IRRODL
THE INTERNATIONAL
REVIEW OF RESEARCH IN
OPEN AND DISTANCE LEARNING

An Investigation of Collaboration Processes in an Online Course: How do Small Groups Develop over Time?

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Abstract

This study investigated communication patterns and behavior in problem-solving groups in a graduate online course. An inductive qualitative analysis method was employed to analyze 732 messages that were retrieved from small group forums. The current study identified a temporal pattern of group development was in comparison with existing theoretical models: the traditional group development model (Tuckman, 1965; Tuckman & Jensen, 1977) and the punctuated equilibrium model (Gersick, 1988; 1991). All the groups had two working phases and three decision-making points. The temporal pattern of group behavior was close to the phase transition concept of Gersick's model. Some groups tended to undergo Tuckman's stages, but their development stages were not necessarily sequential or hierarchical. Thus, it is concluded that Gersick's model could be more useful for researchers and instructors to better understand and assist online students in problem solving collaborative activities.

Keywords: Group development; collaboration; communication; behavior; problem-solving

Introduction

Collaborative learning is a central theme of research and instructional design in online courses. The benefits of collaboration in groups have been confirmed in literature in terms of higher academic achievement, developing higher levels of reasoning and critical thinking, deeper engagement and improved analytic skills, and improving teamwork skills and interpersonal skills (Smith, 2008). Collaboration skills are highly valued in today's workplace (Wang, 2010) and thus important for students in higher education (Walton & Baker, 2009).

Problem-solving activities in small groups are frequently employed as an instructional method to foster collaboration in current online courses. The problem-solving activities can be designed along a continuum from well-structured to ill-structured (Jonassen, 1997). A well-structured problem-solving activity supplies learners with clearer guidelines for an identified goal, a constrained set of rules, and optimal solution paths (Ferreira & Lacerda Santos, 2009). An ill-structured problem-solving activity is designed to allow learners to engage in more complex collaboration processes with divergent ideas and experiences shared among individuals to reach convergent thinking in knowledge building, and commonly based on assumptions and methods of constructivism and situated cognition (Jonassen, 1997). Knowledge coconstruction and advancement (Bereiter & Scardamalia, 2003) and learning from/with peers (Vygotsky, 1978) can occur as learners collaboratively verify problems; relate the problem's goals; clarify alternative perspectives; generate solutions; gather evidence to support/reject positions; determine validity/construct arguments; implement and monitor solutions; and adapt solutions (Jonassen, 1997).

Collaboration in a problem solving activity demands complex learning skills for engaging in constructive arguments as well as proposing alternative solutions to reach a consensus for the best solution (Ferreira & Lacerda Santos, 2009). A group should develop strong cohesion and trust so that members can freely challenge each other's opinions/knowledge/ideas to seek a better solution (Fisher, 1970; Smith, 2008; Tubbs, 1995). Some groups may struggle throughout collaboration processes and others may avoid conflicts among members that can arise in the collaborative approach and thus take the cooperative approach of simply dividing the group's task into individually assigned portions, assembling the partial results into the final output (Dillenbourg, Baker, Blaye, & O'Malley, 1996). Careful monitoring and facilitating of the group process has been emphasized to ensure the quality of collaborative learning in online courses (Jahng & Bullen, 2012; Jahng, Nielsen, & Chan, 2010; Zhang, Peng, & Hung, 2009).

A comprehensive understanding of group process and participation behavior can provide educators and researchers with insights for better planning and assisting learners. This study aims to provide a vivid description of collaboration processes in a problem-solving activity in a graduate online course. Conducting an inductive qualitative analysis on asynchronous communication transcripts, the research identifies a pattern of group changes and examines the factors hindering or facilitating collaboration in each group.

The research questions are (1) How do groups develop or change over time to complete a group project? and (2) What are the problems identified in individual groups through the collaboration process?

