and Christensen 2004). Results from one method can help develop or inform the other method (Greene et al. 1989) and provide insight into different levels or units of analysis (Tashakkori and Teddlie 2003). Mixed methods help researchers develop a fuller understanding of the issues under investigation.

This study adopted a mixed methods design, using results from quantitative data analyses and from qualitative interviews. Specifically, it used a mixed methods design in order to: (1) develop stronger claims to test the hypothesis that different class sizes do affect note reading and note writing; (2) examine the research questions from multiple perspectives, thus providing greater diversity of positions and values; (3) understand online graduate-level discussion loads more insightfully; and (4) develop more comprehensive, more complete, and more enriched portraits of online graduate level discourse.

This study adopted purposeful criteria (Strauss and Corbin 1998) for selecting both quantitative and qualitative samples with maximum variation in the sampling of interview participants, taking into account the notion that participants must have experience (Morgan et al. 1998) of online group discussions in different sizes of classes. The samples for both quantitative and qualitative data analyses were drawn from one Canadian institute, because of its diversity of graduate online courses, its history of online education, its experienced faculty members and the software (Web Knowledge Forum) used for threaded online discussions. Many studies suffer from high attrition or otherwise wind up using statistical analyses with inadequate sample sizes (Schoech 2000), which violate the underlying assumptions of the statistical methods. Here, the sample for the quantitative analyses in this study was made larger than those for most quantitative computer-mediated communication studies described in the literature (Schoech 2000). This study analyzed tracking logs from 25 graduate-level online courses (from fall 2003 to summer 2004) using software Web Knowledge Forum (25 instructors and 341 students) and semi-structured interviews with 10 instructors and 12 graduate students who had diverse backgrounds and extensive online teaching and learning experience. The actual class sizes in this study range from 6 to 22 for the quantitative data and 6 to 25 for the interviews.

25个在线课程
使用wkf平台：25个指导者、341个学生
对10位指导者、12位研究生进行半结构化的访谈

The quantitative and qualitative data analyses were designed to complement each other. In the quantitative data analysis, a number of issues central to ensuring maximum statistical power in the study were considered in order to minimize the risk of Type II errors and to sufficiently protect against Type I errors with a significance level of at least .05. We used two-tailed tests in the analysis, which meant we required a larger sample in order to maximize the study's power. The sample size—341 students and 25 instructors in 25 courses—was large enough to produce effective statistical power. First we conducted data cleaning and checking to ensure the quality of the dataset. The descriptive statistical analyses compared means, standard deviations, maximum, and minimum values of variables from the 25 course datasets concerning note reading and note writing. We employed a Pearson Correlation, one-way ANOVA, *t*-test, ANCOVA, and multiple regression analyses.

The qualitative data analysis followed the principles and practices that Tesch (1990) identified for grounded theory. As Denzin and Lincoln (2005) pointed out, "Grounded theory is probably the most widely employed interpretive strategy in the social sciences today" (p. 204). Following Tesch's principles, the inductive analysis of the qualitative data started with the sorting of transcripts and developing a coding scheme and a description using a sample transcript. This was followed by the coding and typology development of themes. Interview data analysis moved from a detailed, fine-grained analysis of the data (open coding) towards successively more general categories (axial coding), themes, and theories (selective coding). Memoing and diagramming began with initial analysis and continued throughout the research process.

Comparisons of results from both quantitative and qualitative methods were carried out at every stage of the cross-track analysis procedure. Verifications of the analyses were planned and conducted with all possible methods (e.g., triangulation, negative case analysis, peer review, member checks, and external audits) in order to guarantee reliability and validity.

Results

Class size and note reading

Both quantitative and qualitative data analyses suggested that class size plays a pivotal role in supporting or impeding note reading. Statistical analyses (see Table 1 in Appendix) found that class size was positively correlated with the total number of notes students read (from 330 to 900 notes; $r=0.777$, $p<0.001$). As class size increased, students read significantly more notes. However, class size was negatively correlated with the percentage of notes students read (from 90 % to 49 %; $r=-\ 0.801$, $p<0.01$); they read a significantly fewer proportion of the notes as class size increased. As class size increased, instructors also read significantly more notes (from 320 to 1,300 notes; $r=0.902$, $p<0.001$). However, the percentage of notes they read was not significantly correlated with class size (with an average of 82 %). (See Figs. 1 & 2)

