EDUCATION Quarterly

Vol. 71 Issue 2
July-December 2013

Interaction effects and cognitive engagements of collaborative groups in online asynchronous discussions

Ferdinand B. Pitagan
University of the Philippines Diliman

ABSTRACT

This study analyzes the interaction in collaborative homogeneous and heterogeneous groups in an online asynchronous discussion, examines the level of cognitive engagements in each group and investigates the impact of these groups in interaction effects and cognitive engagements. The research employs the triangulation methodology for the content/transcript analysis and utilizes pre-service teachers as participants. Results show that collaborative homogeneous groups are more conducive for widespread interaction and higher cognitive engagements. An overview of the characteristics and implications of grouping strategies in a computer-assisted learning environment is likewise provided.

Keywords: *computer-assisted collaborative learning, grouping strategies, interaction effects, cognitive engagements*

Over the recent years, more and more academic institutions have adopted online learning in their curriculum and consequently extended or moved parts of their classroom interactions into online discussion platforms. An online forum is a social network where teachers and students continue or extend their discussions in course-related topics, thus providing a venue for online collaboration.

Computer-supported collaborative learning (CSCL) is a computer-based network system that supports group work in a common task and provides a shared interface for groups to work with (Ellis, Ginns & Piggott, 2009). Bodies of research provide support for the use of collaborative learning strategies when students use computer-based instruction (Klein& Doran, 1999):

- Understanding the group dynamics of graduate students working collaboratively to design WWW processes, Sherry, Tavalin and Billig (2001) confirm Scardamalia and Bereiter's (1994) hypothesis that the group becomes a self-reflective and self-organizing system where each member contributes her own expertise that results in learning of new skills and extending of the group knowledge base;
- There is substantial evidence that students working in groups can master science and mathematics materials better than students working alone (Slavin, 1990).
- The combination of group rewards and strategy training produces better outcomes than either one alone (Fantuzzo, King & Heller, 1992);
- CSCL could positively enhance learning, problem solving and other higher-order thinking (Johnston, 1996); and
- CSCL promotes active learning, involving students in doing things and thinking about the things they are doing (Bonwell & Eison, 1991).

Research in online interaction is often framed within the theoretical context of socio-cultural and collaborative learning theories (Zhu, 2006). A paper in Illinois Online Network (2007) states that online environment facilitates group communication making it ideal for the types of information exchange typical in forums. It posits that discussions can be more convenient and effective in the online environment than that of traditional classrooms because speakers, experts, and moderators can participate without having to travel and even be available at a particular time. It also argues that online discussion is a computer-mediated communication (CMC) social structure that can be designed to support online interpersonal and intrapersonal interaction.

One of the learning outcomes that can be revealed in online collaborative discussion is the level of cognitive engagement defined by Manzano and Kendall (2007) as a personality dimension that influences attitudes, values, and social interaction. For the online learning environment, Zhu (2006) clarifies cognitive engagement as the attention to related readings and the effort in analyzing and synthesizing readings demonstrated in discussion messages. Cognitive engagement involves seeking, interpreting, analyzing and summarizing information; critiquing and reasoning through various opinions and arguments; and making decisions. Although cognitive engagements cannot be observed online, it is discernible from discussion messages. Online collaborative discussion can engage students in either lower or higher level of cognitive engagement (Zhu, 2006). Hara, Bonk and Angeli (2000) theorize that electronic conferencing can be a tool to restructure student cognitive representations of information and foster student knowledge gains.

When CSCL-like online asynchronous discussion links people, institutions and knowledge, they become computer-supported networks that can reveal the types of interaction effects among its members. Interaction effect is the relationship among three or more variables and describes a situation in which the variables simultaneously influence one another (Dodge, 2003; Cox, 1984). In the field of distance education, Moore (1990) posits that interaction takes place in three dimensions: learner and content, learner and instructor, and learner and learner. The content of messages in an online discussion can reveal the depth of interaction effects among the participants. There are distinct social and emotional dimensions to all channels of communications (Tanner, 2005) and online discussion is no exception (Seepersad, 2004; Rovai, 2002; Walther, 1992).

Collaborative learning is based on the notions of socially shared cognition (Resnick, Levine & Teasley, 1991), of distributed cognition (Salmon, 2004) and of jointly accomplished performance (Pea, 1993). More often than not, collaborative learning employs a wide variety of grouping strategies, which Slavin *(1990)* refers to as a variety of structured classroom management techniques and grading systems. The focal point of collaborative learning is for students to learn within the context of a group. However, studies report different findings in the use of collaborative groupings. Many recommend heterogeneous groupings although there is considerable disagreement regarding the effects of such groupings on performance and attitudes of students with differing abilities (Klein & Doran, 1999). Some studies suggest that heterogeneous groupings assist students of all ability levels with the acquisition of knowledge (Slavin, 1990) and are more creative, likely to solve problems and are less likely to engage in *"groupthink"* (Spear, 1992). Others argue that for the optimal development and the maintenance of self-esteem, group members should have homogeneous cognitive abilities (Saleh, Lazonder & DeJong, 2005). Ballinger (2006) argues that homogeneous grouping is the best way to help a class experience the most successful learning and is usually consistent with the idea of accelerated learning.

Aims

Although the potential for CSCL to foster online collaboration is well recognized, its effect on learners' interaction and cognitive engagements is a continuous debate. There remains scant knowledge about interaction in online asynchronous discussion (Zhu, 2006). Hara, Bonk, and Angeli (2000) suggest that future studies should assess cognitive gains resulting from online discussion. There is also no common consensus about the effects of collaborative groups in these interactions effects and cognitive engagements. Thus, the study aimed to answer the following:

1. What types of interaction effects are present in collaborative groups in online asynchronous discussion?
2. What levels of cognitive engagements are present in collaborative groups in online asynchronous discussion?
3. What are the implications of collaborative groups in learners' interaction effects and cognitive engagements in online asynchronous discussion?

Methodology

Participants and Research Design

The study participants were 68 students enrolled in an educational technology course. This course aimed to analyze major issues in computer applications in education and discuss ways to integrate technology effectively and efficiently into the learning and teaching process. There were 65 (97%) undergraduate and 2 (3%) graduate students. They were composed of 57 (85%) female and 10 (15%) male participants.

The study employed a quasi-experiment design through the use of an intact group and was quantitative and descriptive in nature. The independent variable was the collaborative groups while the dependent variables were the interaction effects and cognitive engagements.

