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Additive and disruptive pedagogies: The use of slowmation as an example of digital technology implementation

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ABSTRACT

The purpose of this study was to explore the experiences of 35 preservice teachers as they were introduced to a new digital technology, "Slowmation" (abbreviated from Slow Animation), as a "disruptive" pedagogy over a period of 12 months. The participants in the study were 35 preservice teachers from an elementary cohort. Primary data sources included field notes and semi-structured interviews. Findings revealed that the preservice teachers enjoyed using slowmation as learners during the on-campus part of their program, yet very few used it as a disruptive pedagogy when teaching during their extended practicum. Our study highlights the challenges inherent in introducing "disruptive" pedagogies in a teacher education program.

1. Introduction

One of the main goals of a teacher education program is to introduce preservice teachers to new ways of teaching and learning so that they can use these approaches in their own pedagogical practices as classroom teachers (Darling-Hammond, 1995; Hoban, 2005). To achieve this goal, preservice teachers require an understanding of the complexities of teaching and learning and how to adapt pedagogy and practice to suit varying classroom contexts (Clarke & Mitchell, 2007). For example, over the last 20 years, preservice teachers in universities have been introduced to a range of digital technologies (DT) in their programs including social media (i.e. wikis and blogs), as well as programs such as PowerPoint, databases, spreadsheets, and electronic portfolios. However, introducing preservice teachers to instructional approaches in their teacher education program to create new ways of learning does not necessarily mean that they will be able to adopt these as teaching approaches in schools. Extensive research (Albirini, 2006; Bauer & Kenton, 2005; Butler & Sellbom, 2002; Demetriadis et al., 2003; Fullan & Steigelbauer, 1991; Grabe & Grabe, 2001; Granger & Morbey, 2002; Tong & Trinidad, 2005) has shown that DT integration is a complex process, especially when there is resistance by influential others.

The field of teacher education is inundated with digital technologies (DT) initiatives (Neiss, 2005; Niederhauser & Stoddart, 2001; Zhao, 2003). As new DT enter the arena of education, advocates spend time and funding exploring how they may provide solutions to existing or emergent educational challenges. Similarly, skeptics frame their position with rhetoric about how "the new" is replacing "the old" in educational contexts. Goodyear and Ellis (2008) asserted that both positions are problematic because they contribute to the following mind-set: "Each technological innovation is accompanied by questions about whether it is better than what exists, rather than questions about how it should integrate with what exists" (p. 2). We suggest that this predilection for positioning DT as either a solution to or catalyst for educational change contributes to a simplistic understanding of DT integration. What is required is an exploration of the complexity of implementing pedagogies that incorporate digital technologies as they relate to successful or unsuccessful integration into educational contexts.

Pellegrino, Goldman, Bertenthal, and Lawless (2007) conducted a longitudinal case study in order to explore the "instructional and learning experiences" of preservice teachers in eight teacher-preparation programs. For the purpose of their project, preservice teachers were shadowed during their teacher-preparation program, their extended practicum (i.e. field placement) and their first few

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years of teaching. Their study helps elucidate the complexity of transfer from what is experienced during teacher preparation to subsequent classroom practice. Pellegrino and his colleagues noted, "There is virtually no empirical data on the degree to which teachers actually do implement what they have learned in their teacher-preparation programs, nor the conditions that facilitate as compared to inhibit their ability to do so" (p. 6). Results from this study revealed that although there was considerable effort to integrate DT into classroom practice, and there was general consensus that DT integration should be an integral part of K–12 teaching, preservice teachers were uncertain of how to integrate DT in ways that support student learning.

Mishra and Koehler (2006) provided a conceptual framework for DT integration by exploring the complexity of pedagogies which use innovative technologies. This five-year study explored how teachers integrate DT into their pedagogy. In this study, Mishra and Koehler explored the "essential qualities of teacher knowledge required for technology integration in teaching" (p. 1). They suggest that DT integration requires an understanding of Technological Pedagogical Content Knowledge (TPCK) meaning how to use technologies in relation to teaching specific content. Results from both research studies indicated that understanding DT integration in K–12 schools and teacher education requires a complex exploration of DT in relation to pedagogical practice.

2. Theoretical framework

A review of the research literature revealed that despite current expectations that teachers use DT in their classrooms to support their teaching and improve student learning, barriers to technology integration persist (Hew & Brush, 2007; Keengwe, Onchwari, & Wachira, 2008; Mumtaz, 2000; Wright & Wilson, 2007). The most prominent challenges to technology use in educational contexts are as follows: (i) inadequate pedagogical understanding of how to integrate DT in ways that support student learning (Mishra & Koehler, 2006; Mumtaz, 2000; Pellegrino et al., 2007); (ii) the belief that DT offer only minimal educational benefit (Ertmer, 2005; Lumpe & Chambers, 2001; Mumtaz, 2000; Van Braak, 2001; Vannatta & Fordham, 2004); and (iii) a lack of technology support networks amongst teachers within schools (Lowther, Inan, Strahl, & Ross, 2008; Ringstaff & Kelly, 2002; Sandholtz & Reilly, 2004; Van Melle, Cimellaro, & Shulha, 2003). Researchers such as Earle (2002) suggested that teachers are at times reluctant to integrate DT because they are embedded in a school culture that does not foster peer support or in-school collaboration. Sometimes, DT are often used as a reward in classrooms after so-called "content area" or "real learning" is completed (Vratulis, 2008). This approach to DT uptake ignores the pedagogical constructs that are required in order to utilize the many affordances of DT within and across the curriculum (Mishra & Koehler, 2006; Mumtaz, 2000).

Hedberg and Freebody (2007) described "disruptive" pedagogy with DT as a process whereby technology integration creates "change in teaching approaches because (they) encourage new ways of teaching and learning" (p. 8). In contrast, an "additive" pedagogy using DT refers to a process whereby DT are integrated to support existing, often teacher directed, classroom practice. For instance, specific to the exploration of students' literacy practice with DT, studies that fall within an additive approach to DT integration frequently allude to research on how DT can be used to improve student print-based writing and research skills (Chambers, Cheung, Madden, Slavin, & Gifford, 2006; Elliott, 2000; Guinee, 2004; Lindsay & McLaren, 2000). In this same field there exists a group of studies that focus primarily on improving student's grammar (Allender, 2006; Lacina, 2005), and processes of editing (Felix, 2003; Finley & Hartman, 2004). Minimal attention is placed on how the use of DT can broaden conceptions of literacy examples as primarily alphabetic text.

