

Exploring Nontraditional Undergraduates' Resistance to Active Learning in an Online Support Forum in Calculus

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Abstract

This research paper explores the behaviors of an interdisciplinary group of nontraditional science, engineering, education, and mathematics undergraduates who were required to participate in an online support forum for graded credit in first-year calculus. Student resistance is often highlighted as one of the least explored and, perhaps, least understood of all instructional roadblocks to active learning. Efforts to understand resistant behaviors may be complicated by context and viewpoint; students may view their own behaviors, perceived as “resistant” by instructors, differently. Moreover, the rationales and behaviors of students who resist asynchronous, technology-based active learning strategies (e.g., web-based discussion forums) may diverge from those of students who are asked to participate in active learning exercises within a physical classroom.

In this study, researchers gathered mixed methods data related to student participation in an online support forum during sequential course offerings of Calculus I and II. Using a concurrent, embedded, mixed methods research design, the researchers gathered several forms of quantitative and qualitative data: text-based forum posts and posting statistics, student survey responses, and one-on-one student interviews. Researchers conducted an exploratory thematic analysis of the combined dataset to understand how students resisted participation in the forum.

Results describe student behaviors related to participation and resistance in the online support forum. Several factors were shown to affect student resistance including instructor activity in the forum, forum response times, technological barriers to participation, and the participation grading scheme. Implications for instructors seeking to employ asynchronous active learning with nontraditional students using currently available online forums are provided.

Introduction

“I never teach my pupils, I only attempt to provide the conditions in which they can learn.”
Albert Einstein

Einstein explains that his main goal as an instructor was to provide the means and opportunities for students to take control of their own learning. Currently popular, this idea of emboldening students to create their own knowledge and understanding isn't entirely new. Throughout history, several renowned instructors—including Socrates, Aristotle, Pythagoras, and Einstein—have encouraged students to formulate questions as well as find their own answers and solutions. These celebrated instructors helped students develop their own innate reasoning skills to make sense of the problems they faced and the solutions they created.

Appreciating the benefits of student-centered teaching approaches, educators today are increasingly interested in incorporating these tenets into their own pedagogical practices. Doing so, however, often leads to mixed results within the classroom. As many instructors find, there can be pushback or resistance on the part of the student to accept the new teaching practices

whenever different or new instructional methods are introduced. This resistance can be exhibited by a variety of behaviors that can impede the learning of not only the resistant student, but also other students in the class.

As teaching practitioners and researchers, our goal in conducting this study was to promote active student knowledge construction by exploring how and why students resist an asynchronous, web-based active learning strategy. In this study, online forum participation was considered to be an active learning activity because it a) encouraged student-initiated question and answer style dialogue with the instructor and b) enabled participation in common active learning strategies (e.g., group discussion and peer-to-peer learning) among the students while out-of-class. Specifically, we share findings related to student resistance to required participation in an online forum in first year calculus.

Literature Review

Active learning. It is typical for instructors in science, technology, engineering, and mathematics (STEM) to adopt more traditional pedagogical approaches¹. Traditional approaches are often linked to a belief that students come into class “empty,” waiting to be filled with all the knowledge that the instructor can give them¹. With this mindset, the role of the instructor is to disseminate as much knowledge as possible within the time allotted; the role of the student is to passively accept this knowledge, memorizing and recalling all that the instructor instructs. Instructors who adopt a traditional teaching approach often use lecture and direct instruction as their primary teaching strategies.

Although direct instruction has its place in many STEM classrooms, sole reliance on this method of teaching may have less than desired effects on student learning². Recognition of the adverse effects of reliance on direct instruction has lead many to explore other teaching approaches that have been shown to develop student knowledge and understanding¹⁻⁴. Borrego et al.³ discuss strong evidence suggesting that students increase their knowledge and understanding when Research-Based Instructional Strategies (RBIS), like active learning, are implemented in the classroom. In fact, when properly employed, active learning is believed to “promote high-level problem-solving, creative and critical thinking skills, deep learning and improved knowledge retention”⁵. Johnson, Johnson, and Smith outline three beliefs that lay the foundation for active learning. First, knowledge is constructed, discovered, transformed, and extended by students; second, students actively construct their own knowledge; and finally, instructor effort is aimed at developing students’ understanding¹. In other words, active learning engages students to do things and think about those things they are doing⁶.

Active learning helps to transform students from passive participants in their education into participative ones by encouraging them to engage with the course material and exercise their critical thinking skills⁶. Active learning enables students to be physically, emotionally, cognitively, and psychologically involved in constructing their own knowledge and understanding of course material¹. In other words, active learning “allows students to customize their own pursuit of learning” and, thus, to stay connected to the knowledge they seek to use and create⁷. Active learning puts the control of understanding into the hands of the students, where

knowledge becomes less abstract and more tangible. Active learning is considered to be more effective in educating diverse classrooms and also to improve the retention in STEM programs³.

Online discussion as an active learning strategy. One of the most common ways to begin to implement active learning, and the way that instructors often try first, is large group discussion¹. This teaching approach allows students, perhaps an entire class, to discuss content while guided by the instructor. Large group discussion requires students to take a more active role in listening and following the thought pattern of the instructor and other students². As Cangelosi² points out, students need to be “cognitively active, but physically inactive” during group discussion, thus requiring students to think more about the material and other students’ comments. However, because students are not accustomed to such cognitive activity and are more frequently placed in the role of a passive spectator, it can often be difficult to get students to participate in class¹⁻³.

Despite some of its drawbacks and difficulties, discussion can also be used as a tool for active learning when applied in an online discussion forum. During discussion, participants have the opportunity to interact and collaborate with one another to fulfill and meet their learning needs⁸. Furthermore, moving discussion to an online venue has several advantages. First, instructors and students have the convenience of being able to add to a discussion asynchronously. They have the time to reflect on discussion prompts and to formulate a well-thought out response. Second, online discussions can increase the amount of participation because many students feel more comfortable sharing online (either because of some sense of anonymity or because they had more time to ponder and formulate a response). Third, instructors may get more interaction with their students because they are communicating outside of classroom hours⁹. Moving discussions online can also free up class time to allow for other forms of active learning.

Another benefit provided by the use of online forums as an active learning strategy is the ability they provide students to access help outside-of-class. It is common for most STEM students, especially those engaged in mathematics, to seek help when working on homework assignments or attempting to master conceptual understanding¹⁰. By implementing online forums as support mechanisms (i.e., question and answer forums), students are able to seek support at the precise time they are engaging with difficult concepts: out of class while completing assignments or studying. Additionally, online forums enable other students to deepen their understanding by having the opportunity to answer questions and explain concepts and problem solving approaches to other students. In this way, teachers can promote peer instruction, another RBIS³, to occur organically among the students in a class.

Student resistance to active learning. While the goal of any active learning strategy is to improve student learning outcomes^{3,6}, some students may resist participation due to anxiety and stress caused by the introduction of new active learning activities⁷. As Burger⁷ explains, students can become concerned about their lack of experience with and knowledge about topics covered in class. These concerns can cause students to disengage from active learning activities. Active learning requires students to take responsibility for their own learning; some students might not feel ready for this challenge⁵. Furthermore, newer, nontraditional teaching methods

can cause students to incorrectly assume that they will experience a decrease in their learning³ and resist participation based upon these assumptions.

When students become frustrated, upset, angry, disengaged, or even overly concerned, it can cause them to behave or act differently than they typically would. Often, these behaviors and actions are referred to as instructional dissent, student misbehavior, or student demotivation¹¹. When these behaviors are associated with a new teaching strategy (e.g. active learning strategies) they are collectively referred to as student “resistance”³. Student resistance, however, should not always be perceived as negative behavior or treated as completely problematic⁴.

Richmond and McCroskey⁴ explain how student resistance can be considered as either constructive or destructive oppositional behavior. The most visible and problematic type of resistance is destructive resistance. Examples of destructive resistance include cheating on tests and assignments, refusal to participate during in-class activities, missing class, or attempting to distract the instructor or other students from a given task. Destructive resistance acts to halt or stunt student learning.

