

“I Tolerate Technology—I Don't Embrace It”: Instructor Surprise and Sensemaking in a Technology-Rich Learning Environment

Jennifer L. Fairchild¹, Eric B. Meiners², and Jayne L. Violette³

Abstract: Assuming a dialectical approach to technology and pedagogy, this study explores sensemaking processes for instructors teaching in a technologically enhanced college classroom environment. Through a series of semi-structured individual and group interviews, seven instructors provided narrative accounts of the problems encountered with progressive instructional technology and their emergent strategies to make sense of and manage it. Three primary dialectical tensions were described: freedom vs. confinement, connectedness vs. fragmentation, and change vs. stability. Two related modes of sensemaking in response to these tensions were also uncovered: adaptation, involving day-to-day adjustments to non-routine failures, and reframing, entailing gradual reflection upon the instructors' roles in the classroom. Implications for the current findings are discussed.

Keywords: instructional technology, dialectics, sensemaking

The integration of Information and Communication Technology (ICT) has had a significant impact on instructional design and pedagogy in higher education (Baker, Lusk, & Neuhauser, 2012; Guzman & Nussbaum, 2009). Emergent technologies currently afford college faculty opportunities for enhanced multi-media instruction, real time peer-to-peer collaboration and distance and mobile delivery that would have been unimaginable a decade or two ago (Nworie & Haughton, 2008). Improved access to technology is a prominent talking point in education reform, as considerable time, money and energy are being invested to furnish classrooms with the latest technologies to enrich the student learning experience (Beam, Eunseong, & Voakes, 2003; Groff & Mouza, 2008). Instructors at all levels are increasingly expected to integrate innovative technology within their teaching (Nworie & Haughton, 2008).

Despite its potential benefits, the integration of ICT in higher education poses inherent problems and contradictions. While instructors' competence with ICT is critical for its successful integration into pedagogical practice (Guzman & Nussbaum, 2009; Venezky, 2004), they often have limited experience with technology and little training selecting tools to match teaching objectives (Brown & Warschauer, 2006; Hughes, 2005). While ICT offers a range of possible uses in the classroom, its role is often ill-defined (Guri-Rosenblit, 2003). Many tools are poorly fitted with existing curriculum, while others merely serve as substitutes for existing teaching techniques (Baytiyeh & Naja, 2010; Gao, Choy, Wong, & Wu, 2009; Mann & Robinson, 2009). As technological innovation continues to pervade higher learning, it is critical to explore the ways college faculty adapt their teaching philosophies and implicit theories of instruction in response.

Much of the existing research in classroom ICT centers on questions such as which technology or medium will have the strongest effect on specific learning outcomes (Zhang, 2009).

¹ Department of Communication, Eastern Kentucky University, 521 Lancaster Ave., Richmond KY, 40475, jennifer.fairchild@eku.edu.

² Department of Communication, Eastern Kentucky University, 521 Lancaster Ave., Richmond KY, 40475, eric.meiners@eku.edu.

³ Department of Communication Studies, University of South Carolina Beaufort, One University Boulevard, Bluffton, SC 29909, jviolett@uscb.edu.

Zhang (2009) suggests this approach overlooks the complex and systemic nature of the learning environment. A growing body of scholars views the classroom as a system of connected, interdependent elements (Levin & Wadmany, 2008; Parr, 1999). The structures of this system do not remain static, but are built, maintained and altered through ongoing interaction among its members (Barley, 1990). Relationships among users and tools in the social environment are tightly coupled and reciprocal, and changes to any one component of the system exert direct and indirect effects on other components (Lim, Lee, & Hung, 2008).

Accordingly, the effects of ICT in the classroom are imagined to be neither simple nor linear (Okojie & Olinzock, 2006). The application of any given tool is "underdetermined" by its design, as users interpret and negotiate the meanings they ascribe to it (White, 2008). Weick (1990) suggests that innovative technologies, with their inherent complexity, create non-routine problems offering multiple plausible meanings and interpretations for users. The uncertainties accompanying new technologies require "ongoing structuring and sensemaking if they are to be managed" (Weick, 1990; p. 1). ICT thus seems unlikely to have a uniform effect on instructors and learners in all classroom settings. ICT is instead ideal to stimulate reflection, sense-making and interpretation among instructors and learners.

Given the vital role instructors play in implementing classroom ICT (Almas & Krumsvik, 2008; Levin & Wadmany, 2008), the current study explores sensemaking processes undertaken by college instructors in an innovative, technology-rich classroom. This research is intended not only to identify key areas of tension brought about by emergent instructional technologies, but to uncover some of the sensemaking strategies arising in response to these tensions. It is hoped that addressing the ambiguity and sensemaking in the classroom will yield a richer understanding of instructors' experiences with innovative ICT. Such research may also reveal important practical applications for the development of strategies for more effective implementation of technologies in higher education.

Consistent with systems theory, this study adopts a dialectical approach to instructor sensemaking. This approach addresses the intrinsic duality within interactive systems at the relational, group or organizational levels (Baxter & Montgomery, 1996; von Bertalanffy, 1968). Oppositional tendencies among interdependent parts create tensions, which serve as the catalyst for communicative adjustments and negotiation (Baxter & Montgomery, 1996). Given the tightly-coupled nature of the classroom system, instructors are apt to experience a host of dialectical tensions in a technologically rich space. These experienced tensions are further predicted to stimulate sensemaking processes, whereby instructors seek to reconcile the use of technology with previously held models of effective instructional practice. The following section addresses the relations between sense-making and technology

Sensemaking and Technology

Scholars in education suggest that the classroom can be seen as a complex social system, existing in a state of intrinsic uncertainty and flux (Cvetek, 2008; Harjunen, 2012). Generally, individuals faced with ambiguity engage in sensemaking as they construct meanings through repeated testing of plausible alternatives. More succinctly stated, "people search for meaning, settle for plausibility, and move on" (Weick, Sutcliffe, & Obstfeld, 2005, p. 419). Sensemaking involves more than thinking about one's environment, but is linked with behavior as well. Plausible meanings emerge incrementally, as action precedes reflection, which in turn facilitates continued action (Berente, Hansen, Pike, & Bateman, 2011). A key tenet of sensemaking is that individuals assimilate new

information through their existing knowledge and experience. Mental models, previously developed through training or experience, continually help the sensemaker select and organize phenomena they experience (Weick et al., 2005).