In contrast, a disruptive model requires that teaching is altered to account for the particular affordances of DT. For instance, a research study conducted by Hedberg and Freebody (2007) involved a year-long project with 20 participating teachers during which they explored the use of whiteboards, interactive learning materials, and a variety of digital resources (i.e., pictures, movie clips and sound bytes). The purpose of this study was to determine if and/or how the integration DT might impact existing pedagogy and classroom practice. The teachers in the study were provided with a curriculum consultant who helped them envision ways (and reasons) for DT integration that extended and at times challenged existing pedagogical practice. Teachers engaged in disruptive pedagogy understand that DT "encourages new ways of teaching and learning that could bring about a pedagogical shift" (p. 8). Table 1 summarizes key distinctions between disruptive and additive pedagogies using DT:

In their study, the authors suggested that using DT creates an opportunity to engage in teaching activities that provide, "disruptive pedagogical options in which the learner not only experiences views of the world that are multimodal but requires a range of literacies to understand the different representative descriptions and to construct and communicate their ideas with others" (p. 10). Adapting a disruptive pedagogy with DT requires that students shift from a position of passive participation toward a process of active engagement whereby they are "constructors(s) of their own experiences" (p. 10). Hedberg and Freebody (2007) emphasized the necessity to pay closer attention to the "nature of the learning activities, an exploration of how interactions are managed and facilitated, and a choice of the right tool for the pedagogical task." (p. 10)

Specific to teacher-preparation programs, successful technology integration that falls within a model of disruptive pedagogy relies on sustained and continuous uptake by teachers (Rogers, 2000; Strudler & Wetzel, 2003). This requires that conditions, strategies and resources are made available to overcome the above mentioned barriers (Schmidt, Thompson, & Chuang, 2004). What becomes increasingly complex, however, is the challenge of supporting and preparing prospective teachers for using DT during their practicum because classrooms vary so much. The time during practicum is critical to their eventual efforts to integrate DT into their classroom practice (Clarke & Mitchell, 2007). It is during this time that preservice teachers should experiment with pedagogies and observe in varying contexts for teaching (Vratulis, 2008). Research reveals that preservice teachers are being introduced to

Table 1
Features of disruptive and additive pedagogies.

Disruptive	Additive
• Observable change in teaching/learning when using DT	• No change in teaching/learning when using DT
• Developing activities that require generic pedagogical sequences that can be applied across curriculum areas. Encouraging interdisciplinary learning.	• Information dissemination and acquisition in content-specific areas. Content-area learning.
• Encouraging multiple modes of representations beyond just alphabetic.	• Primarily valuing alphabetic modes of representation.
• Active engagement. Encourages interaction that enables the social construction of meaningful knowledge.	• Passive learning. Engaging in a process of information delivery.
• Process oriented assessment ("learning journey")	• Assessment of product.
• Digital repositories.	• Content management systems.

Adapted from Hedberg & Freebody, 2007.

student-centered models of learning with DT in their courses; yet often this is not enough to "disrupt" an already existing pedagogy that is more closely aligned to an additive model, constructed from years of experience in teacher-centered classrooms (Strudler & Wetzel, 2003).

This raises an interesting dilemma: How do preservice teachers experiment with pedagogical approaches learned in their teacher education program, especially those that use DT, if they are not evident in schools and may not be supported by sponsor teachers on practicum? Perhaps it is necessary for sponsor teachers to share a vision of technology integration which challenges preservice teachers' existing conceptions of teaching and learning. We suggest that preservice teachers are being introduced to more DT than ever before in teacher education programs; yet these efforts are not translating into application to classroom practice in schools (O'Dwyer, Russell, Bebell, & Tucker-Seeley, 2005). The research literature reveals that in part, this is due to disjuncture between technology integration as it is introduced in teacher education programs and the culture of resistance for pedagogical change embedded in K–12 schools (Hruskocy, Cennamo, Ertmer, & Johnson, 2000; Russell, Bebell, & Higgins, 2004). Results from their research, however, suggest that the issue of uptake is considerably more complex.

2.1. Introducing a new pedagogy

"Slowmation" (abbreviated from Slow Animation) is a new pedagogy that encourages learners (preservice teachers or school students) to create their own narrated stop-motion animation to explain content knowledge (Hoban, 2005, 2007, 2009). It is a simplified way of making an animation resulting in a 1–2 min animation that integrates aspects of claymation, object animation and digital storytelling. There are several phases in the creation process. In order to construct their animated mini-movies, preservice teachers were asked to select a topic and storyboard their ideas whilst gathering appropriate materials to construct a "stage scene" for each individual frame of their slowmation. The topics were from a range of subjects such as Science, Math, Language Arts and Social Studies. In this context, storyboarding involved organizing their ideas into individual frames and deciding which materials and resources to use to represent their ideas. Because the materials are often laid flat on a table or the floor, many different types of materials can be used such as plasticine, paper, cardboard or existing 2-D and 3-D models. The next step involves manually manipulating the materials to represent each frame and taking digital still photos of each movement with a camera mounted on a tripod looking down at the models (a mobile phone camera can also be used). As a final step, students used free digital animation software (i.e. Windows Movie Maker on a PC or SAM Animation on a Mac) to display a sequence of the still images. Participants ran their slowmation image sequences at approximately 2 frames per second (i.e., 120 frames per minute), to create a slow-moving images, hence the name "slowmation". Many then added spoken narrative, music and/or sound effects to enhance the explanation.

This process was modeled for preservice teachers as a student-centered approach during their program orientation as well as making their own and reinforced during their science method class in which they made another slowmation. Relevant to this study, the approach as the potential to be a "disruptive pedagogy," when implemented as intended because it addresses many of the features of a disruptive pedagogy as identified in Table 1: (i) it involves students in creating a narrated animation, which is unusual in a classroom; (ii) there is active engagement in the process because the students design and make them; (ii) the narrated animation is a multimodal representation; (iii) the content can be focused in different discipline areas; (iv) when constructed in a group it involves social construction of knowledge; and (v) the narrated animation is a digital repository.

From the perspective of literacy learning, one of the benefits of constructing slowmation projects is the development of students' proficiency for constructing multimodal texts with digital technologies (Callow, 2008; Hoban & Nielsen, 2010). Students are already engaged with a multiplicity of multimodal texts both in school and at home (Leu, Kinzer, Coiro, & Cammack, 2004). As stated by Callow, these texts range from multimodal representations on a cereal box to the multiple modes (i.e., audio, visual, written and gestural) of representation found in video games. Yet research suggests that they are uncertain of how to engage with such multimodal texts in critical ways (Thompson, 2008). For instance, what are the visual literacies required to construct multimedia presentations? The task of visual representation becomes even more complicated when trying to represent concepts and ideas that are content specific (Williams, 2007). There are many educational benefits to constructing slowmation projects. The process of construction, for example, encourages a practice of collaborative learning and requires that students negotiate what content to include and how to best represent their ideas in multiple modalities (Walsh, 2006). The process of construction also encourages problem-solving because students have to decide how to combine modes of representation according to intent and purpose (Kozma & Russell, 2005). Furthermore, the process thus required the preservice teachers to negotiate the use of different media for the purpose of constructing their projects.

The purpose of this study, therefore, was to explore the experiences of 35 preservice elementary teachers as they were introduced to "Slowmation" during their 12-month teacher education program. This was addressed by collecting data to answer the following research questions:

1. How did preservice teachers experience the introduction to slowmation during their teacher education program?
2. What influences determine if and how preservice teachers use slowmation as a new teaching approach during their extended practicum?

3. Context and methodology

3.1. Context, setting and participants

This qualitative case study was conducted in the context of a 12-month elementary Bachelor of Education program within a metropolitan university located in British Columbia, Canada. The university offers 15 different cohorts options to prospective teachers wishing to pursue an elementary-school teacher certification. Of these 15 groups, the cohort known as a Community of Inquiry in Teacher Education (CITE) served as the study group for this research. The CITE cohort emphasizes community, inquiry, and innovative use of DT. Instructors meet weekly to review coursework and discuss ongoing and impromptu improvements of the program for CITE students. Two student representatives are invited to these meetings to ensure a student voice is present in decision-making about the program.

