Analysis of an Online Case Discussion about Teaching Stochastics

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Online learning, case discussions, and stochastics instruction have all become increasingly active strands of research in mathematics education. This study integrates the three strands. The nature of the discourse during an online case discussion among prospective secondary teachers is analysed. The case focused on the teaching and learning of a version of a classic statistical sampling problem. Participants formed several threads of conversation in discussing the case. During the online discussion, the prospective teachers conversed about multiple elements embedded in the case, including: mathematical issues, assessment of students, pedagogical strategies, the context of the case, and writing choices made by the case author. The discussion also contained substantive contributions from individuals who were normally silent in face-to-face class sessions, and allowed extended time for participants to craft responses to one another.

This paper lies at the intersection of three relatively recent trends: (i) the use of case discussions for mathematics teacher preparation (Merseth, 1991); (ii) the use of asynchronous online learning environments for teacher education (Newell, Wilsman, Langenfeld, & McIntosh, 2002; Shotsberger, 1999); and (iii) the growing emphasis on stochastics in pre-tertiary curricula (Chick & Watson, 2003). To begin the paper, I discuss the three trends and some of their interrelationships. I then describe the design of an online case discussion assignment related to stochastics. The discourse among a group of prospective secondary school teachers completing the assignment is then analysed in order to shed light on teaching and learning with cases in the online environment.

Case Discussions, Online Learning, and Stochastics Education

Shulman (1986) was among the first to argue that cases depicting realistic classroom episodes should be used in teacher education. Expressing agreement with Fenstermacher (1978) and Green (1971), he argued that teacher education should be concerned with influencing the premises upon which teachers base their decisions in specific situations rather than with "inculcating a knowledge base in the form of a specific set of teaching skills and competencies" (Shulman, 1986, p. 32). He conjectured that studying cases would be effective because of individuals' tendency to be more influenced by specific cases than by the presentation of general principles. Merseth (1991) echoed Shulman's recommendations, arguing that cases can help pre-service teachers diagnose classroom problems, pose solutions to them, and think about what to do in similar situations. These recommendations helped spark interest in using cases for teacher education during the 1990s (Grossman, 2005).

Alongside the increased incorporation of case studies in teacher education was the increased utilisation of online learning environments. One such environment was the asynchronous learning network (ALN). Harism (1990) defined an ALN in the following terms: "(1) Many-to-many communication; (2) place independence; (3) time independence (that is, time-flexible, not atemporal); (4) text-based; and (5) computer-mediated interaction" (p. 43). Some forms of mathematics teacher education began to take place on ALNs. Shotsberger (1999) reported that an ALN environment allowed mathematics teachers to engage in prolonged and thoughtful exchanges of ideas relating to reform-based pedagogy. Newell et al. (2002) noted that "holding a discussion over a period of days or weeks allows time to reflect, experiment with new ideas, share successes and failures, and receive feedback from others who are undergoing the same experiences" (p. 506).

Although the bodies of work surrounding case-based teacher education and ALNs grew largely in isolation from one another, there are compelling reasons to combine the study of the two. The fact that ALNs are many-to-many communication environments means they can facilitate the sharing of diverse perspectives about a given case. As participants share perspectives, a number of threads of conversation can be formed alongside one another, and individuals can participate in as many of those threads as desired. Participation in numerous simultaneously-formed conversations is not facilitated by synchronous (i.e., real-time) or face-to-face discourse. The ALN characteristic of time independence also allows case discussion participants to reflect carefully on contributions they make to the conversation. Synchronous and face-to-face discussions generally occur over shorter time spans, leaving individuals less time to craft contributions. While some benefits of face-to-face discourse, such as being able to read facial expressions, are lost in an asynchronous environment, benefits such as the ability to participate in several different threads of conversation and extended reflection time during a discussion are gained.

The third trend pertinent to this study is the growing emphasis on teaching data analysis and probability at the pre-tertiary level. In reviewing the research literature on teaching and learning stochastics, Shaughnessy (1992) noted, "Since very little probability or statistics has been systematically taught in our schools in the past, there has been little impetus to carry out research on the problems that students have learning it" (p. 465). Since this initial assessment, stochastics have increasingly found their way into pre-tertiary curricula (Shaughnessy, 2006). Influential curriculum documents assembled over the past two decades gave stochastics a prominent curricular position (e.g., Australian Education Council, 1994; National Council of Teachers of Mathematics (NCTM), 2000). Since stochastics is a relatively new curricular emphasis, prospective teachers often lack experiences from pre-tertiary courses that taught the subject in accord with reform-oriented recommendations. There is a great need to develop methods to help teachers better understand the subject and how to teach it (Conference Board of the Mathematical Sciences, 2001; Watson, 2001).