Constructive resistance enables students to continue to learn, but not necessarily in the way the instructor intends. Some possible constructive oppositional behaviors exhibited by students include asking challenging questions, submitting constructive feedback to the instructor, helping other students without being asked, or offering corrections to the instructor¹¹. Constructive resistance is often inadvertently encouraged by instructors who implement teaching practices that elicit off-task behavior (e.g., encouraging students to shout out answers); provide homework that is too repetitious, monotonous, or difficult; or appeal to the emotions instead of cognitive learning of their students⁴. Ultimately, constructive resistance may help students to engage more deeply if managed appropriately by the instructor.

Research Questions

Acknowledging the need for a deeper understanding of student resistance to active learning, this study was guided by two research questions:

1. To what extent do nontraditional undergraduates resist required participation in an asynchronous, online support forum in first year calculus? [QUAN]
2. What are the attitudes and rationales of nontraditional undergraduates who resist participation in the online forum? [QUAL]

Frameworks

Theoretical framework. The theoretical framework for this study is social constructivism (Social Development Theory). Social constructivism, as pioneered by Lev Vygotsky, purports that learning is a socially and culturally participatory process. For social constructivists, knowledge is perpetually built within a social context. Social constructivists assert that learning is not “...an unfolding or maturation of pre-existing ‘ideas;’ learning is the

formation of such ideas—out of what originally was not an idea—in the course of socially meaningful activity”¹². Social constructivists argue that the motivation to learn (i.e., social motivation) increases when knowledge is used to help others¹³. Application of a social constructivist framework made it possible to envision an asynchronous online forum as a pedagogical tool that can be used to connect learners and promote learning.

It is more common to see application of frameworks grounded in Piagetian or cognitive constructivism within the mathematics education research literature. Cognitive constructivism emphasizes the “...autonomy of the individual in the construction of her or his knowing...”¹⁴ over social and cultural influences on learning. Despite cognitive constructivism’s history of use within mathematics education research, we adopt social constructivism for this study based upon the consideration it gives to contextual factors (i.e., situated learning) and learner intersubjectivity¹² as important influences in the learning process. Moreover, because social constructivism can account for the learning effects of an active and involved instructor (i.e., Vygotsky’s Zone of Proximal Development¹³), it is a more appropriate theoretical frame for this study wherein the instructor may be involved in meaning-making on the online forum.

Methodological framework. In order to develop a framework for assessing student participation in the online forum employed in this study, we looked to the literature to find approaches used by other researchers in similar environments. We found several studies^{10,15–17} that outline ways used to categorize the level of student participation in online classes and/or utilizing online discussion forums. Vonderwell and Zachariah¹⁷ point out that there are several factors that determine the amount of student participation in online learning. These factors include the weight that participation has in determining a student’s grade, criteria used to determine adequate participation, course design and instructor interventions (i.e. the way the instructor implements the online support forum), learner background knowledge, and the design of the discussion forum interface. Taking all of these factors into account, Vonderwell and Zachariah define online forum participation as “taking part and joining in a dialogue for engaged and active learning”¹⁷.

In order to better understand the level of participation of online learners, Hammond¹⁵ divides the online participants into three groups: communicative learners (those who found time and had the confidence to take part of the discussion), quiet learners (those who found time to participate by reading, but didn’t add to the discussion), and non-participants (those who did not read other’s posts or participate in the discussion). Vonderwell and Zacharias¹⁷ discuss similar categories: workers (those who are proactive in participating), lurkers (those who participated in more of a “read-only” capacity), and shirkers (those who had minimal participation). In both categorizations, the number of posts a student made determined their categorized level of participation.

It is argued that the determination of a student’s level of participation in online learning is complex and should not be determined solely by the number of posts a student makes^{16, 17}. In fact, the kind of posts a student makes may provide a better indication of their intended or perceived level of participation. Hrastinski¹⁶ suggests that online learner participation in an online discussion forum can be sorted across six groups or levels: participation as accessing e-learning environments (level 1), participation as writing (level 2), participation as quality writing

(level 3), participation as writing and reading (level 4), participation as actual and perceived writing (level 5), and participation as taking part and joining in a dialogue (level 6). Although these categorizations were developed for a broad spectrum of non-STEM disciplines, the complexity associated with making an assessment of online learner participation is clear.

In order to describe and understand learner participation in an open, online mathematics support forum, van de Sande¹⁰ categorized student posts into one of four types: slacking, coasting, ramping, or sustaining. Slacking described the behavior of posters who post a question without any initial attempt toward a solution. Coasting described the behavior of posters who, in addition to posting an initial question, post initial action to resolve a conflict or attempt a solution to a problem. However, after the initial questions and one further attempt, students who are coasting make no further posts—even after helping interventions. Ramping described the behavior of posters who post an initial question but do not make further posts until help or intervention has been posted. Sustaining described the behaviors of posters who, in addition to an initial question and an attempt to provide a solution, also make additional posts after help intervention in order to continue to develop their understanding.

Research Context and Limitations

Context of instruction. This study took place at a western, public, land-grant university within two first-year calculus sequences (i.e., sequential offerings of Calculus I and II). The courses were taught in the evenings, within the university's regional campus system, to facilitate participation of nontraditional students who work or care for dependents during the day or who have to commute to educational centers to attend class. A veteran calculus instructor from the university's Department of Mathematics provided instruction for all of the courses in the study. Classes were delivered via interactive video conferencing ("synchronous broadcast" delivery) and accessed real-time by students located at several regional campuses and education sites located throughout the state¹⁸.

Researchers gathered mixed methods data in the first-year calculus courses that were delivered during the 2013-2014 and 2014-2015 academic years (AY). Courses in the first sequence (AY 2013-2014) were considered "control" sections and those in the second sequence (AY 2014-2015) were considered "treatment" sections within a quasi-experimental design framework¹⁹. Within treatment sections, a freely available online support platform, Piazza (www.piazza.com), was implemented as the treatment intervention. Data gathered in the treatment sections of Calculus I and II (AY 2014-2015) are the subject of this study.

The calculus instructor required students enrolled in the treatment sections to post questions related to concepts or out-of-class assignments (i.e., homework) in the online forum weekly. Posting was required a) to provide opportunities for collaborative learning and peer-to-peer instruction among students and b) to improve instructor-based support for the geographically dispersed student body. Researchers selected the Piazza platform as the intervention based on its a) wiki nature that allows participants to edit posts for organization and content, b) conceptual organization, and c) built in equation-editor with symbolic editing features²⁰. The instructor hand-graded (for on-topic completion only) the posts. Posting was worth 8-9% of the final course grade.

Nontraditional student context. The calculus courses in this study were delivered as part of the university’s regional campus program that seeks to extend educational access to geographically dispersed and nontraditional students located throughout the state via distance delivered instruction²¹. Choy²² describes a “traditional student” as

One who earns a high school diploma, enrolls full time immediately after finishing high school, depends on parents for financial support, and either does not work during the school year or works part time.

Understanding that there are varied ways in which students differ from this traditional student archetype, Horn²³ proposed a continuum model to describe the extent to which students can be considered nontraditional. According to this model, a nontraditional student in postsecondary education is one who possesses *any one of the following characteristics*:

- Delays enrollment (does not enter postsecondary education in the same calendar year as high school graduation);
- Attends part-time for at least part of the academic year;
- Works full-time (35 hours or more per week) while enrolled;
- Is considered “financially independent” (i.e., is not a dependent of a parent or guardian) for the determination of eligibility for financial aid;
- Has dependents other than a spouse (usually children, but may also be caregivers of sick or elderly family members);
- Is a single parent (either not married or married but separated and has dependents); or
- Does not have a high school diploma (completed high school with a GED or other high school completion certificate or did not finish high school).

Students are categorized as “minimally nontraditional” if they possess only one (i.e., any one) of these characteristics, “moderately nontraditional” if they possess two or three characteristics, and “highly nontraditional” if they possess four or more characteristics²³.

Table 1.