During 1999, DT were introduced to CITE as an important element of the program. The premise was that CITE students were less likely to obtain the requisite skills for integrating DT into classroom practice if they did not develop a comfort and competence with such technology during their teacher preparation. Since then, CITE has researched and modified their model of DT integration on an annual basis to optimize their support of teacher candidates. In 2006, the instructor who facilitated the slowmation

workshop during the program orientation along with the instructor who was already part of an ongoing research initiative to improve DT integration in the cohort and the instructor who used slowmation as an assignment in his science methods course decided to explore the innovative possibilities of slowmation within the CITE cohort. It was during the 2006–2007 school year that data were collected from CITE preservice teachers for this study. There were 35 preservice teachers enrolled in the CITE cohort during the year of this study; all 35 preservice teachers participated. All reference to preservice teachers and the program are for the 2006–2007 year.

3.2. Data collection

A range of data gathering methods were used as follows: field notes were taken during orientation when the preservice teachers were first introduced to slowmation and during the development of their slowmation videos in their science methods course; and semi-structured interviews were conducted upon completion of the program. Data were subsequently used to contextualize comments from the semi-structured interviews conducted at the end of the year. All names used in this paper are pseudonyms.

3.3. Data analysis

Data analysis was based on an inductive process (Creswell, 1998). Preservice teachers' comments were organized into thematic categories according to dominant patterns of response. For instance, the first two broad categories emerged from comments specific to DT during coursework and practicum. Sub-categories specific to coursework emerged as follows: community building, DT skills, purpose for using DT, process of construction, personal comfort and potential use for classroom practice. Data within sub-categories were then reviewed with attention to emergent patterns of response. This process of identifying and creating sub-categories according to emergent themes is outlined by Creswell (1998) and Stake (1995). The dominant themes and patterns identified within each of the categories provided a framework for organizing the results section of this paper.

4. Results of the study

To address the first research question, data were collected when slowmation was introduced in the program orientation (phase 1) and also used as a compulsory assignment in a science method course (phase 2) during the second semester.

4.1. Introduction of slowmation to preservice teachers

4.1.1. Phase 1: program orientation

The CITE students were introduced to their prospective instructors and peers during a 3-day orientation at the beginning of the school year. During the first day of orientation, the preservice teachers participated in activities intended to develop peer relationships such as name games, cultural roadmaps, and creating iMovies. Opportunities to build trust (Gulldberg & Pilkington, 2006; Preece, 2000) and community (Wang, Sierra, & Folger, 2003) at the start of a teacher education program are cited in the research literature as critical to uptake of new concepts and ideas such as DT during teacher preparation (Brown & Davis, 2004).

Slowmation was introduced at the beginning of the program during orientation consisting of a workshop conducted over 2 days and in four stages. Examples of slowmation projects were presented on Day 1 with a brief synopsis of the history of slowmation. Time was allotted for the students to meet in groups to decide on a topic and begin storyboarding. During Day 2, the participants completed the following four steps of a simple slowmation project: (i) creation of an individual or group storyboard with attention to the materials and/or specific content-area information required; (ii) outlining the type and number of visuals (i.e., models) required for each frame; (iii) developing a narrative to accompany the slowmation visuals; and (iv)capturing and importing the slowmation images employing QuickTime Pro™. All of the preservice teachers created a slowmation (in groups of four) across a range of subject areas: Science, English, Maths, Social Studies and Language Arts.

Student comments on this process revealed that their comfort and competence with DT helped shape their varying roles within the CITE community. For instance, one of the technology coaches (a preservice teacher hired for the year to provide technical support for his/her peers) commented that his knowledge of technology helped him take on a leadership role within the class: "You can't just be an anonymous student in the back when you can do things with technology. That was great for me because I tend to be a bit shy, especially at first" (Randy). Another teacher candidate commented on her reluctance to reveal her competence with DT at the start of the year because of her efforts to foster her role as an artist: "I didn't want others to see me as the tech person… I am the art person…once you become the tech person, I don't know, everything else disappears" (Emma).

Therefore, Randy used his expertise and comfort with DT in order to try and prevent others from viewing him as shy; Emma distanced herself from engaging in the role of digital technologies expert because of her existing conception that technology and art are mutually exclusive. The process of constructing professional identities as teachers is complex, socially negotiated, and constantly changing (Ellis & Allaire, 2001; Fisk, Rogers, Charness, Czaja, & Sharit, 2004). These quotations demonstrate how preservice teachers' existing comfort and conceptions of DT has already informed the construction of their professional identities at the outset of their professional year in education.

Miller (2003) argues that when prospective teachers are first introduced to DT in teacher education they develop self-efficacy beliefs about technology use, and beliefs about the perceived value of computers on student learning" (p. 5). It is necessary to disrupt existing misconceptions about DT integration at the first moments of introduction (Paul & Rowsell, 2006; Willis, 2000) if the intent is improved uptake of DT during practicum and within eventual classrooms (Smaldino, Russell, Heinich, & Molenda, 2005). For instance, in extension to the quotations above, if a teacher adopts the role of a DT leader during teacher education they are more likely to take on leadership roles during their extended practicum (Christensen, 2002; Dupagne & Krendl, 1992; Shapka & Ferrari, 2005; Vannatta & Beyerbach, 2001; Wang, 2002; Zhao & Cziko, 2001; Zhao, Pugh, Sheldon, & Byers, 2002). Similarly, an initial demonstration of resistance may be rooted in (mis)conceptions that the prospective teachers then carry with them for years (Goose, 2005; Windschitl & Sahl, 2002).

The focus on community inquiry with the slowmation project alleviated anxiety for preservice teachers because of the degree to which they could turn to their peers for support. "It made a big difference that you didn't have to go up to an instructor every 5 min. We were really encouraged to ask our peers" (Laura). A number of the instructors were also learning slowmation for the first time alongside the students, which also allayed student fears. It encouraged the students to focus more on the process of creating their slowmation projects than on the expected final product. One of the preservice teachers explained, "When you see your instructor learning for the first time too, you realize…It is more about learning and getting to know each other" (Kelly). Another preservice teacher added that orientation helped her

connect with her peers and alleviated concerns about technology: "We learned so much from each other creating that project. No one could hide. I guess that is what they mean about learning in a community of inquiry" (Tania).

4.1.2. Phase 2: the science methods course

It was decided to encourage the preservice teachers to make a narrated animation during their science method course as a way to revisit the slowmation pedagogy that they learned in their orientation. CITE students selected a concept for their slowmation projects that their sponsor teacher had already suggested they teach, alternatively they could "default" to the science curriculum of the grade they would be teaching. The term default was most commonly used by the students to describe their selections for their projects. Curriculum was often described as "binding" and "limiting." A preservice teacher commented, "Constantly focusing on curriculum doesn't let you teach creatively with technology. Too much focus on getting the facts across" (Heather). This comment revealed preservice teachers did not view themselves as "curriculum designers" (Koehler & Mishra, 2005). Instead, they viewed curriculum as a body of knowledge to be acquired.

Preservice teachers were uncertain about the purpose for constructing their slowmation projects. They were uncertain of how to select a topic for their projects because they were preoccupied with "getting it right" (Laura). They found the process engaging, but were unclear about how slowmation might inform their own teaching, or the learning of their prospective students. Laura claimed, "we loved doing it, but just weren't sure what it would mean for our kids." This demonstrated a lack of understanding of educational benefits of integrating DT. These findings are consistent with current research literature suggesting that prospective and practicing teachers now have more access, opportunities for support and "freedom" to interpret curriculum when using DT than ever before (Ertmer, 2005), yet the reality is that they continue to struggle with negotiating their understanding of curriculum in relation to new and innovative DT (Abbott & Faris, 2000; Albee, 2003; Snider, 2002).