Literature Review

For decades now, researchers and theorists have proposed various models to explain how groups develop over time (Gersick, 1988) and whether all groups change according to a similar pattern (McGrath & Tschan, 2004). Tuckman's (1965) group development model

has been most frequently cited and supported in the literature (Wheelan & Lisk, 2000). Tuckman's model consists of four sequential stages (i.e., forming, storming, norming, and performing) through which group members should accomplish specific types of interactions. Forming is characterized by members' dependency on the designated leader while the group deals with inclusion issues and some concerns about safety. Storming refers to a period of counter-dependency and fight. At this stage, members often disagree among themselves about group goals and procedures. Norming is a period of establishing trust among members and building group structure, which is characterized by more mature negotiations about roles, organization, and procedures. The final stage, performing, is a time of intense team productivity and effectiveness. Tuckman and Jensen (1977) updated the model by adding a fifth stage (i.e., adjourning) at which a group disbands after completing a group task.

Subsequent models have repeated similar concepts to Tuckman's model with minor alterations (Gersick, 1988). For example, McGrath (1991) suggests the four modes of inception, technical problem solving, conflict resolution, and execution. Fisher's model (1970) includes the four linear stages of orientation, conflict, emergence, and reinforcement. Tubb's model (1995) proposes four phases of decision-making processes (orientation, conflict, consensus, and closure). Salmon's (2002) five-stage e-learning model, which has been adopted as a standard learning model for online courses in many institutions in the UK, also presents similar concepts for each stage: Stage 1 (access and motivation), 2 (online socialization), 3 (information exchange), 4 (knowledge construction), and 5 (development).

Gersick's model (1988; 1991) deviates from the prevailing view of traditional group development models. Gersick (1988) examined the life-spans of eight naturally occurring project groups and found that the groups did not go through a universal series of stages across time, as traditional group development models would predict. Rather, it proposes the punctuated equilibrium model to describe the groups' changes as Phase 1 – transition – Phase 2 across time:

> Phase 1, the first half of groups' calendar time, is an initial period of inertial movement whose direction is set by the end of the group's first meeting. At the midpoint of their allotted calendar time, groups undergo a transition, which sets a revised direction for phase 2, a second period of inertial movement. (p. 17)

Researchers such as Wheelan, Davidson, and Tilin (2003) and Johnson, Suriya, Yoon, Berrett, and LaFleur (2002) recognize Gersick's model as a noteworthy threat to the dominant view on group developmental stages across time. Wheelan and colleagues investigated the verbal behavior patterns and perceptions of 26 groups. They report that the findings of the study supported traditional models of group development and cast doubt on Gersick's punctuated equilibrium model. Johnson and colleagues described the community-building process of virtual learning teams by conducting both an inductive qualitative analysis and a quantitative analysis on survey data collected from 36 graduate students. The authors

initially considered both Tuckman's (1965) and Gersick's (1988) models as frameworks for the study, but they found their data fit better with Tuckman's model. They reported that the virtual teams went through three stages of forming, norming, and performing, but there was "no evidence of the storming stage" in each group (p. 385).

Skipping the storming stage in online courses should be taken seriously with respect to the quality of collaborative learning. As Wheelan and Lisk (2000) report, the storming stage is "necessary for establishment of trust and a climate in which members feel free to disagree with each other" (p. 727). Avoiding constructive conflicts may lead to superficial collaboration. In this regard, quite a few studies about online collaborative learning have reported that only a small percentage of groups productively accomplished tasks by reaching a fully developed stage in online courses (e.g., Francescato, Porcelli, Mebane, Cuddetta, Klobas, & Renzi, 2006; Johnson, Johnson, & Stanne, 2000).

Understanding group development patterns and members' behavior changes through the collaboration period provides insights to better assist online students. Tuckman's (1965) stage model may not describe precisely the collaboration process in terms of how the members solve problems by resolving conflicts and overcoming specific online obstacles. Online project groups that are engaged in problem-solving activities may reveal specific patterns of group dynamics and decision-making behaviors. Gersick's (1988) mid-point transition may inspire online educators. Motivated with these assumptions, the current study conducts an inductive qualitative analysis on asynchronous communication scripts exchanged during a problem-solving activity in a graduate online course.