Purpose of the Study

This paper evaluates an attempt to help prospective high school teachers gain a better understanding of issues involved in stochastics instruction. In particular, the process and content of the discourse that occurred during an ALN case discussion related to teaching and learning statistical sampling are analysed. The process of discourse refers to the ways individuals participated in the discussion, while the content refers to the substance of individuals' comments (Sherin, 2002). Both aspects were examined to shed light on the extent to which the online discussion supported the analysis of the case.

Methodology

Participants

Fourteen prospective high school teachers enrolled in a teaching methods course in the Mid-Atlantic U.S. participated in the study. There were four male and ten female participants. As the course instructor, I moderated the ALN case discussion that is the focus of this study. The online case discussion replaced one regularly-scheduled face-to-face class session during the twelfth week of the course. All previous sessions had been face-to-face rather than online. The participants, had, however, participated in an unmoderated ALN case discussion as an outside-of-class assignment during the fourth week of the course. Groth (in press) described that experience and some of the discourse themes that occurred. The unmoderated ALN case discussion helped familiarize participants with the functions of posting messages and replying to those posted by others.

Each participant had also received credit for an introductory tertiary-level statistics course before the study took place. Some had received credit by taking a statistics course at the same institution or an equivalent course from another university, and others received credit for passing the Advanced Placement (AP) Statistics Examination. A description of the AP course of study (College Board, 2006) provides an overview of the statistical content each participant had likely encountered in the past, since it was considered equivalent to the elementary statistics course offered by the institution at which the study took place. The AP course goes beyond descriptive statistics to include techniques of formal inference. Table 1 summarizes some key information about the participants and assigns a pseudonym to each.

Table 1
Summary of Participants' Characteristics

Pseudonym	Gender	Statistical background
Andrew	Male	Tertiary-level elementary statistics course
Brittany	Female	Tertiary-level elementary statistics course
Claire	Female	AP Statistics exam credit

Diana	Female	Tertiary-level elementary statistics course
Elaine	Female	Tertiary-level elementary statistics course
Fran	Female	Tertiary-level elementary statistics course
Greg	Male	Tertiary-level elementary statistics course
Harold	Male	Tertiary-level elementary statistics course
Ivan	Male	AP Statistics exam credit
Janet	Female	Tertiary-level elementary statistics course
Kelly	Female	Tertiary-level elementary statistics course
Laura	Female	Tertiary-level elementary statistics course
Megan	Female	Tertiary-level elementary statistics course
Nancy	Female	AP Statistics exam credit

Case Details

The case providing the springboard for ALN discourse was entitled *Chances Are* (Merseth, 2003a). It described conversations among high school students about a version of the "hospital problem" (Kahneman & Tversky, 1972; Watson, 2000):

> A town has two hospitals. On the average, there are 45 babies delivered each day in the larger hospital. The smaller hospital has about 15 births each day. Fifty percent of all babies born in the town are boys. In one year each hospital recorded those days in which the number of boys born was 60% or more of the total deliveries for that day in that hospital. Do you think it's more likely that the larger hospital recorded more such days than the smaller hospital or that the two recorded roughly the same number of such days? (Merseth, 2003a, p. 69).

This task was given at the beginning of the case, and readers were encouraged to work the problem on their own before reading on.

The case told the story of a class session taught by a teacher given the pseudonym of Mrs. Wexler. Much of the case consisted of samples of dialogue that one small group of students had about the hospital problem. Mrs. Wexler encouraged the group to debate their ideas about the problem with one another. Students in the group debated whether or not the size of the hospital mattered in the solution to the problem. At one point, Mrs. Wexler gave the group a box of 150 pennies and told them they should use them to help resolve the debate. At the conclusion of the case, Mrs. Wexler gathered the class back together as a large group to attempt to come to a conclusion about the solution to the hospital problem. In the end, however, the class did not come to consensus on the solution. The reader is then given several questions to think about in analysing the case, dealing with topics such as: the teaching strategies employed in the lesson, the teacher's questioning techniques, the teacher's use of manipulatives (the pennies), and what the next lesson should look like.

Procedure

Before discussing the case online, participants constructed written responses to the version of the hospital problem stated above. They were asked to write out the solution to the problem as well as any assumptions made in solving it. This was done in order to obtain a frame of reference about participants' content knowledge through which the nature of their online discourse could be better understood. I asked them to be thorough in their descriptions because I would be using their responses as part of a research study and would also refer to them to help guide the ALN case discussion. All fourteen participants individually generated handwritten responses to the problem during the face-to-face class session before the ALN discussion.

Participants were given instructions for accessing the online discussion board during a face-to-face class session. Upon reaching the discussion board, they encountered the instructions shown in Figure 1. The discussion board was open for a period of seven days (the day after the assignment was given until the next face-to-face class session). They were informed that, with their permission, the messages they posted to the discussion board would be used in the present study. All participants granted permission for this to occur.