In interviews, problems reported in small classes were slow discussions, not enough information to read and less diversity of ideas. In large classes, both instructors and students often encountered information overload. Student interviewees knew that graduate students were expected to read a lot and have deeper discussions. However, in online graduate courses, the reading load comprises articles plus notes. If the students were not reading others' notes, they were not participating and not learning, especially because they had to

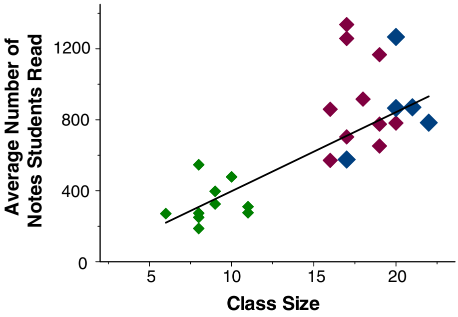

Fig. 1 Correlation between class size and total notes each student read. The colors on the figures represent classes of small, large, and large with subgroups

read a substantial number of messages before they could contribute their own. As class size increased, most students in large classes started to feel that there was always "a lot to read". When the number of notes that students were meant to read increased beyond a certain point, the percentage of notes they actually read declined, mainly because of information overload. They reported that information overload was mainly caused by increased numbers of students; so students in larger classes were particularly vulnerable to information overload. When they logged on and saw all those unread notes, they sometimes became disheartened. They felt that they could not read so many messages closely. Besides, students did not all have the same amount of time to deal with their course work; an excessive reading load was particularly difficult for those students who had full-time jobs or had to log on later in the week. The students in the study admitted that they used a variety of compensatory strategies to cope with overload: selective reading (by topic or author), scanning through messages quickly, skimming some messages, skipping reading some messages completely, or simply ignoring large numbers of messages. The consequences were significant: If students were not closely attending to each other's notes in large classes, they might miss important information and collaborative learning might not be realized, contrary to some instructors' intention of putting all students in one large class so that they could be exposed to more information. The findings also implied that letting students choose which notes they wanted to read was not an ideal strategy. For example, students could select notes by reading the note titles only. In such a case, they still might miss important information in notes with less attractive titles.

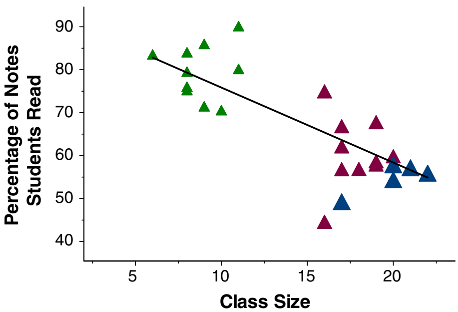

Figure 2 Correlation between class size and percentage of notes students read. The colors on the figures represent classes of small, large, and large with subgroups

Class size and note writing

是根据美国Rudolf Flesch博士的统计方法计算的，计算根据是句子的字数和句子中含的音节数等，数值在0和100之间，数目越大，文章越容易易读。
Flesch-Kincaid Grade Level按美国中小学年级水平评定文本的得分。分数越高表示作者的英语写作水平越高，当然对读者的英语阅读水平要求也就越高。根据中小学年级分12级

The main learning for online students comes not only from reading other people's notes but also from having to construct their own ideas in their own notes. Writing is essential for learning, even more so than reading as Instructor 3 stated. Generally speaking, a larger number of notes is supposed to further students' understanding of the discussion and provide information and knowledge for the target learning. It also indicates active learning in the class. The findings suggest that class size may have played a key role in the quantity and quality of instructors' and students' note writing (See Tables 2 & 3). Increased class size was positively correlated with a larger total number of notes written in a class, with a larger average number of notes written per student (from 50 to 80 notes; r=0.498, p<0.01) and per instructor (from 12 to 461 notes; r=0.554, p<0.01), and with a higher note Flesch-Kincaid Reading Ease Scores by students (r=0.517, p<0.01). Yet, larger class size correlated negatively with students' note sizes (r=0.613, p<0.001) and students' note Flesch-Kincaid Grade Level Score (r=0.555, p<0.01), but not with instructors'. Thus, class size relates not only to overall note quantity but also to students' note length and writing style. As class size increased, only students tended to write shorter notes with simpler vocabulary (See Figs. 3, 4, 5, 6).