Research Instruments

Pretest as Basis for Collaborative Grouping. Self-efficacy is the persons' belief in their ability to produce desired results by their own actions (Bandura, 2003). Research suggests that there is a direct positive correlation between students' self-efficacy level and achievements in arithmetic (Bandura & Schunk, 1981) and performance motivation (Bandura & Cervone, 1986). The final measure of self-efficacy with online technologies and course content was identified as a significant predictor of performance (Lee & Witta, 2001).

The study adapted the use of the self-efficacy as pretest, which evaluated the students' self-efficacy in technology proficiency that included experience level and manner of learning and English language proficiency since it was the medium of instruction. However, because most participants were in their first year undergraduate course, it was the basic assumption that they have the same level of knowledge in terms of the course content. Therefore, a test in this area was assumed as unnecessary.

The self-efficacy in computer-mediated communication (CMC) proficiency pretest is based on the instrument developed by Miltiadou (2001), combined with the scale competencies of the General Self-Efficacy Scale of Jerusalem and Schwarzer (1995). The pretest in self-efficacy in English language proficiency employed Bloom's (1956) Taxonomy that utilized the formative and summative evaluation in educational objectives through the use of command verbs.

The first part of the pretest was the socio-demographic profiling but answering it was optional. The second part was the test of self-efficacy in CMC and English language divided into three competency areas: (1) Internet, (2) Asynchronous Online Interaction and (3) English Language. The phrase "***I can*** …." was used to reflect respondent self-efficacy. It was a Lickert-type survey sheet with the following ranking: (1) not true at all (very poor), (2) hardly true (poor), (3) moderately true (good) and (4) exactly true (excellent).

Online Facilitation Technique. An online instructor should solicit creation of knowledge by facilitating interaction (Berge, 1995). The e-facilitator such as the site owner can provide a fertile ground in which a community may grow then give some gentle guidance to help the group thrive (White, 2004). The term online facilitation (e-facilitation) is synonymous to e-moderation. Salmon's (2003, 2004)

Five Stage Model was utilized as the facilitating technique. The model summarized the roles and experiences that evolve between the teacher and the students in asynchronous interactive online activities.

Interaction Effects Framework. The study adapted the scheme formulated by Zhu (2006) for analyzing interaction in online discussion. It examined interaction through network size (NS), density (D), discussion topics (DT), average message per topic (AMPT), number of messages (NofM) and average word per message (AWPM). Furthermore, a graphical map of the interaction effects of each group was presented.

Cognitive Engagements Framework. Manzano and Kendall's (2007) General Form of Educational Objectives for Each Level of the New Taxonomy of Mental Operations (see Table 1 on the next page) was adapted as the basis for content analysis for cognitive engagements. Although based on Bloom's (1956) Taxonomy of cognitive engagements, it offered a new perspective and a more detailed analysis.

Data Collection and Analysis

Sorting Participants into Homogeneous or Heterogeneous Groups Using Pretest. The pilot testing and assessment of the pretest was performed by the use of an evaluation sheet for pretest questionnaire to clarify instructions and questions; appropriateness of the length of time; number of items; and overall presentation with an open-ended part for questions, comments and suggestions. The researcher conducted an interview to validate the randomly selected pilot testing respondents' (8 first year undergraduate and 2 graduate students) answers to this questionnaire. Revisions were undertaken based on their recommendations: (1) the original number of items should be minimized; (2) instructions should be made very clear; and (3) technical terms have to be made simple. The respondents found the presentation and layout clear, concise and well-organized. On average, the pretest took 5-10 minutes to accomplish. In addition, expert validation was solicited. The test for validity and reliability was conducted using the variability of the observation of the test scores by the use of analysis of variance (ANOVA), which resulted in 10% ($p = 0.0681$, $\propto = 0.10$). The pretest was administered to the research participants approximately two weeks before the online collaborative asynchronous discussion (OCAD). That same day, the consent for participation was also solicited.

The pretest divided the participants into experts and novices in CMC and English language proficiency. The expert students were those who scored above the mean score and the remaining students were marked as novices. The test scores were tabulated from the highest to the lowest. Purposive sampling was used for homogeneous groups by assigning the top scoring students first to a group. For heterogeneous groups, random sampling was employed by assigning a corresponding number to the remaining students and performing a draw lot. It was also predetermined that each group will consist of 10-13 members. A scheme was devised so that each student was assigned a code for blanket analysis: Group1 (S1-S12), Group2 (S13-S23), Group3 (S24-S33), Group4 (S34-S43), Group5 (S44-S55) and Group6 (S56-S68).
Homogeneous groups (Group 1 to 3) accounted for 49% while heterogeneous groups (Group 4 to 6) included the rest

Table 1. Educational Objectives for Each Level of the New Taxonomy of Mental Operations *(Adapted from Manzano and Kendall, 2007)*

Level 1 Retrieval	
Recognizing	Students recognize features of information but do not necessarily understand the structure of the knowledge or differentiate critical from noncritical components
Recalling	Students produce features of information but do not necessarily understand the structure of the knowledge or differentiate critical from noncritical
Executing	Students perform a procedure without significant error but do not necessarily understand how and why the procedure works
Level 2 Comprehension	
Integrating	Students identify the basic structure of knowledge and the critical as opposed to noncritical characteristics
Symbolizing	Students construct an accurate symbolic representation of the knowledge, differentiating critical and noncritical components
Level 3 Analysis	
Matching	Students identify important similarities and differences between knowledge and components
Classifying	Students identify superordinate and subordinate categories related to knowledge
Analyzing errors	Students identify errors in the use and presentation of the knowledge
Generalizing	Students construct new generalizations or principles based on the knowledge
Specifying	Students identify specific applications or logical sequences of the knowledge
Level 4 Knowledge Utilization	
Decision Making	Students use the knowledge to make decisions or make decisions about the knowledge
Problem Solving	Students use the knowledge to solve problems or solve problems about the knowledge
Experimenting	Students use the knowledge to generate or test hypotheses or generate or test hypotheses about the knowledge
Investigating	Students use the knowledge to conduct investigations or conduct investigations about the knowledge
Level 5 Metacognition	
Examining Importance	Students identify how important the knowledge is to them and the reasoning underlying this perception
Examining Efficacy	Students identify their beliefs about their ability to improve competence or understanding relative to knowledge and the reasoning underlying this perception
Examining Emotional Response	Students identify emotional responses to knowledge and the reasons for these responses
Examining Motivation	Students identify their overall level of motivation to improve competence or understanding relative to knowledge and the reasons for this level of motivation

of the participants. Groups 3 and 4 have all female participants. The actual distribution is presented in Table 2.