Welcome to the online discussion of case 10 from Windows on Teaching Math by Katherine Merseth. The intent of this assignment is to give you the chance to interact with your classmates in analyzing a case based on realistic classroom events. After you read the entire case and think about the questions posed at the end of it, here are the guidelines for participating in the discussion:

(1) Process guidelines: In order to successfully complete this assignment, you must make at least 4 posts to the discussion board before our next class (but feel free to post as many as you want!). You should post on at least 4 different days. At least 3 of the posts you make should be replies to comments made by others.

(2) Content guidelines: While there are no specific restrictions on the content of your posts, here are some ideas to consider as you think about what to write: Respond to one of Merseth's questions at the end of the case; Raise questions about how the case may be applicable/relevant to classroom practice; Affirm the views of another participant and provide a detailed explanation for your agreement; Express disagreement with the view of another participant and provide a detailed explanation for your disagreement; Raise a related classroom dilemma and ask for input from other participants; Describe a related teaching activity; Propose a shift in the direction of conversation within a given conversation thread.

Please email me immediately (regroth@salisbury.edu) if you run into any problems completing this assignment. Enjoy the discussion!

Figure 1. ALN case discussion assignment instructions.

In moderating the discussion, I based my actions upon Simonsen and Banfield's (2006) typology of ALN moderator interventions. According to the typology, a moderator may withhold comment, expand on participants' posts, redirect the group, validate a participant's post, or resolve a participant's question. This placed me in the role of participant-observer (Glesne, 1999) rather than that of detached researcher. Instead of trying to minimize my impact on ALN interaction, I sought to understand how different moderator choices within the typology might help shape discourse. Accordingly, the role of moderator posts within the discourse is described in the results section alongside the conversation themes that emerged among participants.

Data Analysis

I began the process of data analysis by evaluating the prospective teachers' written responses to the hospital problem. The SOLO Taxonomy (Biggs, 1999; Biggs & Collis, 1982) was used to categorize responses into different levels. Five levels of the taxonomy were considered:

1. Prestructural: the response does not address the task at hand;
2. Unistructural: one relevant aspect is evident in response to the task;
3. Multistructural: several relevant aspects are evident but not integrated;
4. Relational: several relevant aspects are apparent and they are integrated into a coherent whole; and
5. Extended Abstract: the response goes beyond immediate task requirements and introduces a new level of abstraction.

Thread response trees (Aviv, Ehrlich, Ravid, & Geva, 2003) were constructed to represent the process of online discourse. Figure 2 shows a sample thread response tree. Each circle in Figure 2 represents a message posted to the
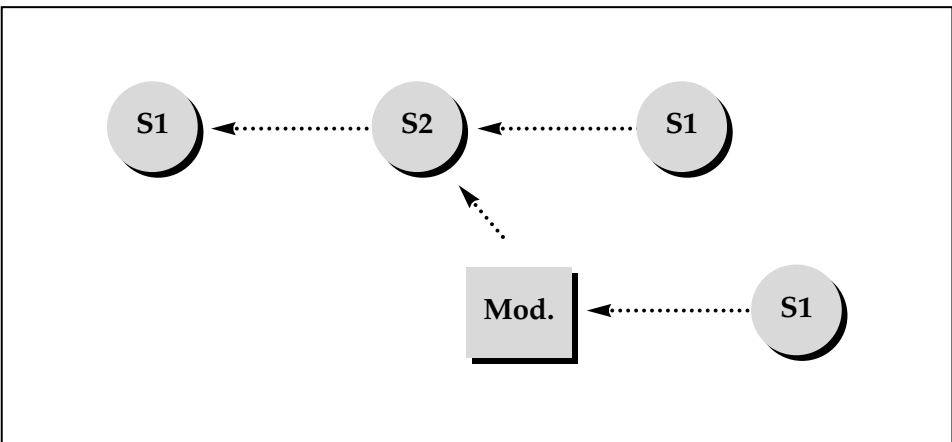

Figure 2. Sample thread response tree

discussion board, and dashed lines with arrows connect messages posted as replies to others. Squares are used rather than circles to set apart posts made by the moderator. Figure 2, then, represents this sequence:

- S1 made a post to the discussion board
- S2 replied to S1's post
- S1 replied back to S2
- The moderator replied to S2
- S1 replied to the moderator's post

The thread response trees illustrated a variety of aspects of the process of the discourse, including the number of discussion threads that formed, how many threads each individual participated in, and the growth and lifespan of each thread.

