

**CORRELATION BETWEEN ELEMENTARY AND MIDDLE SCHOOL
TEACHERS' TEACHING STYLES AND
FREQUENCY AND VARIETY OF DIGITAL TECHNOLOGY USE**

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Abstract

Kindergarten to grade nine teachers (n=61) in a large urban school district in Alberta were surveyed on their teaching styles and variety and frequency of technology use. Teacher responses to a Teaching Styles Inventory were used to assign teaching styles and were compared to responses from a Technology Inventory that measured the approximate frequency and variety of technology use of each teacher. Using bivariate analysis, significant positive Pearson's correlation coefficients were found between the Facilitator and Delegator teaching styles ($p < .01$), Technology use was negatively associated with the Expert teaching style ($p < .10$) and Formal Authority teaching style ($p < .05$). No significant correlation was found between the Personal Model teaching style and technology use. Technology use may be influenced by a teacher's teaching style in that teachers with a more traditional or teacher-directed style may use technology less frequently while teachers with a more student-directed approach may choose technology as an instructional tool with more frequency and variety.

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Chapter 1: Introduction

As a young, new administrator touring a Calgary, Alberta school with its principal, it was pointed out to me how well the teachers had adopted technology in their classrooms. The evidence for this was the presence of an interactive whiteboard (IWB) at the front of every classroom. Although other digital technologies – digital software and hardware used in the classroom – were present in the school, it was clear, after some time there, that the presence of the IWBs was this administrator's idea of proper technology integration. Certainly, an IWB is no small addition to the classroom. These are often costly items for schools to purchase and, even with some support for funding by Alberta Education, educational societies throughout the city regularly dedicate a large portion of their fund-raising efforts to providing current technology in their students' classrooms.

As we continued our tour, I wondered how often teachers used digital technology in the school. After all, the presence of a tool in the classroom is a poor way of measuring its frequency of use. Did certain teachers adopt technology more easily than others? If the IWB was the foremost digital technology in use, how easy was it for teachers with differing teaching styles to integrate this tool? Was there any connection between the way teachers taught their students and the tools they chose to use while teaching?

Each teacher has a unique instructional style, or combination of styles, that sets him or her apart. These styles are connected to the way he or she delivers instruction to students; some teachers might lean toward a student-directed approach, while others are more teacher-directed in their delivery. It is reasonable to believe that teaching styles

might also influence the tools that a teacher uses in the classroom during instruction, including the frequency and variety of digital technology.

Technology integration is no trivial issue. Today's educators, including those in the province of Alberta, are not only expected to educate students in literacy, numeracy, and other core areas, but in the new tools of the 21st century. This expectation comes from various stakeholders including parents, business leaders, members of the community, and the students themselves. Knowing the importance of technology integration in our educational climate today, and seeing a variety of levels of adoption among my colleagues in my district, I became curious to explore the correlation between teachers' teaching styles and the choices (variety and frequency of use) they made in the classroom when using digital technologies as instructional tools.

ICT in Alberta Today

In order to properly understand the importance placed on digital technology – often referred to as Information and Communications Technology (ICT) – in Alberta today, it is necessary to consider recent publications from Alberta Education and other stakeholders that monitor the effectiveness of the education system, such as the Alberta Teachers' Association (ATA).

Murgatroyd & Couture, writing on behalf of the ATA in their research update, *Using Technology to Support Real Learning First in Alberta Schools*, explained that Alberta Education's stance over the last 30 years has been that:

- ICT makes education more efficient.
- ICT helps students to build a sense of community and connect to the world.

- ICT is needed to engage the interest of the so-called digital generation.
- ICT is essential to equip students to function in the knowledge age of the 21st century. (2010, p. 1)

The ICT Program of Studies was initially developed by Alberta Learning in 2000 to identify the outcomes that students were expected to achieve, from the time they began kindergarten to the moment they graduate from grade 12. According to Alberta Education's website for the ICT Program of Studies, "[t]his ICT curriculum provides a broad perspective on the nature of technology, how to use and apply a variety of technologies, and the impact on self and society" (Government of Alberta, 2011). The outcomes were not meant to be taught as a unique subject, rather, the intention was that they would be integrated with the other programs of study, "within the context of applications, activities, projects, and problems that replicate real-life situations" (Government of Alberta, 2011). Naturally, certain topics in core subjects might lend themselves particularly well to this purpose, such as in Language Arts, Mathematics, Science, and Social Studies. To facilitate the integration of ICT Outcomes in the Alberta programs of study, the most recent editions have included the ICT outcomes as bullet points within the outcomes of core curricular areas. For instance, the Social Studies Program of Study (Alberta Education, 2005) embeds the ICT Outcomes in the Skills and Processes for grade five.

