Teacher Education: Modes of Communication within Asynchronous and Synchronous Communication Platforms

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Abstract

New tools for teaching with distance education afford students with a variety of modes of communication. This study examined students' interactions during an online science education course. All interactions that took place with Elluminate Chat, Elluminate Voice, and Moodle learning platforms were recorded, transcribed, and analyzed. Interactions were coded according to the target of the interaction, the content, and the type of interaction (comment or question). Results showed that the different modes of interaction provided distinctly different opportunities for communication and served different purposes with the instruction. Furthermore, there were individual differences in students' behaviors across the communication modes. The implications of the study for synchronous and asynchronous distance education of teachers are discussed.

Keywords: hybrid distance education, graduate science teacher education

Introduction

Recent developments in distance education have the potential to help teacher educators reach teachers in remote areas and to provide professional education in ways that are novel and unique. Increasingly, universities are turning to distance education (DE) as the vehicle for offering teachers

graduate teacher education. Instruction through DE has resulted in benefits for many learners. For example, studies have shown that DE courses promote gender equity (Wishart & Guy, 2009), reach learners in remote locations (Anderson & Dron, 2012) and those whose needs have not been met by traditional face-to-face learning (Gill, 2006). On the other hand, DE can also result in drawbacks such as feelings of social disconnectedness among students (Brannon & Essex, 2001), difficulty for instructors moderating large discussions (Jeong et al., 2011), and assessing course participation (Gill, 2006).

DE has evolved considerably over time, from correspondence courses to fully synchronous online courses (Morrison & Anglin, 2012). This evolution has resulted in a multitude of instructional formats currently being used to teach at a distance. DE courses also vary considerably in terms of level of instruction (e.g., K-12, higher education, adult education) as well as the type of content delivered. A number of studies and meta analyses have evaluated the efficacy of DE, and compared DE to traditional face-to-face classroom instruction (Abrami, Bernard, Bures, Borokhovski, & Tamim, 2011). However, because of the vast variations in DE courses and experimental designs, few firm conclusions can be made as a result of these studies, and caution must be taken when interpreting their findings (Bernard, Abrami, Borokhovski, Wade, Tamim, Surkes, & Bethel, 2009).

The work of Zhao, Lei, Lai, and Tan (2005) suggested that DE seems to be improving over time. In a large meta analysis, these authors found no significant differences in learning outcomes between DE and face-to-face instruction, but suggested that some learners (such as those in military or undergraduate settings) might be better suited to DE and some topics (e.g. business, medical science and computer science) might better lend themselves to this type of instruction. Although there has been an increase in research on distance education in general, there is much less known about science teacher education offered through DE. Furthermore, there is limited research on how different types of communication modes (e.g., synchronous versus asynchronous communication) may have a differential effect on students. The present study examines interactions between students in a hybrid asynchronous/synchronous graduate level DE course for practicing science teachers. The goal was to develop insight into how students in a science education methods class use different modes of communication while learning. Specifically, we were interested in how communications varied across synchronous voice and chat modes, as well as asynchronous written modes.

Successful Distance Education

Past studies suggest that successful DE is associated with a number of pedagogical and technological factors (An & Kim, 2007; An, Kim, & Kim, 2008; Bernard, Abrami, Lou, Borokhovski, Wade, Wozney, Wallet, Fiset, & Huang, 2004; 2009; Brannon & Essex, 2010; Gill, 2006; Latchman, Salzmann, Thottapilly & Bouzekri, 1998; Zhao et al., 2005), and these include:

- Interactions between students and among students and instructors,
- Multiple modes of communication and mechanisms for feedback,
- Multiple types of static (e.g., videos, reading) and multimedia content (website walkthroughs, group chats),
- Clear guidelines and criteria for communication (e.g., number and type of postings),
- Clear criteria for dealing with conflict, and
- Access to reliable Internet connections, learning management systems, and video quality.