Providing Facilitation. As part of facilitation, a face-to-face orientation of the participants was conducted in the week before the Online Collaborative Asynchronous Discussion (OCAD). The nature, objectives and requirements of the quasi-experiment were made available. The study accounted for 5% percent of the course grade. Moreover, questions and statements of clarifications by the students were answered. In the following week, the designation of participants into groups and the face-to-face orientation ensued. The start of OCAD was the following Monday.

Salmon's (2003, 2004) Five Stage Model was utilized as the online facilitating technique, however, due to time constraint, the processes were reduced and combined into three stages: Stage A (Access and Motivation), Stage B (Online Socialization and Information Exchange) and Stage C (Knowledge Construction and Development or Independence).

- Stage A (Day 1) was alloted for online orientation and all participants were requested to introduce themselves;
- Stage B (Days 2-6) was the start of making the group online technology portfolio;
- Stage C (Days 7-10) was the discussion about the future jobs of educational technologists; in addition, the last day (Day 10) was the submission of the final group work and individual reflection essay.

The researcher sent four messages using a new discussion topic (DT) to all participants: (1) self-introduction; (2) explanation of task at hand; (3) interventions; and (4) framework for the submission of the final project.

Performing the Content/Transcript Analysis. The 723 transcripts and reflection papers were printed a week after the end of the OCAD. The triangulation approach involved the researcher and 2 graduate students in the field of education. Each of them were given the printed online transcripts and took approximately 4 months to separately assign the cognitive engagement levels and interaction effects. After this, they met face-to-face to compare and agree on the corresponding level of each message. Great efforts were made to avoid subjectivity and reach objectivity. The study combined the Network Properties (Zhu, 2006) to examine interaction effects and New Taxonomy of Mental Operations

Table 2. Collaborative Groupings of Study Participants

Grouping Strategies	Homogeneous Groups			Heterogeneous Groups		
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Expert CMC Expert Language	18%			3%	9%	9%
Expert CMC Novice Language		16%		3%	3%	6%
Expert Language Novice CMC			15%	2%	1%	3%
Novice CMC Novice Language				7%	4%	1%
Total	18%	16%	15%	15%	17%	19%

(Manzano & Kendall, 2007) to identify cognitive engagements. The combined framework was the heart of the qualitative and quantitative data analysis of the study.

Analyzing Interaction Effects. The scheme for analyzing interaction in online discussion by Zhu (2006) was the basis for presenting and analyzing interaction in terms of quantifiable variables. The computations and definitions are as follows:

- Network size (NS) = number of participants in a certain group.
- Density (D) = (2 * a / NS) * (NS – 1). The formula for the computation of density is based on the Berkowitz Formula (1982), where a = the actual number of interaction (or actual number of messages) and n = the number of participants in the network (Scott, 2000).
- Discussion Topics (DT) = correspond to the actual discussion thread initiated either by the participants or instructors; it is also considered as one network within the entire online discussion network.
- Number of Messages (NofM) = the actual number of messages posted by the participants.
- Average Message per Topic (AMPDT) = the number of messages embedded in each discussion topic (DT)
- Average Word per Message (AWPM) = the actual number of words contained in a single message excluding punctuation marks and emoticons.

Furthermore, graphical representations of the interaction effects were presented for each group. The circle symbolized each participant in their his coded name; the line going in and out of each circle corresponded to the interaction that has taken place; the number beside the arrow tallied the actual number of messages one receives or sends and the DT represented the number of discussion topic that each of them initiated.

Analyzing Cognitive Engagements. The unit of analysis was per posted message following the footsteps of Garrison (1992) who argued on the lack of clarity and burdensome procedure in splitting units into smaller sections. In the case that there were several levels of cognitive engagements in a single message, it was agreed upon that the highest will be marked as the final level. There were several messages 30 (2.58%) that have been debated and appropriate adjustments have been made.

Analyzing Qualitative and Quantitative Data. The tabulated data from the interaction effects and cognitive engagements were coded into SPSS and analyzed from various angles for quantitative analysis. The contents of the discussion transcripts and reflection papers form the basis for qualitative analysis.

Results and Discussions

The total 656 discussion messages were posted during the 10 days duration of the OCAD. In addition, all participants (67) submitted their reflection papers. There were 61 discussion topics initiated by the participants containing more than 99% of all the messages with an average word per message of 55.77. The researchers' messages were excluded in the data presentation and analysis.

Types of Interaction Effects in Collaborative Groups in Online Asynchronous Discussion

Interaction Effects in Quantifiable Variables. The density refers to the completeness and the extent where all possible relations are present and the number of lines in a network divided by the maximum number of participants when all the points are connected (Scott, 2000). The ideal density is 100% where all participants are interconnected with one another. The low density shows the absence or little interaction among the members of the network. The density in the pilot study ranged from 18% to 29%. The summary of the interaction is presented on Table 3.

In homogenous groups, the network size was the same except in Group 1. The density of these groups ranged from 23% (Group 1) and 22% (Group 3). Group 3 had the highest number of DT at 44% more than Group 1 but in contradiction had the lowest AMPDT. Group 3 had the most NofM and the most words in their postings (AWPM).

The differences, however, are more glaring in heterogeneous groups: Almost 35% in density (across the groups); 47% in DT (between groups 4 and 5); and 35% in AMPDT (between groups 4 and 5); 39% in NofM (between groups 5 and 6). It was only in AWPM that the 5% difference could be negligible. In all of these comparisons, Group 6 emerged as having better participants, and compared with the homogeneous groups, it had the highest values except in NofM.

Interaction Map. According to Zhu (2006), interaction effects can be presented either by a star (mostly centralized in minimal number of participants) or an interconnected web (multiple point centrality).

A star interaction is a type of network characterized by minimal interaction that could lead to little inter-personal relationships among the members. Heterogeneous Group 4 and Heterogeneous Group 5 are considered having a star interaction effect (see Figures 1 and 2).