难度系数

班级数量增加，总的笔记数量和每个学生与指导者写笔记的数量增加
笔记的弗莱是-金凯德易读度增加
班级容量增加，学生的弗莱是-金凯德年级水平下降
班级容量增加，学生写作的笔记会更短更简单

The reason is unclear: one possibility, as some interviewees stated, is that students only had a certain amount of time to read and write notes. When they were facing information overload, they had less time to think about using more academic words and writing longer notes. They chose a simpler vocabulary and wrote shorter notes in order to dialogue. Several students reported that when they "were competing" for participation marks in a larger class, they paid more attention to their numbers of notes and chose easier ways to convey their ideas than to write longer notes with more academic phrasing. One student participant explained thus: The statistical analyses showed that Larger class sizes meant more total notes and hence more notes to respond to. The results revealed that a student in a class of less than 10 students would write approximately 50 notes on average, while a student in a class of more than 16 wrote close to 80. More students produced more topics, and more topics might inspire more notes. Competition to establish students' status in the large classes was also reported to have encouraged more note-writing. Instructors, accordingly, also wrote more notes as the number of students increased in a class. However, the note size, the Flesch-Kincaid Reading Ease Score and Grade Level Score of instructors' notes did not change significantly as class size increased. Consequently, when class size increased, it influenced students' note writing behaviors more. A large number of classmates appeared to "force" students to write shorter notes to save time and to "beat" their classmates in number of notes

学生阅读和撰写笔记的时间有限
学生为了竞争，更关注与笔记的数量，选择简单的方式写作

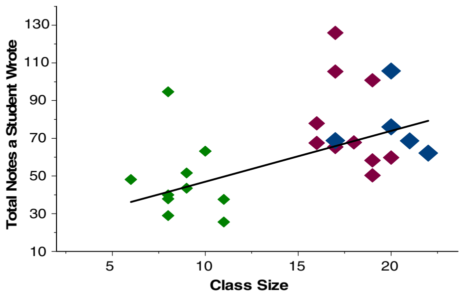

Fig. 3 Correlation between class size and total notes by a student. The colors on the figures represent classes of small, large, and large with subgroups.

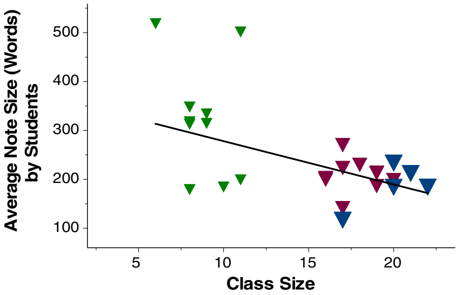

Fig. 4 Correlation between class size and average note size by students. The colors on the figures represent classes of small, large, and large with subgroups

for participation marks. With limited time spent on a larger number of notes, note quality declined.

To some extent, it is believed that the more notes that the students write, the more productive the class discussion will be and the more the students will learn. In the small classes in this study, sometimes less information was produced and the discussion tended to slow down, especially when instructors did not participate actively. Thus, instructors' participation became even more important in small classes. Strategies instructors adopted to encourage note writing and keep the class discussion going might not always work as intended. From the interviews, most instructors said that they had a participation requirement —usually 2 to 3 notes per week. However, some students said that they tried to exceed the minimum requirement for postings only in order to secure a good participation mark. Such note-writing for quantity might reduce the quality of the notes, which then did not contribute much knowledge to the learning community but added to information overload. Information overload was also reported correlated with improper contents and lengthy notes, because it related to the time it took to read a note. Discussions were arguably helped by shorter and to-the-point notes. Long rambling notes tended to lose readers and confuse the discourse. Especially in larger classes, some students reported that when they opened a lengthy note with copy-and-paste contents, an off-topic note, or a note like a mini-essay, they tended to skim it without really reading it carefully or else skip it entirely.