Given this list of factors, one might conclude that the best-case scenario for successful DE is a hybrid format incorporating elements of both asynchronous and synchronous communication with clear and coherent communication guidelines. However, Bernard et al. (2009) found that student achievement outcomes were not significantly different between synchronous, asynchronous, and mixed course formats. Thus, the "best of both worlds" idea of mixed formats is not one grounded in research. Johnson (2006) suggested that, "systematic and objective research on the ways in which synchronous and asynchronous online discussion can be combined to maximize student learning is required." Nonetheless, many instructors choose to mixed formats allowing learners to minimize shortcomings and capitalize on the benefits of each format (Motycka, Onge, & Williams, 2013).

Asynchronous Versus Synchronous Distance Education

Early forms of DE learning were completely asynchronous and allowed students to decide when and where to learn. Although it has evolved considerably, much of the DE used currently follows an asynchronous model. One key strength of asynchronous learning is that it is self-paced by the individual learner (Morrison & Anglin, 2012). Researchers agree that asynchronous course formats allow for deeper reflection on learning and critical thinking as the learners can be flexible in their response time to prompts (Bryce, 2009). This flexibility allows for more purposeful two–way communication between the instructor and student. Similarly this type of format facilitates learners' understanding of their own and peers' thinking as time goes on (An & Kim, 2007), as responses can be more thoughtful when they aren't immediate. On the other hand, research has shown that learners sometimes report feelings of anxiety when group members don't respond quickly to prompts or discussions in asynchronous DE courses (An & Kim, 2007). Additionally, some learners might be more willing to "give in" when working in a group happens over longer periods of time (An et al., 2008). For the instructor, it can be time consuming to get back to students' questions and prompts over extended periods of time.

As DE has developed synchronous formats in which learners log on to a learning management system and participate in a course at a regular set time have become more prevalent. Morrison and Anglin (2012) suggested that these formats can serve as communities of inquiry for the learners involved. These courses allow for real-time interactions similar to those

occurring in face-to-face courses. Belderrain (2006) suggested that, "through synchronous communication tools, peers can rehearse presentations, provide instant feedback, clarify misunderstandings, and share knowledge. A broader knowledge base means that distance learners can reap the benefits of collaboration as they learn from each other and construct their own knowledge (p. 148)."

Synchronous DE courses also allow instructors to provide on-the-spot feedback and get a quick glimpse of how well the class is doing (Hines & Pearl, 2004). However, many benefits of synchronous DE hinge on the technology available. Internet connectivity and glitches with learning management systems can leave learners behind. Similarly, working across time zones can be difficult (An & Kim, 2007). Belderrain (2006) claims that synchronous collaboration doesn't allow for full student-student collaboration and is, "only as good as the tools built into the delivery platform (p. 146)." Similarly, Motycka et al. (2013) caution that the technology needed to allow for full participation in synchronous courses can be costly.

Distance Education Learning

Regardless of format (asynchronous or synchronous), Bernard et al. (2009) discovered that the types of interactions in DE influenced student achievement. These authors delineated three types of interaction: student-student, student-content, and student-teacher. They found that the student-student, and student-content interactions had greater effects on achievement than student-teacher interactions. Borokhovski, Tamim, Bernard, Abrami, and Sokolovskaya (2012) found that designed student interactions in which students work *collaboratively* were more beneficial when students interacted but were not required to collaborate. Similarly, Bernard and colleagues (2004) observed that when students were required to engage in "active" learning that involved collaboration (e.g., problem-based learning) improvements were seen in achievement. Though Ohlund, Yu, Jannasch-Pennell, and DiGangi (2000) found that student *attitudes* regarding collaboration had little influence on success in an online course, the large majority of research on the topic suggests that purposeful collaboration is critical to successful DE.