Table 3. Summary of Interaction Effects in Collaborative Groups

Interaction Effects Overview	Homogeneous Groups			Heterogeneous Groups		
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Network Size (NS)	12	10	10	10	12	13
Density (D)	23%	21%	22%	18%	19%	29%
Discussion Topic (DT)	8	12	18	10	7	13
Average Message per Discussion Topic (AMPDT)	11.45	7.63	6.05	11.23	10.3	15.74
Number of Messages (NofM)	108	80	114	127	74	120
Average Word Per Message (AWPM)	50.78	45.6	56.34	60.41	59.21	62.3

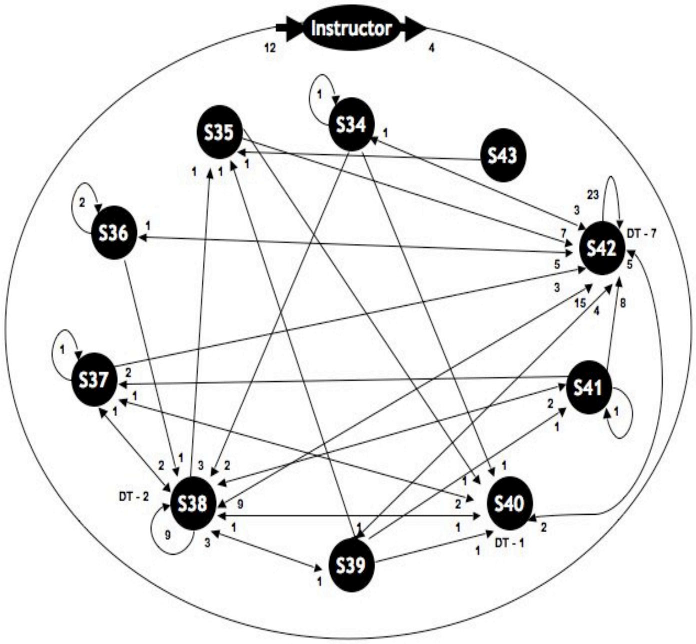

Figure 1. **Star Interaction Map of Heterogeneous Group 4**

— represents the connection among participants
→ actual count of posted messages
DT – the number of discussion topic/s initiated by the participant
← actual count of the received messages

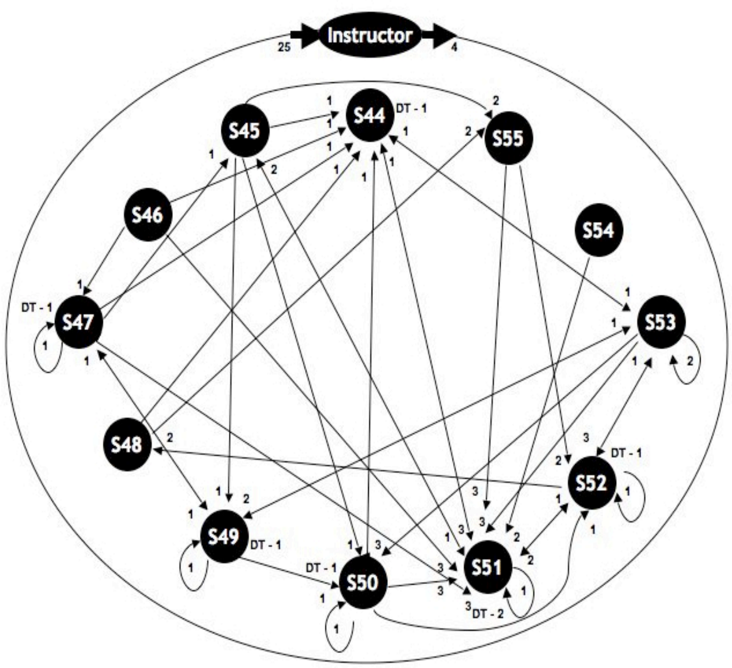

Figure 2. **Star Interaction Map of Heterogeneous Group 5**

— represents the connection among participants
→ actual count of posted messages
DT – the number of discussion topic/s initiated by the participant
← actual count of the received messages

Heterogeneous Group 4 (Figure 1) had 10 (15%) members with an interaction density of 18% and 14 DT with 109 messages containing 11.23 average message topic with AWPM = 60.41. Three (3) of all participants (S38, S40, S42) initiated their own discussion topics; however, most of the discussions involved only two (S38, S42), and all other participants had little or no interaction at all. The discussion was dominated by S42 who initiated 50% of DT with titles that reflected the domains of the task and accounted for more than 65% of message exchanges. There was also a high level of interaction between S42 and S38 while the rest of the group members remained dormant. In addition, all members responded to the posting of the researcher.

Heterogeneous Group 5 (Figure 2) was also considered to have a star interaction effect having 12 (17%) participants with an interaction density of 19%, 103 NofM, and 10 DT (lowest in all groups) containing 10.3 AMPDT with AWPM of 59.21. Although five (5) of the participants (S47, S49, S50, S51, and S52) initiated their own DT, most of the discussions involved S51, and all other participants had little or no interaction at all. It was also noteworthy that most of the participants responded to her (S51) posting while remaining silent with other group members. The message exchanges between her and most of the group members accounted for almost 50% of the interaction that took place. She had taken the *"star"* position and although she contributed greatly to the fulfillment of the group task, it did not encourage multiple interactions with all the members of the group. She was also widely acknowledged as the leader of the group. Moreover, there were 28 (25%) messages from the participants to the researcher.

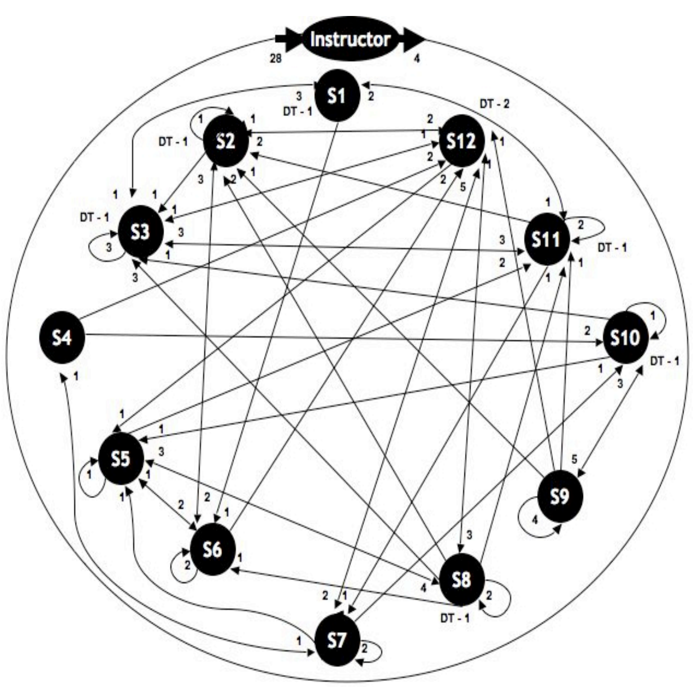

Figure 3. **Interconnected Web Interaction Map of Homogeneous Group 1**

— represents the connection among participants
→ actual count of posted messages
DT – the number of discussion topic/s initiated by the participant
the actual count of the received messages