Method

An inductive qualitative analysis approach was employed to identify the emerging pattern of group changes. The coding and analysis approaches are similar to the methods employed in Johnson et al. (2002) and Gersick (1988), which are based on grounded theory (Glaser & Strauss, 1967). Instead of using priori categories within a particular theoretical model, the researcher read the communication scripts repeatedly and summarized specific behaviors and dynamics occurring in each group. Following open coding proceures (Glaser, 1992), a message unit was used for the summary, focusing on the following items: (a) when, specific time points (month, date, time); (b) what, discussion subjects (cognitive, social, procedural topic); and (c) how, decision-making process (proposing, dis/agreeing, resolving conflicts, overcoming troubles, reaching consensus). The next step was to identify congruent patterns across the included groups even though the details in each group may be heterogeneous. The patterns were interpreted in comparison with the existing theoretical models in terms of which model better explained the findings. Detailed description of the findings was done in a qualitative exploratory case study to provide a holistic picture of group dynamics and reveal critical behaviors and factors occurring in each group (Krathwohl, 1998; Merriam, 1988; Yin, 2003).

Data (732 messages) were retrieved from six group forum spaces of an online course of an

educational technology program. Twenty-four graduate students were enrolled in the online course that was delivered for 13 weeks through the WebCT Vista course management system.

The small group problem-solving activity was designed to require students to write a group paper as an assignment. There were two types of problem options for each group to choose. Option 1 was to analyze a real example of institutional planning for e-learning and the use of learning technology. The groups who had chosen this option had to read and analyze a series of documents that were produced as part of the planning process. These documents were supplied on the course Web site. In addition, the groups needed to do some background research on the institution to fully understand the context. The group paper was intended to answer a list of questions based on their analysis and research. Option 2 was to create an imaginary case to recommend a vision for the use of e-learning. The information for the two options was posted on the course Web site at the beginning of the course (January 7, 2008). The students were told to allocate themselves into a group. The submission deadline for the group paper was firmly set (March 3), but no formal guidelines were announced about when and how to start the activity. The assignment mark for the small group activity was 35% including 5% peer-evaluation of the final course mark.

Findings

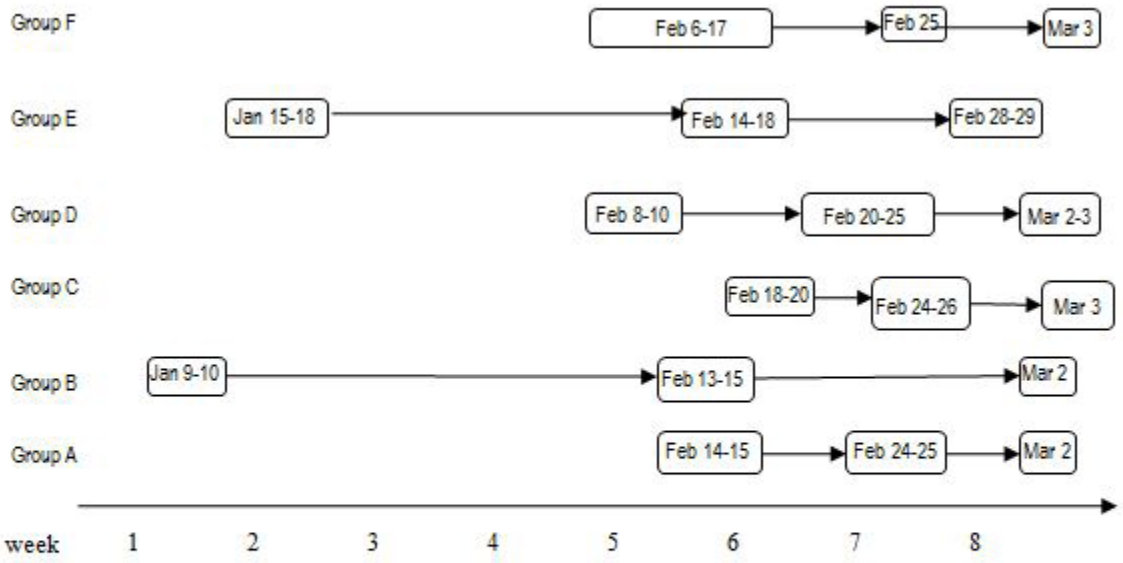
A temporal pattern of group behavior changes across the six groups is presented in Figure 1. The figure represents how the groups moved toward making decisions that were necessary for completing the group paper. All the groups went through three decision-making points (DM1, DM2, and DM3) and had two working-phases (working-phase 1 and 2) between the decision-making points. The first decision-making point (DM1) was for selecting a problem from the given two options. The second decision (DM2) was for structuring the group paper that was going to be the basis for dividing the task into individual portions. The final decision (DM3) was to reach a consensus for completing and submitting the paper. During working-phase 1, the groups that had selected problem option 1 spent time mostly on reading the documents provided on the course Web site while the other groups working with option 2 was brainstorming to create an imaginary context of a case. The working-phase 2 was a time period of writing individually, commenting on each other's works, compiling the individual pieces, and editing the compiled paper.

