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Résumé de l'article

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Interaction, Critical Thinking, and Social Network Analysis (SNA) in Online Courses




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Abstract

This study tried to ascertain a possible relationship between the number of student moderators (1, 2, and 3), online interactions, and critical thinking of K-12 educators enrolled in an online course that was taught from a constructivist approach. The course topic was use of technology in special education. Social network analysis (SNA) and measures of critical thinking (Newman, Webb, & Cochrane, 1995) were used to research and assess if there was a difference in interaction and critical thinking between 1, 2, or 3 student moderators who facilitated a forum discussion of an assignment in an online course. The same course was repeated over three years. Each year either 1, 2, or 3 students moderated. The analysis indicated more discussion per non-moderating student with the three student moderated group. Using SNA we found that there was only one noticeable difference among the three groups which was in the value of network centralization. Using critical thinking measures the three student moderator group scored higher in five of the eight critical thinking categories. Variations in instructor presence in the online courses may have influenced these findings.

Keywords: Constructivism; critical thinking; distance education; online learning; peer facilitators; social network analysis; student moderators; teacher education

Introduction

As online teaching and learning becomes more prominent it is important to consider the effectiveness of various pedagogical approaches. Many in the field (Chang & Smith, 2008; Legg, Adelman, Mueller, & Levitt, 2009; Murphy, Mahoney, Chen, Mendoza-Diaz, & Yang, 2005; Murphy & Rodriguez-Manzanares, 2009; Payne & Reinhart, 2008) concur that the constructivist approach is well suited to the online format. Within this pedagogic frame there are educators and researchers who have students moderate/facilitate online discussions (Baran & Correia, 2009; Barnett-Queen, Blair, & Merrick, 2005; Hylton, 2007; Murphy et al., 2005; Thormann, 2008). Examination of literature about student moderation, critical thinking, and the constructivist approach in online learning provides a foundation for this research in which we used SNA and Newman et al's (1995) critical thinking measures.

Literature Review

Student Moderation

Use of student moderators in online courses has been shown to generate more frequent and in-depth communication on the part of students (Hara, Bonk, & Angeli, 1998; Seo, 2007; Poole, 2000; Thormann, 2008). Thormann (2008) reported that student moderation enhances student ownership of the content, increases participation, and broadens the discussion.

In a study by Barnett-Queen, Blair, and Merrick (2005) student-led discussions were viewed as encouraging more student-to-student interaction by undergraduates. However, some students in this study viewed the sparseness of instructor participation negatively. Poole (2000) found that student moderator presence increased posting frequency and length of posts and that students' self-reports suggest peer moderation helps to build a sense of community and shared responsibility. Similarly, the online education model of Murphy et al. (2005) incorporates student facilitators to enhance the development of an online community. Moderation can be positive for the moderator's learning as well since the moderator processes content on the level normally reserved for the instructor (Hara et al., 1998; Poole, 2000).

Since instructor presence in online forums may dominate a discussion and cause students to curb participation, student moderation may encourage freer discussion and analysis of ideas (Seo, 2007). Tagg (1994) suggests that the differing power relationships of student-student and student-instructor can benefit learning when student moderators are used, in that instructors and student moderators perform

complementary functions to create a welcoming learning environment and generate discussions.

Student Moderator Role

In a study to examine student collaboration, Wang (2009) found that student group work encouraged individual accountability and positive interdependence, but that external supervision by an instructor or facilitator benefited group learning by facilitating organization, interpreting, and synthesizing of information and ideas. Wang's discussion of the role of external supervision aligns with potential tasks student moderators can perform.

Hara et al. (1998) conceptualize the moderator role as fulfilling "starter-wrapper" duties, which include encouraging conversation through questions and statements and synthesizing peer contribution. Since students may be reluctant to respond to a complex or unpopular topic, the moderator initiates and supports discussions. Student moderators can encourage group interaction by validating contributions and linking postings, which allows students to learn from the contributions of others (Hara et al., 1998; Winograd, 2000). According to Tagg (1994), teacher validation of students' contributions is experienced as having a greater impact than peer validation, although the latter was effective as well.

Cifuentes, Murphy, Segur, and Kodali's (1997) definition of student moderation goes beyond the starter-wrapper role to include intellectual, social, and organizational roles. Intellectually, moderators can encourage participation by formulating questions and commenting on student posts. Socially, moderators facilitate discussion and help to maintain a welcoming learning environment. As organizers, moderators set agendas and monitor requirements. Student moderators often fulfill the role of synthesizing discussion across student posts, so that the time-consuming task of cross-group communication does not fall entirely on the instructor or other students (Tagg, 1994; Thormann & Zimmerman, 2012).