Homogeneous Groups 1, 2 and 3 and Heterogeneous Group 6 were considered to have interconnected web interaction effects. With this type of interaction, participants were more likely to exchange ideas and collaborate in the fulfillment of the task at hand. For instance, most of the participants have initiated their own DT (average = 40%) with eager, prompt, and lengthy replies from most of the other members (AWPM = 57.11%).

Homogeneous Group 1 (Figure 3) had 12 (18%) participants with 12 DT with 108 messages (NofM) containing 11.45 AMPDT with AWPM = 50.78. Seven (7) out of 12 participants initiated their own DT, and the discussions were widely spread among them. Although the interaction was not fully complete (there were members who did not post messages for others' DT), most of the members posted messages on each other's discussion threads. Most DT reflected the domains of the final paper created by different individuals. In addition, no one had taken the role of leader nor has one been the center of the discussion activities. Moreover, 28 (20%) of the messages were answers to the postings of the researcher.

Homogeneous Group 2 (Figure 4) had 10 (15%) participants with 13 DT with 110 messages (NofM) containing 7.63 AMPDT with AWPM = 45.6 (lowest among groups). Initially, S13 had been included in the grouping; however, she did not participate in the discussion because she opted to drop the course. She has, therefore, been excluded from the analysis of this research. The DT was created by 50% of the group members and most of discussions were widely spread among them. Moreover, the titles of the DT reflected the tasks of the group. It can

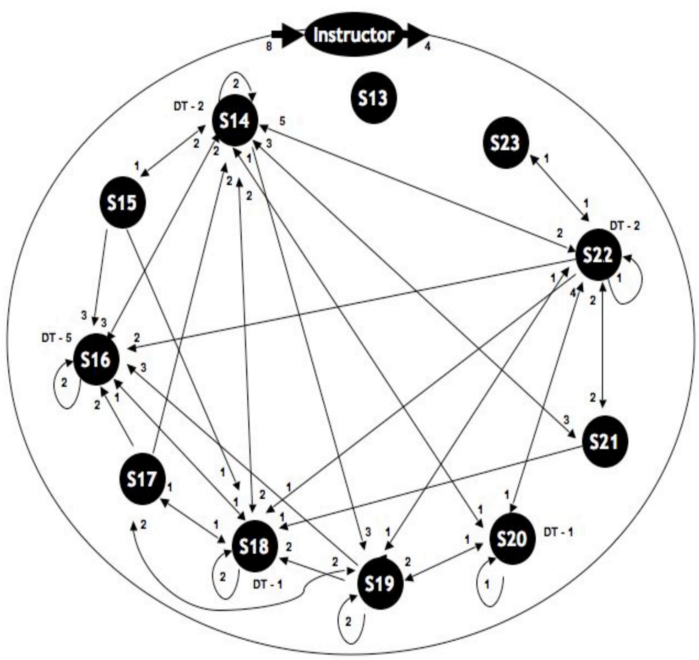

Figure 4. **Interconnected Web Interaction Map of Homogeneous Group 2**

— represents the connection among participants DT – the number of discussion topic/s initiated by the participant

→ actual count of posted messages ← actual count of the received messages

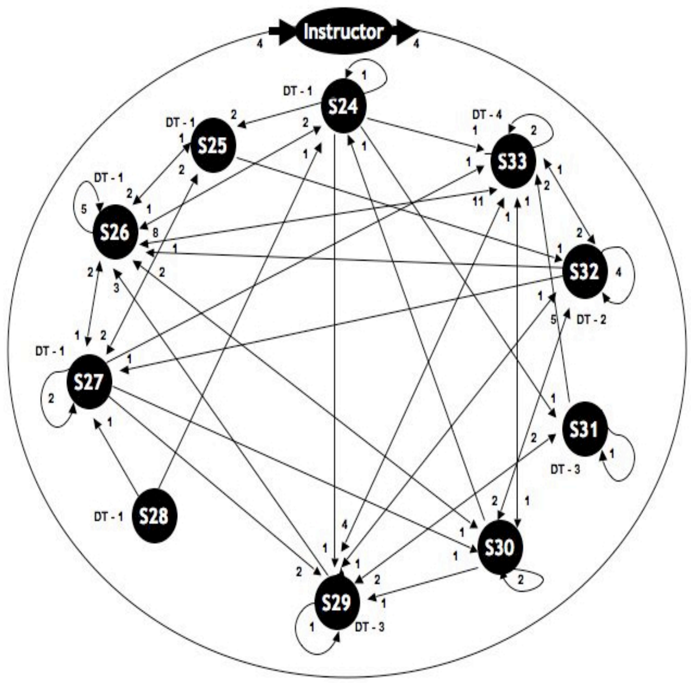

Figure 5. **Interconnected Web Interaction Map of Homogeneous Group 3**

— represents the connection between participants — DT – the amount of discussion topic/s the initiated by the participant

→ represents the posted messages with the actual count — ← represents the received messages with the actual count5