Participant Self-Identification of Nontraditional Student Characteristics

	Number of Nontraditional Student Characteristics Indicated by Survey Participants							
	0	1	2	3	4	5	6	7
Calculus I Treatment	0	3	3	7	3	1	1	0
Calculus II Treatment	1	2	2	5	1	0	0	0

Anecdotally, students who participate in the university’s regional campus programs—instead of the more traditional daytime programs offered at the university’s main campus—are considered nontraditional for a variety of reasons including having a break between high school and college, attending school part-time, working while attending school, and having dependent care responsibilities. Specifically, the survey administered in this study listed the seven

nontraditional student characteristics presented by Horn²³ and asked participants to select all of the characteristics that applied to them. Participant responses to this question are provided in Table 1. Using this data, survey participants were grouped into the three nontraditional student categories as shown in Table 2. Survey data supported anecdotal evidence by confirming that only one participant in this study self-identified as being a traditional student (i.e., having no nontraditional student characteristics).

Table 2.

Participant Categorization as Nontraditional Students

	Traditional	Minimally Nontraditional	Moderately Nontraditional	Highly Nontraditional
Calculus I Treatment	0	3	10	5
Calculus II Treatment	1	2	7	1

Limitations. While the nontraditional student context of the study limits the transferability of the findings, it is interesting to consider that traditional students in higher education are becoming the “exception rather than the rule”²². As Choy notes, “In 1999-2000, just 27 percent of all undergraduates [from all types of post secondary institutions, including less-than-2 year, 2-year and 4-year] met all of these criteria”²². Thus, we contend that the results of this study may present broad transferability to other educational contexts, namely community and non-residential colleges or other institutions with substantial nontraditional student populations.

Another limitation to the transferability of the findings is the way in which the calculus courses were taught (i.e., via synchronous broadcast delivery). Synchronous broadcast instruction requires an instructor to teach co-located students in a traditional, face-to-face environment while simultaneously instructing other students located at up to several remote sites via real-time audio and video feeds. Students located at these remote locations may have been more (or less) apt to participate in the online forum outside of class due to their perceptions of or attitudes toward the distance instruction they were already receiving. Thus, the synchronous broadcast mode of delivery could have affected the results of the study.

Methodology

Using a concurrent, embedded (qualitative methods embedded within a quasi-experimental, quantitative design framework), equal emphasis, mixed-methods design informed by theory²⁴ (Figure 1.), the research team gathered quantitative and qualitative data during the control and treatment sections of each course. A mixed-method approach was chosen based on Bryman’s concept of “completeness” as “...the notion that the researcher can bring together a more comprehensive account of the area of enquiry... if both quantitative and qualitative research are employed”²⁵. Findings of this study consider a holistic interpretation of the mixed methods dataset.

While the mixed methods research design we selected indicates that the data were gathered concurrently within the calculus courses, individual data collection occurred at different times in the courses. Forum posts were collected automatically in the online forum database throughout the courses as participants posted. The survey was opened and the interviews were conducted during the two to three weeks following the course final exam. Survey and interview data was collected at the end of the courses retrospectively so that participants would feel free to openly express their ideas and insights while their experiences using the online forum were still fresh in their memories. Therefore, the survey results were not used to inform interview selection. However, forum posting statistics were used to identify participants to purposely invite for interviews. In this way we hoped to uncover a wide range of rationales that students used to justify actions in relation to the forum.

Methods. The complete mixed dataset includes quantitative and qualitative data. The quantitative data consists of posting statistics (days online, number of posts viewed, number of contributions), and results from the affective outcome survey. The survey used was a tailored version of the Duke University survey entitled “The Student Opinion about Calculus Courses Survey,” developed for the NSF sponsored Project CALC: Calculus as Laboratory Course^{18,26–28}. Qualitative data consists of text-based forum posts and transcripts of audio-recorded one-on-one semi-structured interviews with the participants.

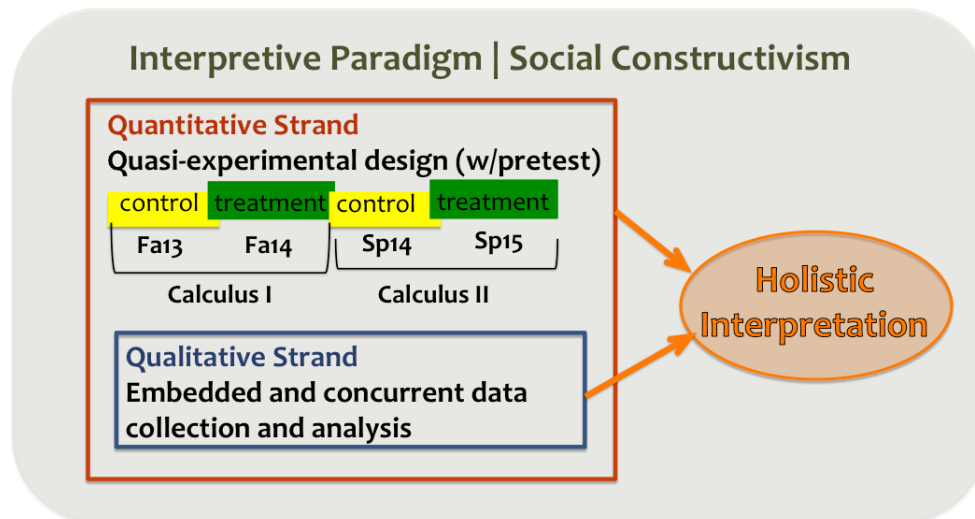


Figure 1. Mixed methods typology: Embedded, concurrent, equal emphasis design informed by theory.

Study Participants. Study participants included a subset of students enrolled in the treatment calculus sections (Table 3). At the start of each course, the principal investigator (PI) met with the students to discuss the project per the IRB protocol and to provide a letter of informed consent. To volunteer for the study, students were required to sign and return the letter. Volunteers were given an individual identifier used to link mixed-methods data while maintaining participant confidentiality. Not all students who volunteered to participate in the study by signing the letter of informed consent at the beginning of the semester completed the online survey at the end of the semester. Those volunteers who did complete the online survey (\$5) or interviews (\$25) were provided gift cards to the university bookstore.

Table 3.

Study Participant Breakdown within Treatment Sections

Students who...	Enrolled	Withdrew	Eligible to Volunteer	Volunteered	Surveyed	Interviewed
Calculus I Treatment	35	5	30	25 (83%)	18 (60%)	5 (17%)
Calculus II Treatment	16	0	16	15 (94%)	11 (69%)	2* (19%)

* Two students from Calculus II were interviewed but the data from one interview was lost due to a recording malfunction.

Assessing online forum participation in this study: Coding text-based posts. Because the participants in this study were encouraged to ask questions as well as provide answers on the online forum, it is important to account for both of these roles when assessing levels of participation or resistance. Utilizing the research from several prior studies^{10,15-17} we created a hierarchy of online forum participation (Figure 2) to envision the ways in which participants could engage in active participation in the online forum in this study. The hierarchy begins by separating the study participants into two distinct groups: online forum participant and non-participant. Those who make no effort to participate in the forum in any way (e.g. viewing posts, posting initial questions, or responding to posts) fall in the non-participant group. Those who do participate fall into either the viewer or poster category. Those who participate solely by viewing posts but do not engage in asking questions or adding to discussions are categorized as viewers while those who ask questions or attempt to join in discussions and discover solutions are considered posters.

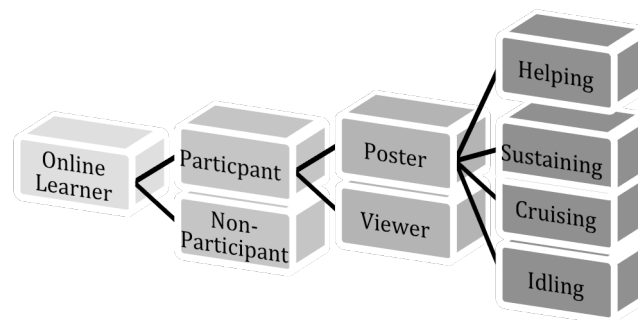


Figure 2. Hierarchy of online forum participation.

Then, building from the online forum posting categories presented by van de Sande¹⁰, posting behavior was broken down into four categories: idling, cruising, sustaining, and helping. Using social constructivism to frame this study, we envision these behavioral categories to lie on a continuum with nonparticipation (i.e., destructive resistance) on one end and full engagement (i.e., socially constructed knowledge and peer instruction) on the other as shown in Figure 3. The goal for instructors is to encourage and facilitate students to traverse along the continuum in the direction of increasingly active knowledge construction.