Fidalgo and Thormann (2012) studied interaction from an SNA perspective in two online courses, one taught by an experienced online teacher and the other by a novice. Student moderation was one feature that the experienced instructor used to promote student interaction. These researchers found that there was greater inclusiveness and a higher degree of centrality (distribution of power) in the course with student moderators. Tagg (1994) supports the notion of shared responsibility and explains that student moderators aid in distributing the labor of facilitation. An instructor is typically responsible for these duties in face-to-face courses, but peer-based moderation may function well in online forums due to organizational and collaborative needs of online learning. Examples of these needs might be pulling together ideas from asynchronous postings, ameliorating the lack of audio-visual cues, and reading and responding to large numbers of posts (Hara et al., 1998; Tagg, 1994; Winograd, 2000). Student moderators can also aid in trouble-shooting technology issues (Cifuentes et al., 1997).

Additionally when all students are required to moderate during a course, students may participate fully to support their moderating classmates. This could be to ensure similar cooperation when they take the moderating role (Thormann & Zimmerman, 2012). Student participation can be influenced by discussion requirements. More participation can be seen when students are assessed weekly rather than earning a participation grade at the end of a semester (Fidalgo & Thormann, 2012). Thormann and Zimmerman (2012) indicate that most students responded positively to student moderation and instructors found it a useful tool for instruction and community building.

Critical Thinking

According to research about critical thinking in online learning, online forums offer the potential for critical thinking, problem solving, and active group participation similar to face-to-face classrooms (Al-Fadhli & Khalfan, 2009; Marra, Moore, & Klimczak, 2004). Aspects of online communication may lend themselves to deeper critical analysis in student posts compared to oral discourse, due to having the time to write, edit, and read others' posts and the reduction of social anxiety through relative anonymity compared to face-to-face settings (Maurino, 2006-2007). However, research studies (Gazi, 2011; Maurino, 2006-2007) suggest that the presence and competence of instructors or tutors remains important to ensure that online students engage with the material and each other in an active, substantive, and critical manner. Similarly, Fidalgo and Thormann (2012) found that online course structure, discussion guidelines, and requirements are important to ensure the quality, rate, and depth of student interaction.

Constructivism and Critical Thinking in Online Learning

Despite individual learners demonstrating facets of critical thinking, Newman et al. (1995) posit that critical thinking is generated from student-student or group interaction, whether online or face-to-face. In accordance with this, Fidalgo and Thormann (2012) equate shared reflection of content and discussion to be fundamental to critical discourse in online courses. In studies conducted by Akyol and Garrison (2007) and Gold (2001) they found that student collaboration in both online and blended courses engendered higher-order learning outcomes. The facilitation of critical thinking through the co-construction of knowledge aligns with the constructivist approach to learning. In this approach, student-student combined with student-instructor interaction facilitates critical thinking and problem solving (Gold, 2001; Ladyshewsky, 2006).

Constructivism is learner-centered and typically based on authentic learning, in which the problems and scenarios reflect students' lives (Gold, 2001; Carwile, 2007). Instead of the traditional 'sage on the stage' approach, in which instructors impart knowledge that learners passively take in, online constructivist learning requires that students engage critically with new information through problem solving, analysis, and the interpretation of new information through prior beliefs, experiences, and perspectives (Ladyshewsky, 2006; Murphy & Rodriguez-Manzanares, 2009). The instructor's role in

constructivist learning takes a de-centered position as a facilitator who guides learners to engage critically with the material and collaborate with other students, and rarely imparts knowledge directly (Carwile, 2007). Research by Gold (2001) found that a constructivist approach increases interaction between students in online settings. Since individual perspectives cause interpretation of the same information differently, constructivist learners benefit from student-student interaction and the ability to demonstrate learning through shared posts (Gold, 2001; Ladyshweky, 2006). In doing this the learners may form a more cohesive understanding of information.

Statement of Purpose

The research cited establishes that having students serve as moderators for discussions in online courses can be advantageous for learning. In addition, there is evidence that critical thinking skills can be exercised well in constructivist learner-centered online courses involving peer interaction. But there is not agreement as to how student moderation should be implemented to promote interaction and critical thinking in online courses. The authors have used various strategies including having one, two, and three student moderators (SM).

This study may help provide direction as to how and if the number of SM makes a difference. SNA was used to measure interactions while Newman et al.'s (1995) measures were used for critical thinking. This study will hopefully also start a discussion about other aspects of SM implementation and promotion of critical thinking in online course discourse.

Methods

Setting

The course discussions that are analyzed are from three separate graduate level courses about technology and special education. The analysis focuses on the same assignment in three different course sections. The assignment was in the same ordinal position in each section. Courses were held in the fall of 2007, 2008, and 2010 with 13, 9, and 13 students enrolled in the courses, respectively.

In the assignment, non-moderating students selected a web accessibility tool to evaluate five pages of their school or district's Web site. After posting their report in 2010 each student was required to read at least one classmate's report. They were asked to compare and contrast their report with others, ask at least one question, and then respond to all comments and questions about their own report. In 2007 and 2008

although follow up was not required for this assignment almost all previous assignments in these two years (and 2010) required this follow up. Students participated fully in 2007 and 2008. In all years each group contributed at least the "required" number of responses without being a requisite.