After the SOLO and thread response tree analyses, the discourse content was analysed. The four major ideas Merseth (2003b) identified as embedded in the case served as initial categories for generating codes: (i) mathematical concepts related to sampling; (ii) assessment of student thinking (with assessment conceived of as "an integral part of instruction that informs and guides teachers as they make instructional decisions") (NCTM, 2000, p. 22); (iii) pedagogical strategies used by the teacher in the case; and (iv) the context of the class including the dynamics among small groups of students. Coding of segments of text went beyond the four categories when discussion themes outside of them occurred.

Results

Pre-Case Exercise Results

Four different SOLO levels were apparent in participants' responses to the pre-case exercise. The qualitative description of each level, sample response excerpts, and the frequency of responses fitting each category are shown in Table 2.

Table 2
SOLO Levels of Response to the Pre-case Exercise

SOLO Level	Qualitative Description	Sample response excerpt
Unistructural (*n* = 10)	Percentages are considered important to the solution, but sample size is not	"I believe that the number of days the number of boys was 60% or greater is equal in the larger and smaller hospital because if you take 60% for each hospital, they each come out to be equal, percentage wise. 9 to 15 is 27 to 45."
Multistructural (*n* = 1)	Percentages and sample size are both considered important	"I think that roughly the same because if the percent is

	to the solution. However, these two ideas are not combined to produce a plausible response.	consistent then the chances that some days are recorded are about the same. ... Since 45 and 15 aren't very large then it would be rather similar."
Relational (*n* = 2)	Concepts of percent and sample size are combined to produce a plausible response.	"Since it will be more likely that at least 9 boys are born in a given day than 27, I predict that the smaller hospital will record more days of which the number of boys born was 60% or more."
Extended Abstract (*n* = 1)	Concepts of percent and sample size are combined to produce a plausible response. An analogy to a parallel situation is drawn.	"The larger a sample of a population is the more likely it is for it to be comparable with the theoretical mean. For example, if you flip a coin 5 times you are more likely to get 60% heads than if you flipped it 1000 times. ... The more data you have (in this case babies) the closer you will stay to the theoretical probability."

SOLO levels ranged from unistructural to extended abstract. Most responses were unistructural, since they focused on the single concept of percent, but not sample size. Unistructural responses, given by ten of the participants, generally calculated sixty percent of the average number of births at each hospital but did not consider sample size to be important to the solution of the problem. The one multistructural response, given by Claire, considered percentages and sample size to be important to the solution, but concluded that the average number of births at each hospital, 45 and 15, were so close together that there wouldn't be much difference between the two. The two relational level responses, given by Ivan and Elaine, used the concepts of percent and sample size to reason that the smaller hospital was likely to have more variability. The one extended abstract response, given by Nancy, extended the relational line of reasoning by offering an analogy to the similar situation of flipping a coin different numbers of times.

Thread Structure

Threads formed by participants during the discussion often did not focus exclusively on one discourse theme. Multiple discourse themes were often evident. There was also overlap in the topics of conversation among the threads. These thread-related phenomena are illustrated further in the next few sections, which describe the discourse themes that emerged during the conversation. The descriptions of discourse themes sometimes draw from posts in a variety of different threads. A summary of the discourse themes that arose appears in Table 3. The first four themes relate to the ideas Merseth (2003b) identified as embedded in the case.

Table 3
Summary of Discourse Themes

Discussion board theme	Subcategories
Mathematical content and participants' reflections on their content knowledge	Pre-case exercise solution Pre-case exercise difficulty
Assessment of students' thinking	Sources of difficulty for students
Pedagogy	Lesson planning (mathematical goals, timing, sequencing)
	Forms of pedagogy (manipulatives, group work, homework assignments)
	Questioning techniques
Context	Organization of groups
	Group dynamics
Other	Case writer choices

Figure 3 shows the seven threads of conversation formed by participants during the case discussion. The seven thread response trees constructed during data analysis are stacked on top of one another to provide a comprehensive picture of thread development during the seven days allotted for the assignment. As shown in Figure 3, each thread spanned multiple days. Thread 1 spanned the greatest number of days, as the first post was made on the first day of discussion, and the last post was made on the last day of discussion. Thread 7 spanned the least number of days, as the first and last posts were only two days apart. The number of posts to the board was at its minimum on the first day of the discussion, with three posts being made. The number of posts reached its maximum on the second-to-last day, with 13 posts being made. Thread 3 contained the greatest number of participant posts with 13. Thread 2 contained the least number of posts with 3. Participants' first initials are used in Figure 3 as a way to indicate which posts they made.