Researchers in education and information technology have utilized the concept of sensemaking in analyzing topics such as policy change (Coburn, 2005; Smerek, 2010; Spillane, Reiser, & Reimer, 2002), innovation (Berente et al., 2011; Griffin, 1999) and instructor learning (Ng & Tan, 2009). In this research, teachers are commonly viewed, not as passive recipients of ICT, but as active constructors of knowledge whose professional growth involves not only formal socialization, but continuous reflection on successful and unsuccessful instructional practice (Schon, 1987). As teachers consider the connection between past instructional performance and student learning outcomes, they build a set of cognitive resources to guide them as they experience novel classroom situations (Almas & Krumsvik, 2008; Coburn, 2005).

Although formal, preservice training can provide instructors basic skills with technology (Shoffner, 2009), it is likely most sufficient for teachers in routine, predictable environments, where the need for sensemaking may be minimal. More active sensemaking can be triggered, however, when: a) situations are novel, b) discrepancies emerge between what is expected and what is observed directly, and c) there is motivation to derive plausible meanings from one's environment. As instructors attempt to implement new, often untested, technologies into a classroom, they are prone to experience non-routine issues, ill-addressed during pre-professional learning. Instructors in this situation may have little experience from which to draw for their sensemaking efforts. Here, sensemaking is situated in the day-to-day action of the authentic learning context (Coburn, 2005; Ng & Tan, 2009; Putnam & Borko, 2000).

A variety of unforeseen consequences are likely to accompany the implementation of communication technology in the college classroom. These include increased opportunities for students' cheating using electronic media, or heightened distractions from text-messages, email or social networking sites (Nworie & Haughton, 2008). In addition to these relatively routine issues, ICT is also tied with underlying ideologies at play as well (Zhang, 2009). Instructors' use of ICT is dialectically related with their own epistemological beliefs about learning, teaching and the role of the instructor in the classroom (Reybold, Flores, & Riojas-Cortez, 2006). Instructors' beliefs and attitudes help shape, and are shaped by, the technological tools available, and as they seek to reconcile the use of ICT with their own philosophical stance (Putnam & Borko, 2000; Wong, Li, Choi, & Lee, 2008) the resulting tensions are a likely catalyst for sensemaking.

Theories of educational reform often, directly or indirectly, view the integration of classroom technology as a means to support students in their pursuit of constructivist learning (Russell & Schneiderheinze, 2005; Zhang, 2009). Where traditional approaches to learning emphasize instructors as sources of knowledge and factual information (Rosenfeld & Rosenfeld, 2006), the constructivist model views learning as an active, social activity, and learners as co-constructors of knowledge. Under constructivist philosophy, ICT serves less as of a tool of information transfer and more a medium for the construction of knowledge (Wong et al., 2008). This student-centered approach views technology as a vehicle for enhanced group interaction and peer-to-peer involvement essential for an authentic, cooperative learning experience (Gao et al., 2009; Schweitzer & Stephenson, 2008).

The introduction of ICT not only affects curriculum and instructional practice, but has implications for the instructor's role in the classroom as well. In a constructivist environment, the instructor is more a facilitator of student inquiry than a source of factual knowledge. With emphasis on technology-based collaborative learning, instructors not only step out of the center of the class,

but may be forced to take on more unfamiliar roles, such as trainer, collaborator or consultant (Groff & Mouza, 2008; Hughes, 2005). ICT can further affect the balance of power between students and instructors (Black, 2009). Students' comfort with, and mastery of, emergent technologies might in fact outstrip that of their instructors, who have often spent a smaller portion of their lives immersed in communication technologies.

In fostering a decentralized, student-centered learning environment, instructional ICT can pose a challenge to instructors' belief systems. Those with more traditional epistemological beliefs (e.g., teachers are figures of authority, learning is an inherently passive process) may be particularly reticent in incorporating innovative technology into their teaching practices (Amory, 2007). Teachers with more liberal approaches to pedagogy, where individual expression and critical alternative perspectives are valued highly, may be more receptive to innovative classroom practices including the integration of emergent ICT.

In summary, the present research is grounded in a few key assumptions. The first is that teaching with instructional technology is a dialectical practice enacted within the classroom's social and physical environment (Lim et al, 2008). Second, the implementation of new tools and technology into the classroom can create tension as instructors seek to integrate innovative technological tools with their existing skill set and pedagogical philosophy (Russell & Schneiderheinze, 2005). Third, faced with these tensions and other equivocal pieces of information, instructors will attempt to make sense of, and assimilate to, changes in the learning environment (Weick, 1990).

While the concept of sensemaking holds rich potential for analyzing instructors' experiences with emergent ICT, some questions are worthy of consideration. First, although it is commonly assumed that a technology-rich learning environment will create a number of possible tensions among opposing elements, research has yet to fully articulate the key dialectical tensions. In other words, which aspects of the technology-rich classroom system are particularly likely to give rise to dialectical tension and sensemaking? Second, given that instructors can be constructors of meaning within their classrooms, what personal strategies do instructors employ to make sense of and assimilate ICT into their emerging epistemological beliefs? These gaps in the literature prompt the following questions:

RQ1: What dialectical tensions will be revealed for instructors teaching in a technology-rich classroom?