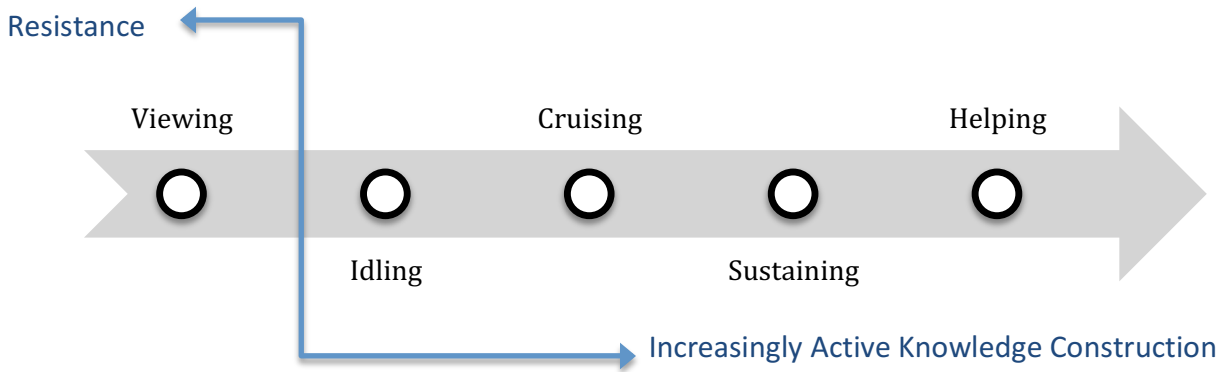


Figure 3. Continuum model for online forum participation.

Definitions for the posting behavioral categories that were applied to the student's posts by the graduate student researcher during coding are shown in Table 4. Due to the negative connotations often associated with the term "slacker"¹⁰, we labeled the posting behavior in which students post only questions and make no initial or follow-up action towards finding a solution as "idling." We defined "cruising" as the behavior of students who post questions and either a) offer initial action towards a solution (i.e., a coasting as defined by van de Sande¹⁰) or b) add to the discussion by posting again after a helping intervention has occurred (i.e., ramping as defined by van de Sande¹⁰). The act of "sustaining", as defined by van de Sande¹⁰, occurs when students ask questions and a) provide initial action toward solving the problem and b) follow up after a helping intervention. We defined "helping" as the behavior of students who attempt to provide an answer or possible solution method in response to another student's content-related question.

Table 4.

Definitions of Posting Behaviors

Code	Post question	Post Initial action toward a solution	Post after getting help	Offer help to another poster
Idling*	YES	NO	NO	N/A
Cruising**	YES	YES ----- OR -----	YES	N/A
Sustaining***	YES	YES	YES	N/A
Helping	N/A	N/A	N/A	YES

*Slacking from van de Sande (2011)

** Coasting and Ramping combined from van de Sande (2011)

***Sustaining from van de Sande (2011)

In order to determine the level of participation of an individual student and where they sit on the participation hierarchy, each post was read and categorized. This was done by examining the initial post and determining if the poster made any contribution to answering his or her own question or providing any insight on how to gain a solution. After looking at the initial post, subsequent posts in the thread were examined to determine if the poster offered any additional insight after a helping intervention was received. Based on how the student interacted in these situations, the post was categorized according to the definitions established in Table 4.

Furthermore, each helping intervention post was also categorized separately as a helping post. If, during the post another student asked for help on a different, but similar problem, such a post was treated as its own individual post.

Table 5.

Examples of Posting Behaviors

Idling Example	
Initial Question	These two problems are really messing with my head. Anyone have a way of making them make any sense?
Helping Intervention	Well, looking at the problem $1 - \frac{x^2}{6} < \frac{x \sin x}{2 - 2 \cos x} < 1$ the first thing that comes to mind is the squeeze/sandwich theorem. However, the problem is a tad confusing as it has less-than's(<) instead of less than/equal to's (\leq) even though the answer is the same. Tip: Try solving $1 - \frac{x^2}{6} \leq \frac{x \sin x}{2 - 2 \cos x} \leq 1$ using the squeeze/sandwich theorem.
Cruising Example	
Initial Question	$x = \sin y, \quad 0 \leq y \leq \pi; \quad y\text{-axis}$ For this one do we have to switch it around to make it an "x=" problem or just go through the same steps just with the variables switched around?
Helping Intervention	Yes, it need to be an $x = \sin y$ problem since it revolves about the y-axis. You need to use the surface area for revolution about the y-axis formula $S = \int_c^d 2\pi x \sqrt{1 + \left(\frac{dx}{dy}\right)^2} dy$
Sustaining Example	
Initial Question	Can someone show me how to simplify this one? I get as far as $\frac{2\pi}{9} \int_0^2 x^3 \sqrt{1 + \frac{x^4}{9}} dx$ but then I get confused. Did I set the problem up

	right? Thanks!
Helping Intervention	$U = 1 + \frac{x^4}{9}$ $du = \frac{4}{9}x^3 dx$ <p>. . . . simplifies to</p> $\frac{1}{4} du = \frac{x^3}{9} dx$ <p>Then integrate with new bounds of integration. I hope that is correct that's what I did.</p>
Follow Up (by original poster)	I'm really rusty on substitution. How do you get the new limits of integration again?
Second Helping Intervention	<p>You plug the old limits into your final u(substitution) equation.</p> <p>https://www.youtube.com/watch?v=FJoyIAIC1Ag</p>

Table 5 provides examples of typical idling, cruising, and sustaining posts and helping interventions. The idling post began with a generic “how do you do this” question followed by a helping intervention which walked the poster through a possible solution. The cruising example demonstrates how, after the posting of the question, the poster offers a possible step to the solution, making it clear exactly how the student is struggling with the problem. After the helping intervention, no other activity on this post took place. The sustaining example demonstrates the posters willingness to attempt a solution in the initial post. After a helping intervention, the original poster asked a follow-up question with regard to the helper’s response. At this point, a second helper posted a response to the follow-up question, ending the activity on this post.

Assessing resistance to online forum participation in this study: Weighted participation scoring. Within each calculus treatment section, students were required to post at least two questions or one answer to another student’s question each week over the course of sixteen weeks (a total of 32 questions or 16 answers) in order to receive full credit for participation. Since the grading scheme required students to participate at least at the idling level (posting two questions per week) to receive full credit, posting less than that was considered resistant behavior. Thus, even though viewing may be justifiably considered as a level of engagement¹⁷ in other settings, in this study students who did not post at the minimum level (i.e., idling) were considered to be engaging in resistant behavior regardless of the number of posts they viewed.

While the majority of coded forum posts fell into one of the four categories defined in Table 4 (idling, cruising, sustaining, and helping), there were three other types of posts that

emerged from the data during coding: antagonistic posts, administrative questions, and general notes. Antagonistic posts communicated negative comments about the class or instruction and were considered a form of resistance. Administrative posts communicated questions about the class structure (e.g., When is the next quiz? or What sections will be on the test?) instead of course content. Notes also communicated non-content based information but did so without specifically asking a question (e.g., introduction posts, tutoring information). For the purposes of determining resistant behavior, administrative posts and general notes were considered commensurate with idling posts (since that is the way that the instructor viewed and graded them). Answers to administrative posts were handled differently; to be coded as a helping post, the answer had to address a content-related question. Therefore, answers to administrative posts were not coded as helping posts. Furthermore, follow-up questions posted by a student other than the original poster were considered to be separate posts and coded accordingly.

Table 6.

Sample Calculations of Weighted Participation Scores

	Number of posts by category						PS Score	
	Administrative	Note	Idling	Cruising	Sustaining	Helping		
Student 1	1	1	7	4	1	29	2.305	NR
Student 2	3	1	12	2	0	7	1.016	NR
Student 3	0	1	6	3	0	7	0.773	MR
Student 4	0	1	0	0	0	2	0.156	SR

To assess student resistance, a weighted participation score was calculated for each student based on that student's posting behavior over the entire semester. This score was calculated as a weighted average based on the number of each type of post made during the semester. Weights were assigned to the code categories (administrative, notes, idling, cruising, sustaining, and helping) based on the level of engagement in active knowledge construction that each behavior represented: An administrative, note, or idling post received one point, a cruising post received 1.25 points, a sustaining post received 1.75 points, and a helping post (to a content-related question) received two points. Antagonistic posts (of which there was only one) did not receive points. Additionally, since viewing was not counted as participation in the courses, views were also not given points in the participation score.