Preservice teachers experienced slowmation as a student-centered process (i.e., working in groups during the construction of their projects, sharing and commenting on each others' completed work through in class discussion once their projects were completed); yet the majority of preservice teachers maintained an understanding of slowmation that is consistent with an additive approach to integration. We suggest that this was in part because they continued to view slowmation as an instructional resource, whereas the educational benefits of slowmation rest in the process of construction. Therefore, an ongoing emphasis in the research literature on the importance of student-centered and sustained practice when using DT (Mumtaz, 2000; Sherry, Billig, Tavalin, & Gibson, 2002) is not enough.

4.2. Implementation on practicum

4.2.1. Phase 3: the extended practicum

To address the second research question, data were based primarily on semi-structured interviews at the end of the year. Specifically, preservice teachers responded to the following questions: Did you intend to use slowmation during your practicum? If so, how? If not, could you please explain why? Before their practicum began, the majority of the CITE students participating in this study stated that they hoped to use slowmation during their extended practicum. Even if they did not expect prospective pupils to create their own slowmation projects in class (a potentially disruptive pedagogy), CITE students intended to use their projects as resources during classroom instruction (a potentially additive use). As one preservice teacher explained, "Slowmation gave us a chance to motivate kids and get them interested… The kids loved it" (Jane). Only two of the 35 CITE students encouraged their pupils to create their own slowmation projects as consistent with a disruptive pedagogy and neither were about science. In both cases, their cooperating were concerned as to whether sufficient time would be available to complete the projects. In both cases, preservice teachers were able to complete the slowmation projects with their students on time and their sponsor teachers felt that the process was valuable to student learning. One preservice teacher commented that he was, "relieved that (his) sponsor teacher was so supportive in the end. She was happy the kids were so excited about writing myths" (Jane). In sum, of the 33 teachers (two had dropped out of the course), only 2 implemented slowmation as a disruptive pedagogy by getting their children to create narrated animation, however, the remaining 31 still showed the slowmations that they made during the program to the school children which is consistent with an additive pedagogy. The reasons for this low use of slowmation as intended is evident in four key influences on if and how slowmation was used by the preservice elementary teachers on practicum.

4.3. Influences on the implementation of slowmation

4.3.1. Competing use for classroom instructor time

One of the CITE students participating in this study, Tiffany, voiced concern over using a new approach such as slowmation during practicum when there is already so little time to focus on the development of content-area skills associated with math, reading, and writing. Tiffany commented that she "really wanted to use slowmation during practicum", then thought, "there is just no time to play with technology. Half my kids have trouble reading." This comment revealed that for some preservice teachers it is not a question of how to integrate DT (i.e., disruptive or additive), but whether there is even any educational value in using DT in their particular context.

Preservice teachers were uncertain of how to proceed when their use of slowmation might conflict with the understanding of their sponsoring teacher's conceptions of DT in terms of teaching and learning priorities within their classrooms. This is expressed in the following quotation, "I wanted to ask my students to create their own animations as part of our anti-bullying unit, but my sponsor teacher felt strongly that I only use [my project] to teach them about the life cycle" (Karen). As might be expected, some sponsor teachers are readily open to the prospect of DT application and others are reluctant. One preservice teacher stated, "I wanted to use technology during practicum, but I was way too stressed out because I knew my sponsor teacher wasn't really into it" (Kelly). Another preservice teacher responded, "That is a big risk to take during practicum, don't you think?" (Sarah)

4.3.2. Slowmation content

For CITE students whose slowmation projects included visuals not already recommended within existing curriculum guidelines, uncertainty existed. For instance, one group wanted to create a slowmation project on the physical impact of environmental pollution. Because the topic was not an explicit aspect of the curriculum, the teacher candidates were concerned as to whether parents or their sponsoring teachers might question, for example, the graphic images of dying crows they hoped to include. In the end, these CITE students incorporated more text than images due to their uncertainty regarding which images that were appropriate for a fifth-grade class. One teacher candidate demonstrated her uncertainty about appropriate content to teach in her class during extended practicum: "Like with environmental pollution, that

would be something I would love to do it, but then, I don't know if it is OK to really show kids those kinds of images" (Tania). Another participant described the complexity of the issue: "They are still pretty young… but if you just tame it down, what is the point? It is tricky, especially during practicum" (Amanda). This finding is consistent with only a handful of studies exploring the anxiety and uncertainty about how to negotiate visual texts in the context of elementary teaching (Albers, 2006; Berson, 2004; Callow & Zammit, 2002; Cherney, Seiwert, Dickey, & Flichtbeil, 2006).

Two groups of CITE students revealed anxiety over concerns of their sponsoring teachers about representing inaccurate information in their slowmation projects since the animations are made by students. They felt their sponsoring teachers may attribute any inaccuracy in the slowmation to a lack of content-area knowledge on behalf of the student teachers. For instance, one group of preservice teachers created a slowmation project that did not accurately represent the number of eggs laid by frogs during the spring. Their sponsoring teachers had various responses to the representation. While one did not view it as a problem, another suggested the creation of an alternate teaching resource to the slowmation. One teacher candidate remarked, "We can't just include three eggs and say they lay thousands. My sponsor teacher would not be OK with that. I did that on one of my pictures and she said to me that the picture is what the kids are going to remember more than the words" (Michelle). This issue provided an intriguing forum for preservice teachers to consider the challenges associated with representation in other media, not just digital video such as slowmation. For several preservice teachers, this provided an unanticipated disruption of their own conceptions of how to teach and learn in a science classroom. One preservice teacher observed, "Sometimes I think we are so busy trying to make things, information and concepts, you know, accurate, that we forget there is more to science than that" (Ralph). We suggest that some sponsor teachers and preservice teachers "content specific" understandings about the appropriateness of particular texts when representing knowledge is problematic to a process of disruptive pedagogy with DT. In effect, what is required of sponsor teachers and the preservice teachers is an understanding of how constructing and representing knowledge using visual imagery is different from constructing and representing knowledge using other modes of meaning making, such as with written and/or spoken language. Such an understanding is important to a process of understanding how to integrate digital technologies in ways that extend preservice teachers' already existing literacy practices (Burn & Parker, 2003; Jewitt, 2006).

4.3.3. Sponsor teacher support

Student interviews conducted upon practicum completion revealed disjuncture between how particular CITE students envisioned using slowmation during practicum and their actual implementation of this teaching approach within their own classrooms following their on-campus courses. During their extended practicum, these CITE students were guided by their sponsoring teachers. For nearly all of the students, their decisions as to whether to use slowmation depended upon the comfort and competence of their sponsoring teachers with DT. As may be expected, the sponsoring teachers who were already avid users of technology were readily receptive to the slowmation initiative and all that it entailed. Conversely, those reluctant or unfamiliar with the integration of technology passed their anxieties on to the preservice teachers. As described by one teacher candidate, "Anything else was OK, but then if I was going to use technology, I could just feel how stressed out she [sponsoring teacher] would get. Then I would get stressed out too… Just too much stress—not with the technology, but with using it with her" (Sarah).

Several CITE students viewed sponsoring teachers as having different values or expectations for lessons for technology use. For instance, one preservice teacher described how she was often encouraged to take risks within the classroom in all other areas of her teaching; yet, with DT, there was no room for "deviating from the plan of action" (Mandy). If she did not precisely follow her lesson plan, or if the technology did not work or another unexpected challenge emerged, she stated that she could almost hear the voice of her sponsoring teacher stating, "See, I told you; technology never works. It is a waste of time" (Mandy). This was in stark contrast with how her sponsoring teacher reacted to unexpected changes in classroom practice when DT were not integrated.