The moderator directions were the same for all three sections. Each student was asked to select a week/topic to moderate. Moderators were not required to write or post a report for the assignment they moderated but were directed to be familiar with the assignment content.

The moderator(s) role was as follows:

a. Focus the discussion on course content and encourage new ideas;

b. Initiate further discussion through questions or observations;

c. Find unifying threads and communicate them;

d. Draw attention to opposing perspectives, different directions, or conflicting opinions and encourage debates;

e. Summarize and post a report about the discussion by restating the ideas and controversies, as well as clarifying misconceptions. The summary serves to pull ideas together.

Students took the moderator role after the third assignment was completed. This was done so students could observe the instructor moderate. When modeling moderation, the instructor attempted to engage students to use critical thinking skills. In addition, the instructor stayed on topic, responded to each student's assignment, and extended knowledge.

The constructivist teaching approach encouraged student participation and critical thinking by giving students time to engage with each other before the instructor entered the conversation, especially once student moderators were in charge. In the past the instructor found that if she entered the conversation too early it curtailed student contributions.

The analysis of Web sites in the assignment studied was used as a jumping off point for the discussions. In addition, class structure included *Coffee Shop* and *Teacher's Room* forums, where students could discuss topics that did not relate directly to the weekly assignment. This seemed to help students write focused contributions and the requirements asked that contributions to discussions be substantive.

Participants

The instructor, who has taught online courses since 1996, was the same for the three courses. Students were nationwide K-12 educators in the United States, most of whom were earning a master's degree in Technology in Education online. This course ranged from being the fifth course in the online program for some students to the eleventh and final course for others.

Ethical Considerations

The instructor did not contemplate conducting this research until a year after the last class was completed. Thus students were not involved in an experimental design. No student names or identifying information is revealed. In addition, students' contributions in the discussion were not included in this study.

Student Postings Data Analysis Procedure

A statistical comparison among the three forms of student moderation was performed on the participant student (non-moderator) posting frequencies. A single factor ANOVA was used to compare the effect of a variable number of student moderators on the participation rate of the other students enrolled in the course, as measured by the number of postings to course discussion forums.

Social Network Data Analysis Procedures

SNAPP (Bakharia, Heathcote, & Dawson, 2009) produced the matrices for SNA. In addition, SNA using UCINET software (Borgatti, Everett, & Freeman, 1999) was used to do in-depth analysis of network structures and participant interactions. The main indices calculated were cohesion, centrality and centralization, betweenness, and closeness.

SNA is defined by Breiger (2004) as "the disciplined inquiry into the patterning of relations among social actors, as well as the patterning of relationships among actors at different levels of analysis (such as persons and groups)" (p. 507). Reinforcing this idea, Scott (2000) adds that "Social network analysis emerged as a set of methods for the analysis of social structures, methods that specifically allow an investigation of the relational aspects of these structures" (p. 38). SNA describes interactions using numerical data. In an effort to gain a deeper understanding of the SNA measures, text analysis was done.

Critical Thinking Data Analysis Procedures

The text analysis method consisted of reading and coding student interactions and doing a content analysis using Newman et al.'s (1995) 10 critical thinking categories. These coding categories have been used by others (Wickersham & Dooley, 2006), compared with other coding systems (Marra et al., 2004), and found to be acceptable to

examine students' critical thinking in online communications. Other critical thinking measures were considered (Gunawardena, Lowe, & Anderson, 1997; Hara et al., 1998; Seo, 2007), but Newman et al.'s measures appeared to be more widely used and were more amenable to interpretation.

In their content analysis method for critical thinking of online discussion threads, Newman et al. (1995) divide critical thinking into multiple categories, graded positively or negatively depending on the use of the facets of critical thinking. These categories are relevancy, importance, new ideas or outside knowledge, clearing ambiguities, linking ideas, facts and notions, justification, critical assessment of contributions, practical utility of ideas, and widening the discussion. Although the precise definition of critical thinking and categories in online learning settings can vary between fields of study and cultural contexts (Woo & Wang, 2009), Newman et al.'s method achieves generalizability due to its thorough scope and combination of previous, accepted models of analysis for critical thinking, such as Henri's (1991) cognitive reasoning skills and Garrison's (1992) five-stage critical thinking model (Wickersham & Dooley, 2006).

Two of the researchers coded the data. Training was done by first discussing the 10 categories to establish a shared understanding. For practice, we coded student postings in other forums together followed by coding non-research postings independently. Once some inter-rater reliability was reached each student's threaded discussion was copied into a text document and the researchers coded the postings separately. One point was given for each occurrence within a category. There were 31 student postings for the 1 SM group, 56 for the 2 SM, and 52 for the 3 SM. The length of each posting was typically from 1 to 10 sentences. Thus the *y* axis in Figures 5 and 6 represents the number of each category occurrence. Afterwards, each posting was reviewed to check for rating agreement.

Newman et al.'s categories of I (importance) and R (relevance) were difficult to distinguish. Thus we decided to eliminate I. We also found overlap between C (critical assessment) and J (justification) and L (linking ideas, interpretation), but we came to a consensus of how to interpret each category in our final coding discussions.