To calculate a participation score (PS) for each student, we divided the sum of points based upon a student's coded posts throughout the semester by 32 (the minimum number of posts required by the course). Envisioning participation and resistance to lie on a continuum, we classified study participants, based upon their individual participation scores, into three categories. Those who demonstrated an unwillingness to meet the grading criteria at least half the time were categorized as "strong resistors" or "SR" (PS less than 0.5). Students who met the grading criteria at least half the time, but did not complete the required number of posts were categorized as "moderate resistors" or "MR" (PS between 0.5 and 1). Finally, those students who met or exceeded the posting requirements were categorized as "non-resistors" or "NR" (PS greater or equal to 1). Table 6 illustrates four sample calculations of participation scores.

Findings

Describing online forum participation in this study. During the Calculus I treatment section, twenty-five study participants made a total of 630 posts over 16 weeks. Total posts per participant ranged from 43 to 2. The average number of posts per participant was 20. A categorized breakdown of the types posts made by the study participants in Calculus I is provided in Figure 4.

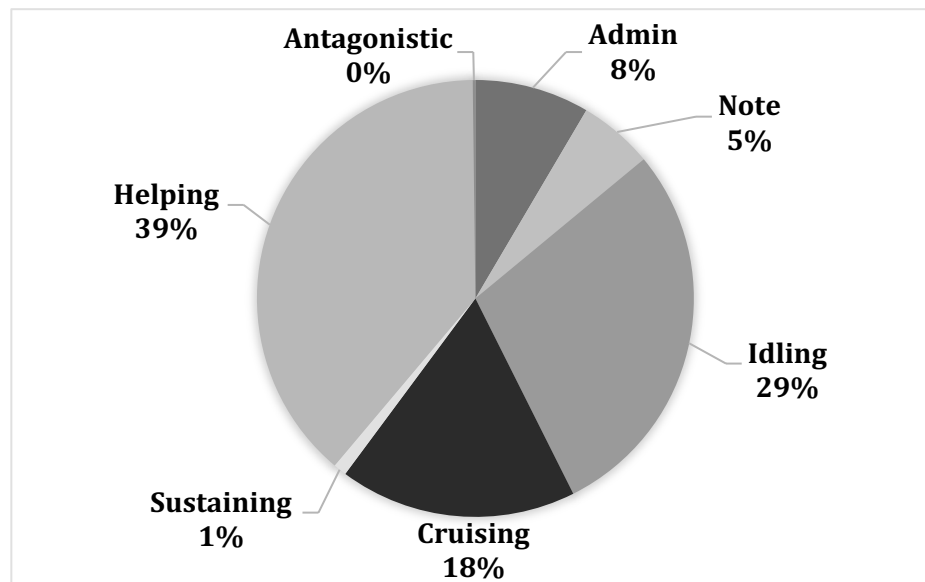


Figure 4. Calculus I posts by category

The largest single category of posts in Calculus I was helping posts (39%), followed by idling posts (29%), cruising posts (18%), and sustaining posts (1%). Administrative posts and questions, notes, and one antagonistic post accounted for the remaining posts (13%) in Calculus I.

During the Calculus II treatment section, fifteen study participants made a total of 232 posts over 16 weeks. Total posts per participant ranged from 33 to 3. The average number of posts per participant was 16. A categorized breakdown of the types of posts made by the study participants in Calculus II is provided in Figure 5.

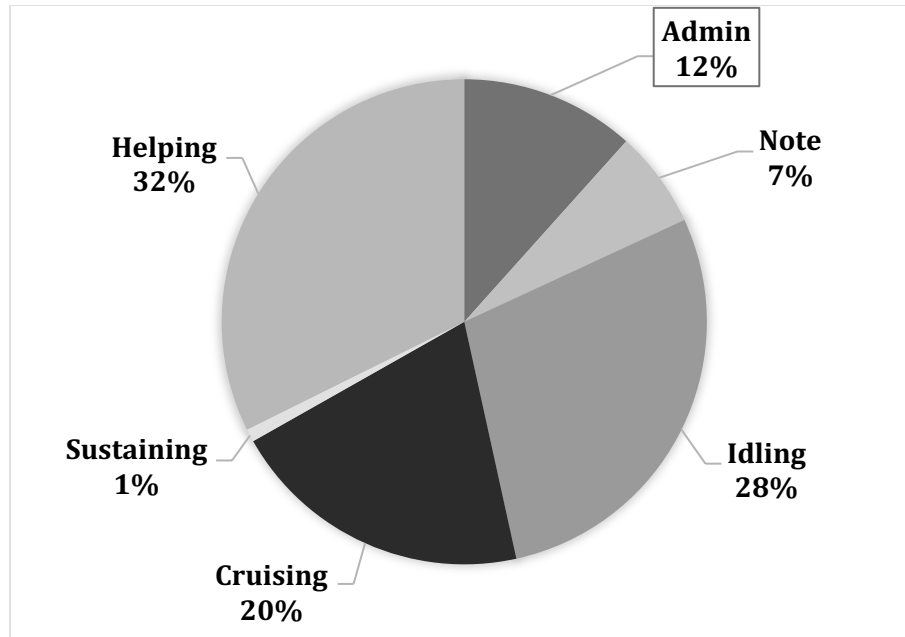


Figure 5. Calculus II posts by category

The largest single category of posts in Calculus II was helping posts (32%), followed by idling posts (28%), cruising posts (20%), and sustaining posts (1%). Administrative posts, such as questions and notes, accounted for the remaining posts (19%) in Calculus II.

Table 7.

Numbers of Study Participants Making Posts in Each Category

	Study Participants	Idling	Cruising	Sustaining	Helping	Administrative and Notes	Antagonistic
Calculus I	25	18 (72%)	17 (68%)	5 (20%)	23 (92%)	22 (88%)	1 (4%)
Calculus II	15	10 (67%)	8 (53%)	2 (13%)	14 (93%)	14 (93%)	0 (0%)

The number of Calculus I and II students who made posts in each category is shown in Table 7. Most students in both classes (Calculus I | Calculus II: 92% | 93%) made at least one helping post and one administrative post or note (88% | 93%). A substantial number of students in both classes made at least one idling (72% | 67%) and one cruising (68% | 53%) post. A relatively small proportion of students in either class made at least one sustaining (20% | 13%) post.

Describing resistance to online forum participation in this study.

Online Forum Participation Scores. The weighted participation scores were used to identify the strong resistors (SR), moderate resistors (MR), and non-resistors (NR) in both the Calculus I and II treatment sections. The number of study participants who were identified as strong, moderate, and non-resistors are shown in Table 8.

Table 8.

Identification of Online Forum Resistors from Weighted Participation Scores

	Study Participants	Strong Resistors (SR) (PS < 0.5)	Moderate Resistors (MR) (0.5 < PS < 1)	Non-Resistors (NR) (PS > 1)
Calculus I	25	6 (24%)	9 (36%)	10 (40%)
Calculus II	15	5 (33%)	8 (53%)	2 (13%)

PS: Online Forum Participation score

Survey Results. End of course survey responses (for the subset of study participants who completed the survey as shown in Table 1) were compared for the Calculus I and II sections using descriptive statistics. Analysis was limited to the use of descriptive statistics due to the small number of survey respondents. Survey responses indicated that most of the respondents were minimally to moderately nontraditional²³ (as was previously shown in Tables 1- 2). Working while going to school was the most common nontraditional student characteristic reported by the respondents; many respondents worked full time. Only two respondents in Calculus I and one respondent in Calculus II reported that they did not work. The average number of hours worked per week was reported to be 35.18 (12.709) for the Calculus I respondents and 33.10 (13.1) for the Calculus II respondents.

Respondents reported using desktop or laptop computers, tablets, and small mobile devices to achieve online access to course materials. The most commonly reported online access points to the course materials were from home, the home of a friend or relative, or the university campus. Very few students accessed the course from other establishments such as a library, coffee shop, or restaurants.