We suggest that perhaps this has less to do with the extent of technology understanding and more to do with how sponsor teachers view their roles. The role of a sponsor teacher is to provide support and constructive feedback to prospective teachers and to facilitate the development of their skills and expertise in teaching. Perhaps the sponsor teacher felt this would only be possible if the preservice teacher were integrating resources with which he or she were already familiar. The following comments from a participating preservice teacher seem to reflect that potentiality:

> I notice that during lessons where I used technology, she didn't really write anything bad, but she was really stressed out, definitely. Actually, she didn't write much at all. I mean, when I was teaching kids reading, she had an entire book… of things [that] went well or that I could improve on and ideas of how to improve. You never know; maybe that was also the reason she got so stressed out when I mentioned technology. Maybe it comes from a really good place, from wanting to help and not being able to. (Carly)

The difference between how CITE students might use slowmation during practicum and in their own classrooms is that as practicing teachers they can implement DT in a way that supports their own pedagogical positioning; this is consistent with other studies specific to transfer of practice with DT from practicum to teaching within their own classrooms (Margerum-Leys & Marx, 2004; Rosaen, Hobson, & Khan, 2003; Russell, Bebell, O'Dwyer, & O'Conner, 2003). One of the preservice teachers stated that it will "make a big difference when someone else doesn't have all the power. I want my students to create their own project, but not during practicum. Not with my sponsor teacher watching" (Laura).

It is natural that some sponsor teachers might demonstrate anxiety when preservice teachers use DT if they (the sponsor teachers) are uncertain how to support preservice teachers in the classroom. We suggest that this is why it is especially important that preservice teachers articulate and demonstrate the educational value of such innovation on practicum. What is required is an understanding of the educational benefits of slowmation, and how to best use slowmation to achieve such benefits. We suggest that the educational benefits of slowmation for students primarily rests in the process of construction.

In particular, the process of construction encourages students to reconsider concepts from multiple perspectives: they are forced to reassess content continuously as they try to determine how to organize and represent their ideas either for themselves or their pupils. Students constructing slowmation also have to create their own objects, which means they have to translate their understanding of an idea from one sign system to the next. For instance, if they are representing a scientific concept such as the food chain, they would have to consider how to represent relationships amongst animals in the food cycle. They must also consider color, special relations and size of objects. All of these considerations

encourage students to think in new ways, fostering both creativity and comprehension.

4.3.4. Shifting roles: from learner to teacher

One of the challenges with using slowmation during practicum was the uncertainty of preservice teachers in regard to how to use it for teaching their pupils i.e. what is the appropriate pedagogy for a particular class? The majority of the participating CITE students felt comfortable with their technology skills, and a number of them worked within tech-savvy classrooms where the pupils were quite familiar with various DT. However, preservice teachers were uncertain how to adapt their knowledge as learners of slowmation and transfer this knowledge to settings to suit the needs of a specific grade/class. They had only experienced slowmation as adult learners during orientation to the program and in a science method class, but not as teachers in a real classroom. They were equipped with a comprehensive handbook outlining a process for the creation of slowmation projects, and they had practical experience from completing their own slowmation projects. However, both of these experiences were modeled for adult learning, a process radically different from teaching slowmation within classrooms serving kindergarten through seventh-grade classrooms. This is especially true if the intent is to have pupils create their own slowmation projects. As described by one CITE student,

> I really wanted to use slowmation because I thought it was lots of fun, but like lots of us, I think we ended up not using [it] because we just didn't know what to do. I mean, we couldn't replicate what Garry did, even though that was great because that worked with us as adults. What does that look like in my Grade 4 class that has seven ESL students, a gifted boy, and half the class that knows more about technology than me? That would have really helped. I mean, to have an idea of how to change things for different grades, different students. I wasn't even sure if it was acceptable to ask kids who are that young to put together a project like slowmation. (Heather)

In effect, they were uncertain of how slowmation could be used to promote an interdisciplinary model of learning and they questioned how to choose an "appropriate focus" for pupils creating their own slowmations.

In order to transition from learner to teacher CITE students required more examples of intended implementation. After all, developing an understanding of how to modify one's pedagogical approach as it applies to the teaching and learning context of different classrooms requires more explicit education on adapting the process of slowmation construction for various grade levels and classroom contexts. It is also requisite for teachers to develop an improved understanding for how to shift from didactic to learner-centered approaches. This parallels a shift from an additive to a disruptive model of pedagogical practice. Lorna comments:

> As a teacher with slowmation, I wasn't sure what to do with myself. I knew I had to change my teaching from what I was doing when I was teaching math, for instance, but then I didn't know how. That is what I really needed help with. How much should I talk or model? I didn't know where to start with how to change my teaching, so I didn't start at all. I mean, I couldn't teach it the way Gaalen did because they are only in Grade 5. So then, what do you do? I sure wasn't going to guess on practicum, at least not until I have my own classroom.

This last comment points to the challenges associated with any disruptive pedagogy and the conceptual shift requisite for adapting disruptive pedagogy in one's own classroom practice.

5. Discussion

This research study highlighted the challenges of preservice teachers using approaches, especially those that involve disruptive pedagogies with technology, which are presented to them as learners in teacher education courses and then adapting them as teachers in school classrooms. According to Ertmer (2005), "although many teachers are using technology for numerous low-level tasks…higher level uses are still very much in the minority" (p. 4). It is therefore, not that surprising that despite a proliferation of research studies over the past 20 years providing some evidence that integrating DT creates positive effects to student learning, there is still minimal evidence of uptake in schools (Wallace, 2004). A decade ago, researchers argued that a lack of uptake was contextualized within issues such as the following: (i) lack of access; (ii) teaching experience; (iii) on-site support; (iii) financial support; (iv) fear amongst educators; and (v) a lack of opportunity for student-centered learning with DT (Mumtaz, 2000; Rogers, 2003). However, more recent research in the area of DT integration has moved beyond such initial barriers to exploring other barriers that are more closely aligned to teacher identity, beliefs about technology, learning and pedagogical practice (Albion & Ertmer, 2002; Miller, 2003; O'Dwyer, Russell, & Bebell, 2004; Richardson, 2006). This study adds to these challenges by identifying the pressures on preservice teachers in the practicum setting and the difficulties of swapping roles as a learner of DT in teacher education courses to a teacher of DT in schools.

There are currently only a handful of studies that explore any aspect of how teachers' beliefs about technology are constructed (Ertmer, 2005). The research study provides a glimpse into the ways in which preservice teachers' belief systems might impact innovative, student-centered models of uptake with DT. This study also fills an existing gap in the research literature on the complexity of "interrupting" pre-conceived notions of DT integration. For instance, Kagan (1992) argues that prospective and/or practicing teachers are unlikely to respond to the possibility of integrating DT in ways that are inconsistent with their already existing beliefs and experiences. Thus, even when DT are introduced as a student-centered approach the very integration of DT may motivate preservice to default to a more teacher-directed practice (Niederhauser & Stoddart, 2001; Zhao et al., 2002). Such research studies are critical to our understand of effective DT integration because "without a clear understanding of this relationship, practitioners and researchers may continue to advocate for specific uses of technology that they are unable to facilitate or support, because of these underlying fundamental beliefs" (p. 35).