Figure 1. Temporal pattern of group collaboration process.

Although groups performed similar tasks during these phases in either option, each group revealed completely heterogeneous group behaviors. Not only the timing of decision-mak-

ing points and the duration of the working-phases were different, but also the types and levels of group work strategies varied widely. Some groups started the group work much earlier than the others; some groups spent much longer time in decision-making than others (Figure 2).

Details of the similarities and differences as well as facilitating and hindering factors for group collaboration are described in the following sections. In the provided excerpts from group forums, individual members are identified by anonymous codes composed by two characters: an alphabet upper case (A to F) and a digit (1 to 5) to indicate the group and its individual member, respectively. Writings in italic in brackets are interpretive comments added by the author.



Note: the dates correspond to each of the 3 decision-making (DM) phases.

Figure 2. Individual groups' decision-making points.

Decision-Making 1 (DM1): Topic Selection

Two problem options were given for each group to choose as described in the Method section. The subject of the first thread in each of the six groups' forum postings was about choosing one of the options. Four out of six groups (A, B, D, and F) chose option 1 (real-case analysis) while two groups (C and E) chose option 2 (imaginary-case design). All the groups except for Group F made a quick decision to select the problem option after exchanging several messages over a period of one or two days. Each group generally followed a similar process: One member expressed his/her preference for an option with a brief explanation of the reason or rationale and then the other members agreed or disagreed until the group reached a consensus. Group F, however, really struggled in this process. The group spent the initial 10 days out of their total 25 days for doing the group activity to choose an option.

The problem in this group appeared to be that individual members did not clearly express their preference for a particular option.

> F4: Hi there, I'm ok with either option.
> F3: Either option is fine with me.
> F4: just re-read the thread and was wondering if we've actually decided on option 1 or 2.
> F1: If you want option #2 and the others in our group are happy with that - that's ok with me too. How to start? *(This implies somebody would lead the project.)*

Working-Phase 1: Reading Materials/Creating Context

Working-phase 1 included the time period after selecting the problem option until reaching a next agreement on a paper structure for job division. The four groups that chose option 1 (real-case analysis) began reading the documents provided on the course Web site. The other two groups working with option 2 (creating an imaginary case) began discussion to prepare a context. During working-phase 1, each group revealed different communication relationships and behaviors in terms of taking a collaborative, cooperative, or individualistic approach. Some technology problems and personality conflicts began to arise. Some groups made an effort to build team morale while others made no such effort.

Group B exhibited ideal behaviors for the collaborative learning process. The group decided that each member would take responsibility for answering two or three questions and share notes of the readings in Google Notebook. As shown in the following excerpts, the members used nicknames (e.g., Mr. T), used socializing words for building teamwork (e.g., "Hey Team"), and made jokes throughout the period.

> B2: Hey Team, I had a thought … What if instead of answering all the questions and divvying up the readings we do all the readings and divvy up the questions? … Cheers, Mr. T.
> B1: Good idea, Mr. T. I think we all need to read through all the readings too.
> B3: … I am dyslexic *(humor)*, and the likelihood of me having read all of the papers in time is low. I will see how far I can get though.
> B2: I gather the real key documents are … *(the list of key documents)*.