Discourse Theme 1: Mathematical Content and Participants' Reflections on their Content Knowledge

During discussion board interaction, several themes emerged, as shown in Table 3. One of the themes pertained to mathematical content of the case. Within this theme, the solution to the pre-case exercise was discussed. Nancy, who had written an extended abstract response to the task, posted her solution to the discussion board when Brittany began thread 4 by writing that she wasn't sure how to solve it. After reading Nancy's solution, I made a post asking other participants if they agreed with her thinking. Greg, Brittany, and Elaine each made posts stating that Nancy's analogy to the similar situation of flipping coins was helpful. Elaine, for example, remarked, "I can relate to Brittany's initial post, because I struggled to understand and reason through this problem as well when we were given it in class. I think Nancy's comment was very helpful and on target." Hence, the discussion board served as a platform for communication among participants who had exhibited different levels of thinking in their initial solutions to the pre-case exercise.

The wording of the pre-case exercise was another topic of discussion under the theme of mathematical content. In her Friday post to thread 4, Claire remarked, "The question was worded poorly and is misleading. The way it is worded makes it seem as though the smaller hospital having more days that are 60% than the larger hospital not an option." When I made a Saturday post to thread 4 validating the concern but also asking if there were any advantages to leaving the exercise worded as it was, Fran and Nancy posted messages to express agreement with Claire's original position about the wording of the question. Elaine deviated slightly from Claire's position, stating: "When I think about it ... I almost didn't pay attention to the choices that it gave more so as I simply tried to reason through the general question that it was asking." This portion of the conversation allowed participants to consider how the manner in which a problem is posed may or may not influence students' success with it.
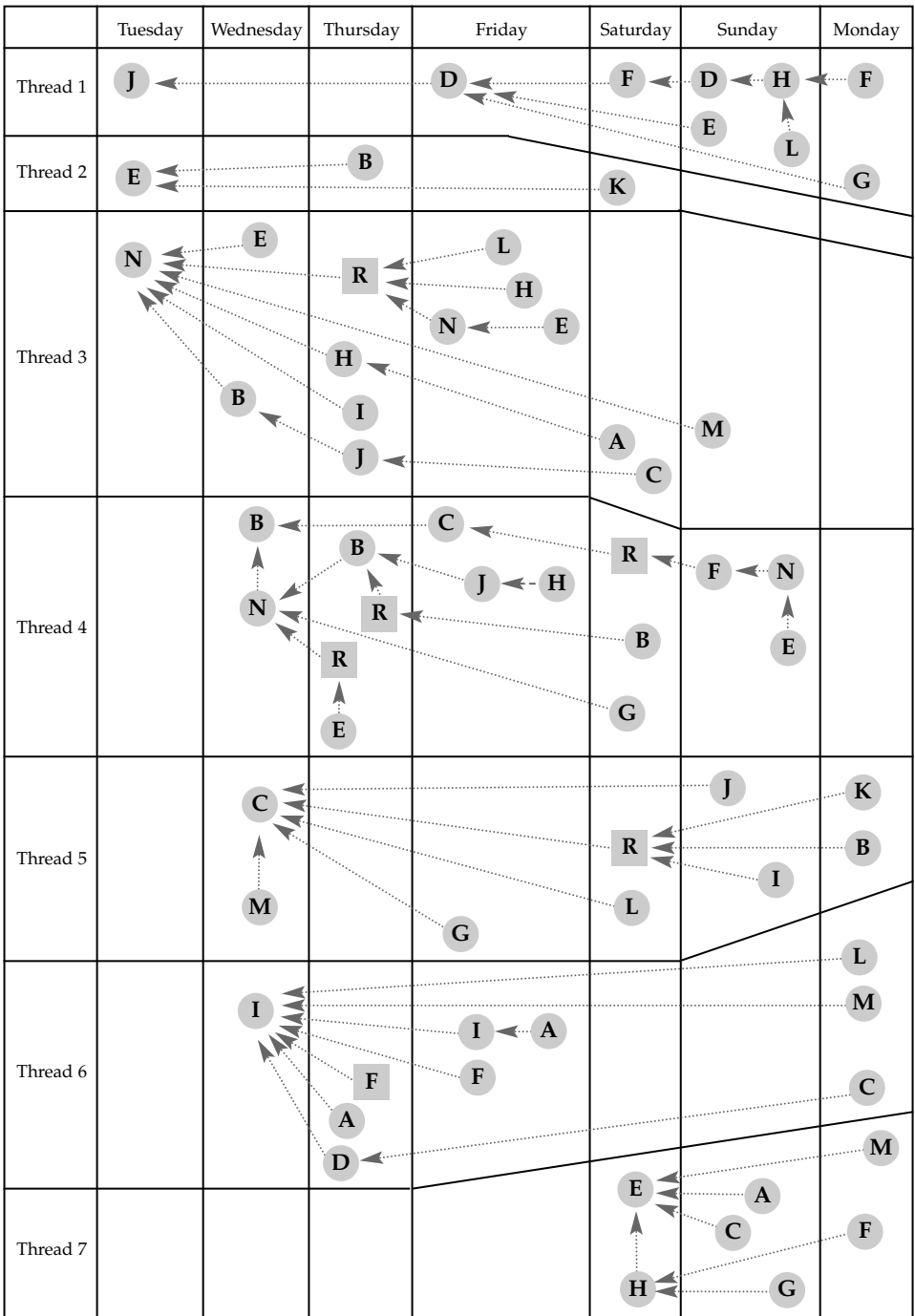
Figure 3. Threads of conversation formed by participants