The ratio and data analysis procedures that Newman et al. used were not applicable to this study due to a minimal number of negative critical thinking scores. The course guidelines required that students post substantive information, and there were specific outlets for socializing.

Although we changed the way the analysis of interactions was calculated, the categories were still valuable to assess critical thinking between different treatment groups. We compared the differences in the types and quantities of categories between groups. We did not code the instructor's postings since we were not investigating instructor critical thinking. In order to compare directly the results of the group of 9 students with those of the two groups of 13 students, we scaled the numbers from the group of 9 by a factor of 13/9 [1.44].

A chi square test of independence was applied to the resulting data of critical thinking category postings to determine whether the frequency and/or pattern of responses was significantly different. Each of the three student moderator intervention groups was compared with the other two in paired fashion.

Findings

Number of Posts

The 3 SM group had the greatest average number of postings but the lowest average number of moderator postings. The 1 and 2 SM groups had approximately the same average numbers for SM postings and non-moderator postings.

Table 1

Numeric Participation and Average Number of Postings

# of Student Moderators	3	2	1
Year	Fall 2010	Fall 2007	Fall 2008
# of Total postings	106	78	46
# of Instructor postings	24	8	7
# Student Moderator postings	10	14	8
# Student Non-Moderator postings	72	56	31
# of Student Non-Moderator participants	10	11	8
Average # of Student Non-Moderator postings	7.20	5.09	3.88
Average # of Student Moderator postings	3.33	7.00	8.00

Figures 1, 2, and 3 indicate the number of interactions by participants in each group.

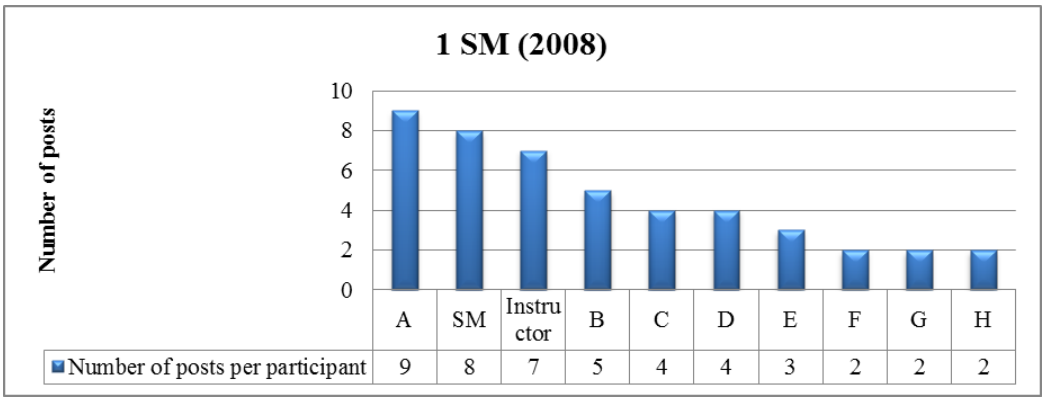

Figure 1. Number of posts per participant of 1 SM forum.

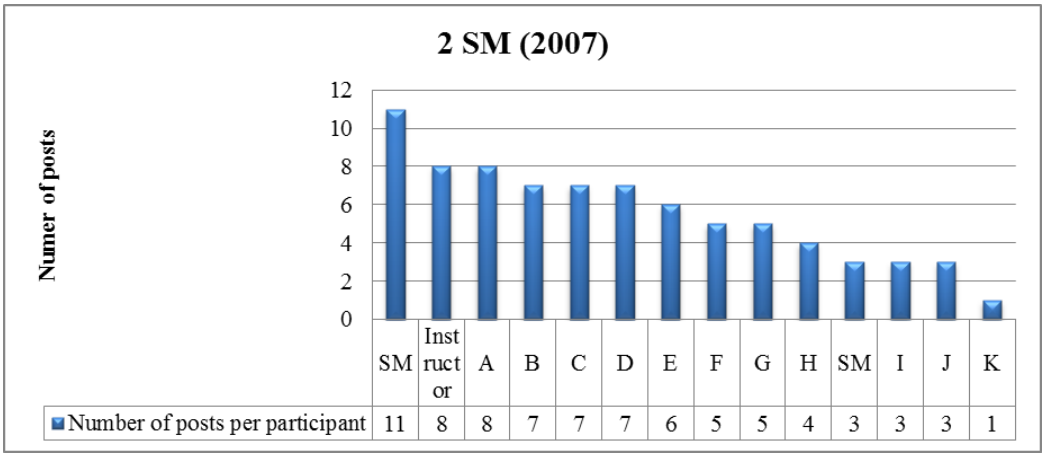

Figure 2. Number of posts per participant of 2 SM forum.