Group D used a similar strategy to Group B in terms of splitting questions for individuals to manage, but the group work process was quite different. The group proceeded through working-phase 1 in a very cooperative manner. For instance, D3 thought the 'individualistic approach' would be efficient in answering the questions. When D1 made a suggestion to work in a Wiki page, D3 was against the idea and created a rubric table for individuals to fill out answers for each of the questions. Each person would then be responsible for a portion

of the rubric/table:

> D1: Hi … To assist us in collaborating for our assignment, I have created a Wiki page for us, …
> D3: Hi: Wiki good idea, well suited developing thoughts further when perform further research. Would prefer though that individually compile initial thoughts to avoid group think….Attached is the Rubric. Please complete & post, can then discuss… I will convert it into a draft paper…

Group A, which made a very late start (see Figure 2), moved quickly to choose the questions for option 1. One member took a lead role in the group by posting a message to notify the members of her having set up a Google Doc and started some notes as responses to the questions posed in the assignment description. She asked the members to comment and correct her points. The group planned to simply answer the questions in point form and then smooth them out to complete the task. The group did not communicate in the forum again until they were ready to structure the paper.

Group F was even quieter in the forum and seemed to be lost, failing to build up teamwork or leadership. F4 suggested having synchronous chats, but others did not respond to her suggestion. F3 once posted a very long message based on his reading and research related to the topic. Only one member, F1, responded to the long post with a short comment: "Interesting background, F3. It also gives a sense of the work after the dissolution of (the institution). Thank you!" The group did not exchange any informal messages with humor or personal information for socializing purposes.

Groups C and E started to exchange ideas to create a context for a vision of e-learning (option 2). Both groups recognized a need to have synchronous chats. However, scheduling a meeting time was not easy for the members who were living in dispersed geographical zones and working full/part-time. Group C consisted of three members while Group E had five. Group C started to brainstorm ideas through synchronous chatting in Vista Chats or MSN, but not all members could attend all meetings. Instead, the group meet in pairs and posted a chat summary for the third member. Unlike Group C, synchronous brainstorming did not happen in Group E. Although E4 was persistent in requesting voice chats, the other members preferred to stick to asynchronous communication. Even with the initial disagreement on a strategy for better communication, collaboration in this group was smooth in the absence of voice chats. The group overcame a conflicting idea over tools because other members persuaded the member who suggested the synchronous chats in a patient manner. Instead of having synchronous chats, the group decided to post messages frequently as they brainstormed ideas for deciding on a context.

Decision-Making 2 (DM2): Structuring/Dividing the Job

After working-phase 1, the groups began to check the due date and to feel time pressure. All groups recognized the need for an outline/structure of the group paper to which members

would add details. The DM2 made groups speed up their work processes and encourage members' contribution. Based on discussions with readings or ideas, each group posted a structure of a paper in the forum. Three groups (B, C, E), where members communicated smoothly during the first working-phase, produced the structure by reaching a consensus. On the other hand, in groups A, D, and F, one member proposed a structure of the paper with headings for sections and suggested the members to take some sections to write up. Without having much discussion, the other members simply picked one or two sections. This decision-making was the major transition to enter the working-phase 2.

Working-Phase 2: Writing Individually, Compiling, and Editing

Working-phase 2 was a period of individual work after structuring and dividing the jobs. Communication revealed how groups struggle in narrowing opinion gaps and negotiating discrepancies. As the group process became more complex, emotional conflicts occurred more frequently. Some groups (B and E) dealt with problems more successfully based on their strong team spirit while others (D and F) failed to overcome technology problems and personal conflicts. Some groups (A and F) took a more cooperative approach through which they simply assembled individual pieces of work to complete the task without seriously attempting collaboration. Factors facilitating or hindering groups' collaboration processes can be seen in examples from the groups.

Group B maintained high team spirit as all the members were engaging in collaboration. While writing individual sections, the members continually asked questions of and expressed concerns to the other group members. They assisted by answering each other's problems and concerns promptly, which helped to reduce inconsistencies when they combined the individual pieces into a collected version. The members continued exchanging humor, jokes, and emotional encouragement, and shared informal information:

> B3: If we are the A-team, can I be Murdock?
> B4: Guess you've got a good supply of t-shirts! :) Only if I can be Face .... more for the name than the character :).
> ... Hey ya Murdock ~ ...
> B1: you are right, Mr. T.