Issues of task wording aside, participants raised concerns about the difficulties they had in solving the pre-case exercise. Brittany remarked in her Thursday post to thread 4, "If we didn't get the question right, how can we expect our students to come up with the right answer?" Janet posted a reply to Brittany's message echoing her concern, stating, "I worry about this when I become a teacher, not being able to explain myself and then expecting the students to explain it." Harold addressed these concerns with a message posted in reply to Janet:

> If a student asks you a question and you do not know the answer then it is OK to say I don't know but I'll get back to you. It is OK to not be perfect. ... I also think that we all need to reflect upon how we are doing in the classroom and try and continually find ways to improve upon our teaching strategies and techniques.

In this instance, the discussion board served as a platform for voicing anxieties about lacking mathematics content knowledge and identifying areas for professional growth.

Discourse Theme 2: Assessment of Students' Thinking

As mentioned earlier, the case provided descriptions of students' conversations with one another as they worked through the hospital problem. The conversation among one group of students struggling with the problem was given in detail. Participants took advantage of this feature of the case to note possible obstacles to students' thinking. This occurred in threads 2, 3, and 4. The way in which the question was phrased was identified as one possible obstacle. For example, after posting her solution to the hospital problem, Nancy acknowledged, "I can see how this question would really confuse students since all of the possibilities are not included." Elaine conjectured that students in the case became so caught up in trying to figure out the theoretical probability connected to the problem that they did not see how a concrete simulation could be done to produce a related empirical probability. Mrs. Wexler's actions during the case were also identified as a possible source of student difficulty, as some participants felt she should have attended more to the students' thinking to help guide her actions. For example, as part of thread 3, Laura remarked:

> I think it is essential that the teacher pay very close attention to the individual student's thinking process ... if the majority of the class is having difficulty solving a particular problem then the teacher may need to provide more information.

Therefore, discussing the case allowed the formation of hypotheses about various possible hindrances to students' statistical thinking.

Discourse Theme 3: Pedagogy

Discussions about pedagogical issues related to the case occurred in each of the threads on the discussion board. The different pedagogical issues discussed can be grouped into the three categories: lesson planning, forms of pedagogy, and questioning techniques.

As participants analysed the lesson planning in the case, they focused on its mathematical goals, timing, and sequencing. Comments about the mathematical goals included those related specifically to the hospital problem (e.g., "I imagine that through this activity she was hoping that the students would be able to draw upon this knowledge of probability and sample size and make connections with the problem."), as well as more general goals (e.g., "I think that a teacher's main objective should be to show students that they can solve problems on their own."). In regard to the timing of the lesson, a disagreement arose about how this lesson should have been closed. Some argued that time should have been allowed to "wrap-up" the lesson, as Janet started thread 1 by stating:

> The only thing that bothered me about the way the teacher went about teaching this case was that she did not leave time at the end of class to discuss it. She said they would discuss it the next day, but many of the students will have forgotten what they discussed the day before. She should have planned ahead and made sure she had enough time for discussion.

Some participating in the same thread disagreed with the idea that problems must be completed within one class session, as shown in Harold's remark: "I disagree with having to wrap up the lesson in one class discussion. If you can peak [sic] their interest allowing them to think it over for a day or two is not a bad idea."

The final pedagogical aspect of the case that drew participants' attention was the sequence in which events took place. Most who focused on this theme commented that the teacher's strategy of having the students work individually before working in groups was effective, although Kelly was critical of this aspect of the lesson, stating, "it would have been good to start this discussion with a group discussion of what exactly the question was asking, to make sure that all the students were on the right track to figuring out the answer." Therefore, the ALN discourse contained a diversity of perspectives about various aspects of the lesson presented in the case.