In the introduction to the ICT Program of Studies, Alberta Learning explained that "[a]dvanced technologies are more pervasive today than they have ever been, and their uses are expanding continually" (2000-2003, p. 1). If this was the case in 2000, then

surely it is still applicable in 2014. The program outlined three categories into which the specific learning outcomes were categorized:

- Communicating, inquiring, decision making and problem solving
- Foundational operations, knowledge and concepts
- Processes for productivity (p. 2)

Through a combination of “foundational operations, knowledge and concepts” and “processes for productivity”, graduating students in Alberta are expected to be able to communicate, inquire and possess the necessary competencies for decision making and problem solving, using the following “appropriate computer-based software tools” as identified in the ICT Program of Studies:

- word processing
- database
- spreadsheet
- draw/paint/graphics applications
- Internet browser
- email
- multimedia applications
- clipart/media clips (Government of Alberta, 2011, pp. 2-3)

In *Figure 1*. Word Cloud of Alberta ICT Program of Study (Government of Alberta, 2011), a word cloud, or Wordle, of the ICT curriculum illustrates the frequency of incidence of certain words in the document. By pasting the entire document into the *Wordle* website, the software produces a cloud of words in a variety of sizes. Words that

per year, over a three year period “to support further integration of technology in Alberta's Grade 1 to 12 classrooms in all publicly funded school jurisdictions and charter schools” (Alberta Education, 2011, para. 1). The funding was expected to help jurisdictions provide “key technologies” (para. 3), including an instructional computer for all instructional staff members and a data projection device and/or interactive whiteboard in all instructional spaces. Remaining funding was expected to be used for other ICT equipment, as deemed necessary by individual jurisdictions. Usage of the *Innovative Classrooms* funding was monitored by surveys distributed to school jurisdictions, which were meant to help Alberta Education identify how the funding was allocated and what were the perceived outcomes of the new technology.

In 2010, the Education Minister of the time, and Member of the Legislative Assembly, Dave Hancock made it clear that: “[t]he questions of the last century were about if technology had a role in learning and, if so, how it should be integrated into teaching and learning. That debate is over” (Hancock, 2010, p. 4). Referencing *Inspiring Education* and *Inspiring Action*, Minister Hancock explained that the transformation of education in Alberta is “clearly only possible with the acceptance and integration of technology as a fundamental part of students’ learning experiences” (p. 5). He added that the 21st century competencies that are the ultimate goal of the school systems in Alberta are more easily achieved by the assistance of technology in the classroom, although he cautioned:

The point is not to use technology in the same way we always have, but to use it as a powerful tool to facilitate real change and power up the student learning experience in engaging, authentic and challenging ways. (Hancock, 2010, p. 5)

Hancock (2010) further clarified that Alberta's students *expect* to use technology to: become more productive and collaborative; create authentic learning experiences; and personalize their learning. "Technology is no longer a priority--it is a fundamental component of today's learning environments to which every child deserves equitable access" (p. 5). Although Hancock does not define the term "authentic," Alberta Education defines "authentic" as "real-life" on the *Inquiry Based Learning* section of its *Alberta Initiative for School Improvement* website (Alberta Education, 1995-2014). Authentic is a term that is often associated with technology integration. Looking to sources outside Alberta, Prensky (2010) refers to the term authentic as being synonymous with relevant, meaning "that kids can relate something you are teaching, or something you say, to something they know" (p. 72).

More recently, Alberta Education released a *Learning and Technology Policy Framework* (Andrews et al., 2013), designed to meet the policy shifts identified in *Inspiring Education* (Alberta Education, 2010). The expectations, stated simply in the executive summary, include that technology be "used to support student-centred, personalized, authentic learning for all students", that educators in Alberta "develop, maintain and apply the knowledge, skills and attributes that enable them to use technology effectively, efficiently and innovatively in support of learning and teaching", that technology be used to increase "system efficiencies" and that students and staff members "have access to appropriate devices, reliable infrastructure, high-speed networks and digital learning environments" (Andrews et al., 2013, p. 5).