Instructors' presence and facilitation affected how students interact. The findings suggested that frequency of instructors' note writing was associated with students' note-writing

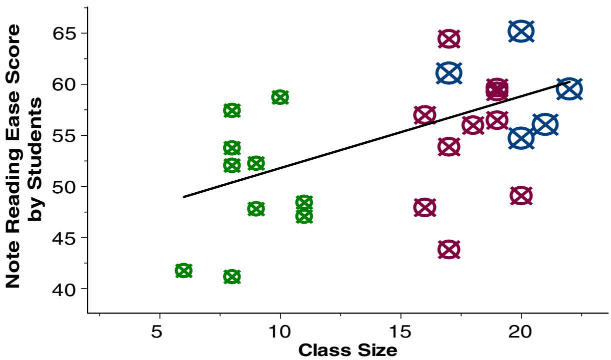

Fig. 5 Correlation between class size and note Reading Ease Score by students. The colors on the figures represent classes of small, large, and large with subgroups

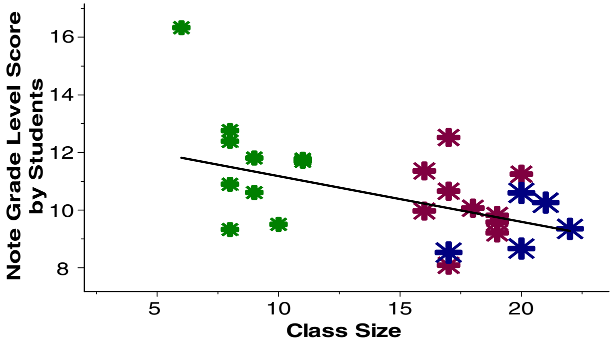

Fig. 6 Correlation between class size and note Grade Level Score by students. The colors on the figures represent classes of small, large, and large with subgroups

activities. Instructors often found it hard to draw a line between participating too much and not enough. Students perceived instructors' not writing "enough" notes as "absence". It tended to discourage students' note writing and even stop the discourse. Some students complained that their instructors 'disappear' this way, especially in smaller classes or subgroups, even though the instructors were actually reading the students' notes; the instructors just did not respond as much. That perception was another reason for instructors to write more in small classes. Otherwise, the discussion tended to slow down or stop due to the lack of stimuli and the students' perception that the instructor was neglectful. Students felt that instructors, in addition to reading notes or facilitating the discussion, should "teach" by writing a proper number of notes to "lead the discussion" instead of just giving answers to questions or not participating. But it could also be a problem if instructors were "too active" in writing. Some instructors felt that very active note writing (e.g., answering most questions) was perceived as their "dominating the discussion". If instructors did dominate discussions, the students tended to respond to their instructors more than to their peers, thereby losing opportunities to collaborate with their peers, especially in larger classes, and perhaps even halting the discussion. Instructors found different ways to participate in discussions by writing notes. For example, some wrote comment notes, bridged ideas by writing convergent notes, summarized at the end of a session, or guided students to take over and summarize the discussions. Instructors' summary notes were welcomed because they helped students get a whole picture of the issues under discussion.

指导者的角色问题：不能参与太多或者太少。对于小班额学生，指导者如果不能及时反馈，会降低讨论的质量。对于大班额学生，指导者的过于频繁的回应会显得专横，学生疲于应付指导者的反馈

The study also found that note-writing assessments could powerfully encourage and guide students' note-writing activities, affecting how students interact. Some instructors assessed students' participation by requiring a certain number of notes (usually two to three) weekly, though some students did not feel comfortable at "being forced to write". Some instructors counted the total number of notes students wrote and gave a specific mark for that. However, any quota system sometimes produced excess note 配额制 writing to gain participation marks, with concomitant decline in quantity and meaning. In contrast, some instructors assessed note writing by quality, monitoring the content of students' notes. These instructors valued notes into which students had put a lot of thought and which advanced the discussion. This study suggested that setting requirements for high-quality notes would help in reducing information overload, particularly in larger classes. Nevertheless, most students felt that standards for high-quality notes were not as objective as judging by number of notes, and often involved unclear requirements or rubrics. To avoid bias, most of the instructors assessed students' note writing by both quantity and quality, with a rubric heavily oriented toward quality. This method appeared to be more effective. However, this study found that most instructors' assessment of note writing had not taken class size into consideration.

Discussions

Using mixed methods helped this study to arrive at an essential finding: that different sizes of classes led to different reading and writing loads for students and instructors respectively. The students' and instructors' feedback and opinions are essential and pertinent. Both students and instructors felt that a class of eight or fewer would not have enough stimuli, perspectives or interaction for a proper discussion, while a class of 18 or more, at least for a graduate-level course, would make a single conversation difficult and would become overwhelming and less manageable for both students and instructors. Apparently, the participants' ideal, manageable class size would be about 13 to 15. This size allows students to have a good sense of their peers and to read and respond to other participants' contributions, while maintaining enough stimuli and diversity. For some small classes in this study, information is limited to about 360 notes on average plus course reading materials. However, the knowledge that students gain from such courses is restricted to the background knowledge of the limited number of members. The students felt that having peers from varied backgrounds would contribute to more diverse discussions and learning experiences. They favored being exposed to more ideas than would have been possible with a more homogeneous small learning community.