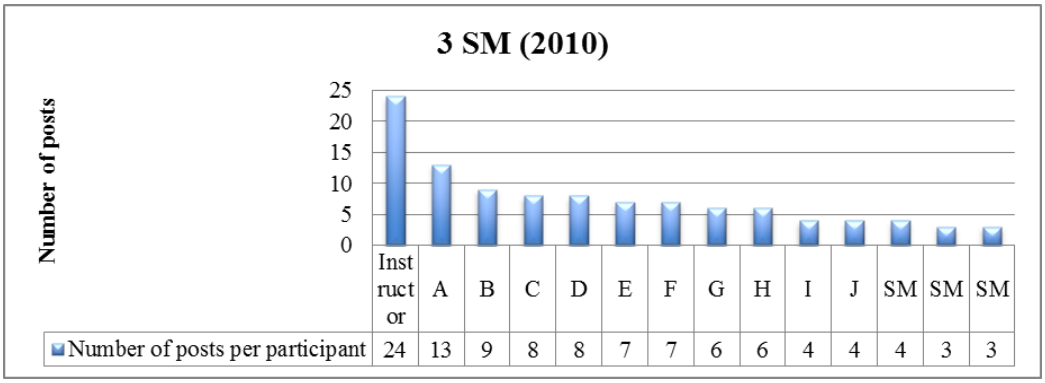

Figure 3. Number of posts per participant of 3 SM forum.

The 3 SM group had the greatest average number of participant student postings; the 1 and 2 SM groups had significantly less as measured by a single factor (course SM size) ANOVA (Table 3). With an *F*-value of 4.574, the differences in the number of student postings between the different SM size groups was significant at the $p = 0.02$ level.

Table 2

Single Factor ANOVA on Number of Student Postings by SM Size

ANOVA

Source of Variation	SS	*df*	MS	*F*	*P*-value
Between Groups	51.857	2	25.929	4.574	0.020
Within Groups	147.384	26	5.669		
Total	199.241	28			

Paired class examination of student non-moderator participation with the t-test indicates that the significance in performance occurs between two and three student moderators. Table 3 shows that there is no significant difference in student non-moderator participation between the one and two student moderated classes ($p = 0.13$). But both one and two student moderated classes experienced significantly lower posting rates than the class with three student moderators (Table 4 $p = 0.01$ and Table 5 $p = 0.03$, respectively).

Table 3

Student Non-Moderator Participation

t-Test: 1 vs 2 Student Moderators

# of Student Moderators	1 SM	2 SM
Mean	3.88	5.09
Variance	5.55	4.69
Number Non-Moderator Students	8	11
df	17	
t Stat	-1.16	
p	0.13	

Table 4

Student Non-Moderator Participation

t-Test: 1 vs 3 Student Moderators		
# of Student Moderators	1 SM	3 SM
Mean	3.88	7.20
Variance	5.55	6.84
Number Non-Moderator Students	8	10
df	16	
t Stat	-2.80	
p	0.01	

Table 5

Student Non-Moderator Participation

t-Test: 2 vs 3 Student Moderators		
# of Student Moderators	2 SM	3 SM
Mean	5.09	7.20
Variance	4.69	6.84
Number Non-Moderator Students	11	10
df	19	
t Stat	-2.02	
p	0.03	

With respect to the participation of the student moderators (SM), we note that in the 3 SM group, moderator participation was low in comparison to others. In the 2 SM group, one moderator's number of postings was high and one low. In the 1 SM group the moderator had a comparable number of interactions but others in the group did not post with great frequency. The instructor was more than four times as active as the moderators in the 3 SM group. In the 1 and 2 SM groups the instructor's participation was a little less than one of the moderators.

SNA Relational Aspects of Networks

Through the use of UCINET software we did the analysis of the main SNA indices. Most of the main indices did not show any significant difference between the groups moderated by one, two, and three students. We decided to present only the indices in which differences were found between the three groups.

Centralization

"A graph centralization measure is an expression of how tightly the graph is organized around its most central point" (Scott, 2000, p. 66). Centralization is a special condition in which an actor plays a central role by being connected to all other actors, all of whom need to go through him or her to connect to each other (Alejandro & Norman, 2005).

The values of centralization are shown in Figure 4. The most active actors (focal points) from the three networks were not always student moderators. In the 2 SM group two students acted as moderators but only one stood out. In the 3 SM course all student moderators participated equally. The 1 SM course had the highest value of network centralization which means that the student in charge of moderating the forum played a central role connecting the other participants, unlike the other two courses. Despite these students' values, the instructor was also a focal point in the three courses, sharing higher values of centralization with some students.