Survey questions that provided direct insight into respondents' attitudes toward use of the online support forum in calculus included items categorized as "collaboration, community, and support" "online community", and "Piazza" items. Mean survey responses (Likert style scale ranging from 1-7) with standard deviations from respondents in the Calculus I and II treatment sections are provided in tables 9, 10 and 11.

Table 9.

Average Response Scores (Standard Deviations) to Collaboration, Community, and Support Survey Items

Collaboration, Community, and Support Items	Calculus I	Calculus II
I easily found the materials that I needed to complete assignments.	3.68 (2.056)	5.09 (1.514)
In this calculus class, I felt like I was part of a learning community.	3.63 (1.892)	5.09 (1.221)
There was plenty of support available to help me be successful in this course.	4.16 (2.035)	5.64 (1.120)
Interactions with other students in this course were helpful in learning the course material.	4.74 (1.485)	5.18 (1.401)
The textbook and readings were useful in learning the course material.	4.05 (1.779)	5.45 (.934)

I felt like I had plenty of opportunities to ask questions and receive answers.	4.53 (1.837)	6.09 (.944)
I knew when I could expect to hear back from the instructor if I asked a question of him.	4.53 (2.038)	5.91 (1.044)
Interactions with my instructor were helpful in learning the course material.	3.47 (2.245)	5.91 (1.044)
The purpose of course activities (e.g. readings, assignments, discussions, quizzes, etc.) was clearly explained.	5.00 (1.528)	5.82 (.874)
I knew what is expected of me in terms of participation in the course.	5.32 (1.529)	5.82 (.874)

Table 10.

Average Response Scores (Standard Deviations) to Online Community Survey Items

Online Community Items	Calculus I	Calculus II
Online discussions were valuable in helping me appreciate different perspectives.	3.32 (1.565)	4.09 (1.640)
Online discussions help me to develop a sense of collaboration.	3.47 (1.429)	4.73 (1.555)
Online or web-based communication is an excellent medium for social interaction.	3.16 (1.425)	4.73 (1.489)
I felt comfortable conversing through the online medium.	4.16 (1.642)	4.91 (1.514)
I was able to form distinct impressions of some students.	4.89 (1.100)	4.36 (1.286)
Getting to know other students gave me a sense of belonging in the course.	4.42 (1.610)	4.55 (1.214)
The instructor helped to keep course participants engaged and participating in productive dialogue.	3.05 (1.840)	5.64 (1.502)
I felt comfortable interacting with other students.	5.32 (.946)	5.09 (1.221)
Instructor actions reinforced the development of a sense of community among students	3.58 (1.427)	5.27 (1.104)
I felt comfortable participating in the course discussions	4.37 (1.535)	5.18 (1.328)

Table 11.

Average Response Scores (Standard Deviations) to Piazza Survey Items

Piazza Items	Calculus I	Calculus II
I found Piazza helpful in answering my questions with course assignments.	3.71 (2.138)	5.90 (.876)
Using Piazza helped me to feel part of a learning community.	2.71 (1.890)	5.50 (1.179)
Overall, my experience with Piazza was positive.	3.00 (1.826)	5.78 (.972)
I would use Piazza in the future to help me with my course work.	3.00 (2.00)	5.70 (1.160)
I found the Piazza tutorial video helpful.	4.43 (.787)	5.30 (1.252)

Interviews. All six interviewees were enrolled in the treatment section of Calculus I. One interviewee (“Student F”) was also enrolled in the treatment section of Calculus II and was

interviewed after completion of Calculus II. The posting behavior and participation score of each interviewee are provided in Table 12.

Table 12.

Posting Behaviors and Participation Scores of Interviewees.

Interviewee		Number of posts by category							
	Course	Administrative	Note	Idling	Cruising	Sustaining	Helping	PS Score	
Student A	Calculus I	2	2	0	0	0	8	0.625	MR
Student B	Calculus I	5	1	5	10	0	9	1.297	NR
Student C	Calculus I	3	1	26	3	0	3	1.242	NR
Student D*	Calculus I	0	1	3	2	0	10	0.828	MR
Student E	Calculus I	1	1	4	5	0	13	1.195	NR
Student F**	Calculus I	3	1	12	3	0	7	1.016	NR
Student F**	Calculus II	12	1	3	13	0	3	1.164	NR

*Student D also made one antagonistic post.

**Student F was enrolled in the treatment sections of Calculus I and II. Student F participated in the interview after completing Calculus II.

Interview thematic analysis. The transcribed interview texts from the six study participants were analyzed thematically. According to Saldaña²⁹, a theme is “an extended phrase or sentence that identifies what a unit of data is about and/or what it means.” The thematic analysis of the interviews was performed in two stages. First, the analysis was performed jointly as a research team. Later, the PI worked to synthesize data categories and refine the themes developed in the joint analysis. To jointly analyze the transcripts, each member of the research team was provided electronic copies of the transcribed interviews. Each member was asked to read the interviews carefully and to identify categories³⁰ or “chunks” of data that they felt were applicable to the research questions and, if possible, broader themes they saw represented among the chunks. Potential data categories and themes for each transcript were discussed as a group during four data workshops held monthly during the summer of 2015. At the conclusion of the workshops, the PI synthesized data categories into generalized themes that represented the data across all of the interviews. The PI used the thematic ideas discussed by the team to guide the development of the presented themes.

Three themes regarding student use and perceptions of the online support forum were discovered within the interviews. These themes are the a) promise of the idea, b) reality of response time and tutor effects, and c) grading dilemma and are discussed below.

Promise of the idea. Several students discussed being excited when they heard about the use of the online support forum in their synchronous broadcast calculus class. Student C (NR), an early education major who was taking Calculus I for a math endorsement, participated in the course from a small site while viewing the instructor remotely through the broadcast system. Student C commented,

When they said this was gonna be a resource I thought oh, this is gonna be so great, you know, because I was nervous about taking calculus. And I thought, ...what a wonderful tool, I'm so glad they have this.

Student C went on to describe what s/he saw as the promise of the online support forum:

I think ... its intended purpose was to provide a forum for us to as classmates to be able to communicate and work together to help solve problems and things. Because we're not all in the same classroom you've got to have that some way to connect as a class, to interact with other students and typically in a math class there's so much lecture that there's not a lot of opportunity for that. So my feeling was that it was intended to kind of fill that need of interacting with your classmates and being able to work together, study together.

Student C indicated that she had a clear understanding of the intent of the forum to provide a mechanism for help as well as a means to actively work with classmates outside of class. Student C's initial enthusiasm about using the tool was evident, and the level of this enthusiasm made it apparent she planned on being an active participant.

Student E (NR) was another student participating from a small, remote site. Student E was majoring in soil science in the College of Agriculture and was taking Calculus I for a second time as a refresher after a two and one-half year break from school. (Student E did well in Calculus I the first time). While math generally came easy to Student E, Student E was still excited to try out the online support forum because s/he "really wanted help" and viewed it as "a great resource." Student E figured that posting to the forum would be better than emailing the instructor for help because "you got classroom response" with posts to the forum. Like Student C, Student E was able to see the promise of added value in using the forum over using more traditional support mechanisms like email.

Student F (NR) was an electrical engineering major with prior experience in distance education courses. Student F was also located at a small remote site and had only one other student in the classroom with them during calculus class. In general, Student F felt comfortable using online discussion boards. Student F was particularly excited about using the Piazza forum in calculus because of its integrated equation editor—a feature that s/he suggested that many discussion boards do not have. Student F commented,

Right off the bat, [the instructor] ... gave us a general formula to learn how to put in because most programs don't have [an equation editor], and especially not [for] calculus types of variables ... So he had us do that which is cool because on other boards you'd take up a whole paragraph describing what you're trying to explain rather than just being able to write it in mathematical notation. So I thought that was good right off the bat.

Student F was excited because s/he saw particular promise in using the Piazza discussion board based upon its integrated equation tool.

Overall, at the beginning of their calculus course, the interviewees appeared very open to—if not excited about—using the online forum as both a support tool and as a way to connect to their classmates. They certainly saw “the promise” of better support and peer interaction embedded within the instructor’s implementation of the forum. The strong desire to connect with classmates that these participants exhibited may have been at least partially fueled by their location at small remote sites where they had little interaction with other students in their class.