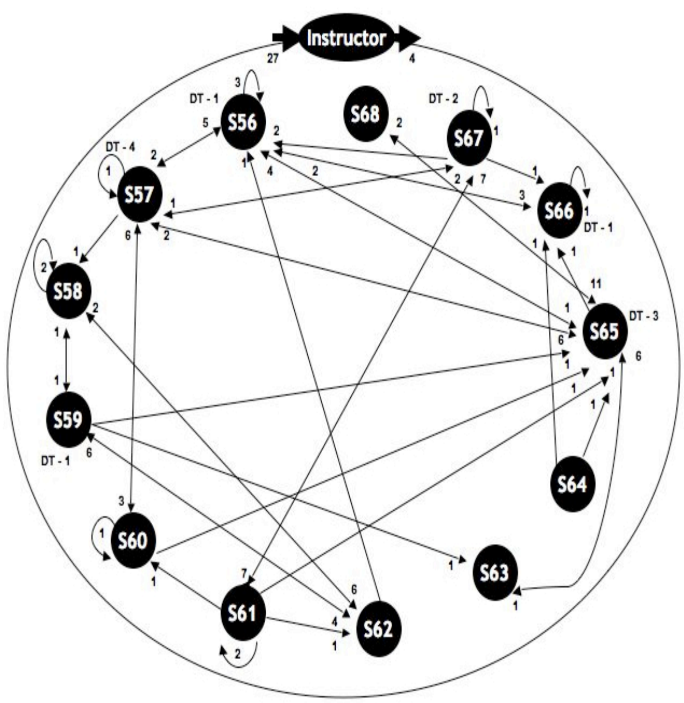

Figure 5. **Interconnected Web Interaction Map of Homogeneous Group 3**

— represents the connection between participants — DT – the amount of discussion topic/s the initiated by the participant

→ represents the posted messages with the actual count — ← represents the received messages with the actual count5 be seen that S14 and S16 have more interaction with most of the participants. Furthermore, 80% of the participants responded to the postings of the researcher.

Homogeneous Group 3 (Figure 5) had 10 (15%) participants with 22 DT with 121 messages (NofM) containing 6.05 AMPDT (lowest among groups) with AWPM = 56.34. All participants except one (S30) initiated their own DT reflecting the domains of the final paper. Most of the participants interacted with one another. Participants had been assigned into smaller groups to accomplish the task. There was a heightened exchange of messages between S26 and S33, but otherwise the postings were widespread. Although S28 had limited postings (only 2) and only 4 participants responded to the postings of the researcher, this did not affect the interaction of all group members as a whole.

Heterogeneous Group 6 (Figure 6) had 13 (19%) participants with 17 DT with 157 messages (NofM) containing 15.74 AMPDT (highest among groups) with AWPM = 62.3 (highest among groups). Six out of the 13 participants initiated multiple DT reflecting the domains of the final paper and the task they were willing to do. The message exchanges between participants were widespread and several group members had bi-directional interaction (i.e. S58–S62; S61–S67; S62–S59; S57–S60; S65-S68). This group was also characterized as having the most exchanges with all members. There were also multiple responses on the postings of the researcher. There were also postings that signified the acknowledgement of leadership.

Findings. It can be hypothesized that homogeneous groupings (Groups 1, 2, and 3) were more suited to facilitate well spread interaction in online collaborative asynchronous discussion (OCAD). Homogeneous groups provided a conducive environment for interaction. Learners realized that they belong to the same level, thereby facilitating the confidence and eagerness to participate more. It seemed that in homogeneous groups, most participants, if not all, have taken the initiative to encourage and cooperate with one another. The group members' postings reflected these sentiments:

"I like your idea…."
"I totally agree with you on this one…"
"Keep up the good work…"
"Job well done…"
"Thank you very much…"
"I really appreciate it…"

Moreover, homogeneous groups tended to divide the task at hand into smaller parts. Homogeneous group members created discussion threads that reflected the sections of the final paper they were working on and assigned themselves to the smaller groups. This process was done without the intervention of the researcher.

However, heterogeneous groupings seemed less conducive for widespread interaction. With the exception of Group 6, which had widespread interaction (highest in all groups), Groups 4 and 5 were not fully engaged in their discussions.

Furthermore, heterogeneous groups tended to recognize leadership within the group. Without the intervention of the researcher, someone assumed leadership in the discussion, as evidenced by members' messages which facilitated the exchanges, allocating tasks to group members, solicitation of outputs and submission of the final paper, as in the case of Groups 5 (S51) and 6 (S65). Most group members posted in their discussion threads and recognized the leadership as manifested in the following messages:

> *"Thank you for leading the group discussion…."*
> *"I really appreciate your guidance with this discussion…"*
> *"I think you are right, I think you can assign…"*

Furthermore, all groups were inclined to respond promptly to the researcher's messages. This could be attributed to the acknowledgement of authority within the OCAD. In this light, the researcher posted specific instructions, guides, and references and answered questions promptly.

Levels of Cognitive Engagements in Collaborative Groups in Online Asynchronous Discussion

Almost all homogeneous and heterogeneous groups tended to go through all the levels of cognitive engagements in a sequential phase except in metacognition and self system-thinking (Table 4). However, since the cognitive engagements were presented in a group format, the levels cannot be associated with all participants. A concrete example is in Heterogeneous Groups 5 and 6, where S51 and S65 dominated the group discussions and accounted for almost 50% of the groups' transcript summary.

All collaborative groups have utilized higher cognitive levels (Table 4) specifically metacognition level (average - 35%). Metacognition is the knowledge or awareness of one's cognitive processes and the efficient use of this self-awareness to self-regulate these cognitive processes (Shimamura, 2000). Homogeneous Group 1 had the highest level (45%) while Heterogeneous Group 4 had the lowest (27%). This may be due to the fact that group 1 contained the students who scored highest in the pretest and group 4 with most of the lowest scorers (7% of novice participants). Homogeneous Groups 2 and 3 and Heterogeneous Group 5 had 36%, 31%, 35% metacognition levels, respectively.

Table 4. Summary of Cognitive Engagements in Collaborative Groups

Cognitive Engagements	Homogeneous Groups			Heterogeneous Groups		
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Level 1: Retrieval	8%	4%	3%	5%	3%	4%
Level 2: Comprehension	8%	10%	14%	9%	13%	8%
Level 3: Analysis	9%	15%	25%	22%	17%	18%
Level 4: Knowledge Utilization	13%	19%	14%	24%	18%	17%
Level 5: Metacognition	45%	36%	31%	27%	35%	37%
Level 6: Self-System Thinking	17%	16%	13%	13%	14%	16%

Having a high metacognition level meant that participants established the goals, monitored the execution, and determined the extent of clarity and accuracy of the knowledge they are to achieve. The goals were evident in the discussion transcript through creating discussions thread that reflected the task at hand and posted points of clarifications.