RQ2: What sensemaking strategies will instructors report in response to these tensions?

Method

Research Site

To explore instructors' sensemaking activity in the technology-rich classroom, a qualitative research strategy was employed. All data for this study were collected using a purposeful sample of 7 instructors teaching 15-week courses meeting in a technologically-enhanced classroom at a mid-sized regional university in the southeastern United States. Four of the instructors taught math courses, while three taught courses in communication. The courses included freshman-level introductory courses and upper division major courses as well. This 40-seat facility was equipped with progressive technologies including: tablet PCs for each learner, audience response systems,

and an interactive whiteboard. This room featured four high fidelity projectors, a DVD player, and document camera; all connected through a central routing system. In addition, the seating for this facility was arranged in four-person modular units with swivel chairs designed to encourage peer-to-peer interaction and involvement with the technologies.

This facility was designed as part of a university-wide initiative to provide faculty opportunities to better integrate their knowledge and skills with innovative ICT. The participants for the current research were involved in collective project aimed at allowing instructors to adopt and master new instructional tools in a controlled environment with the ongoing support and consultation of specialists and scholars from technology, instructional communication, education, instructional design, and the campus teaching and learning center. As part of their support network, faculty members invited to teach in this enhanced classroom also participated in an established professional learning community (PLC), meeting monthly. The purpose of the PLC was to encourage involved faculty to discuss the pedagogical and technological challenges and rewards experienced in the space with their students. Following the approval of the university's institutional review board, participants for the current study were solicited in person during the initial PLC meeting of the target semester.

Interviews

Over three months, individual interviews were conducted with seven faculty members from the professional learning community, ranging from 30 to 90 minutes. Interviews were conducted by the principle researcher at the place of the participants' choosing, including classrooms, the researcher's office or the faculty member's office. At each location, the interviewer first sought to answer any questions that the research participant had and obtained the participant's written consent before proceeding with the interview.

Semi-structured interviews with open-ended questions designed to facilitate reflection and storytelling allowed the interviewees to share their experiences, while highlighting the issues that mattered most to them (Glaser & Strauss, 1967; Vanderford & Smith, 1996). Respondents were asked to describe the challenges they experienced while teaching in the technology-rich classroom and ways they modified or revised their teaching strategies in response to technology-related uncertainty. Instructors were also asked how their role in the classroom and relationship with their students might have changed during the target semester and what they would do differently if they taught in the room again (See Appendix for the complete interview guide).

All interviews were recorded using digital audio recording software. Recording the interviews (rather than taking notes) allowed us to focus our attention more fully on the interviewees' verbal and non-verbal reactions during the interview. We did take limited notes on certain phrases or parts of the story that particularly stood out as we talked. Participants were told that confidentiality would be maintained for any direct quotations reported in our findings through the use of pseudonyms.

A secondary method of gathering data was also employed. Faculty discussions about teaching and learning experiences in the technology-rich classroom were audio-recorded in the actual PLC meetings as well, providing additional insights on how the instructors interpreted their (and their students') experiences, prompting instructors to share stories with each other and to seek advice and encouragement from others. One of the researchers in this study served as the PLC discussion facilitator, while the other two researchers listened, took limited notes, and made observations. As with the interviews, instructors' permission was obtained and privacy ensured.

Analysis

Once the transcripts were typed and printed, we used the constant comparison method (Cawyer & Smith-Dupre, 1995) to compare the notes from each interview with the other interviews in order to determine the significant themes of each account. We analyzed the transcripts using narrative analysis. After gathering the faculty members' stories, we followed the example of Vanderford et al. (2001) by creating lists of the most dominant narrative elements represented in each story. Once we were ready to organize the data and reduce it to manageable categories, we began with the printed version of the transcripts, organized in chronological order. The transcripts were read multiple times in their entirety. The first time we read the transcripts, we employed grounded theory and used a broad open coding system. According to Lindlof and Taylor (2002), starting with open coding during initial analysis allows for a great deal of flexibility and creativity when one later refines the data and develops a codebook. During this initial coding, we looked for consistencies and commonalities in the data. We based the codebook on the research questions and on emergent themes from the data. As we coded, we paid close attention not only to what the respondents explicitly stated in the interviews but also to what was implied during the conversation. After the initial round of coding, we read through the data set another time to refine the codebook. This open coding system led to more refined categories of data, which then yielded answers to the research questions.

The primary researcher's status as a faculty member who also taught at least one class in the technology-rich classroom seemed to help facilitate the interview process as well as inform the research. Since two of the researchers also teach in this particular classroom environment, we enjoyed status as authentic members of this particular teaching community. Being able to discuss the shared challenges faced in this learning environment seemed to help the interview unfold smoothly.

Results

The first research question sought to identify key dialectical tensions in the technology-enhanced classroom. To tap into these tensions, instructors were asked to discuss the rewards and challenges they experienced when teaching in this environment. Through their diverse narrative accounts, unfolding during both individual interviews and the group PLC meetings, three sets of dialectical tensions were revealed: Freedom vs. Confinement, Connectedness vs. Fragmentation, and Change vs. Stability. One unexpected result was that, in addition to the specific ICT afforded in this classroom, the dialectics and sensemaking processes were often related to the unique *spatial* arrangement of the classroom (i.e., decentralized seating, modular arrangements, multi-directional screens). Although we did not originally intend to focus upon the impact of physical space for the current study, the emergence of the topic of space in the instructors' accounts of sensemaking warranted attention and added depth to the reported findings.