Therefore, the process of students creating their own animations of science concepts was engaging, yet they were not always able to transfer knowledge acquired at the university to practice in their respective classrooms. In part, we suggest that this is because they held firmly engrained notions about teaching and learning that remained unchallenged during their use of slowmation in their teacher education program. We suggest that what is required is an improved understanding of how to modify a pedagogical approach when incorporating ideas about planning, technological resources, coping with classroom management and ways to scaffold the learning when adapting a disruptive and/or additive pedagogy with digital technologies.

Loughran and Russell (1996) suggested that teacher education programs have tremendous influence on the views preservice teachers carry with them into their future classrooms. It is during teacher preparation that prospective educators are apprenticed into particular pedagogies and practices, literacies, and DT. It is partially their perspectives of the relevance of their teacher

preparation that will inform their future practice. Teacher education programs must equip prospective teachers with not only practical and experiential skills of using technology, but also the support structures that need to accompany the introduction of new pedagogies. It is the responsibility of teacher-preparation programs to ensure that prospective teachers be aware of the presuppositions they bring to their classrooms. In addition, it is necessary for teacher-preparation programs to work more closely with sponsor teachers to ensure that academic and professional communities are working toward the same goal: to prepare preservice teachers to teach in 21st century classrooms. As stated by Loughran and Russell, this requires "appropriate ways and times of challenging their beliefs about teaching and learning" (p. 4). The multimodal process of constructing a stop-motion animation such as slowmation provides such an opportunity.

Findings from this study also highlight the influence that faculty advisors and sponsoring teachers have on the expectations and practice of preservice teachers on practicum (Pence & Macgillivray, 2008). They provide guidance, assurance, and constructive criticism when lessons do not unfold as expected. Practicum allows preservice teachers to engage in professional development with "seasoned" educators. The hope is that they will draw upon their experiences within the teacher-preparation program that they view as valuable and effective in their own practice. In the case of slowmation, this requires understanding of the purpose for the teaching technique and how it might be modified to better meet the unique needs of pupils. For instance, the process of constructing slowmation projects encourages students to represent their understandings of information and/or concepts in multiple ways; they have to navigate multiple texts in order to make decisions about which ideas to include in each frame and how to best represent those ideas. The process involves researching, analyzing, synthesizing, and representing information and ideas using multiple modes of representation. As demonstrated in this study, focusing too much on engagement, or ease of use, is not enough to justify a pedagogical approach, and does not necessary lead to transformative learning. As a study participant expressed, "It is really fun and I know I learned a lot but I really wasn't sure what my students were going to learn, and well, my sponsor teacher always says, "If you can't explain it to yourself, you probably shouldn't do it yet." (Faerah).

The majority of the preservice teachers participating in this study voiced concern over the ability of their sponsoring teachers to support their use of technology with slowmation and other DT. In fact, a perceived inexperience and discomfort amongst sponsoring teachers with DT was one of the primary reasons the student participants avoided use of slowmation during their extended practicum or used it solely as a 2-min instructional tool or lesson introduction. While the majority of the prospective teachers in this study described supportive and collegial relationships with their sponsoring teachers, a "common thread" throughout the exit interviews was the understanding that the sponsoring teachers acted differently toward the preservice teachers as soon as the use of technology in the classroom was approached.

6. Conclusion

We began this paper with a discussion of disruptive pedagogy as a prospective approach of implementation that could lead to innovative uptake of DT in educational settings. As illustrated throughout this paper, one of the challenges for teacher-preparation programs is that preservice teachers may still meet resistance from sponsor teachers on practicum. As indicated at the start of this paper, the majority of practicing teachers subscribe to an additive pedagogy with DT, whereby existing pedagogical practice remains largely unaltered. This is problematic for preservice teachers who may wish to experiment with disruptive pedagogical practice during their practicum. After all, it is not enough to engage in disruptive pedagogy in the context of teacher preparation if these experiences rest within the confines of campus-based coursework. Instead, what is required is a way to encourage sponsor teachers to employ a model of collaboration whereby they, as well as their preservice teachers, are working toward the collective goal of creating meaningful learning opportunities for their pupils.

The preservice teachers participating in this study engaged in a collaborative process during the construction of their slowmation; however, it was not until they described the process and responded to related questioning that they were able to identify the merits of the teaching technique and its potential challenges within their prospective classrooms. Data collected during the study showed that he majority of the preservice teachers used their campus-made slowmations as an instructional resource,; however, for a variety of reasons they did not encourage their pupils to design and make slowmation projects despite the student-centered approach modeled to them during the program.

The study findings revealed that introducing preservice teachers to alternate instructional strategies employing DT as learners in a teacher education program is not enough for them to take advantage of the full range of possibilities of such technologies in schools. Use of DT in teacher education programs needs to be accompanied by appropriate theory and practical application in grade-specific examples to increase the likelihood that preservice teachers will successfully implement DT use in school contexts to the greatest possible advantage (Rogers, 1995). This should occur in teacher education courses through explicit modeling and through a process of active reflection and discussion. In an attempt to address potential resistance to DT during practicum, perhaps the idea of exploring use of new instructional strategies on practicum could be negotiated in advance of the practicum with the sponsor teachers.

This paper provides an important lesson in how we might think about the introduction of alternate instructional methodologies incorporating DT in teacher education. The additive/disruptive distinction provides a useful sensitizing frame for examining and highlighting the challenges faced when preservice teachers try to implement instructional strategies that they learn in their teacher education course but may be unknown to their cooperating teacher. If teacher educators are aware of these challenges, then they may well be encouraged to discuss these with preservice teachers when they introduce potentially disruptive pedagogies in their methods courses as well. If this does not occur, then the well known divide between technology-savvy children and teachers who are reluctant users of technology will continue to widen.

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References

Abbott, J. A., & Faris, S. E. (2000). Integrating technology into preservice literacy instruction: a survey of elementary education students' attitude toward computers. *Journal of Research in Education, 33*, 149–161.

Albee, J. (2003). A study of preservice elementary teachers' technology skills preparedness and examples of how it can be increased. *Journal of Technology and Teacher Education, 11*(1), 53–71.

Albers, P. (2006). Imagining the possibilities in multimodal curriculum design. *English Education, 38*(2), 75–101.

Albion, P., & Ertmer, P. A. (2002). Beyond the foundations: the role of vision and belief in teachers' preparation for integration of technology. *TechTrends, 46*(5), 34–38.

Albirini, A. (2006). Teachers' attitudes toward information and communication technologies. *Journal of Computer & Education, 47*, 373–398.

Allender, D. (2006). Trends and issues in English instruction. Summaries of informal annual discussions of the Commissions of the National Council of Teachers of English. Retrieved 05.09.06, from the ERIC database.

Bauer, J., & Kenton, J. (2005). Technology integration in the schools: why it isn't happening. *Journal of Technology & Teacher Education, 13*, 519–526.

Berson, M. (2004). Digital imagery in the elementary social studies classroom. In R. Ferdig, et al. (Eds.), *Proceedings of Society for Information Technology & Teacher Education international conference 2004* (pp. 773–780). Chesapeake, VA: AACE.

Brown, A. J., & Davis, N. (Eds.). (2004). *Digital technology, communities and education*. Albany, London: Routledge Falmer.

Burn, A., & Parker, D. (2003). Tiger's big plan: multimodality and moving image. In C. Jewitt, & G. Kress (Eds.), *Multimodal literacy* (pp. 56–72). New York: Peter Lang.

Butler, D., & Sellbom, M. (2002). Barriers to adopting technology for teaching and learning. *EDUCAUSE Quarterly, 25*(2), 22–28.