Reality of response time and tutor effects. Despite initial excitement at the promise of the online support forum, several students felt that the reality of how the tool was implemented did not meet their expectations, especially in terms of the time it took to get responses to their questions. Student A (MR) was a declared electrical engineering major but still very new to the program and “nervous” about what calculus would be like. Student A, who attended the course at a small remote site, found the forum “...kind of helpful, but more tedious than anything else...just because it was one more thing to add to the pile” of things to do. Student A, for the most part, posted as was required but said that, “...When it became obvious I was going to have to repeat the course, I let it slide and didn't bother with it.” Student A never posted questions, only answers. Student A said,

If I had a question I went straight to the tutor...because if I go to the tutor I get an instant answer and I get a good explanation from somebody who really knows the material. Whereas on the website with peer review, I’m waiting at least an hour for somebody else to log on, see the question, decide they want to answer it, they may decide to answer it or not – if nobody else understands what I’m asking, nobody’s going to answer it. So it’s hit and miss with getting any answers that way.

For Student A, the forum—most likely—could never live up to the tutor support s/he was getting from the tutor—unless perhaps if it was real-time online support. Being nervous about calculus, Student A didn't feel comfortable waiting for an online answer that may, or may not, come. Because Student A had access to a local tutor in whom s/he had a great deal of confidence, Student A posted only strategically (i.e., one answer) to get the participation points.

Student D (MR) had a similar reaction to Student A. Student D was a mechanical engineering major who attended calculus class at the broadcast class origination site where the instructor was located. Student D “used the forum some, but not religiously.” Student D explained:

It took a long time to type in the text editor to write the problem out, some of the problems were pretty hard. Then writing the solutions – some of the solutions were really long as well. So you’d get – you know, on the easier problems you get a pretty good response. On the harder, longer problems it was really time consuming. Some problems could take you an hour to kind of try and type through and get it all in the text editor to where it would show up. So I didn’t use that a lot. Plus if you just wanted a quick question answered, you had to log on the computer and log on to your site and then go – kind of like checking your

campus mail and then pulling up a separate problem and scrolling through the problems. So it was a little cumbersome, but it was available.

Student D's insights suggest that time was not only a factor in receiving responses but also in asking questions. Participants might have benefitted from earlier exposure to the online tool so that by the time they got to calculus they were skilled at the mechanics of posting.

Although Student E was located at the same campus as Student A, Student E had to rely on the online forum for support due to having a work schedule that conflicted with the tutor hours. While Student E contended that the forum "was a great resource" and used it throughout the semester, Student E wished that s/he "understood how to use the Piazza thing more." Student E often felt "slammed with emails" announcing posts and remarked that, "it would be nice to get 'this person answered your question'" emails instead. Student E became frustrated with vague answers that sometimes appeared on the forum in response to questions and disliked the fact that follow-up posts "were never answered."

Unlike Students A and E, Student D did not have access to a campus math tutor that semester. (The well-respected math tutor at Student A's campus unexpectedly quit and there was no math tutor at that campus during that semester). However, instead of relying on the online forum for support in absence of the tutor, Student D and some friends hired a personal calculus tutor, using their own money, for the semester. This action suggests that Student D had high confidence in tutor support based on past experience and comparatively low confidence in using a new, online method for support. Moreover, hiring a personal tutor made getting support even quicker and easier than using the online forum. Instead of posting questions to the forum, Student D and friends would "snap [the tutor] a picture, send it, then [the tutor] would do it [the problem] and send it back, then you're done. So it was easier that way."

Student C, who had been, perhaps the most excited by the promise of the online forum initially, appeared to be the most disappointed by its implementation. Student C primarily posted questions because, as s/he commented, "I really struggled with the material." Moreover, Student C found the tutor located on campus, whom Student C called "a body in the room," to be extremely unhelpful. Therefore, since s/he did not have access to a supportive math tutor on campus, Student C relied exclusively on the online forum:

I needed help. I had never taken calculus before. This was my first experience with calculus in this class and I had no clue what calculus even entailed before I took this class. And so I needed help understanding it and I needed to have some way to get my answers to my questions and to get concepts clarified in a way that I can understand them because reading the book didn't do it. The professor's lecture didn't do it. I wasn't getting it and I needed help. So for me I turned to [the online forum] initially [as] a source of—it felt, yeah, it was an assignment and I thought well that won't be a problem to get that assignment done because I need help. I need my questions answered. But unfortunately it just didn't work like that.... Eventually the professor would answer but by that point we may have moved on to something else. And it just felt like a real frustration point for me.

While Student C had questions and faithfully posted them, s/he felt that they were not answered quickly enough and that s/he fell behind waiting for answers. Student C went on to discuss how posting changed from an exciting promise of help and support to a frustration saying,

I was asking questions, they weren't getting answered, it was hard to use to ask the questions in the first place sometimes especially if you needed to post like a formula as part of your question it was really difficult to get that posted. And it really just felt like it was a source of frustration. So I guess I would say it was not helpful for me for the most part. Just because I didn't feel like I was getting answered I got more frustrated by it.

In addition, being frustrated by a lack of timely response, Student C grew even more frustrated trying to use the equation editor:

The main source of frustration for me was the equation editor.... it does take a while to get to the point where it isn't a major task. Especially if you've got integrals or whatever going on. I became more frustrated with it and I quit using the equation editor. I would just go in and post, you know, I need help on question number blah-blah-blah because I just could not deal with that equation editor.

Student C's frustrations were so extreme that s/he called that semester in calculus "horrible." Student C's experiences underline the importance for instructors to keep tabs on newly implemented interventions in order to understand if they are truly having the desired effects in reality.

Despite the negative experiences of Students A, C and D on the forum, Students B (NR) and F were relatively content with how the online support forum operated. Student B was an exercise science major who planned to go into physical therapy and had never taken calculus before. Student B posted mainly questions until the first exam when Student B began posting lots of answers instead. Student B explained,

Before the first exam, I think I took it [calculus] kind of lightly—not expecting it to be too difficult. So I didn't put in the time that I did later on. I got a C on the first exam, which for me is like—I'm freaking out about it and was super mad. And so I just kind of buckled down and started working endless hours every day to understand it.

I felt like [the online forum] was nice for me. I guess for the first half of the semester I would ask questions and then the second half of the semester it was mostly just answering other people's questions. It was nice for me to be able to solidify what I know and be able to get it all out in words and explain why it works.

Being someone using the online forum as a tool to solidify personal understanding through peer instruction and, perhaps, not heavily relying on it for timely answers, Student B was pleased with how the online forum operated.

Likewise, Student F seemed content with how the forum worked. Student F's contentment was, perhaps, in large part due to his own technological savvy. Student F was able to get online at work and "checked [the online forum] most days of the week." Student F explained that, "I did check [the online forum] kind of regularly especially when there was like a section I didn't understand it would be good to see that other people struggled as well." Student F also "found the app" (mobile Piazza app) and felt like "it was very helpful because I always have my phone." Therefore, based on his comfort for using technology, Student F felt as if the forum was a productive tool rather than an added frustration. Student F's experiences suggest that instructors who implement online forums should plan to provide additional support to students who may have little experience using web-based tools.

Grading dilemma. Interviewees seemed to see the requirement to post and the grading scheme as both helpful and hurtful to the implementation of the forum. Several interviewees, including Students A, B, D, and F, said they probably wouldn't have tried posting or posted as frequently if it were not for the graded requirement to do so. As Student F said, "I probably wouldn't have put up as many posts...some weeks I didn't have questions.... If I didn't have a question, I wasn't going on[line] to look for things to do." Apart from "add[ing] to the pile" (Student A) of things to do, the requirement to post was generally viewed as a motivator to engage.

The grading scheme, however, seemed to work against the intent of online forum in some important ways. The requirement to post two questions or one answer each week appeared to lead some students to focus on posting answers since, perhaps, it seemed like less work. Student A explained,

[The instructor] gave you three points per week and if you answered somebody's question correctly you got all three points just off that one. You had to ask two or three questions in order to receive the same credit and I didn't find it very effective. I got on there and I found a question that I knew how to answer and I would do those. 'Cause I got it out of the way in one shot.