Dialectical Tensions

Freedom vs. confinement. The first dialectic uncovered was that progressive instructional technology allows the instructor to venture into new areas of pedagogy, but, at the same time, can impose unique restrictions. Several instructors shared that the innovative technology and unique

spatial arrangement simultaneously afford freedom to explore new techniques in their teaching and introduce unforeseen constraints on their instructional activities. At the outset of the semester, the instructors were excited to have the opportunity to learn new instructional tools and techniques. Some of the metaphors (Lakoff & Johnson, 1980) the instructors used to describe the classroom reflected the idea of enhanced freedom. One instructor described the room as a “spaceship,” an obvious reference to a vehicle of exploration. Another likened the room to “kitchen stadium,” a reference to the T.V. cooking competition show, *Iron Chef*, in which master chefs compete in a high-tech, fully equipped facility.

The idea of freedom was also evident in the other instructors’ accounts of their early experience of the classroom. Beth⁴ stated that she enjoyed the freedom of being able to move around the space, and by virtue of having a “clicker” (a presentation aid she used to advance her PowerPoint slides), she is not restricted to any one part of the classroom space. Because of her use of space, Beth said that “I can physically get closer to them. They can’t hide.”

While some faculty like Tina enjoyed the freedom afforded by the technologically rich space, other instructors revealed how the innovative environment and tools could be confining as well. Ryan quipped, “There are challenges to driving a Lamborghini.” Confinement was evident in the sheer amount of work required to learn the new technology. Another faculty member, Sam, stated,

Technology issues were problems from time to time. Things that I wanted to do in that class were not as simple as I had expected. And then my having to redesign the way I did things to fit that classroom was another issue that took a lot of work and probably affected my performance in the classroom.

Tina also expressed frustration with her own level of expertise with technology compared with her students,

I feel like I should be an expert but I’m not, so when there’s glitches, I’m kinda like ‘oh crap.’ ...The perfectionist side of me—I want to be better at this than they are, challenging myself, how can I use this technology better.

Connectedness vs. fragmentation. Although constructivist learning theories typically posit that enhanced technology can create greater connectedness among learners (Cetin-Dindar, 2016), a tension between connectedness and fragmentation was evident. In this dialectic, technology affords opportunities for greater interaction and collaboration among students, but also grants students greater opportunity to disengage from the course, its content and class interaction. Faculty told stories that illustrated both poles of this dialectical tension.

Some faculty lauded the classroom, stating that the available technological tools and spatial arrangement allowed them to build a stronger sense of community in the classroom. For example, Ryan shared stories of how he was able to use cloud-based software in the classroom (since all students had access to a tablet computer), and how students could use specific computer programs to give immediate feedback to their peers on their work. Ryan reported that the technology allowed his class to build and maintain more peer-to-peer interactions than a traditional learning space, stating that “having the technology available makes it a social network and not just a place we sit for a couple of hours.”

The instructors also commented on the impact of the physical arrangement of the classroom on connectedness between themselves and the students. John for instance reported, "I'm able to be much more closely connected to students, I think...I'm able to walk around. It is much better at creating a sense of community." While Tina was quick to applaud the level of opportunities for interaction that technology affords, she also claimed, "It's not about the technology as much as the level of engagement."

While some instructors believed that the technology afforded opportunities for more interaction and collaboration between the students, others thought that the abundance of technology, coupled with the modular arrangement of the room, allowed students greater opportunity to disengage from the course content and from each other. For example, John admitted "the real challenge...is holding the attention of the room and being able to connect with all the people, far apart, at far tables. You must command the room's attention." Even with experience teaching in the technology-rich classroom, he still admits that every time he teaches in this classroom it is a challenge to hold the students' attention.

Other faculty echoed John's sentiment. Tom said that the "biggest challenge...was probably just trying to keep students focused on what we were doing and not having them go into their own little environment and kind of do their own thing." Keeping the students connected to what was happening in class was also a challenge for Julie. Julie echoed John and Tom's sentiments by saying that her biggest challenge was "keeping the students' attention." She further stated that all the technology available to her students in that classroom was "just too tempting." When discussing her students, she stated that "they were dumbfounded as to why I would even ask them to close their laptops." Even Ryan, who embraced the technology-rich classroom, acknowledged that "There's more distractions [sic]. Not a place where you want to lecture the whole time."

Change vs. stability. As noted previously, instructors typically employ a relatively stable set of beliefs about teaching and learning to help them make sense in new teaching environments. Innovative instructional technology, however, can often challenge instructors' beliefs about the nature of learning and their role in the classroom itself. The change-stability dialectic is evident as instructors seek to embrace the new technology and space afforded by the classroom, while drawing from their existing cognitive resources to teach in a way that is comfortable and familiar.

Some instructors seemed to embrace the changes in their teaching that occurred in the classroom. For example Tina, stated that she completely changed things around, "going digital" during this experience. She acknowledged that the class was "good for hands-on learning, and it was a different way to do the same thing." She noted that there were many choices for ways to approach teaching her class, and that she feels more creative when she teaches in that space. Tina also mentioned that it was "rewarding" to learn how to use the technology.

Other instructors, such as Beth, felt that the spatial aspects of the room were helpful in pursuing pedagogical goals. Beth mentioned that the "classroom itself is very conducive to group work." Even Julie, who used technology least of all, acknowledged that the physical space and configuration of the room worked to her advantage. Since the students sit at tables of four, not in rows or desks, she noted, "When they had to do group work, they were already grouped off, with the seating." Tina suggested that the longer she teaches in the technology-rich classroom, she finds herself "backing off technology and using space to her advantage," asking, "how can I use the space...even more?" She also mentioned the ease of being able to move students around in the room for group work or class activities as well.