However, complaints about information overload came mainly from larger classes, especially those with whole-class discussion setups. In the study, students in large classes have workloads of reading more than 1,700 notes on average plus course reading materials. As a result, students complained that it is impossible for them to digest the huge amount of information in large classes. Some of them felt lost in the crowd. Thus, most students reported that they had frustrating and exhausting learning experiences in large whole-class discussions. Students would welcome the design of subgroup discussions embedded in large classes, because it allows them more interactions with their peers and an escape from mass, large whole-class discussions. They felt less frustration with more intimate, more focused discourse in small groups, in which they could experience the formation of a sense of an online learning community among the members.

This study found that students' learning experiences varied with instructors' online teaching experiences and strategies in different sizes of classes. Small whole-class discussion worked well and received positive reflections from students, according to one instructor who has taught only small classes in her 5 years of online teaching experiences and consequently can maintain the strategy of whole-class discussions. One new instructor has whole-class discussions in her large online class and is distressed that there are more dropouts than in her face-to-face classes. She has never thought of utilizing the subgroup strategy, because she does not have solid information about the different workloads in different sizes of classes. She plans to use large whole-class discussions again in her next online course. She says she has noticed that her one-on-one note responding practice in large whole-class discussions has weakened student participation. She also noticed that in her large class students tend to have fewer opportunities to "talk" with their peers or to initiate discussions. Three instructors use the large whole-class discussion strategy for its benefits of diversity.

These three instructors usually have large classes. Their strategy was to let students choose which notes to read or respond to. Two of them had not thought of dividing students into subgroups, while one felt that subgroup discussions might limit students' exposure to diverse ideas. Students in large classes like theirs complained about information overload more. Five out of the 10 instructors interviewed use the subgroup strategy to reduce information overload in large classes and to provide students with small intimate learning environments. Before the interviews, all of these five instructors had taught online graduate-level courses with different class sizes for more than 9 years; among them are pioneers in online teaching at the institute and in the world. On the basis of their years of online teaching experiences, when they have small classes, they usually adopt a whole-class discussion format and participate more actively as a member in the class. When they have large classes, they usually introduce the class members and course contents in whole-class settings. Later, for certain weeks they divide students into subgroups, aiming to promote focused, in-depth discussions. The subgroups' insights are reported back to benefit large whole-class discussions. To preserve the advantages of diversity in large classes, their instructors rotate the students through different subgroups and make the subgroup discussions public to the whole class. When assigning students to subgroups, they group or mix students with different skills, professions, gender and characters. They allow students to choose subgroups on the basis of topics, contents or interests. Their students appreciated the strategies these instructors used to deal with reading and writing loads in different sizes of classes, reporting that their learning experiences were thereby made more satisfactory.

Recommendations

The study arrived at a listing of pedagogical recommendations, suggestions for new software features, and a call for applying multiple educational theories that may help remedy problems relating to class size in online courses. 1). *Pre-informing the Participants* Using orientation video or audio clips and detailed rubrics pre-informing students of possible reading and writing loads in different sizes of classes may help students prepare for reading and writing notes. It may also provide students with an initial understanding of the expectations. Tutorials seem necessary to provide instructors and students with information about possible problems due to different class sizes. 2). *Providing Proper Guidance* This study found that instructors' presence and facilitation affect students' note reading and writing. Instructors' pre-structuring discussions can significantly increase the number of times students challenge each other. Proper instructor participation may reduce students' anxiety about being left to continue the discussion on their own, especially in subgroups. "Supervision behind the scene" needs to become "visible" to let students know that instructors are reading their notes. 3). *Assigning Appropriate Workloads* Both the quantitative and qualitative data analyses suggest that instructors' expectations for students' participation need to be adjusted to fit different class sizes in order to achieve effective collaborative discourse. This study suggests that the required number of notes should be higher in small classes than in large ones in order to guarantee participation and class energy. Notes in small classes can be expected to be better-quality and longer. It may be more satisfactory to assess note writing by both quantity and quality, with an emphasis on quality. Requiring high-quality notes may reduce information overload and achieve better discussions. Standards should set out how to write "good" notes with proper length and "come-to-the-point" contents. 4).