Belderrain (2006) argued that multiple approaches and theories must be used to guide the development of DE programs in order to enhance the level of interaction between and among students. Thus, the instructor plays a key role facilitating course interactions and helping learners to develop an online social presence. Tsai, Laffey, and Hanuscin (2010) discussed the difficulty of forming communities of practice in online environments and suggest learning how to better use a variety of tools in online classes can help students feel more engaged with their DE communities. Anderson and Dron (2012) examined the evolution of DE and found that there have been three key trends in the pedagogy of DE courses, which have resulted in differences in types of interactions—and thus communication and community building.

These authors contend that both pedagogy and technology are critical and necessary to consider when examining these frameworks (without

appropriate technology, certain pedagogical strategies are impossible). The first trend was DE courses that tend to follow a cognitive or behaviorist (CB) instructional design. In these courses, all course content is delivered without interaction between teacher and student or between students, thus all interactions are student-content interactions. The exception is evaluation, in which the teacher provides information to the students regarding achievement. Some more sophisticated CB courses allow for "adaptive" design in which the content presented next varies based on student's achievement, yet the interactions are dominated by the student-content category.

The next trend in DE courses described by Anderson and Dron (2012) is the social constructivist model (SC) drawing on the work of Piaget (1972) and Vygotsky (1978). The SC model is less prescriptive in terms of content and encourages learners to work together (synchronously through chat or voice or asynchronously through threaded discussions) to construct understandings using prior knowledge and experiences, language, tools, and multiple perspectives. Belderrain (2006) supported this SC pedagogy in DE as it allows students to influence the course content. It should be noted that this type of DE can only occur using newer technologies. Finally, Anderson and Dron described connectivist pedagogy (CP) in DE which suggests that learning occurs by building networks of information and resources and applying it to real ideas and assumes that (1) information is plentiful, and (2) learners have tools and competencies to find, evaluate, sort, filter, and reformat online resources. Anderson and Dron (2012) contend that each of these pedagogical models has a place in DE, and each builds upon one another.

Parallel to constructivist models of learning are models of adult learning that are built on self-regulation theory and the critical role of metacognition and reflection (Zimmerman & Tsikalas, 2005). For teachers engaged in professional education, this model argues for teachers taking responsibility for their own learning, for them to be aware of the learning process, and for teachers to be reflective about their learning (Knowles, 1980; Brookfield, 1995).

In light of the research on successful DE and teacher professional development, we believe that communication and community building are critical to the success of online learning experiences. In order to better understand communication and community building within online science professional development communities, student interaction patterns should be examined. In this study we examine the student interactions in a graduate level science education DE course with both asynchronous and synchronous components. Specifically, we analyzed interactions in three separate modes of communication within this course:

- Asynchronous threaded discussion board postings
- Synchronous spoken communication during web conferencing
- Synchronous chat communication during web conferencing

Through these analyses we explored the following research questions:

1. How do the frequency and type of student interactions vary among the three modes of communication?
2. Are there differential responses of students to the different instructional communication tools?

Method

Study Context

This study involved science teachers enrolled in a graduate science methods class offered as part of a distance education masters program in science education at a large public university in the southeastern region of the United States. The course was offered as part of a grant-funded program providing online courses for practicing science teachers in rural schools. The course was taught with two learning management systems (LMSs). The first was Elluminate® webconferencing software used once weekly for 1.5-2 hours and incorporated audio, video, and chat. Instructors and students used headsets to allow them to both talk and listen throughout class meetings. The instructors also used video during most lectures and encouraged students to do the same during class presentations. Throughout class discussions, students were encouraged to use both the voice and chat function to share perspectives and ask questions throughout the class.

The second LMS used was Moodle®, an asynchronous course management system. Students were required to post at least one question and respond to one classmate's question each week based on the class' assigned topics and readings.

Participants

The course was team-taught by two instructors: one professor and one graduate assistant. Both instructors were Caucasian females. There were 22 students in the course (1 male, 21 female). Four students were African American and 18 were Caucasian. Twenty of the students were practicing teachers at the middle or high school level, one was a former teacher on leave, and 1 was a Ph.D. student and former community college instructor. The students taught a variety of courses ranging from basic integrated middle school science to advanced placement biology and physics. A wide range of teaching experiences were represented in the students from just a few years to more than 30 years in the classroom. About half the students lived and taught in rural areas.