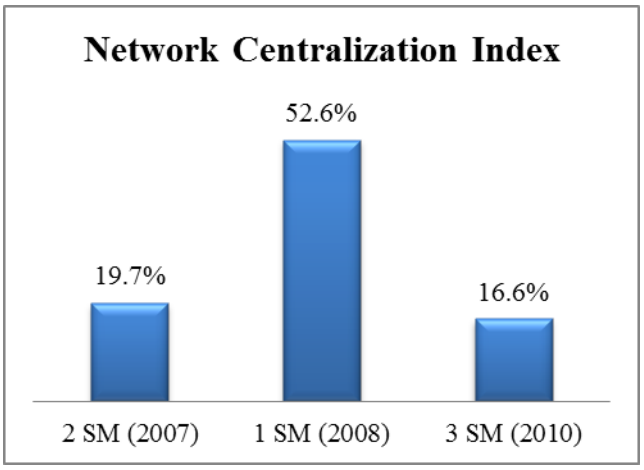

Figure 4. Network centralization index of 1, 2, and 3 SM forums.

Critical Thinking

On measures of critical thinking, paired chi square tests of independence show that the frequency of postings by critical thinking category by the 1 SM group is significantly lower than either of the 2 SM and 3 SM groups. The 2 SM and 3 SM groups did not show a statistically significant difference, even though the number of postings of the 3 SM group was noticeably greater.

Table 6

Chi Square of Critical Thinking Postings by SM Size

Chi Square

Group	2 SM	3 SM
1 SM	0.003	0.002
2 SM	-	0.313

The relevance rating was very high for all groups with the 3 SM group having about 25% more relevant postings than the other groups. Practical utility, outside knowledge/experience, and width of understanding were the most frequent types of critical thinking content and provided the differences that appeared between and among the three levels of student moderation. This was followed by critical assessment and linking ideas. The topic, type of student, and the questions and comments from the student moderators and instructor may have influenced this type of interaction. In almost all categories the 3 SM rate was higher than the others, followed by the 2 SM. The 1 SM group seemed to have posted fewer critical thinking postings than the other groups. In only two categories did any of the groups show negative scores, which were critical assessment and linking ideas. However, the number of postings in these categories was miniscule in comparison to the other positive postings. This was possibly due to course requirements.

Table 7

Critical Thinking Occurrences with One, Two, and Three Student Moderators

Critical Thinking Categories	1 Moderator (2008)	2 Moderator (2007)	3 Moderator (2010)
Justification+	32	33	24
Practical utility+	37	49	59
Outside knowledge/experience +	29	58	72
Critical assessment+	3	16	24
Width of understanding+	29	25	44
New information+	3	3	4
Linking ideas+	1	13	8
Ambiguities+	6	1	2
Relevance+	111	137	201
Justification -			
Practical utility -			
Outside knowledge/experience -			
Critical assessment -	10	12	20
Width of understanding -			
New information -			1
Linking ideas -	1		3
Ambiguities -			
Relevance -			

In summary, in five of the eight positive critical thinking categories the 3 SM group had a higher score followed by the 2 and 1 SM, respectively. Figure 3 shows that the instructor participated more than four times as much as the 3 SMs. This may have influenced the critical thinking in the discussion.

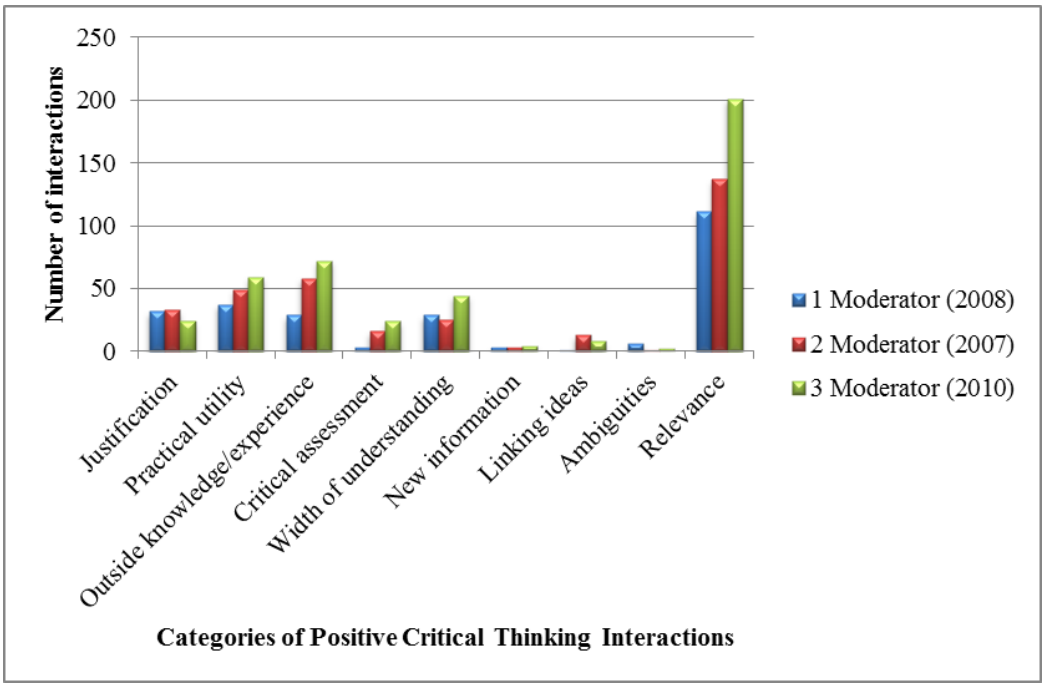

Figure 5. Number (*y* axis) and positive critical thinking interactions (*x* axis) of 1, 2, and 3 SM groups.