Not only is there a clear expectation that technology be used, but Alberta Education clearly hopes that technology will also provide a catalyst for change in the way that education is delivered in Alberta schools in the future:

One of the key roles technology can serve in K-12 education is to shift the focus from the system, school and content toward learning and the learner, building competencies and enabling the learner to create and share knowledge. Technology is recognized as playing an integral role in creating student-centred, personalized, authentic learning environments. (Andrews et al., 2013, p. 14)

Suddenly, the point where the integration of technology in Alberta and teaching styles meet becomes clear. In order for technology to be able to make such a shift in the delivery of education, namely from a teacher-directed to a student-centered teaching style, the teacher in the classroom must come to terms with the fact that he or she may be required to adjust his or her teaching style. Similarly, administrators attempting to implement technology integration in their schools must take into account that not every teacher's style may easily accommodate digital technology in his or her instruction.

It is clear that the Government of Alberta not only expects that digital technology be integrated into the province's classrooms, but that the teacher has an important part in deciding how this technology is most effectively presented to and used by students. Understanding the relationship between a teacher's teaching style and digital technology is an important consideration when planning for successful implementation.

Purpose of Study

To date, a fair amount of attention has been given to the teaching styles of instructors in post-secondary institutions (Berg, Dickhaut, Hughes, McCabe, & Rayburn, 1995; Brown, 2004; Coldren & Hively, 2009; Hativa & Birenbaum, 2000; Michel, Cater, & Varela, 2009; Quiamzade, Mugny, & Chatard, 2009; Schumacher & Kennedy, 2008; Seperson & Joyce, 1973; Yoder & Hochevar, 2005; Zhang, 2004a, 2004b), however, there seems to be a need for similar research on the teaching styles of teachers in elementary and junior high (often referred to as middle) schools. Additionally, although a great deal of literature exists on the efficacy and application of technology in schools, only a few studies have been concerned with the interaction of technology and the teacher's teaching style. Moreover, these studies also predominantly take place in university or community college environments.

Given the importance placed on the use of technology in the 21st century classroom as demonstrated in this chapter, it is crucial that teachers and administrators understand how the teacher's instructional style affects the choices of digital technologies he or she makes. Do certain teaching styles make a teacher more likely to use digital technology more frequently with students? Do teachers of a certain style make more varied use of technology as a tool in the classroom?

The purpose of this thesis is to determine whether there is a correlation between elementary and middle school teachers' teaching styles and the frequency and variety of digital technologies they use in their instructional settings. A review of the literature will show that most research into teaching styles and technology focuses on post-secondary instructors, so there is a need for more study at the elementary, middle, and high school

levels. In addition, it is important for school leaders to be able to predict which members of their staff are more likely to use digital technology, when attempting to integrate digital technology in school classrooms.

The research question for this thesis is: Is there a correlation between teachers' teaching styles and the frequency and variety of digital technologies used in their classrooms?

Hypotheses

It is conjectured that a correlation will be found between teachers' teaching styles and the frequency and variety of digital technologies used in their classrooms. Specifically, that teachers who practise a more teacher-directed instructional style will not make as varied or frequent use of technology as teachers with more student-centred styles.

Summary

The importance of digital technology integration in Alberta is clearly demonstrated by Alberta Education's and other stakeholder's 21st century publications. Similarly, the need for technology to not only be present in the classroom, but also to change the delivery of instruction toward a more student-centered environment is evident. Finally, a wealth of literature at the post-secondary level indicates a need for more research into how teaching style and technology might be connected in the primary, middle, and secondary levels. The purpose of this thesis will be to investigate the possible link between teachers' teaching styles and the frequency and variety of digital technologies use in instructional settings. It is hypothesized that teachers who already

teach with a student-centered approach will make more frequent use of technology in an instructional environment.

Chapter 2: Literature Review

Defining Digital Technology

A variety of terms are used to describe technology in schools today, including digital technology, information and communications technology (ICT), educational technology, and information technology. In general, these terms may be used interchangeably, and the term digital technology has been chosen for this thesis.

Schwartzbeck and Wolf (2012) define information technology as “computers, devices that can be attached to computers (e.g., LCD projector, interactive whiteboard, digital camera), networks (e.g., internet, local networks), and computer software” (p. 8).

Obviously, a vast number of tools have been and will be used in education.