Class Meetings

The class included 15 regular class "meetings" using Elluminate. There were several orientation meetings including one full-day face-to-face professional development on technology and two online orientation sessions

focused on using the two LMSs (Elluminate and Moodle). Five class sessions were excluded from the study: 4 were student presentations and 1 was an orientation class. Six class sessions of approximately 2 hours in length were analyzed as part of this study. Each class session had an accompanying asynchronous discussion regarding class readings. Transcripts of these online discussions were also analyzed.

Data Sources

Three sources of data were analyzed in this study and included:

- Postings in the Moodle forums for each week,
- Transcripts of the discussion for each week, (Elluminate Voice)
- Transcripts of chat communication during class meetings (Elluminate Chat)

The two instructors communicated with students using all three modes: Moodle, Elluminate Voice, and Elluminate Chat. The utterances made by instructors were not included in these analyses.

Data Analyses

Each data source was uploaded into Atlas.ti® for qualitative analysis. A thematic coding scheme was used to quantify and analyze trends in the data. The coding scheme was as follows: nature of utterance (question or comment), type of utterance (see coding sheet in the appendix), and the target of the utterance (general, peer, instructor). Three coders independently coded approximately 20% of the dataset, with an inter-rater reliability of approximately 90%. After discussing coding discrepancies, the remainder of the dataset was divided, coded independently, and spot-checked (~10% of codes were checked, no discrepancies were found) by the other two coders. Frequencies of each code were obtained and further analyzed using SPSS®.

Results

Students tended to interact the most with Elluminate Chat followed by Moodle, and the least often with Elluminate Voice (Table 1 below).

The repeated measures ANOVA showed that the mean number of interactions among participants differed significantly among the Elluminate Chat, Elluminate Voice, and Moodle instructional modes ($F(2, 25.322)$, $p < .000$). Post hoc tests using the Bonferroni correction showed that the

Table 1
Mean and Standard Deviation of Instruction Mode/Interaction Mode Frequencies

Instructional Mode	Mean Number of Interactions	Standard Deviation
Elluminate Chat	52.91	28.63
Elluminate Voice	13.43	12.67
Moodle	49.29	18.92

Table 2
Mean and Standard Deviation of Instruction Mode/Interaction Mode Frequencies

	Elluminate Chat	**Elluminate Voice**	**Moodle**
Comments	45.86%	11.58%	42.55%
Questions	45.34%	11.74%	42.92%

number interactions of the participants through the use of Elluminate Chat and Moodle were significantly higher in comparison to the number of interactions in Elluminate Voice ($p < .000$ and $p < .000$, respectively). There was no significant difference in the number of interactions between Elluminate Chat and Moodle ($p = 1.000$).

When interactions were analyzed by type (comments or questions), the most frequent mode of interaction for both comments and questions was Elluminate Chat (43%) (see Table 2 above). Comments and questions on Moodle were almost equal in frequency to the chat interactions (42%). Elluminate Voice was the least utilized by students with only about 12% of all interactions.

The utterances coded as comments were further analyzed by target, mode of instruction, and sub-type. Sub-types included categories such as: course content, peers, student learning, policies, and class assignments. The results show that participants use Elluminate Chat and Moodle in very different ways. Elluminate Chat was used more than the other modes of interaction for process and interpretation types of interactions (such as comments about the content of the class, agreements, greetings, assessments and procedures). For example, following a demonstration using live termites following a line drawn with an ink pen, one student commented, *"[are they attracted to] a natural product in the ink? Is it like the wood they eat?"* (Elluminate Chat).