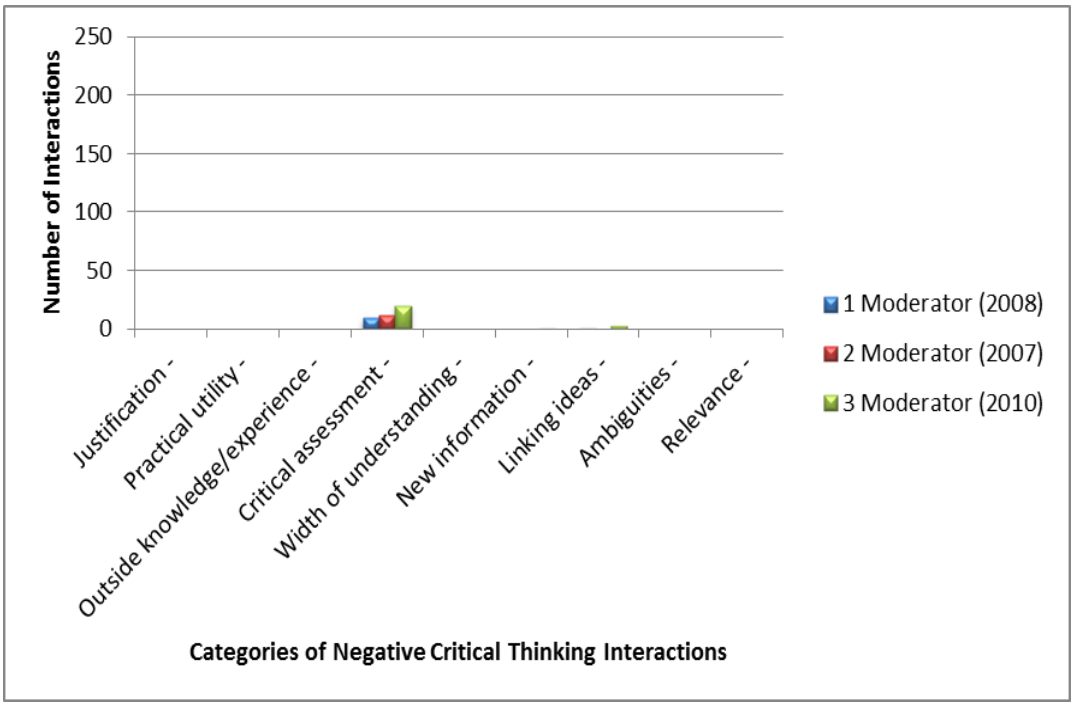

Figure 6. Number (*y* axis) and negative critical thinking interactions (*x* axis) of 1, 2, and 3 SM groups.

Implications for SNA

The presence of 1, 2, or 3 SM did not affect most measures of SNA. With the exception of centralization (how tightly the group is organized around its most central point), the measures of cohesion, centrality, betweenness centrality, and closeness had negligible variance.

The 1 SM network had a higher value of centralization (52.6%) which means that the network members were more tightly organized around focal points (Student A, the SM, and the instructor). This may have been due to the interaction dynamics promoted by having one SM.

The expected focal points were not exclusively the SM. In all three courses the instructor had a prominent role and in the 3 SM course another student competed with SM values. Despite the different centralization values, network cohesion (density) had similar values, which may indicate that although the focal points had higher centralization values (especially in 1 SM forum) the speed of dissemination of information among actors and the extent that those focal points had a high degree of social capital and/or social constraint was not very different.

Although the presence of student moderators did not greatly affect most SNA measures, the number of student moderators was positively aligned with average non-moderator postings. Average non-moderator posts increased with the number of student moderators, such that the 1 SM group had 4.2, the 2 SM had 5.3, and the 3 SM had 8.7. Additionally, the average number of moderator postings was negatively matched with the number of student moderators: 1 SM had 8, 2 SM had 7, and 3 SM had 3.3. This suggests that as the number of moderators increased individual moderators contributed less.

Implication for Critical Thinking

Generally, as the number of moderators increased the positive measures of critical thinking increased. Interestingly, just as the number of student moderators increased positive measures of critical thinking, the same occurred for negative measures. The only two negative categories of critical thinking exhibited by students, critical assessment and linking ideas, increased with the number of student moderators. This suggests that with the increase of non-moderator posts comes an increase in the use of critical thinking overall with 1, 2, and 3 SM.

The influence of the instructor is worth investigating regarding average posting and measures of critical thinking. This study concurs with the research conducted by Tagg (1994), which indicates that shared responsibility between instructor and moderator is useful. The 3 SM group had the most average non-moderator postings, least average moderator postings, and the highest levels of critical thinking, but had the greatest instructor contribution as well. It is possible that the instructor had an influence on

non-moderator postings, measures of critical thinking, and moderator contribution. This analysis should be examined with the understanding that the only statistically significant difference in critical thinking was between the 1 SM group as compared to the 2 or 3 SM group.