Student C explained how the grading scheme incentivized students, ultimately even themselves, to post hurried questions and give canned answers from solution manuals:

I kind of felt like it was easier to get the points if you just asked the two questions than if you answered one. So I think most people just went on there like, 'oh, oh, I gotta get the points, I gotta do the assignment.' Here you post two questions and move on with life and that left a lot for the professor to go back and answer. And even there were a few people that would answer questions but I felt like they were just posting stuff like out of the solution manual as an answer. It really didn't feel like there was a discussion point, didn't feel like there was explanation that went

with things. So I guess my expectation would be that it would be more explanatory.

Eventually you post enough questions that you want answered and you don't get them answered you sort of think this is just a frustration point I can't deal with this. I gotta post two questions to get the points. I just post two questions and move on with life. Because it just got to be one more thing on an already abysmally frustrating semester.

Student E concurred with Students A and C about the effects that the grading scheme had on posting behavior in the long term saying,

The instructor made [posting] a requirement to get credit which I'm thinking we had a lot of questions that were mostly just for credit. And then the answers were that way, too. Answers were also [counted for] credit for the class and then we got answers were like, "Oh, it's B." Well that didn't help me, you know?

These insights concerning the short term and long term effects of the grading scheme used to grade participation in the forum uncover a dilemma for instructors who choose to implement online forums in their courses. Participants suggested that grading was necessary to get them to start posting and to post regularly. Yet, the way in which posts were graded appeared to cause many participants to post strategically in the long run, especially if they felt that the time they spent on the forum was not useful or helpful.

Student F related to this trend in posting behavior, too. Student F shared,

I could tell that some people would post a question just 'cause you need points some weeks. But at the same time I mean I have those weeks too where it's like I understand this and I don't need additional help so I post kind of a, not a mundane question, but just something that's not as needful as like 'tomorrow's the exam can someone please re-explain this to me?' I can see some kids that got really into it and posted really long things and some people posted half a sentence. So it varied.

Student F brings up a valid point that every student may not be able to post deep, meaningful questions every week. This insight suggests that new approaches to grading participation may be worthwhile to pursue.

Discussion

The goal of the mixed methods analysis is to bring together the individual data sets into a single, holistic focus in order to answer the research questions.

1. To what extent do nontraditional undergraduates resist required participation in an asynchronous, online support forum in first year calculus? [QUAN]

Based on the coding scheme (idling, cruising, sustaining, and helping)—which is strongly underpinned by the asynchronous learning network literature—applied to the online forum posts and the subsequent calculation of an overall “participation score” for each student, we found that 15/25 (60%) study participants in Calculus I and 13/15 (87%) study participants in Calculus II were considered as either strong or moderate resistors to the level of online forum participation required by the instructor. Clearly, these results indicate a substantial degree of resistance to an activity meant to support and enhance student learning in first year calculus via engagement in question, answer, and discussion of the topics discussed in class, practiced on homework problems, formatively assessed on quizzes, and summatively assessed on exams.

An important point— and one that may have not been fully realized upon first analyzing the quantitative data—is the fact that student posting behavior was strongly tied to the way in which the instructor graded participation in the forum. This interdependence was seen in the distributions of posting behaviors in Calculus I and II (Figures 4-5): larger proportions of idling (asking questions) and helping (answering questions) behaviors combined with lower proportions of cruising and much lower proportions of sustaining behaviors— these latter behaviors are arguably seen as where the important dialogue, discussion, and meaning-making occur. Because the grading scheme awarded credit for questions and answers, posters mostly engaged in idling and helping. Students did not appear to move along the continuum of participation in the direction of increasingly active participation. The trend was more in the opposite direction where students resorted to just asking two questions in order to be done with the assignment for the week (Student C). This finding has implication for practice.

In looking at the quantitative and qualitative data together holistically, the picture becomes clearer. In addition to not posting “enough”— not asking enough questions, not answering enough questions—or posting antagonistically, student resistance to participation in the online forum was more widespread and took other forms. These “other” forms of resistance tended to obey the letter but resist the spirit of the law (i.e., grading scheme). Resistors asked uninspired questions they already know the answers to just to get the points. Resistors purposely trolled the forum for questions they can answer quickly and easily just to be done with the assignment and go offline. Resistors posted solutions —taken directly from solution manuals or other resources— as answers. Perhaps the reason that resistors provided no explanations for their answers and failed to answer follow-ups was because they did not understand the answer themselves. Some or all of these “other” resistant behaviors may be present among posters earning high participations scores by our method of estimation.

2. What are the associated attitudes and rationales of nontraditional undergraduates who resist participation in the online forum? [QUAL]

Due to the difficulty involved in (more) accurately quantifying student resistance to participation in the online forum, it may also be insightful to consider student rationales for their posting behaviors in the online forum.

The qualitative data indicated that the promise of an online support forum could be compelling for nontraditional students in STEM who are physically separated from their instructors and/or from other students in their courses. In general, the graded posting

requirement was viewed as a motivator, at least initially, to post. Students who exhibited the least resistant behavior initially (Students C, E, and F) appeared to have well-developed internal motivations to be active in the forum upon coming in to the calculus course. Students C and E wanted the help the forum could provide. Student F's techno-savvy and way of accessing the online forum frequently fit well with the operation of the forum. Student B developed an internal motivation to engage actively in helping on the forum after doing poorly on the first exam.

However, the data also showed how these internal motivations to participate in the forum were undermined by tensions resulting from constraints on students' time and frustrations with technology and/or Internet access. Students had distinct expectations concerning the appropriate response time. Such expectations could vary substantially from student to student (e.g., Student A: 1 hour, Student C: 24 hours). Workflow played a role in these expectations. For example, Student A perceived posting as an extra assignment to be accomplished separately from or after working problems and expected a short response time on questions (1 hour). Students C and E, who posted questions while working problems and were comfortable moving on to another problem while a post was pending, had longer expectations for response times (24 hours). For some students, just the time needed to log in and see that no one, not even the instructor, had responded to a post was enough to cause frustration. Managing expectations of appropriate response times is another finding with implications for practice.

The perceived effort of accessing and using the online forum varied greatly among students, especially depending on each student's technological savvy and experience with online tools. While most students indicated the Piazza forum was intuitive and easy to use, several students voiced complaints about using the equation editor, the ease of logon to the university system, and proper setup of email notifications for posts. All of these areas were shown to increase the frustration level and contribute to increased resistance by students. The technological aspects of using the online forum, especially by nontraditional students, are another area with implications for practice.

Finally, it is important to note that the instructor's perceived lack of presence on the forum appeared to (detrimentally) affect students' attitudes toward and motivations for using the forum. Perhaps the grading scheme was justified in the sense that idling (asking questions) and helping (answering questions) were straightforward tasks with little need for scaffolding or demonstration. In order to elicit more involved engagement of students within the forum (i.e., cruising, sustaining, and helping with follow-up explanations), a stronger instructor presence was required. The amount and timing of instructor presence on the forum holds further implications for practice.

Implications for Instructors

For instructors, the key question to be answered by this research is how can active knowledge construction be promoted using asynchronous, online support forums?

This research points to several areas where an instructor should focus planning and attention when choosing to implement an online support forum in their course, especially with nontraditional students.

- Since online support forums are an asynchronous, out-of-class active learning activity, instructors must consider the effects of required participation on the students' time. Things that can be done during class time (training, tutorials, practice, demonstrations, other assignments using the forum that will help students to gain competence and confidence) to get the students up and running quickly will be beneficial to the overall implementation of the forum. Consider student time demands when setting up posting requirements.
- Instructor presence and management of expectations of response time are important to maintaining student motivation to post in the forum. Instructors may promote online forum use by supporting more rapid time responses in the early stages. Give students reasons to build confidence in using the forum.
- Students, especially nontraditional students, may experience technological frustrations and barriers (e.g., tools such as equation editors, online access from home, use of mobile apps, emails notifications) to participation in the forum. Management of these issues can greatly improve the online forum experience for students who may not have high-speed Internet access off campus. Consider arranging support or trainings for these issues by others if you cannot provide them yourself.
- Be aware that forum posting, just like group discussion, should be scaffolded and modeled. Building a self-sustaining learning community takes time; do not expect students to support such a community (at other than a very modest level of participation) without frequent and consistent instructor/TA presence and support on the forum. Instructors should consider what they want students to do in the forum and then model that behavior for students by doing it themselves.

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