Ryan, a faculty member comfortable with technology in this environment, taught public speaking in the classroom, acknowledging that the physical space presented a “challenge of having to reconfigure space for each time they gave a speech.” The physical space is different from the traditional rows of desks with a teacher at the front of the classroom. The physical configuration and spatial dimensions of the room presented challenges for some, but rewards for others.

Some faculty offered counterstories to the use of space or the advantages of trying new strategies in their teaching. Some, like Julie and Tom, while not resistant to the technology, were resistant to the innovation required when simultaneously navigating the less traditional open space. Tom stated that he wanted someone to say, “Here’s the structure, put yourself in it. Here’s what works, go do it. I would love that.” So Tom, who did not embrace many innovations in his teaching, stated that he would possibly do so, but only if someone told him specifically how to innovate. It seemed that stability was maintained when he was given instructions on how to use the various technologies instead of viewing his student learning outcomes as the motivation behind his choices for trying and using new technologies.

Even for faculty who were not uncomfortable using innovative technology, there were times when they were uncomfortable learning when and how to implement the technology into their curriculum. For example, Tom stated, “I feel comfortable with the technology. The thing I didn’t feel comfortable with was how to incorporate it to its full ability or to its maximum potential.” As a result, he initially took the approach of not adapting his teaching style or taking the restrictions of using technology into account, but eventually noted the futility of treating the space like a conventional classroom, “I tried to teach very similar...but the way that it’s set up you can’t help but be different.”

Julie stated that she did not attempt to use several of the technologies available in the classroom “just because of the time restraints” of her teaching within a 50-minute class period; she perceived that she had a large amount of content to cover in that time frame. Julie regarded the technology-rich classroom as the same type of environment as a traditional classroom, and she was also the faculty member who used the least technology available to her.

John, the faculty member with the most experience teaching in the technology-rich classroom, represented this dialectic best when he stated that “There’s more to technology than electronics and if you have an instructor that secretly thinks it’s still a normal classroom, just with a fancy projector, then it’s still a normal classroom.” Comments from Sam’s interview echoed this sentiment as well, “I made the mistake of having the room and trying to make the course fit the room. I think it needs to go the other way around.” These comments reflect how the change-stability dialectic is evident between user and tool. Although progressive technology and space can facilitate change, its effects cannot seemingly be understood without considering instructors’ individual desires for comfort and stability.

Sensemaking Strategies

The second research question involved the process of sensemaking employed in the face of tensions experienced in the technology-rich classroom. The instructors’ accounts revealed insights into their strategies for managing these dialectical tensions. These sensemaking processes unfolded over different time-frames. On one hand, short-term modes of sensemaking occurred, often as instructors reacted to the periodic challenges posed by non-routine technological failures in the classroom. This form of sensemaking was labeled, “Adaptation.” Long-term modes of sensemaking were evident as well. These types of sensemaking were more apparent toward the

end of the semester, as instructors had reflected upon their total semester's experience within the space and its impact upon their own outlook, philosophy and relationship with instructional technology. This form of sensemaking was labeled, "Reframing." Both of these strategies are discussed below.

Adaptation. One prominent theme of sensemaking was that of adaptation. This type of adaptation represented a tightly coupled cycle of action and reaction unfolding through day-to-day experiences in the classroom context. This response was frequently prompted when technology failed or did not work as planned. One key aspect of adaptation appeared to be instructors' acknowledging the inherent uncertainty in the classroom's technology subsystem, and developing a greater tolerance for (as well as working through) technological glitches. Beth stated that after having planned her lecture, and then the technology system not working for her, she had learned to "roll with the glitches." Ryan echoed Beth's sentiments, stating, "I don't pretend to be an expert on computers...I don't set myself up for an epic fail. When things fail, you roll with it. You have to be willing to not let something work." The adaptation process, involved not only tolerance for uncertainty, but also the development of greater emotional management in the face of malfunctioning technology. For example, Beth said that after teaching in this classroom, "I'm more comfortable with if something I've planned messes up, not to get too upset in front of my class."

In addition to the adaptation in instructors' mindsets toward technological failures, adaptation was also evident in the daily improvised action and reaction required to cope with systemic failures in the classroom. Instructors reported incidents when they had to "think on their feet" and improvise in response to technological problems. At times, the improvisation involved reverting to more familiar, conventional pedagogy. This was the case with Beth, as she recounted difficulties with the audience response system,

You have this nice smooth lecture all planned out and then you pass out the clickers to your class and they get all excited and then you try to use the system and it doesn't work. And then it's like what do you do? Okay let's just do it by a show of hands.

Other instances of improvisation involved more unconventional "re-purposing" of technology. For instance, Sam recalled that when the connection between the console computer and the projection system failed, he physically placed his laptop computer under the document camera (linked separately to the projectors) so that he could display its content on the four projectors.

While such repurposing of technology was rare, it illustrates the systemic relation between user and tool, and how instructors are not passive recipients of technology, but can sometimes craft the fit between technological tools and their own teaching strategy. Although these non-routine failures were widely acknowledged as frustrating, some instructors directly recognized such failures allowed for learning more about the classroom and being better able to plan for future activities. As Sam stated, "knowing what doesn't work is quite often just as valuable as knowing what does work."

Reframing. A second sensemaking strategy evident in the instructors' accounts reported was reframing. In contrast with the day-to-day adaptation to non-routine technological issues, this process involved a more gradual, holistic process of reflection on the impact of technology on instructors' underlying philosophies over the course of the semester. This reflection also involved teachers' views of their own role in the learning environment. It was evident however, that the reframing process varied considerably among instructors, both in the specific areas of reframing,

and in the *degree* to which reframing occurred. The categories of reframing could be simplified as resistance, co-optation and revision.