Both collaborative groupings also utilized the highest cognitive engagement level, which is self-system thinking, with an average of 18% (Table 4). Self-system thinking is defined as students examining the importance of knowledge, beliefs in their ability, emotional responses, and overall motivation to improve competence (Manzano & Kendall, 2007). Homogeneous Group 1 had the highest self-system thinking level (17%), Homogeneous Group 2 and Heterogeneous Group 6 had 16%, Heterogeneous Group 5 had 14% and Homogeneous Group 4 and Heterogeneous Group 5 both had 13%. Most of the participants identified the importance of a particular knowledge and demonstrated ability to improve competence. Moreover, with the use of visual cues, participants were able to show emotional responses to knowledge. It ranged from smiling, frowning, thinking, approving, and laughing emoticons that conveyed feelings at a particular phase of the OCAD.

Findings. The results of the study showed that most of the participants went beyond the information gathering stage. Retrieval and comprehension levels had the lowest averages, 5% and 8% respectively. As mentioned, metacognition had the highest score across all the groups. In addition, both collaborative groups were suited for self-system thinking.

It seemed that homogeneous groups were more analytical. It was also safe to theorize that most of the participants contributed to the levels of the group cognitive engagements. Homogeneous groups seemed to be more conducive to facilitate intellectual engagements.

Heterogeneous groups tended to have more widespread levels of cognitive engagements. However, since there seemed to be a "leader" and instances when one participant's level contributes to almost 50% of the group's cognitive levels, it can be surmised that not all participants were exhibiting intellectual engagements.

In both collaborative groups, proficiency in CMC and English language played a crucial role in the process of cognitive engagements of the whole group as evidenced in Homogeneous Group 1 where all participants scored highest in the pretest. This finding was also consistent with Heterogeneous Groups 5 and 6, where S51 and S65 dominated the discussion. They were amongst the highest in the pretest. Homogeneously grouping expert students guaranteed higher-order thinking evident in Homogeneous Group 1. Suffice it to say, homogeneously grouping novice learners is not conducive to facilitate high cognitive engagements. And having a large percentage of novice learners in a heterogeneous group will not also facilitate higher-order thinking as evidenced in Heterogeneous Group 4 where almost 50% of the group members scored lowest in the pretest.

Implications of Collaborative Groupings in Learners' Interaction Effects and Cognitive Engagements

There were positive significant relationships between interaction with

Table 5. Correlation of Interaction Effects and Cognitive Engagements in Homogeneous Groups						
Cognitive Engagements	**NS**	**Density**	**DT**	**AMPT**	**NW**	**AWPM**
Retrieval	0.36*	0.36*	0.36*	0.38*	0.36*	0.38*
Comprehension	-0.18	-0.12	0.20	0.22	-0.30	0.36*
Analysis	-0.17	0.49*	0.36*	0.36*	0.38*	0.47*
Knowledge Utilization	-0.16	0.15	-0.15	0.12	0.17	-0.18
Metacognition	0.06	0.45*	0.45*	0.36*	0.36*	0.36*

(* $p < 0.05$)

Table 6. Correlation of Interaction Effects and Cognitive Engagements in Heterogeneous Groups						
Cognitive Engagements	**NS**	**Density**	**DT**	**AMPT**	**NW**	**AWPM**
Retrieval	0.18	0.22	-0.11	0.20	0.23	-0.22
Comprehension	-0.24	-0.12	0.20	-0.27	-0.20	0.36*
Analysis	-0.15	0.21	0.21	-0.18	0.22	0.10
Knowledge Utilization	-0.16	0.14	-0.21	0.17	0.19	-0.23
Metacognition	0.10	-0.23	-0.27	0.25	-0.25	0.29

(* $p < 0.05$)

retrieval, analysis, and metacognition in homogeneous groups (see Table 5). The density (D), number of discussion topics (DT), average message per topic (AMPT), number of messages (NofM) and average word per message (AWPM) had an effect on the levels of cognitive engagements in terms of recognizing, recalling, executing, matching, classifying, analyzing errors, generalizing, specifying applications and goals, process monitoring, monitoring clarity, and accuracy. The number of participants had no relationship with the cognitive engagements except in retrieval (recognizing and recalling). These findings were consistent in Homogeneous Groups 1, 2 and 3, which have interconnected web interactions and cognitive levels distributed among most members of the group.

There were positive relationships between average message per topic (AMPT) and self-system thinking ($p = 0.43$, $\propto = 0.05$) and average word per message (AWPM) and comprehension (p = 0.36, ∝ = 0.05) in heterogeneous groups (Table 6). It seemed that topic threads and the length of messages have an effect on recognizing, recalling, executing and examining importance, efficacy, emotional response and motivation. The heterogeneous groups either involved the participants in a higher or lower level of cognitive engagements but not in middle levels.

Conclusion

Collaborative homogeneous grouping was more conducive for widespread interaction and high cognitive engagements in online asynchronous discussion especially in the event that expert learners were grouped together. Learners realized that they belonged to the same level thereby facilitating confidence, developing eagerness to participate more, and accomplishing the tasks together.

Collaborative heterogeneous groups failed to solicit heightened interaction effects but provided the venue for more distributed high cognitive engagements among the members. This could be due to the variety of participants: they have someone to provide for (lower than their level), someone to identify with (same level), and someone to provide support to (higher than their level). However, a high concentration of novice learners even when mixed with differing ability students to form a heterogeneous group was found as not conducive for widespread interaction and high cognitive engagements.

Moreover, collaborative heterogeneous groups tended to assign a leader, as discerned from their messages. This phenomenon needs further investigation as online discussion leadership seemed to have a crucial role on the type of interaction effects and the level of cognitive engagements in CSCL.

The study showed that the number of members, regardless of the type of collaborative group, had minimal or no effects in interaction effects and cognitive engagements. However, the length and content of messages would impact the type of information exchanges and levels of learning in online asynchronous discussions.

In addition, educators should deliberately include online collaborative grouping activities into the instructional design of the course by making it part of the requirement to guarantee participation that may result in heightened interaction and learning. Furthermore, an active and up-to-date facilitation of the instructor in an online discussion is an important aspect of online learning.

About the Author

Ferdinand B. Pitagan obtained his PhD in Education from the International Christian University, Tokyo, Japan under the Monbukagusho (Japanese Government Scholarship). At present, he is an Assistant Professor of Educational Technology at the College of Education, University of the Philippines Diliman.
Email: eidrefpitagan@yahoo.com

Selected References

Ballinger, C. (2006). Demonstrating rigour and quality? In L Finlay and C Ballinger (Ed.). *Qualitative research for allied health professionals: challenging choices*. Chichester: East Sussex.