Orr and Mrazek (2009) identified eighteen different categories of digital technology, used by teachers, in their Revised List of Technologies for Teaching, as seen in Table 1, with examples of products next to each item. Although this is not an exhaustive itemization due to the changing nature of educational technology, at the time of writing it was expected that the listed technologies were representative of the choices available to teachers. For more information on the Revised List of Technologies for Teaching, please see Instruments and Instrument Reliability & Validity in Chapter 3.

Defining Teaching Style

A teacher’s teaching style is determined by considering a number of different factors. Grasha (2002) stated that “[teaching] style is reflected in how faculty present themselves to students, convey information, interact with learners, manage tasks, supervise work in process, and socialize learners to the field” (p. 140). Therefore, clues

Table 1.

Revised List of Technologies for Teaching

Technology for Teaching	Examples of Products
Presentation Software	Microsoft PowerPoint, Prezi, Apple KeyNote
Classroom Video	VHS, DVD, Learn360, YouTube, streaming video
Concept-Mapping Software	Inspiration, SMART Ideas
Interactive Whiteboard Technology	SMART Board
Interactive Classroom Response System	SMART Board Response PE
Visual Image Capturing Technologies	Digital cameras, document cameras
Visual Imaging Technologies	Adobe Photoshop, Corel Photo Paint
Video Production Software	Windows Live Movie Maker, iMovie, Adobe Premiere
Mobile Devices	iPad, iPod Touch, cellular phones, GPS
Learning/Content Management Systems	Desire2Learn / D2L, Moodle
Podcasting	Recording with digital audio or video devices
Website Development	Dreamweaver, Google Pages
Wiki / Blogging	Wikispaces, Blogger, WordPress
Social Networking	Facebook, Twitter, MySpace
Virtual Worlds	Second Life
Gaming / Simulations	Sims brand games, CD-ROM software, etc.
Large Group Video-Conferencing Technologies	Adobe Connect, Skype, FaceTime
Interactive Desktop Web-Conferencing / Bridging Technology	Bridgit, Blackboard, ooVoo

Note. Table adapted from Orr and Mrazek (2009).

to a teacher's style may be found in the daily interactions he or she makes with faculty and students while instructing, supervising, or planning. The method, or medium, in which a teacher chooses to deliver instruction during class time is probably the most effective means of informing the observer of that teacher's style. This choice in instructional delivery is also an indication of the teacher's desired educational outcome for the student, in much the same way as McLuhan (1964) introduced us to the concept of the medium being the message. For example, a lecturer (the lecture being the medium) desires to create a student who is able to receive information by listening. Conversely, a teacher who instructs using student-directed projects is seeking to encourage students to work individually, with a minimum of teacher intervention (independence being the message).

A similar fascinating example of how the medium is the message in relation to education can be observed in a study conducted by Evans, Kelley, Sikora, and Treiman (2010), in which it was observed that the mere presence of books in the home was the best predictor of the number of years of education that a family's children would complete. It was not so much that the books were being read (the medium) as the culture that was being created by their presence (the message).

When considering a teacher's individual teaching style, a distinction should be made between personality-based teaching style and teaching style designed to improve student outcomes, here known as achievement-based teaching style. A teacher's personality will influence his or her style in the classroom and may be difficult or impossible to change, but a teacher can consciously adapt his or her achievement-based style to accomplish a certain goal with a particular student or group of students. Teachers

implementing an achievement-based teaching style or method may deliberately adapt the way they deliver instruction, the way their students work, or a number of other factors.

Both personality and achievement-based styles may also be categorized along the spectrum of teacher and student involvement. Styles may range from student-centered, where the student makes more educational choices, to teacher-directed, where the teacher is responsible for most decisions. As explained by Kirschner, Sweller, and Clark (2006), instruction with minimal teacher guidance may also be defined as constructivist learning, discovery learning, problem-based learning, inquiry learning, experiential learning, unguided instruction, and others. In many cases, these terms are meant to describe similar educational settings. As the teacher makes more decisions, the classroom becomes increasingly teacher-directed, what Kirschner et al. (2006) refer to as “direct guidance”. Other terms such as guided learning, scaffolding, or direct instruction may be used to indicate that the teacher is making more educational decisions to support the student.

Summary of defining teaching style. Teaching style is determined by observing a teacher’s interactions inside and outside of the classroom. It can be personality-based, determined by the individual’s personality, or achievement-based, when the teacher is consciously trying to achieve certain learning outcomes. Teaching style can be student or teacher directed and may fall at any point on the spectrum in between. In the following two sections the aspects of each teaching style category will be discussed along with the related literature.