Resistance. At least one instructor, Julie, who taught a lower level math course, reported complete resistance to any reframing of technique or philosophy as a result of the semester. “I didn’t change anything that I do as far as basic technology or classroom strategy. In these math classes I’m a lecturer. I don’t see myself any differently now than I did at the beginning of the semester.” She indicated that teaching using a standardized course syllabus limited her ability to modify lesson plans and develop innovative teaching strategies using the tools in the learning space. Julie realized only a few weeks into the semester that the room seemed a poor fit for her learning objectives, stating, “I don’t know that it’s the ideal thing for a math course or a lower level math course...it just doesn’t work as well.” It is not surprising that this person reported the least satisfaction and greatest frustration with the innovative teaching environment.

Co-optation. Some reported less resistance to the constraints of the innovative learning space. For some, this reframing involved co-optation, or application of previously held mental models of teaching and the subtle repurposing of tools and space to fit that mental model. Sam, for instance, had previous experience teaching an ITV course at the university, a distance learning course in which instructors use video conferencing software to present materials in real-time to students at multiple sites throughout the region. He described how he co-opted this previous experience in adapting to non-routine failure in the new environment. He recalled, “one day the smartboard just quit on me in there and I had to go to the document cam and use that instead. I sat there, and it felt so natural for me ... I’d stand behind that station and use the document cam and laptop.” Sam recognized the unconventional strategy of teaching a face-to-face course as if it was a distance course was not really keeping with the intended use of the innovative classroom, but suggested that “if the delivery doesn’t work for the instructor, it’s not going to work for the students.”

Revision. A number of instructors (three out of seven) reported deeper revisions to their teaching craft and philosophy. For some of the instructors with less experience with progressive technology, the semester afforded a valuable teaching experience. Tom spoke in general terms about his semester’s experience, “I think it taught me a whole lot about myself and I think that’s the most valuable thing I could have pulled out of this. I learned a lot about myself and just how to teach.” For others, the semester’s experience in the classroom increased their comfort level with instructional technology on the whole. Ryan, who had less overall experience teaching than any of the instructors, reported a more pronounced impact on his teaching philosophy, “I see my pedagogy as a chairperson...present challenges to a committee. I see myself more in a training sense—doing little training sessions. I wasn’t really expecting to see that shift so it just made me pause.”

Some teachers’ accounts revealed not only comfort with and embrace of technology, but also shifts in their standpoint as they aimed technology more towards engaging students. John suggested, “I’m granting students more responsibility for their own academic welfare.” Tina reported, “Now I encourage more discussion and more group work and not lecture at them so much.” Tina added she was “always trying to think, ‘how can I make them the—controllers of their own learning...how can they become masters of their own learning, without them knowing it?’”

Finally, both Ryan and Beth echoed the sentiments that the specific technology enhanced classroom was the best place to teach on campus. Ryan said, “That class, that’s a dream. I wish I

could always teach in a room like that.” Beth said, “That classroom runs circles around anything we’ve got [in our classroom building]. It is a great room and a great environment.”

Discussion

Drawing from a systemic perspective on technology and pedagogy, this study has sought to uncover key underlying tensions and sensemaking processes for educators in a technologically-rich learning environment. Through their narrative accounts, instructors revealed three primary dialectical tensions: Freedom vs. Confinement, Connectedness vs. Fragmentation, and Change vs. Stability. Although progressive ICT and an enhanced classroom environment can offer instructors greater freedom, foster connection with students and stimulate pedagogical change, potential confinement, fragmentation and a mismatch between instructors’ teaching philosophies and the classroom tools can also emerge. Two modes of sensemaking were found to occur in response to the dialectical tensions, namely adaptation and reframing. The process of adaptation was situated mainly within the day-to-day interactions of the classroom, as instructors faced and responded to non-routine failures and adjusted their tolerance for ambiguity. Reframing involved a more gradual form of reflection upon the semester as a whole, and shifting perceptions of the instructors’ role within it including resistance, co-optation and revision.

Findings from this study hold some practical implications. Clearly, it is important for instructors to gain competence with new technologies before incorporating them into their teaching repertoire. It may not be sufficient, however, to learn the tools removed from the authentic classroom context. Instead, instructors would benefit from considering the possible tensions likely to emerge with advanced instructional technology. Being better aware of the potential for technology to confine their teaching, fragment the learners, and challenge their stable beliefs should facilitate efforts to better integrate technology with their pedagogical skills. Although these tensions are unlikely to ever be fully resolved, managing these dialectics first requires instructors to recognize them when they occur and accept them as a natural part of the classroom system.

In addition, pre-professional training may not give instructors a complete picture of the periodic adaptation necessary to address the non-routine failures likely to occur in the learning environment. Instructor training might emphasize the need for educators to develop their tolerance for ambiguity and ability to think on their feet. Ironically, by anticipating non-routine errors and system failure, instructors may experience greater comfort in integrating technology with their pedagogy. Furthermore, becoming better aware of the potentially transformative effects of technology on one’s long-term teaching philosophy could also be advantageous. Those maintaining resistance to change their teaching style or philosophy in the face of shifting technology may experience greater frustration and difficulty utilizing ICT to its fullest potential. Those recognizing the holistic change and reframing that can often accompany immersion in new ICT may thrive in technology-rich environment.

Finally, within the Professional Learning Community model, participants may find much-needed support and motivation from colleagues to further navigate dialectics in technologically rich learning environments. The value of such relationships cannot be overstated, especially among those who are less tolerant of pedagogical uncertainty or less experienced instructors.