Segmenting the Semester Instructors can segment the semester to achieve different goals and to meet different needs by combining whole-class and subgroup discussions to manage discourse, to reduce information overload in large classes and to bring insights back to the whole class. 5). *Utilizing Multimedia Technologies* Large class size and text-only communication create heavy reading and writing loads. It can be helpful to use multimedia (e.g., audio, video, graph, or even animation) to introduce the course and the weekly discussion topics, to get to know the class members, especially in large classes to humanize their learning environment. 6). *Creating Coherent Environments* Findings from this study suggest that a class of 13 to 15 graduate students is an ideal size. Instructors may need strategies to manage classes smaller or larger than the ideal size in order to achieve collaborative discourse. In small classes, keeping all the students in one group may increase participant accountability and encourage participation, thus compensating for the lack of information and supporting a coherent learning environment. In larger classes, dividing students into subgroups during certain weeks appears an effective strategy for creating opportunities for coherent discussion environments. 7). *Enhancing Individual Learning* Individual learners care more about what they can learn from a course and what they can apply in their future work. An ideal class size is one that serves the purpose of supporting individual learning. The quantity and quality of note reading and writing should be designed to benefit individual learners who have different interests as well as to allow learning in subgroups. Requiring students to write a certain number of notes based on course reading materials may create a collection of ideas that leads to cooperative and/or collaborative discussions. Asking students to write convergent notes can lead students to read notes in related discussions. Assigning students to summarize subgroup discussions will help individual students gain an overall view of the discourse. Appointing students as discussion leaders in subgroups may help them learn better through leading. 8). *Creating new software features* Heavy text-based reading and writing loads in large classes in this study may be reduced by creating functions using audio and video technologies or by creating links to 'invite' existing computer-based multimedia technologies, such as Webinar, to enhance social presence. It would be helpful to create functions to allow students to choose which note to read: for instance, searching (by key words or topics), browsing (for notes in other groups), checking (note length), marking (important convergent or summary notes), filtering (by topics), tailoring (references or quoted contents) and linking (convergent notes). 9). *Applying Multiple Theories* Online learning is a complex learning process. Existing theories supporting and guiding online education tends to direct online work and learning from their own individual perspectives. However, instructors who follow a single theory, hoping that it will solve all the problems they encounter, might find it difficult to explain some issues arising in their online classes. Holistic application of several theories could balance out the biases of any single theory.

Conclusions

The findings from this study points to class size as a major factor affecting note reading and writing loads in online classes. However, it appears not necessarily true that smaller classes have better class discussions and larger classes have worse ones. Both optimal class size and effective organizational strategies, such as appropriate group configuration, contribute to more interactive and productive online conferencing.

When the class size is too small, students may not have access to sufficient information; the instructor's participation usually determines whether a small-class discussion will be successful or not. As class size increases, note reading load for both students and instructors increases greatly. When class size increases beyond an optimal size, information overload may “kick in” and students’ complaints arise. Instructors’ note-reading activities in larger classes are not obviously seen; therefore, some students think that their instructors often are not participating in discussions, especially in subgroup discussions. Instructors’ responding to notes appropriately often seems to encourage students’ note writing.

As class size increases, note-writing load increases accordingly. Both students and instructors tend to write more notes of shorter length and with fewer academic words. Discussions become more like dialogues. However, assessment of note writing has an impact on quantity and quality of student note-writing behaviors.

Different class sizes played an important role in students’ learning experiences and the amount of information the students learn. Instructors’ teaching experiences in different sizes of classes lead to their developing different strategies to cope with different class situations, which then may affect students’ learning experiences. This study found that splitting larger classes into subgroups serves as a strategy to reduce information overload and to encourage focused, in-depth small group discussions. Finally, the study found that class size and group configuration affects how collaborative the online discourse becomes: Larger classes tend to be more cooperative and less collaborative.

The findings from this study may have implications for both practitioners and researchers. They could serve as a base for researchers to further explore the issue of class size and seek optimal patterns of group configuration to achieve more fruitful online conferencing. Nevertheless, a number of concerns suggest a variety of additional questions for further research. There is a need to clarify the definition and processes of effective online collaboration in order to support productive whole class and subgroup discussions. Another area requiring further research concerns further exploration of other potential technologies, especially with the support of existing multimedia, to reduce text-based only communication and to support collaborative online discussions. Further research is recommended to look at the issue in a macro context by inviting more samples from other institutes globally as well as more micro studies of single classes and subgroups. Studies are needed to compare online text only collaborative discourse with discourse utilizing multimedia technologies.