Elluminate Chat also served the purpose of allowing students the opportunity to ask questions and comment on class requirements and the instructional topic. For example, a student wrote, *"I was just wondering where the data was taken for the tool article [a required class reading assignment]...was it rural? near industry?"* (Elluminate Chat). Another student wrote, *"[My action research project] will be something involving my ESL (English as a second language) students; perhaps those who are mainstreamed versus those who are in sheltered classes."* (Elluminate Chat).

As seen in Figure 1 (next page), Eluminate Voice was not often used and the targets and content of the Elluminate Voice interactions were varied, but were dominated by greetings and the occasional "chiming in" throughout the class session. Overall, Moodle tended to be the tool used most often for reflections related to their own teaching or their students. Elluminate Chat served as a vehicle with which to discuss the instruction that took place in the class. Elluminate Voice was used sparingly.

The results showed that there were also differences in the target and content of questions asked in the different modes of instruction. Elluminate

Figure 1. Frequency of different types of comments across the three instructional modes
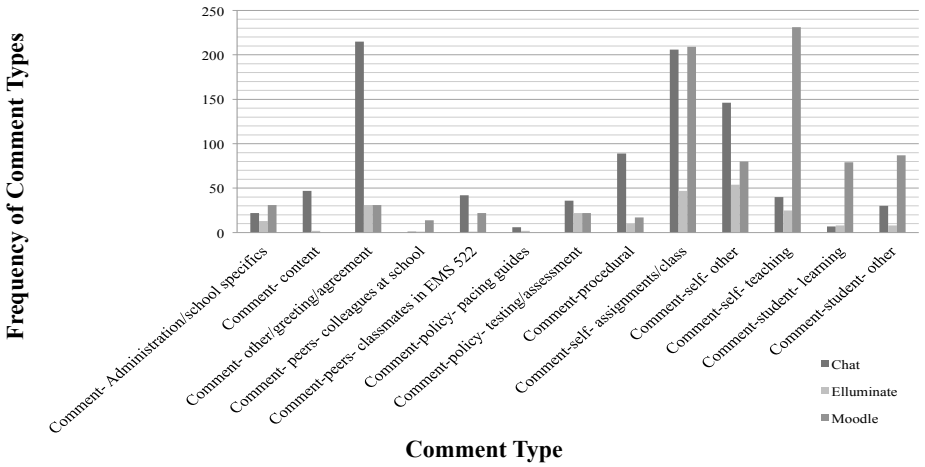
Chat was used as a tool for asking questions on the content of the instruction in class (62%) (see Table 3 on next page). Moodle was used as a vehicle for asking (general) questions. When the participants had questions about procedures they tended to ask them in either Moodle or in Elluminate Chat (written modes of communication) rather than Elluminate Voice (a verbal communication mode).

The target of interactions also varied by instructional mode (Table 4 to the right). Peer interactions occurred most frequently in Elluminate Chat. Interactions with the instructor occurred most frequently in Elluminate Voice. When students used Moodle the interactions were often not addressed to a specific individual, but were general to students and the instructor.

There were differences by individuals in the types of interactions in the different instructional modes (See Figure 2 below). For example, participants who tended to interact often on Moodle (such as participant 17) tended to interact less on Elluminate Voice. There were some examples of individuals who interacted frequently with written forms of interaction such as Elluminate Chat and Moodle but seldom interacted verbally on Elluminate Voice (such as participants 10 and 20).

Though most communication took place using either Elluminate Chat or Moodle, we found that some students' participation was dominated by more posts in one mode or the other (e.g., participants 8 and 18), or evenly

Table 3

Percentage of Question Type by Instructional Mode

Question	Percentage of Elluminate Chat Interactions	Percentage of Elluminate Voice Interactions	Percentage of Moodle Interactions
Content	62.43%	9.52%	28.04%
Other	24.77%	8.26%	66.97%
Procedural	40.31%	15.82%	43.88%

Table 4
Target of Interactions by Instructional Mode (Percentage)

| Target	Elluminate Chat	Elluminate Voice	Moodle
General/Unspecified	44.69%	7.65%	47.66%
Peer	69.92%	1.63%	28.46%
Instructor	42.58%	56.94%	0.48%

distributed (e.g., participants 17 and 21), and some included a considerable amount of Elluminate Voice communication (e.g., participants 1 and 12).