Bandura, A. (2003). Observational learning In J. H. Byrne (Ed.). *Encyclopedia of Learning and Memory* (2nd Ed). New York: Macmillan.

Bandura, A. and Cervone, D. (1986). Differential engagement of self-reactive influences in cognitive motivation. *Organizational Behavior and Human Decision Processes*, 38, 92-113.

Bandura, A. and Schunk, D. M. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality and Social Psychology*, 41(3), 586-598.

Berge, Z.L. (1995). Facilitating Computer Conferencing: Recommendations From the Field. *Educational Technology*, 35(1) 22-30.

Berkowitz, S. D. (1982). *An introduction to structural analysis.* Toronto: Butterworths.

Blooms, B.S. (1956). *Taxonomy of educational objective; The classification of educational goals*. New York: Longmans.

Bonwell, C. C. and Eison, J. A. (1991). Active learning: Creating excitement in courses. *The American Journal of Distance Education,* 19 (1), 23-36.

Cox, D.R. (1984). Interaction. *International Statistical Review,* 52 (1), 1–25.

Dodge, Y. (2003). *The Oxford Dictionary of Statistical Terms.* Oxford University Press.

Ellis, R.A., Ginns, P., and Piggott, L. (2009). E-learning in higher education: Some key aspects and their relationship to approaches to study. *Higher Education Research & Development*, 28(3), 303-318.

Fantuzzo, J.W., King, J.A., and Heller, L.R. (1992). Effects of reciprocal peer tutoring on mathematics and school adjustment: A component analysis. *Journal of Educational Psychology*, 84(3), 331-339.

Garrison, D. R. (1992). A distance education perspective. *Currents,* 2, 3-9.

Hara, N., Bonk, C., and Angeli, C. (2000). Content analysis of online discussion in an applied educational psychology course. *Instructional Science*, 28, 115–152.

Illinois Online Network (2007). Instructional Strategies for Online Courses. Retrieved 5 November 2012 from http://www.ion.illinois.edu/resources/tutorials/pedagogy/instructionalstrategies.asp

Jerusalem M. and Schwarzer, R. (1995). General Self- Efficacy Scale (GSE). Retrieved 10 December 2012 from http://userpage.fu-berlin.de/~health/engscal.htm.

Johnston, V. L. (1996). Toward a global classroom using computer-mediated communications at UAA.

University of Alaska Anchorage, Vocational Teacher Report, ERIC Document database (ED356759).

Klein, J.D. and Doran, M.S. (1999). Implementing individual and small group learning structures with a computer simulation. *Educational Technology Research and Development,* 47(1), 97–109.

Lee, C. and Witta, E. L. (2001). Online students' perceived self-efficacy: Does it change? Annual meeting of the Association for Educational Communications and Technology (AECT), Atlanta: GA.

Manzano R.J. and Kendall, J.S. (2007). *The new taxonomy of educational objectives*. Corwin Press: California.

Miltiadou, M. (2001). Computer-mediated communication in the online classroom. *International Journal of Educational Telecommunications,*7(4), 407-419.

Moore, M. (1990). Recent contributions to the theory of distance education. *Open Learning*, 5(3), 10-15.

Moore, M. (1993). Theory of transactional distance In Desmond Keegan (Ed) *Theoretical Principles of Distance Education*. London & New York: Routledge.

Pea, R. D. (1993). Practices of distributed intelligences and design for education In G. Solomon (Ed.), *Distributed cognitions: Psychological and educational considerations*. UK: Cambridge University.

Resnick, L., Levine, J., and Teasley, S. (eds.). (1991). *Perspectives on socially shared cognition*. American Psychological Association. Washington, DC.

Rovai, A. P. (2002). A preliminary look at structural differences in sense of classroom community between higher education traditional and ALN courses. *Journal of Asynchronous Learning Networks*, 6 (1),41-46.

Saleh, M., Lazonder, A.W., and DeJong, T. (2005). Effects of within-class ability grouping on social interaction, achievement, and motivation: *Instructional Science*, 22, 105-119.

Salmon, G. (2003). *Etivities: the key to active learning. London.* Kogan Page.

Salmon, G. (2004). E-moderating in higher education In C. Howard, K. Schenk, and Discenza (Ed.). *Distance learning and university effectiveness: Changing education paradigms for online learning.* Hershey: Information Science Publishing.

Scott, J. (2000). *Social network analysis: A handbook.* London: Sage Publications.

Scardamalia, M. and Bereiter, C. (1994). Computer support for knowledge-building communities. *The Journal of the Learning Sciences,* 3(3), 265-283.

Seepersad, S. (2004). Coping with loneliness: Adolescent online and offline behavior. *CyberPsychology Behavior*, 7(1), 35-39.

Sherry, L., Tavalin, F., and Billig, S.H. (2001). Good Online Conversation: Building on Research to Information Practice. *Journal of Interactive Learning Research,* 11(1), 85-127.

Slavin, R.E. (1990). *Cooperative learning: Theory, research, and practice.* Englewood Cliffs, NJ: Prentice Hall.

Shimamura, A. P. (2000). *Toward a cognitive neuroscience of metacognition. Consciousness and Cognition*, 9, 313–323.

Spear, R. (1992). Appropriate grouping practices for middle level student In J Irvin (Ed.). *Transforming Middle Level Education: Perspectives and Possibilities.* Needham Heights, MA: Allyn and Bacon. Stevenson, C (1992).

Tanner, K. J. (2005). Emotion, gender and the sustainability of communities. The Journal of Community Informatics, 1(2), 121-139.

Vygotsky, L. S. (1978). Interaction between Learning and Development. In Mind in Society. 79-91, (Trans. M. Cole). Cambridge, MA: Harvard University Press.

Walther, J. B. (1992). Interpersonal effects in computer-mediated interaction: A relational perspective. Communication Research, 19 (1), 52-90.

Wellman, B., and Hiltz, S. R. (2004). Sociological Rob: How Rob Kling brought computing and sociology together. The Information Society, 20(2), 91-95.

White, N. (2004). Facilitating and Hosting Virtual Community. Full Circles Association. Retrieved 15 November 1, 2012 from http://www.fullcirc.com/community/communityfacilitation.com

Zhu, E. (2006). Interaction and cognitive engagements: An analysis of four asynchronous online discussion. Instructional Science, 34(6), 451-480.