The use of different forms of instruction for mathematics also drew a variety of opinions. In this area, participants discussed the use of manipulatives, group work, and homework assignments. All three forms of instruction were at some point framed in positive terms, as illustrated by the following three discussion excerpts:

> Manipulatives: I think that manipulatives really can make a huge difference in students' learning. It makes them see things more clearly and easily. I have always liked to use them because I am more of a visual learner. (Megan, thread 3, Sunday)

Group work: It was a good idea to have the students work in groups to find the answer. This allows students to expound on their own opinions or create new ones based off of other opinions or ideas. (Diana, thread 5, Wednesday)

Homework: I think if she (Mrs. Wexler) assigned them homework, then it would have still been fresh on their minds, because there is never enough time in the day for mathematics discussions. (Diana, thread 1, Friday)

Other posts, however, cast doubt on the manner in which these three pedagogical forms were used in the case at hand:

Manipulatives: I feel that Mrs. Wexler should have given them some direction with the coins. In the story, it said that she gave them the coins and pretty much let them free to work with them. (Brittany, thread 3, Wednesday)

Group work: There are certain ways group work can be non-beneficial. Distraction is a huge part of it. Sometimes, when confusion ensues within a group, group members may begin to listen to other groups for answers. Or depending on the group members, work may be done quickly or not at all. (Ivan, thread 5, Sunday)

Homework: I don't think that assigning it (the hospital problem) for homework would be a good idea. ... I have seen many students not very motivated to do homework or they rush to fill in answers before class starts because they don't feel like doing it at home. (Fran, thread 1, Monday)

Posts questioning group work usage came about after I asked participants to think about any possible instances when that pedagogical form might not be valuable. In my Saturday post to thread 5, I asked:

What are some non-beneficial ways to use group work? The reason I'm asking is because any given form of instruction can be used well or it can be used poorly. I think it can be instructive to think in both directions about any given form of instruction. Any thoughts?

However, the conflicting views about the instructional forms of manipulatives and homework surfaced without moderator intervention.

The third major pedagogical issue that surfaced concerned the types of questions mathematics teachers should ask students. In the case itself, Mrs. Wexler asked students fairly non-leading questions as they worked, such as: "How can you figure this out?," "What else might you do," and "Is that right?" The prospective teachers were again split on this pedagogical issue. Excerpts from thread 7 illustrate the dispute. Kelly, for example, felt that Mrs. Wexler should have asked questions more likely to lead students to the correct answer to the problem. To begin thread 7, she stated: "It seemed to me like the teacher wasn't really helping the confusion of the students with her questions. ... I think she should have tried to ask questions that directed the students more toward the right answer". In his Sunday post to the same thread, Andrew disagreed with this idea, stating: "Somewhat high level learners and should be able to do a lot of the questioning on their own. For that reason, I like how the teacher didn't ask

too many questions but left them to 'battle' it out." As with the other pedagogical issues that arose during the conversation, no final consensus between individuals on either side of the issue was reached.

Discourse Theme 4: Context

The contextual aspect of dynamics among group members was considered at some point in each of the conversation threads. Some participants felt that Mrs. Wexler understood this aspect of the classroom context well and was effective in managing it. Diana's post at the beginning of thread 5 is illustrative:

> The teacher did a good job at monitoring the groups and trying to make sure that everyone was being involved in the conversation. For example, she knows Dawn and Laura are good friends, but she also knows that Dawn works better with Laura in her group.

There was a fair amount of concern, however, over the fact that not all of the students described in the case were able to contribute in a meaningful manner to the group conversation. Some participants suggested that discussion rules should have been imposed to avoid this situation. Ivan, for example, argued in the first post to thread 6: "Mrs. Wexler should have set the rule that the group needed to at least vote on the top two ideas for a consensus. Otherwise anyone yelling the loudest would get their way." Andrew disagreed later in his Thursday post to the same thread, stating: "I kind of like the aspect of group discussion without any rules. This way they don't have anything else to focus on besides working on the problem at hand." Some consensus on the issue was reached later on in the thread when I suggested that the discussion should turn to specific examples of what might be overly-restrictive or overly-permissive ground rules for the given situation. Ivan and Andrew were then able to agree that the students in the case should be expected to follow the rule of respecting one another's contributions.

Discourse Theme 5: Case Writer Choices

One discussion theme emerged that wasn't related to any of the categories that Merseth (2003b) identified as embedded in the case. A brief discussion of the case writer's choices in constructing the case began when Brittany asked as part of thread 4, "How come we don't get to see what happens in class the next class period?" This question arose because the case account concluded at the end of a class period where no resolution about the solution to the hospital problem had been reached. I later made a post hypothesizing that the case writer wanted readers to form their own answers to that question, and Janet made a similar remark, stating, "I like how we don't see what happens in class the next class period because it allows us to think of the many ways the teacher could have approached this problem." This brief exchange illustrated that some participants felt a need to understand the case writer's thinking along with the mathematical, pedagogical, and contextual issues in the case.