Many online courses intended as collaborative learning environments are not effective due to the failure to consider class size and note reading and writing loads. Some experienced online instructors do utilize effective strategies but keep these stored in their own mental “attics” rather than broadcasting them to benefit other online instructors and students. As a result, some online students and instructors, especially new ones, tend to participate in discussions mechanically without noticing that some of the problems they encounter may be caused by class size and note reading and writing due to pure online text-based communication. We need to take class size into consideration rationally and place more emphases on effective student learning with appropriate strategies. Any instructor who is blind to this point may pay a heavy price: their students’ unsatisfied or even failures in online learning.

Many factors affect the success of online graduate-level discourse; class size is only one of them. This study does not aim to provide final answers to some questions or define recipes for instructional design. Rather, it opens up a suggestive window by pointing out practices and opinions from some representative participants. It is to be hoped that it contributes in some modest measure to future understanding and supporting of effective online learning, and that its fundamental conclusions hold true not only for online courses in the institute examined but also for online courses in many other institutes.

Appendixes

Table 1 Percentage of notes read, average number of notes read, or total number of notes read by a participant, a student, or an instructor in the 25 courses

Whole Class			Students			Instructors		
ID	Size	All Notes	Size	%	Avg.	Size	%	Total
1	6	325	5	83.45	271.20	1	72.62	236
2	8	344	7	79.44	273.29	1	81.10	279
3	8	298	7	83.94	250.14	1	86.58	258
4	8	727	7	75.14	546.29	1	42.78	311
5	8	247	7	75.94	187.57	1	87.85	217
6	9	462	8	85.90	396.88	1	86.80	401
7	9	456	8	71.35	325.38	1	73.68	336
8	10	679	9	70.48	478.56	1	74.96	509
9	11	307	10	90.03	276.40	1	87.95	270
10	11	388	10	80.08	310.70	1	98.20	381
11	16	1,284	15	44.49	571.20	1	72.51	931
12	16	1,148	15	74.86	859.33	1	85.28	979
13	17	1,240	16	56.74	703.63	1	85.97	1,066
14	17	2,155	16	62.02	1336.62	1	63.16	1,361
15	17	1,885	16	66.73	1257.94	1	82.33	1,552
16	17	1,171	16	49.16	575.69	1	86.25	1,010
17	18	1,614	17	56.78	916.41	1	73.61	1,188
18	19	1,146	18	67.68	775.56	1	91.36	1,047
19	19	1,128	18	57.83	652.33	1	76.42	862
20	19	1,993	18	58.54	1166.78	1	86.35	1,721
21	20	1,308	19	59.74	781.42	1	87.39	1,143
22	20	1,597	19	54.26	866.53	1	94.55	1,510
23	20	2,194	19	57.74	1266.89	1	89.11	1,955
24	21	1,525	20	57.06	870.10	1	93.84	1,431
25	22	1,404	21	55.80	783.48	1	96.51	1,355

ID = Class ID. Size = Total number of participants, students, or instructors in a class. All Notes = All notes written in a class. % = Percentage of the average number of notes all participants, students, or instructors read in each class. Avg. = Average number of notes all participants or students read in each class. Total = All notes instructors read in a class

Table 2 Percentage of notes written, average number of notes written or total notes written by all participants, students, or instructors in 25 courses