Callow, J. (2008). Show me: principles for assessing students' visual literacy. *International Reading Association, 61*(8), 616–626.

Callow, J., & Zammit, K. (2002). Visual literacy: from picture books to electronic texts. In M. Monteith (Ed.), *Teaching primary literacy with ICT*. Buckingham, UK: Open University Press.

Chambers, B., Cheung, A. C. K., Madden, N. A., Slavin, R. E., & Gifford, R. (2006). Achievement effects of embedded multimedia in a success for all reading program. *Journal of Educational Psychology, 98*(1), 232–237.

Cherney, D., Seiwert, C., Dickey, T., & Flichtbeil, J. (2006). Children's drawings: a mirror to their minds. *Educational Psychology, 26*(1), 127–142.

Christensen, R. (2002). Effects of technology integration education on the attitudes of teachers and students. *Journal of Research on Technology in Education, 34*(4), 411–433.

Clarke, A., & Mitchell, J. (2007). Teacher educators using technology: functional, participative and generative competencies. In L. Farr Darling (Ed.), *Collective improvisation in a teacher education community* (pp. 119–136). Dordrecht: Springer.

Creswell, J. W. (1998). *Research design: Qualitative and quantitative approaches*. London: Sage.

Darling-Hammond, L. (1995). Changing conceptions of teaching and teaching development. *Teacher Education Quarterly, 6*, 9–26.

Demetriadis, S., Barbas, A., Molohides, A., Palaigeorgiou, G., Psillos, D., Vlahavas, I., et al. (2003). "Culture in negotiation": teachers' acceptance/resistance attitudes considering the infusion of technology into schools. *Computers & Education, 41*, 19–37.

Dupagne, M., & Krendl, K. A. (1992). Teachers' attitudes toward computers: a review of the literature. *Journal of Research on Computing in Education, 24*(3), 420–429.

Earle, R. S. (2002). The integration of instructional technology into public education: promises and challenges. *Educational Technology, 42*(1), 5–13.

Elliott, C. (2000). Helping students weave their way through the World Wide Web. *English Journal, 90*(2), 87–92.

Ellis, R. D., & Allaire, J. C. (2001). Modeling computer interest in older adults: the role of age, education, computer knowledge, and computer anxiety. *Human Factors, 41*(3), 345–355.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: the final frontier in our quest for technology integration? *Educational Technology Research and Development, 53*(4), 25–39.

Felix, U. (2003). Teaching languages online: deconstructing the myths. *Australian Journal of Educational Technology, 19*(1), 118–138.

Finley, L., & Hartman, D. (2004). Institutional change and resistance: teacher preparatory faculty and technology integration. *Journal of Technology and Teacher Education, 12*(3), 319–327.

Fisk, A. D., Rogers, W. A., Charness, N., Czaja, S. J., & Sharit, J. (2004). *Designing for older adults: Principles and creative human factors approach*. Boca Raton, FL: CRC Press.

Fullan, M., & Steigelbauer, S. (1991). *The new meaning of educational change*. New York: Teachers College Press.

Goodyear, P., & Ellis, R. (2008). University students' approaches to learning: rethinking the place of technology. *Distance Education, 29*(2), 141–152.

Goose, M. (2005). A sociocultural analysis of the development of pre-service and beginning teachers' pedagogical identities as users of technology. *Journal of Mathematics Teacher Education, 8*(1), 35–59.

Grabe, M., & Grabe, C. (2001). *Integrating technology for meaningful learning*. USA: Houghton Muffin Company.

Granger, C. A., & Morbey, M. L. (2002). Factors contributing to teachers' successful implementation of IT. *Journal of Computer Assisted Learning, 18*, 480–488.

Guinee, K. (2004). *Internet searching by K–12 students: A research-based process model*. Association for Educational Communications and Technology. Retrieved 05.09.06, from the ERIC database.

Guldberg, K., & Pilkington, R. (2006). A community of practice approach to the development of non-traditional learners through networked learning. *Journal of Computer Assisted Learning, 22*, 159–171.

Hedberg, J. G., & Freebody, K. (2007). *Towards a disruptive pedagogy: Classroom practices that combine interactive whiteboards with TLF digital content*. Retrieved 15.08.07, from. Melbourne: Le@rning Federation. http://www.thelearningfederation.edu.au/verve/_resources/towards_a_disruptive_pedagogy.pdf.

Hew, K., & Brush, T. (2007). Integrating technology into K–12 teaching and learning: current knowledge gaps and recommendations for future research. *Educational Technology Research & Development, 55*(3), 223–252.

Hoban, G. (2005). From claymation to slowmation: a teaching procedure to develop students' science understandings. *Teaching Science: Australian Science Teachers' Journal, 51*(2), 26–30.

Hoban, G. (2007). Using slowmation to engage preservice elementary teachers in understanding science content knowledge. *Contemporary Issues in Technology and Teacher Education, 7*(2), 1–9.

Hoban, G. (2009). Facilitating learner-generated animations with slowmation. In L. Lockyer, S. Bennett, S. Agostino, & B. Harper (Eds.), *Handbook of research on learning design and learning objects: Issues, applications, and technologies* (pp. 313–330), Hershey, PA.

Hoban, G., & Nielsen, W. (2010). The 5 Rs: a new teaching approach to encourage slowmations (student-generated animations) of science concepts. *Teaching Science, 56*(3), 33–37.

Hruskocy, C., Cennamo, K. S., Ertmer, P. A., & Johnson, T. (2000). Creating a community of technology users: students become technology experts for teachers and peers. *Journal of Technology and Teacher Education, 8*, 69–84.

Jewitt, C. (2006). *Technology, literacy and learning: A multimodal approach*. New York, NY: Routledge Press.

Kagan, D. M. (1992). Implications of research on teacher belief. *Educational Psychologist, 27*(1), 65–90.

Keengwe, J., Onchwari, G., & Wachira, P. (2008). Computer technology integration and student learning: barriers and promises. *Computers & Education, 17*(6), 560–565.

Koehler, M. J., & Mishra, P. (2005). Teachers learning technology by design. *Journal of Computing in Teacher Education, 21*(3), 94–102.

Kozma, R. B., & Russell, J. (2005). Students becoming chemists: developing representational competence. In J. Gilbert (Ed.), *Visualization in science education*. London: Kluwer.

Lacina, J. (2005). Grammar instruction and technology. *Childhood Education, 81*(4), 247–249.

Leu, D. J., Jr., Kinzer, C. K., Coiro, J., & Cammack, D. (2004). Toward a theory of new literacies emerging from the internet and other information and communication technologies. In R. B. Ruddell, & N. Unrau (Eds.), *Theoretical models and processes of reading* (5th ed.). (pp. 1568–1611) Newark, DE: International Reading Association.

Lindsay, W., & McLaren, S. (2000). The internet: an aid to student research or a source of frustration? *Journal of Educational Media, 25*(2), 115–128.

Loughran, J., & Russell, T. (1996). *Teaching about teaching. Purpose, passion and pedagogy in teacher education*. Chicago: Falmer Press.

Lowther, D. L., Inan, F. A., Strahl, S. J., & Ross, S. M. (2008). Does technology integration work when key barriers are removed? *Educational Media International, 45*(3), 195–213.

Lumpe, A. T., & Chambers, E. (2001). Assessing teachers' context beliefs about technology use. *Journal of Research on Technology in Education, 34*(1), 93–107.

Margerum-Leys, J., & Marx, R. W. (2004). The nature and sharing of teacher knowledge of technology in a student teacher/mentor teacher pair. *Journal of Teacher Education, 55*(5), 421–437.