Limitations

The prior experiences teaching in the technology rich classroom for two of the principal researchers can possibly be viewed as a possible limitation. While we acknowledge that objectivity

in research is an important goal, we recognize the difficulties in achieving complete detachment from the phenomena being studied. As humans, we have the ability to become “attached” to our projects—whether behaviorally, emotionally or psychologically. As qualitative researchers, we acknowledge how our positionality both inadvertently and purposefully influences the research process.

Although we offered bits of ourselves into this research project in an attempt to develop rapport, our goal was to observe the social interaction described in the interviews and professional learning community meetings and to conduct a narrative analysis in order to answer the research questions, not to become members of the study ourselves. Our experience in this classroom allowed us to frame an initial set of research topics, and compare the accounts of the others instructors with our own experiences. This experience and prior knowledge allowed us to have confidence in the data that was consistent with our experiences, but was not so confining as to preclude learning new things about the space through our interaction with the other instructors.

Finally, reflective of our belief that the classroom represents a highly complex system of processes and experiences coupled with how rapidly technological tools for classrooms are evolving, we believe additional scholarly attention about how both instructors *and* students engage in sense-making strategies in technology-rich learning environments will continue to be critically important.

Appendix. Interview Guide

1. What specific challenges have you experienced teaching in a technology-rich environment? What examples can you share?
2. What specific rewards have you experienced teaching in a technology-rich environment? What examples can you share?
3. What strategies do you employ to manage technology-related uncertainty during your first semester in this technology-rich environment?
4. How do you innovate, develop, alter, or revise your teaching strategies during your initial semester in the technology-rich environment?
5. How are your conceptions of your role in the classroom affected by the technology-rich environment?
6. How are your relationships with your students affected by the technology-rich environment?
7. What is your perception about student learning in this technology-rich environment?
8. Talk to me about your likelihood of teaching in this environment again. What would you want to change the next time you teach in this environment?
9. What would you change about your pedagogy if you taught in this environment again?
10. Is there anything else you want to tell me about your experience that I have not asked you already?

References

- Almas, A., & Krumsvik, R. (2008). Teaching in technology-rich classrooms: Is there a gap between teachers' intentions and ICT practices?. *Research In Comparative And International Education*, 3(2), 103-121.
- Amory, A. A. (2007). It's not about the tool, it's about the ideology. *South African Journal of Higher Education*, 21(6), 655-671.
- Baker, W. M., Lusk, E. J., & Neuhauser, K. L. (2012). On the use of cell phones and other electronic devices in the classroom: Evidence from a survey of faculty and students. *Journal Of Education For Business*, 87(5), 275-289.
- Barley, S. R. (1990). The alignment of technology and structure through roles and networks. *Administrative Science Quarterly*, 35(1), 61-103.
- Baxter, L. A., & Montgomery, B. M. (1996). *Relating: Dialogues and dialectics*. New York, NY US: Guilford Press.
- Baytiyeh, H., & Naja, M. K. (2010). Do multimedia features promote understanding and retention. *International Journal Of Instructional Media*, 37(1), 43-53.
- Beam, R. A., Eunseong, K., & Voakes, P. S. (2003). Technology--induced stressors, job satisfaction and workplace exhaustion among journalism and mass communication faculty. *Journalism & Mass Communication Educator*, 57(4), 335-351. Retrieved from EBSCOhost.
- Berente, N., Hansen, S., Pike, J. C., & Bateman, P. J. (2011). Arguing the value of virtual worlds: Patterns of discursive sensemaking of an innovative technology. *MIS Quarterly*, 35(3), 685-709.
- Black, J. (2009). Necessity is the mother of invention: Changing power dynamics between teachers and students in wired art classrooms. *Canadian Review of Art Education: Research And Issues*, 36, 3699-117.
- Brown, D., & Warschauer, M. (2006). From the university to the elementary classroom: Students' experiences in learning to integrate technology in instruction. *Journal Of Technology And Teacher Education*, 14(3), 599-621.
- Cawyer, C.S., & Smith-Dupre, A. (1995). Communicating social support: Identifying supportive episodes in an HIV/AIDS support group. *Communication Quarterly* 43, 243-358.
- Cetin-Dindar, A. (2016). Student motivation in constructivist learning environment. *Eurasia Journal Of Mathematics, Science & Technology Education*, 12(2), 233-247.
doi:10.12973/eurasia.2016.1399a

Coburn, C. E. (2005). Shaping teacher sensemaking: School leaders and the enactment of reading policy. *Educational Policy*, 19(3), 476-509. doi:10.1177/0895904805276143

Cvetek, S. (2008). Applying chaos theory to lesson planning and delivery. *European Journal of Teacher Education*, 31(3), 247-256. doi:10.1080/02619760802208320

Ellingson, L. L., & Buzzanell, P. M. (1999). Listening to women's narratives of breast cancer treatment: A feminist approach to patient satisfaction with physician-patient communication. *Health Communication*, 11, 153-183.

Gao, P., Choy, D., Wong, A. L., & Jing, W. (2009). Developing a better understanding of technology based pedagogy. *Australasian Journal of Educational Technology*, 25(5), 714-730.

Glaser, B. G. & Strauss, A. (1967). *The discovery of grounded theory*. Chicago: Aldine.

Griffith, T. L. (1999). Technology features as triggers for sensemaking. *Academy of Management Review*, 24(3), 472-488. doi:10.5465/AMR.1999.2202132

Groff, J., & Mouza, C. (2008). A framework for addressing challenges to classroom technology use. *AACE Journal*, 16(1), 21-46.