Whole Class				Students				Instructors		
ID	Size	Total	Avg.	Size	%	Total	Avg.	Size	%	Total
1	6	325	54.17	5	74.15	241	29.00	1	25.85	84
2	8	344	43.00	7	81.40	280	40.00	1	18.60	64
3	8	298	37.25	7	88.93	265	37.86	1	11.07	33
4	8	727	90.88	7	91.20	663	94.71	1	8.80	64
5	8	247	30.88	7	82.19	203	29.00	1	17.81	44
6	9	462	51.33	8	89.39	413	51.63	1	10.61	49
7	9	456	50.67	8	76.32	348	43.50	1	23.68	108
8	10	679	67.90	9	83.80	569	63.22	1	16.20	110
9	11	307	27.91	10	83.39	256	25.60	1	16.61	51
10	11	388	35.27	10	96.91	376	37.60	1	3.09	12
11	16	1,284	80.25	15	91.04	1,169	77.93	1	8..96	115
12	16	1,148	71.75	15	88.24	1,013	67.53	1	11.76	135
13	17	1,240	72.94	16	84.44	1,047	65.44	1	15.56	193
14	17	2,155	126.76	16	93.50	2,015	125.94	1	6.50	140
15	17	1,885	110.88	16	89.50	1,683	105.44	1	10.50	198
16	17	1,171	68.88	16	94.02	1,101	68.81	1	5.98	70
17	18	1,614	89.67	17	71.44	1,153	67.82	1	28.56	461
18	19	1,146	60.32	18	91.54	1,049	58.28	1	8.46	97
19	19	1,128	59.37	18	80.32	906	50.33	1	19.68	222
20	19	1,993	104.89	18	91.07	1,815	100.83	1	8.93	178
21	20	1,308	65.40	19	86.85	1,136	59.79	1	13.15	172
22	20	1,597	79.85	19	90.48	1,445	76.05	1	9..52	152
23	20	2,194	109.70	19	91.57	2,009	105.74	1	8.43	185
24	21	1,525	72.62	20	90.03	1,373	68.65	1	9..97	152
25	22	1,404	63.82	21	92.95	1,305	62.14	1	7.05	99

ID = Class ID. Size = Total number of participants, students, or instructors in a class. % = Percentage of the average number of notes all participants, students, or instructors wrote in each class. Avg. = Average number of notes all participants or students Wrote in each class. Total = All notes students or instructors wrote in a class

Table 3 Average size, reading ease score, or grade level score of notes by a participant, a student, or an instructor in the 25 courses

Whole Class				Students			Instructors		
ID	Size	Ease	Grade	Size	Ease	Grade	Size	Ease	Grade
1	484.29	44.12	15.50	518.65	41.75	16.33	312.49	55.96	11.35
2	329.14	53.80	12.29	317.97	53.76	12.39	407.34	54.11	11.59
3	340.85	41.54	12.64	347.95	41.15	12.76	291.15	44.28	11.77
4	168.81	58.88	8.95	179.07	57.43	9.33	97.02	69.04	6.31
5	391.37	50.84	11.06	312.87	52.05	10.90	940.80	42.38	12.19
6	308.38	52.18	10.55	314.67	52.26	10.61	258.08	51.54	10.06
7	304.11	50.69	11.11	334.01	47.80	11.81	64.92	73.84	5.50
8	175.21	60.24	9.12	184.39	58.72	9.51	92.59	73.90	5.62
9	477.28	47.67	11.52	501.53	47.07	11.70	234.77	53.69	9.75
10	254.90	50.17	11.33	199.04	48.43	11.77	813.42	67.49	7.03
11	199.57	57.28	9.88	199.31	56.98	9.97	203.47	61.81	8.46
12	204.48	47.47	11.41	202.71	47.93	11.36	230.92	40.64	12.22
13	219.40	44.61	12.31	223.38	43.82	12.52	155.77	57.36	9.01
14	135.95	65.36	7.88	141.06	64.44	8.09	54.29	79.99	4.53
15	264.79	53.75	10.73	270.22	53.88	10.66	177.93	51.61	11.79
16	225.09	55.59	10.17	229.60	55.98	10.07	148.39	48.98	11.93
17	188.47	56.74	9.76	186.28	56.47	9.82	227.81	61.61	8.74
18	210.14	59.62	9.51	212.58	59.28	9.58	166.27	65.74	8.28
19	210.48	59.32	9.34	213.65	59.67	9.21	153.33	52.90	11.65
20	195.94	49.68	11.10	198.41	49.08	11.25	149.08	61.09	8.26
21	119.35	60.64	8.69	116.40	61.08	8.53	166.63	53.58	11.28
22	183.34	54.75	10.60	183.62	54.71	10.60	178.00	55.61	10.61
23	235.47	65.07	8.73	233.29	65.18	8.67	276.98	62.97	9.89
24	212.37	56.07	10.27	211.82	56.05	10.26	223.36	56.49	10.63
25	185.13	59.49	9.35	183.85	59.53	9.35	211.85	58.76	9.50

ID = Class ID. Size = Average note size by a participant, a student, or an instructor in a class. Ease = Note Reading Ease Score of notes by a participant, a student, or an instructor in a class. Grade = Average Note Grade Level Score of notes by a participant, a student, or an instructor in a class

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