Since the instructor and the moderators perform related tasks of encouraging in-depth and critical discussion, there are implications for moderator training that could make the moderator presence more dominant. The constructivist approach encourages critical thinking through a de-centered teacher presence that guides students to problem solve or engage in deep analysis through peer collaboration (Gold, 2001; Ladyshewsky, 2006). The role of the instructor and moderators, then, is to foster instead of lead discourse. In order to foster critical thinking, prompting questions guide students to elaborate critically within discussions. Moderators could be trained to ask prompting questions based on the Newman et al. (1995) facets of critical thinking. For example, student moderators could ask questions that link ideas from other posts, ask students to elaborate on or invent practical solutions to problems, or bring outside knowledge on a topic.

There are also implications of the efficiency of 2 SM over 3 SM for moderator contributions. Average moderator contributions fell with the increase of student moderators. This drop may signify that multiple moderators exerted less effort while fostering more interaction and critical thinking. The 2 and 3 SM groups had significantly more average non-moderator student postings than the 1 SM group. But the increased instructor presence begs one to consider other implications. For example, it is possible that the 3 SM group did not take as much initiative, possibly due to a poor or unclear distribution of responsibilities that ultimately defaulted to the instructor.

The 3 SM group distributed the work evenly in responding to posts. In the 2 SM group one person interacted with classmates and the other wrote the summary of the discussion, which was one of the SM tasks. In effect, the 2 SM interactions were similar to the 1 SM group in that one moderator was wholly responsible for the discussion, but the 1 SM had to write the summary as well.

The instructor participated later in the conversation in all three forums. The number of days that elapsed appears to have been dependent on when the SM started to engage with classmates. In the 1 SM group the SM started to make comments and ask questions the first and second day her classmates posted their assignments. Similarly the primary SM in the 2 SM group interacted the first, second, and third day. The 3 SM group got involved two days after assignments were posted and ceased interacting after their initial posting. The timing and intensity of the 1 and 2 SM groups allowed the instructor to let the SM take charge, thus the instructor did not join the discussion until the eighth and second day, respectively. However, in the 3 SM group the sparse facilitation of the SMs pushed the instructor to jump in to enhance the discussion on the fourth day, which was one day after the 3 SMs posted.

Relationship between SNA and Critical Thinking Measures

SNA measures show how group interaction changed depending on the number of SMs. Based on a number of SNA measures the only measure that showed a difference was centralization, which was highest in the 1 SM group. The critical thinking data show that as the number of SMs increased the critical thinking measures increased. There seems to be a reverse relationship between the centralization index and the critical thinking measures based on the number of SMs.

Limitations

This study was small in scope. The instructor was obliged to respond to individual course dynamics among students and thus there were differences in the way the instructor interacted, as in the case of the instructor's high participation in the 3 SM course.

Recommendations

To be able to establish with more certainty what is the optimal number of student moderators, additional research could be conducted in courses with different content, with larger classes, or in courses in which the instructor uses a different teaching approach.

The three courses were designed and taught without regard to the research that was conducted. Rather, the research emanated from the observation that the number of student moderators varied and an interest in finding out how this variation affected interaction and critical thinking. It could be useful to examine 1, 2, and 3 SM in a pre-planned environment to control instructor participation as well as other variables.

Our findings indicate that student moderating is beneficial in many ways and supports inclusiveness, power sharing, student ownership of discussions, and critical thinking. Another finding was that the instructor also played an active role, which was contingent on moderator participation. Although the number of student non-moderator postings and critical thinking measures increased with the number of student moderators, moderator participation was the lowest in the 3 SM group and resulted in high instructor participation.

Conclusion

Online interaction is crucial for learning (Anderson, 2003) and we are witnessing increasing interactivity between learners, instructors, and content via computer mediated communication (Rogers et al., 2009). The importance of understanding the mechanisms of online interaction is a central requirement for the success of online interaction processes and dynamics (Rogers et al.). Although the use of online forums is

a common way to promote interaction, instructors are not taking full advantage of these forums for distance education. Educators do not yet fully understand the dynamics of this medium. This study presents a small contribution to the available knowledge about online interactions.

There is evidence that use of student moderators supports student interaction, as shown in this and other research (Hara, Bonk, & Angeli, 1998; Seo, 2007; Thormann, 2008; Thormann & Zimmerman, 2012). Non-moderator posts and use of critical thinking increased when there were more moderators. The 3 SM group averaged about half the number of moderator posts compared to the 1 and 2 SM groups. The 3 SM group had significantly more non-moderator student postings than the 1 or 2 SM groups. Using six SNA measures we found only one sizable difference between 1, 2, and 3 SM groups which was in the measure of centralization. The 3 SM group dynamics resulted in increased instructor presence which may have had an impact on students' postings. More research is needed to determine the most effective use of student moderators in online courses.

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