For example, one participant described her preference for written communication in a Moodle entry:

> I was, and still am, the silent girl in school, and I explain stuff better when I draw/write my ideas. I'm very introverted. I think texting and social websites are good and bad for those who are quiet and shy. It is easier to write and type my thoughts than it is to tell them to someone. Like in class, I prefer typing in the chat over speaking on the mic any day! …[some] students [who prefer written communication]don't know how to have a normal face to face conversation with someone. It hurts shy, quiet students because it allows them to stay quiet, and it is harder for them to learn leadership and communication skills. Does that mean they are ruined for life? I don't think so, because they will find ways to use the skills they have. We have to help them find their own skills and teach them how to put them to use.

These findings indicate that learners had preferences for specific communication modes, and suggest that incorporating all three modes can increase the comfort level and degree of choice each participant is allowed.

Figure 2. Participant interaction frequencies by instructional mode
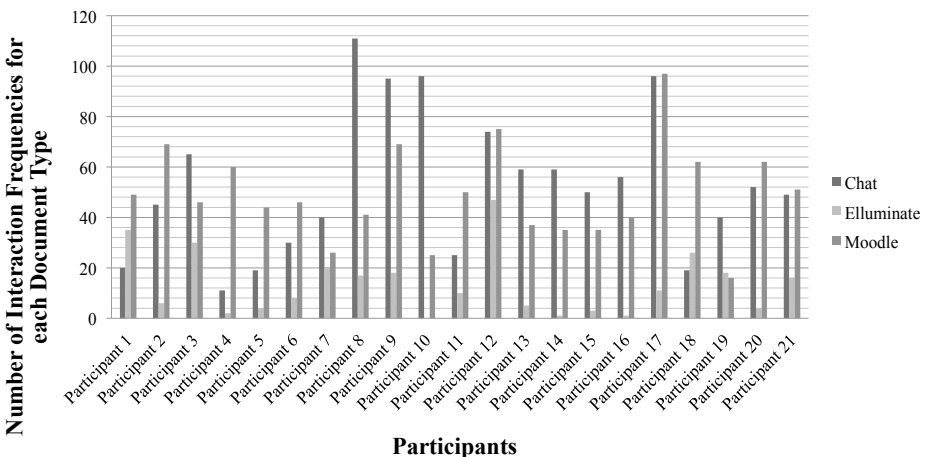
Discussion

Prior studies have found that student interaction and allowing for multiple modes of communication are central to successful DE (An & Kim, 2007; An et al., 2008; Bernard et al., 2004, 2009; Brannon & Essex, 2010; Gil, 2006; Latchman et al, 1998; Zhao et al., 2005). In this study we examined student interactions across multiple communication modes in a graduate science education course and found there are distinctly different patterns of interacting depending on mode of instruction.

Interactions Across the Three Communication Modes

We found significant differences in the types of student interactions across the three communication modes. As shown in Table 1 (see pg. 22), students participated much more using Elluminate Chat and Moodle, rather than Elluminate Voice. When separating the utterances into comments and questions (Table 2 on pg. 23) we also saw that students favored the text-based communication of Elluminate Chat and Moodle with 40-45% of postings for both comments and questions in each of these areas compared to Elluminate Voice that had less than 12% of the postings for both comments and questions in this area. On the surface, it might appear that the types of communication across the text-based modes were similar, but in depth analyses revealed there were differences in purposes of communication for the two text-based modes of communication.