The final editing process in Group C was very intensive. The group successfully managed extreme anxiety with the time pressure through meetings at MSN. Even though the group had some chats during the individual writing period, the members found many overlaps, inconsistent concepts, and irrelevant arguments. They began to edit it by taking turns and attached the developing document to post on the group forum. The members seemed to be online constantly for the last two days before submission. They posted messages to arrange synchronous meetings as well as posing updated versions each hour.

> *(March 2, one day before submission)*
> C3: ... I have spent a lot of time re working some of the content. ...
> C1: It's 9:00 am ... I'll let you know what I think and post

> my comments within the half hour.
> C2: … I will hold off posting my update until after we meet. I'll talk with you at 10:00.

The high level of positive collegial engagement in Groups B and C was not found in Groups E and D whose technical difficulties seemed to interfere with their interactions. Both Groups E and D worked on the Wiki, but the troubles and stresses in Group D were distinctive. One member in Group E knew how to export Wiki documents for reformatting into a Word document. Group E thus saved much time and effort in comparison to Group D. On the other hand, Group D also faced problems as a result of poor Internet connection in a remote area, confusions with the Wiki, and incompatible file extension formats for down- and up-loading files:

> D3: …Am curious why the extension would affect the download…. Its on the wiki too but its a poor medium as all formatting is lost between transfers….Maybe am edgy, but why the sudden switch to google and dropping of version numbering… Please just use this thread to post with appropriate version number (lets not waste time changing processes and try to follow google docs, email, vista…).

Group D used many negative words that expressed anxiousness, even blaming their peers as inattentive or inconsiderate, which exacerbated troubles and brought conflicts to such an extreme level that resolutions became impossible. Conflict between D3 and D1 became so excessive that they poured out harsh feeling toward each other:

> D1: D3, With all due respect, I believe it would have been more meaningful if your responses would have been more factual and if they would have taken into consideration the unique circumstances some of your fellow course colleagues encounter, who happen to reside and work in different time zones, …. I happen to believe very strongly in the concept and in the application of collaborative group work, but, I also, equally, strongly believe that this can only significantly be achieved, if every participant is mindful, without questioning each other's motives and/ or technical ability, of the fact that every group member may experience unforeseen circumstances, which may inadvertently conflict with the time schedule of others.
> D3:D1, I asked why you did not do something that you thought needed to be done, that a personal attack; Interesting explanation though, … I need to be more factual. The good news, its almost due.

Group A seemed to wish simply to split up the task to individuals for later compilation to complete the assignment. Once taking on their own sections of the paper, individual members started working separately without communicating with each other. After working for about two to three days, they put drafts of their individual sections into a Google Doc. There were no obvious conflicts/arguments. The editorial process was quick, as had been the process of picking the topic option and dividing up tasks. After compiling individuals' writing in the Google Doc, they took turns to proofread others' sections to complete the group work.

Group F attempted to work on a Google Doc to produce a collective paper. One week before the submission date, F1 posted a detailed schedule to move the process forward and encouraged members to discuss and clarify their ideas. However, the group members were very quiet on the Google Doc as well as in the group forum space. The final paper had to be stitched up by F1. This group obviously failed at collaborative group work.

> F1: I've shared a document with you called... I spent two more hours or so on the document this morning. Hopefully you will have time this evening.
> *(Only F3 responded to the post.)*
> F3: Hi F1, I am going to edit some content in our document at Google Doc tonight...

Decision-Making 3: Submitting and Adjourning

Decision-making 3 was to finalize the group paper after having rounds of editing earlier versions. Final messages posted in the group forum with an attachment of the completed version of the group paper revealed how the groups had been through the group work process. As the following excerpts show, the messages from three groups (B, E, and C) request other members to 'double check' (B4) and post final 'comments' (E1 and C1) on any errors. These groups had worked collaboratively as all the members had engaged in the group work process. Thus, the finalizing person sought a consensus of approval for the version. The messages from Group B and E, in particular, contain many exclamation marks and/or smile emoticons indicating their satisfaction and excitement in completing the work.