Guri-Rosenblit, S. (2005). *Eight paradoxes in the implementation process of E-learning in higher education*. Higher Education Policy.

Guzman, A. A., & Nussbaum, M. M. (2009). Teaching competencies for technology integration in the classroom. *Journal Of Computer Assisted Learning*, 25(5), 453-469. doi:10.1111/j.1365-2729.2009.00322.x

Harjunen, E. (2012). Patterns of control over the teaching–studying–learning process and classrooms as complex dynamic environments: A theoretical framework. *European Journal of Teacher Education*, 35(2), 139-161. doi:10.1080/02619768.2011.643465

Hughes, J. (2005). The role of teacher knowledge and learning experiences in forming technology-integrated pedagogy. *Journal Of Technology And Teacher Education*, 13(2), 277-302.

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: University of Chicago Press.

Levin, T., & Wadmany, R. (2008). Teachers' views on factors affecting effective integration of information technology in the classroom: Developmental scenery. *Journal Of Technology And Teacher Education*, 16(2), 233-263.

Lim, W., Lee, Y., & Hung, D. (2008). “A prophet never accepted by their own town”: A teacher's learning trajectory when using technology. *Asia-Pacific Journal Of Teacher Education*, 36(3), 215-227. doi:10.1080/13598660802232605

Lindlof, T. & Taylor, B. (2002). *Qualitative communication research methods*. Thousand Oaks: Sage.

Mann, S., & Robinson, A. (2009). Boredom in the lecture theatre: An investigation into the contributors, moderators and outcomes of boredom amongst university students. *British Educational Research Journal*, 35(2), 243-258. doi:10.1080/01411920802042911

Ng, P.T., & Tan, C. (2009). Community of practice for teachers: Sensemaking or critical reflective learning?. *Reflective Practice*, 10(1), 37-44. doi:10.1080/14623940802652730

Nworie, J., & Haughton, N. (2008). Good intentions and unanticipated effects: The unintended consequences of the application of technology in teaching and learning environments. *Techtrends: Linking Research & Practice To Improve Learning*, 52(5), 52-58.

Okojie, M. O., & Olinzock, A. (2006). Developing a positive mind-set toward the use of technology for classroom instruction. *International Journal Of Instructional Media*, 33(1), 33-41.

Parr, J. M. (1999). Going to school the technological way: Co-constructed classrooms and student perceptions of learning with technology. *Journal of Educational Computing Research*, 20(4), 365-377. doi:10.2190/52KL-QD1E-EEUE-6LHQ

Putnam, R.T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning?. *Educational Researcher*, 29 (1), 4-15.

Reybold, L., Flores, B., & Riojas-Cortez, M. (2006). Dueling epistemologies? Implementing a critical model of faculty development in teacher education. *Professional Educator*, 28(2), 1-11.

Rosenfeld, M., & Rosenfeld, S. (2006). Understanding teacher responses to constructivist learning environments: Challenges and resolutions. *Science Education*, 90(3), 385-399.

Russell, D. L., & Schneiderheinze, A. (2005). Understanding innovation in education using activity theory. *Educational Technology & Society*, 8 (1), 38-53.

Schweitzer, L., & Stephenson, M. (2008). Charting the challenges and paradoxes of constructivism: a view from professional education. *Teaching In Higher Education*, 13(5), 583-593. doi:10.1080/13562510802334947

Shoffner, M. (2009). Personal attitudes and technology: Implications for preservice teacher reflective practice. *Teacher Education Quarterly*, 36(2), 143-161.

Schon, D. A. (1987). *Educating the reflective practitioner. Toward a new design for teaching and learning in the professions*. The Jossey-Bass Higher Education Series.

Smerek, R. (2011). Sensemaking and sensegiving: An exploratory study of the simultaneous “being and learning” of new college and university presidents. *Journal Of Leadership & Organizational Studies*, 18(1), 80-94. doi:10.1177/1548051810384268

Spillane, J.P, Reiser, B.J., & Reimer, T. (2002). Policy implementation and cognition: Reframing and refocusing implementation research. *Review of Educational Research*, 72(3), 387-431.

Vanderford, M. L., Stein, T., Sheeler, R., and Skochelak, S. (2001). Communication challenges for experienced clinicians: Topics for an advanced communication curriculum. *Health Communication*, 13, 261-284.

Vanderford, M.L., & Smith, D. H. (1996). *The silicone breast implant story: Communication and uncertainty*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Venezky, R. L. (2004). Technology in the classroom: Steps toward a new vision. *Education, Communication & Information*, 4(1), 3-21. doi:10.1080/1463631042000211024

von Bertalanffy, L. (1968). *General system theory: Foundations, development, applications*. New York: George Braziller.

Weick, K. E. (1990). Technology as equivoque: Sensemaking in new technologies. In P.S. Goodman, L.S. Sproull, and Associates (eds.), *Technology and Organizations*. San Francisco: Jossey-Bass, 1–44.

Weick, K.E., Sutcliffe, K.M., & Obstfeld, D. (2005). Organizing and the process of sensemaking. *Organization Science* 16(4), 409–421.

White, T. (2008). Debugging an artifact, instrumenting a bug: Dialectics of instrumentation and design in technology-rich learning environments. *International Journal of Computers for Mathematical Learning* 13, 1-26.

Wong, E. M. L., Li, S. S. C., Choi, T.-H., & Lee, T. N. (2008). Insights into innovative classroom practices with ICT: Identifying the impetus for change. *Educational Technology & Society*, 11 (1), 248-265.

Zhang, J. (2010). Technology-supported learning innovation in cultural contexts. *Educational Technology Research & Development*, 58(2), 229-243.

Footnote

⁴ All first names used in this report are pseudonyms.