Discussion

The discourse content of the ALN discussion was similar to what one might expect during a face-to-face case discussion. The case helped spark the types of asking, debating, and critique that are essential to teacher education programs that embrace the uncertainty of practice (Ball, 1996). The specific discourse themes largely aligned with the ideas Merseth (2003b) identified as embedded in the case, and therefore might have been brought out in face-to-face discussion as well. However, some aspects of the online discourse process did differ substantially from what one would expect in a face-to-face setting. Two of those process aspects will be examined in the following discussion: (i) The manner in which the online discussion allowed voices that were normally silent to be heard; and (ii) The unusual extent of "wait time" in the asynchronous environment.

Hearing Voices that Would Normally Remain Silent

In some instances, the discussion board provided a forum for students who normally were hesitant to participate in whole-class, face-to-face discussions. Andrew, for example, usually did not get involved in large group, loosely structured face-to-face discourse. On the discussion board, however, he openly debated pedagogical and contextual issues with others such as Kelly and Ivan. In the process of debate, he managed to find some common ground with Ivan about desirable structures for interaction among mathematics students. Andrew's participation in debate in the large group setting helped inject life into the conversation, as such disagreements and debates are valuable in the process of forming a learning community among a group of individuals (Matusov, Hayes, & Pluta, 2005). Many professional development efforts for mathematics teachers fail because of teachers' hesitance to disagree with one another (Ball, 1996). Therefore, Andrew made significant contributions to whole-class online discourse that he would not have been likely to make in whole-class face-to-face discourse about the case.

Like Andrew, Elaine and Nancy rarely spoke during large group face-to-face class discussions. Each of them, however, made productive contributions to the online discussion. Unlike Andrew, the contributions made by Elaine and Nancy generally did not involve participating directly in debates. Elaine's contributions, as described in the earlier narrative, included affirming one of Nancy's posts, offering a different perspective on the importance of the wording of the hospital task, and conjecturing about obstacles to students' statistical thinking. Nancy's contributions included providing a solution to the hospital task and affirming contributions made by other participants. These contributions from Elaine and Nancy would likely have been missing from a large group face-to-face discussion of the case. This would have been unfortunate, because some of their contributions unpacked and examined themes embedded in the case (Merseth, 2003b).

Extent of Wait Time

The notion of "wait time" is often studied as an element of whole-class discourse. Two types of wait time that have been studied are: (i) the pause after a teacher asks a question; and (ii) the pause after a student responds to a question (Rowe, 1974). In some instances, a few seconds of additional wait time can substantially enhance the quality of students' responses (Rowe, 1986). In asynchronous environments, the feasible amount of wait time is extended from a few additional seconds to a few additional days. As noted in the introduction to this article, teachers often find this extra reflection time valuable in crafting their contributions to conversations (Shotsberger, 1999; Newell et al., 2002). The thread response trees suggest that the structure of the ALN case assignment for the present study provided opportunities for participants to carefully construct responses to questions asked by the moderator and by other students. There are several cases in which a moderator or participant post was answered two to three days later by another participant. For example, as part of thread 6, there are three days between Diana's post and Claire's response to it. During those three days, Claire stayed active on the board, but chose to wait to respond to Diana's post. The luxury of waiting this long to formulate a response is not available in a face-to-face class setting.

While the abundance of wait time in an ALN has definite benefits, it can also have drawbacks. In face-to-face settings, case moderators can steer discourse efficiently by asking follow-up questions after responses to an initial question have been given. Some of this efficiency is lost when participants are given large amounts of time to write responses. In the present study, for example, the thread response trees show that a fairly large number of posts were made on the last two days allowed for the assignment. Because the responses came so close to the end of the conversation, it was not possible for the moderator to write responses to these posts that would steer the online discourse. The number of participants waiting until the end of the conversation to post responses may have been even greater if the assignment had not required making posts on four different days. Therefore, in designing ALN case discussion assignments, moderators need to be conscious of striking a balance between taking advantage of extended wait time while also not allowing the extended wait time to be used for procrastination that harms the flow of conversation. Just as too much wait time can be non-beneficial in face-to-face settings (Duell, 1994), too much wait time in an ALN can impede the conversation of a case.

Conclusion

This study provides some information about what one may expect when using ALN discourse as a tool to facilitate case analysis. The decision about how, if at all, to use this tool in a given situation can be informed by the description of what transpired in this case, coupled with the reader's knowledge of his or her own students. It should be kept in mind that this paper describes an instance in which ALN case discourse supplemented a face-to-face class. It is unknown if similar

results would have been obtained had the community existed entirely online. The results suggest, however, that in the particular setting described, the ALN discourse helped participants unpack the important elements of the case while enhancing contributions from normally silent individuals. Future studies might draw comparisons between online and face-to-face case discussions, examine participants' mathematical learning in more detail, and investigate the extent to which participants find the ALN process beneficial. These questions are worth further attention because the present study suggests that, in some situations, online discourse can be a viable tool for facilitating case analyses and enhancing prospective teachers' knowledge.

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