In a traditional face-to-face course, the instructors often seek the smiles and head nods of their students for confirmation that they are following along with the content being presented. DE settings without whole-class video connections eliminate the opportunity for instructors to obtain this informal type information about how the class is progressing. But, when a chat function is available, instructors can use the written chat communication to monitor their students' engagement. In some ways the chat gives a voice to the head nod. Research has shown that the immediate nature of synchronous communication, such as that in Elluminate Chat, allows for learners to form communities of inquiry (Morrison & Anglin, 2012) and to collaborate (Belderrain, 2006). In our study, many of the chat comments were greetings, agreements, and comments about oneself as a science teacher, supporting the research related to professional education communities. Others have reported that synchronous DE allows instructors to give students on-the-spot feedback (Hines & Pearl, 2006). The prevalence of comments in the present study regarding course assignments, suggests that students were using the Elluminate Chat to ensure that they were on track for completing assignments and used Chat to check in with the instructors.

Other studies have shown that asynchronous communication, such as that on the Moodle discussion boards, allows for deeper reflection on learning

and critical thinking (Bryce, 2009; Morrison & Anglin, 2012). An and colleagues (2007, 2008) reported that asynchronous communication also allows for students to be more thoughtful in their feedback. Our findings supported this research as we found that the comments made on Moodle were dominated by thoughtful reflections on their own teaching and their students' learning.

Interactions Across Participants

Zhao and colleagues (2005) suggested different learners might benefit from different communication modes. Yet, Bernard et al. (2009) and Johnson (2006) caution that there is still no research supporting that multiple modes of communication are preferable to single-mode DE courses. Our analyses of the types of postings across the three modes of communication suggest students had preferences for specific communication modes. Though most communication took place using either Elluminate Chat or Moodle, we found that some students' participation was dominated by more posts in one mode or the other (e.g., participants 8 and 18), some was fairly even across the two (e.g., participants 17 and 21), and some included a considerable amount of Elluminate Voice communication (e.g., participants 1 and 12). These findings indicate that learners had preferences for specific communication modes, and suggest that incorporating all three modes could potentially increase the comfort level and overall engagement of participants.

The differences in individuals for modes of communication argue for taking a closer look at DE formats. The reluctance of some students to interact verbally is not uncommon, and was noted by the student described earlier who stated, "I prefer typing in the chat over speaking." Other studies have shown that up to a third of a typical class may be "silent" students (Jones, 1990) and some of these quiet students have preferences for listening rather than talking in class (Jones & Gerig, 1994). The chat function offers these students a unique vehicle for sharing thoughts without having to interact orally.

What is not yet clear is how individual students' prior knowledge, personality traits, and motivation contribute to their utilization of specific communication modes. Furthermore, within the context of teacher education we know little about how different communication modes contribute specifically to the development of advanced pedagogical, pedagogical content knowledge, and content knowledge. Does a highly visual and verbal mode such as Elluminate Voice provide more scaffolding for teaching about new science methods? Alternatively, does chat allow students to ask immediate questions as they struggle with a new form of inquiry? Further research is needed to more clearly document the strengths and limitations of the different forms of communication.

Conclusions & Implications

Research comparing student achievement across synchronous, asynchronous, and hybrid formats of DE shows that there are very few differences in student achievement (Bernard et al., 2009) in comparison to non-hybrid formats, yet many instructors choose to incorporate both synchronous and asynchronous components in DE courses to maximize the benefits of both types of communication (Motyca et al., 2013). Though our study did not incorporate analyses of the same students in synchronous-only and asynchronous-only DE alongside the hybrid format, we did find that using a hybrid format afforded us many benefits. Incorporating multiple communication modes allowed students to post different types of information in different places.

The Elluminate Chat helped students form professional communities and get on-the-spot answers while Moodle allowed for more thoughtful reflection on science teaching and student learning. Additionally, the multiple formats allowed for students to participate in different ways. This study provided clear evidence that the different platforms for interaction served distinctly different purposes. Furthermore, the type of immediate responses that students are able to receive with modes such as Chat provide a new tool for students to use as they engage in the instructional content in ways that are seldom seen with face-to-face science education instruction. ∎

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