Miller, D. (2003). Developing interactive whiteboard activity. *MicroMath, 19*, 33–35.

Mishra, P., & Koehler, M. (2006). Technological pedagogical content knowledge: a framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: a review of the literature. *Journal of Information Technology for Teacher Education, 9*(3), 319–342.

Neiss, M. L. (2005). Preparing teachers to teach science and mathematics with technology: developing a technology pedagogical content knowledge. *Teaching and Teacher Education, 21*(5), 509–523.

Niederhauser, D. S., & Stoddart, T. (2001). Teachers' instructional perspectives and use of educational software. *Teaching and Teacher Education, 17*, 15–31.

O'Dwyer, L. M., Russell, M., & Bebell, D. (2004). *Elementary teachers' use of technology: Characteristics of teachers, schools, and districts associated with technology use*. Boston, MA: Technology and Assessment Study Collaborative, Boston College.

O'Dwyer, L. M., Russell, M., Bebell, D., & Tucker-Seeley, T. (2005). Examining the relationship between home and school computer use and students English/Language arts test scores. *Journal of Technology, Learning, and Assessment, 3*(3).

Paul, K., & Rowsell, J. (Eds.). (2006). *Travel notes from the new literacy studies: Instances of practice*. Clevedon: Multilingual Matters Ltd.

Pellegrino, J., Goldman, S., Bertenthal, M., & Lawless, K. (2007). Teacher education and technology: initial results from the "What Works and Why" project. *Yearbook of the National Society for the Study of Education, 106*(2), 52–86.

Pence, H. M., & Macgillivray, I. K. (2008). The impact of an international field experience on pre-service teachers. *Teacher and Teacher Education, 24*, 14–28.

Preece, J. (2000). *Online communities: Designing usability and supporting sociability*. Chichester, UK: Willey.

Richardson, W. (2006). *Blogs, wikis, podcasts, and other powerful web tools for classrooms*. Thousand Oaks, CA: Corwin Press.
Ringstaff, C., & Kelly, L. (2002). *The learning return on our educational technology investment: A review of findings from research*. San Francisco, CA: West Ed RTEC.
Rogers, E. M. (1995). *Diffusion of innovation*. New York: The Free Press.
Rogers, E. (2003). *Diffusion of innovation*. New York: The Free Press.
Rogers, P. (2000). Barriers to adopting emerging technologies in education. *Journal of Educational Computing Research, 22*(4), 455–472.
Rosaen, C. L., Hobson, S., & Khan, G. (2003). Making connections: collaborative approaches to preparing today's and tomorrow's teachers to use technology. *Journal of Technology and Teacher Education, 11*(2), 281–306.
Russell, M., Bebell, D., & Higgins, J. (2004). Laptop learning: a comparison of teaching and learning in upper elementary classrooms equipped with shared carts of laptops and permanent 1:1 laptops. *Journal of Educational Computing Research, 30*(4), 313–330.
Russell, M., Bebell, D., O'Dwyer, L., & O'Conner, K. (2003). Examining teacher technology use: implications for preservice and inservice teacher preparation. *Journal of Teacher and Teacher Education, 54*(4), 297–310.
Sandholtz, J. H., & Reilly, B. (2004). Teachers, not technicians: rethinking technical expectations for teachers. *Teachers College Record, 106*(3), 487–512.
Schmidt, D., Thompson, A., & Chuang, H. (2004). Preparing pre-service teachers to use technology in classrooms: PT 3 project results. In R. Carlsen, N. Davis, J. Price, R. Weber, & D. Willis (Eds.), *Society for Information Technology and Teacher Education* (pp. 3664–3666). Norfolk, VA: Association for the Advancement of Computing in Education.
Shapka, J. D., & Ferrari, M. (2005). Computer-related attitudes and actions of teacher candidates. *Computers in Human Behaviour, 19*(3), 319–334.
Sherry, L., Billig, S., Tavalin, F., & Gibson, D. (2002). New insights in technology adoption in schools. *THE Journal, 27*(7), 43–46.
Smaldino, S., Russell, J., Heinich, R., & Molenda, M. (2005). *Instructional technology and mediated learning*. Columbus, OH: Pearson.
Snider, S. (2002). Exploring technology integration in a field-based teacher education program: implementation efforts and findings. *Journal of Research on Technology in Education, 34*(3), 230–249.
Stake, R. (1995). *The art of case study research*. London: Sage Publications.
Strudler, N., & Wetzel, K. (2003). Lessons from exemplary colleges of education: factors affecting technology integration in pre-service programs. *Journal of Educational Technology Research and Development, 47*(4), 63–81.
Thompson, M. (2008). Multimodal teaching and learning: creating spaces for content teachers. *Journal of Adolescent and Adult Literacy, 52*(2), 144–153.
Tong, K. P., & Trinidad, S. G. (2005). Conditions and constraints of sustainable innovative pedagogical practices using technology. *Journal of International Electronic for Leadership in Learning, 9*(3), 1–27.
Van Braak, J. (2001). Individual characteristics influencing teachers' class use of computers. *Journal of Educational Computing Research, 25*(2), 141–157.
Van Melle, E., Cimellaro, L., & Shulha, L. (2003). A dynamic framework to guide the implementation and evaluation of educational technologies. *Education and Information Technologies, 8*(3), 267–285.
Vannatta, R. A., & Beyerbach, B. (2001). Digital technologies in 21st century schools. *Journal of Research on Computing in Education, 33*(2), 132–148.
Vannatta, R. A., & Fordham, N. (2004). Teacher dispositions as predictors of classroom technology use. *Journal of Research on Technology in Education, 36*(3), 253–271.
Vratulis, V. (2008). *Digital learning technologies in language arts classrooms*. Germany: VDM Publishing.
Wallace, R. (2004). A framework for understanding teaching with the internet. *American Educational Research Journal, 41*(2), 447–488.
Walsh, C. S. (2006). Beyond the workshop: doing multiliteracies with adolescents. *English in Australia, 41*(3), 49–58.
Wang, M., Sierra, C., & Folger, T. (2003). Building a dynamic online learning community among adult learners. *Education Media International, 40*(1), 49–61.
Wang, Y. M. (2002). When technology meets beliefs: preservice teachers' perception of the teacher's role in the classroom with computers. *Journal of Research on Technology in Education, 35*(1), 150–161.
Williams, D. (2007). The impact of time online: social capital and cyberbalkanization. *CyberPsychology & Behavior, 8*, 580–584.
Willis, J. (2000). The manufacturing of constructivist instructional design: some basic principles that can guide practice. *Educational Technology, 40*(1), 5–16.
Windschitl, M., & Sahl, K. (2002). Tracing teachers' use of technology in a lap-top computer school: the interplay of teacher beliefs, social dynamics, and institutional culture. *American Educational Research Journal, 39*(1), 165–205.
Wright, V., & Wilson, E. (2007). A partnership of educators to promote technology integration: designing a master technology teacher program. *Education, 128*(1), 80–88.
Zhao, Y. (2003). In *What teachers should know about technology: Perspectives and practices*. Greenwich, CT: Information Age.
Zhao, Y., & Cziko, G. A. (2001). Teacher adoption of technology: a perceptual control theory perspective. *Journal of Technology and Teacher Education, 9*(1), 5–30.
Zhao, Y., Pugh, K., Sheldon, S., & Byers, J. (2002). Conditions for classroom technology innovations. *Teachers College Record, 104*(3).