> B4: Dear Team. Please double check the references before submitting the version. I've made sure they were consistent and alphabetized like 3 times, but when I check the attachments to this discussion board - it always seems to be an old version!!! Anyway. This version (I believe) should be the final! ...

> E1: Hi All, I posted this as a pdf in the Final Draft thread in the WIKI .... Please post comments here by Saturday 5pm PST ... We are done - unless someone sees a spelling error or something very tiny! :) Looks great guys. I am amazed at how well it flows after all! ...

> C1: I've read through it a couple of times now. ... I feel that it is pretty comprehensive and I think we'll be fine submitting it. I will be back online after 8 to see if there were any comments from you.

By way of contrast, the final messages from Groups A and F were short and dry. The tone of the messages is very assertive, seemingly not allowing or expecting any further revisions on the version by the other members. No social and emotional expressions were included in the message.

> A1: Hi everyone, Here is the final copy. As you all know, we each have to submit a copy.

> F4: Here's the final copy. I think.

Group D struggled with personal conflicts and members' attitudes. D3, in his final message, notified the members of what he did and why without asking members' opinion or consent.

> D3: Hi there: The reason for the word count was under the course resources, ... *(He writes a long paragraph about APA style, file format, and word count requirements for the assignment, etc.)*

Interestingly, two groups, B (the most collaborative group) and F (the least collaborative group), posted some messages after completing the group activity. Group B debriefed their group experience with satisfaction as well as expressing the wish to work together again sometime. B1 even wanted to visit B4 to talk about something in person. They exchanged phone numbers and personal schedules to meet sometime. When they checked their group grade, everybody felt this was a happy ending of the group's work. F1, who led Group F, posted a brief message with some disappointment after checking his group mark, but no one in the group responded to the message.

Discussion

The purpose of the study was to investigate group processes during a problem-solving activity in order to identify a pattern of group behavior as well as problems and issues that arose through the collaborative learning process. Findings in the above section reported a temporal pattern of group changes and the differences in and similarities of individual groups' behavior within the pattern. This section discusses the findings in relation to the existing literature, suggests further research topics, and recommends some instructional strategies as well as design principles.

Gersick's Time Phase Model versus Tuckman's Hierarchical Stage Model

The groups involved in this research moved toward completing the group assignment by making three decisions and having two working-phases between the decision-makings. The pattern across the activity timeline appears similar to Gersick's (1988) punctuated equilibrium model. In her model, a significant transition occurs at the mid-point of the group process, which "involves groups' revising their understanding of and approach to their work in response to time limits" (p. 36). The current study also found a transition point at the second decision-making point. Although the time point did not exactly match to the mid-point of the work period, four of the six groups reached the transition approximately at their calendar mid-point when they realized the time pressure and a need for a detailed outline of the paper structure in order to divide the workload. The other two groups could be exceptional because they made a much earlier start that may have allowed them to have a longer working-phase before the first transition.

Tuckman's (1965) group development stages were not visible in all groups' communication behaviors in this study. Not all groups moved sequentially through the hierarchical stages of group development and some groups avoided constructive conflicts, skipping the storming stage to strategically take a simple cooperative approach. Groups revealed different types of group behaviors in terms of adopting more individualistic, cooperative, or collaborative approaches to solve the problem. The more collaborative groups tended to move through Tuckman's stages more than less collaborative groups. Less collaborative groups rarely communicated until they had to make the second decision, so they skipped one or more of the forming, storming, and norming stages. More collaborative groups, which took more team-oriented approaches to solve the problem, underwent some of the group development stages, but these stages were not necessarily sequential or hierarchical. One or more stages were skipped in some groups while multiple stages occurred at the same time in other groups.

The timeline model depicted in the current study as well as in Gersick's (1988) can explain group changes better than Tuckman's traditional stage model. The fact that groups should make critical decisions by certain time points and have working-phases between the decision-making points gives useful and practical information for designing and instructing small group activities. Since time is a critical factor influencing more collaborative work in groups, designers and instructors should be mindful of the timeline. The groups could be helped to move more promptly if the course provided detailed guidelines with specific time points for group procedures.

Communication and Collaboration Tools

The course that was the focus of the current study was designed to allow groups to select one of two typical problem-solving activities, that is a real-case analysis (option 1) or an imaginary-case design (option 2) (Jonassen, 1997). More groups, four out of six, selected option 1 perhaps believing that more readings and analysis would be easier than more brainstorming and negotiation to create a new case. This could be different if the activity setting were a face-to-face course where groups might prefer option 2 or show no prefer-

ence with the options. The result and the assumption can be interpreted in consideration of the limitations of asynchronous and synchronous communication tools. According to Mabrito (2006), synchronous tools are beneficial for producing new topics and ideas (69%) as compared to asynchronous communications (47%). Only one used synchronous tools. This same group also experienced problems using different types of synchronous communication tools (Skype, Vista Chats, or MSN). Time delays in their asynchronous communication as well as other technology problems such as Internet access and file formats caused anxiety and personal conflicts. The collaboration tools for writing and editing (Wiki or Google Docs) also caused many troubles owing to the nature of the tools (e.g., formatting issues) and students' lack of familiarity with the tools. Thus, designing and instructing problem-solving activities should be based on careful consideration of appropriate and available tools and students' skills and familiarity with the tools.

Importance of Social Communication

The importance of social communication has been confirmed in this research and aligns with literature in this area. Having an ice-breaking period at the beginning of the group activity was particularly helpful for building a strong bond between members. Group members introducing themselves to each other by sharing personal stories and information resulted in better understanding among group members and helped them to establish warm feelings toward each other. The course should be designed to encourage social communication with some specific activities for ice breaking during the initial period. Using positive words for appreciating others' work can have the effect of cheering up the members. Making jokes and using nicknames are all facilitative communication acts for maintaining and strengthening team spirit. Students entering collaborative group work should recognize that negative words expressing anxiousness, blaming, negligence, or bossy attitudes are unhelpful, often exacerbating troubles and bringing conflict to such a level that resolutions become impossible. Instructors should encourage and remind students that indecisive and ambiguous uses of language also have negative effects on the collaboration process. Individual students need to express their opinions clearly rather than positioning themselves in a grey area. Further research is recommended to identify practical ideas for promoting social communication and also for grouping methods to mix and match more or less active students in consideration of their diverse characteristics and abilities.

Limitations

This is an exploratory study that still has much scope for expansion/refinement in future studies, so the findings of the study should be viewed with some caution. The small groups analyzed in this study were from a graduate online course, which was designed to include a group problem-solving assignment. Thus, the results may not be generalized directly to other types of small groups. Nonetheless, a comprehensive description of group changes/development and some of the challenges occurring over time provides researchers and educators with insight into and a better understanding of online groups. Further research is encouraged to examine the effect of the instructor's intervention on groups' behavior changes across the time frame for making specific decisions as well as to investigate different group-

ing methods in terms of mixing and matching members to form a collaborative group with members who actively participate.

Conclusion

This study examined communication patterns and behavior in problem-solving groups in a graduate online course. A temporal pattern of group changes was identified which consists of three decision-making points and two working-phases. The pattern resembles the concepts of Gersick's (1988) punctuated equilibrium model and differs from some of the propositions of Tuckman's (1965) hierarchical stage model. Looking at individual group behavior across the time frame for the problem-solving activity, some groups were more collaborative while others were individualistic or cooperative. Those collaborative groups underwent some stages of group development, but the stages were not necessarily sequential or hierarchical. The study concludes that the timeline model may better explain group changes and be more useful and practical for course designers and instructors to understand group collaboration processes. The study also found many problems and troubles associated with technology and geographical distance that are regarded as typical limitations of online communication. The findings imply online groups may be more fragile than face-to-face groups in terms of overcoming emotional frustration and personal conflicts and thus recommends careful design and strategies to support group changes across the time frame of group activity.

Acknowledgment

I thank the anonymous reviewers for their constructive comments that helped to improve the quality of the paper. I also thank my friend and colleague, Dr. Wendy Nielsen, for her time and effort in editing.

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