Personality-Based Teaching Style

A teaching style is personality-based when the style is determined by the personality traits of the teacher. Researchers use a variety of terminology to describe personality-based teaching styles. For the purposes of their study, Sieber and Wilder (1967) considered four teaching styles: Content-oriented, Control-oriented, Discovery-oriented, and Sympathy-oriented. Seperson and Joyce (1973) used the Conceptual Systems Manual, developed by Joyce and Harootunian (1967), to categorize teachers' styles, identifying teacher classroom statements into Sanctions, Information, Procedures, or Maintenance. Grasha (1994) used the terms Expert, Formal Authority, Personal Model, Facilitator, and Delegator to describe teaching styles. Cohen and Amidon (2004) identified teachers' delivery styles as either Indirect (i.e. reciprocal learning) or Direct (i.e. lecture style). Coldren and Hively (2009) classified teaching styles as Authoritarian, Authoritative, or Neutral.

A teacher's personality-based teaching style can be influenced by a number of factors, including his or her formative years and teacher training. Cohen and Amidon (2004) found that student teachers who grew up in households where reward techniques (as opposed to punitive methods) were used as discipline were more likely to perceive themselves as indirect teachers (indirect teachers tend to promote acceptance, creativity, growth, achievement, and positive attitudes). Seperson and Joyce (1973) found that student teachers' styles were influenced by their coordinating teachers throughout their practical teaching experiences, especially in the areas of delivery of information to students and procedure handling in the classroom.

Based on a review of other studies, Carpenter and Tait (2001) concluded that university instructors in science and law were more inclined, when compared to faculty of education instructors, to teach in so called non-progressive styles. In other words, teachers in these faculties were deemed more traditional in their approaches, possibly indicating that certain subject areas are best suited to specific types of delivery, or that these curriculum areas may attract teachers of a certain type, or that instructors have continued to teach in the manner in which they were instructed throughout their own undergraduate or graduate studies.

To summarize, a personality-based teaching style is determined by the personality of the teacher, and has been described in a number of different methods by various researchers. Teaching style is influenced by factors that include upbringing and years spent during teacher training. Teachers in scientific fields may show a propensity for traditional teaching styles, while those in the humanities may tend to use more progressive approaches.

Student preferences and personality-based teaching style. Students will typically express a preference toward certain styles, based on their own individual learning styles or personal tastes. When it came to students' preferences regarding their teachers' teaching styles, Zhang (2004b) found that university students generally preferred teachers with styles that aligned with their own thinking styles. In another study published the same year, Zhang (2004a) observed that creative students (also identified as Sternberg's Type I) tended to prefer teachers who used a student-directed approach. Norm-favouring students (Sternberg's Type II) preferred a teacher-directed approach in the classroom. Hativa and Birenbaum (2000) noted that engineering and education

undergraduate students typically gravitated toward teachers who accommodated their learning needs and preferred instructors who delivered clear and interesting lectures (organized and interesting, with clear explanations). Although the students preferred teacher-directed classes, they did not enjoy learning from teachers who simply delivered information, nor did they, interestingly, prefer teachers that actively attempted to foster conceptual change and intellectual development. Hativa and Birenbaum (2000) were especially surprised by the lack of desire from students to learn from teachers who encouraged students to become more independent, since this style was more in line with current models of education and constructivist theory. Also surprising was the observation that education and engineering students seemed to have similar preferences for their instructors' styles, despite the apparent differences between the two faculties.

University professors typically receive higher scores on student evaluations if their style is more authoritative (i.e. an expert in the subject area), rather than authoritarian (i.e. a teacher who has strict control over the class). Although primarily an assessment of the teacher's personality and not the educational conditions, this factor still has an impact on the student's perception of and satisfaction with the educational merits of the course, as these personality traits carry over into instruction (Coldren & Hively, 2009). Gauging success by student preference can be dangerous, however; Kirschner et al. (2006) pointed out a number of studies that showed that lower ability students who chose a more student-directed course (designed to increase success by allowing for a more moderate, individualized pace) nevertheless achieved a lower grade than others who had chosen a more traditionally structured equivalent. Interestingly, the students in the

student-directed course rated their satisfaction more positively on the exit surveys at the end of the semester than the control group did.

To illustrate how student satisfaction can be influenced by teacher and student personality combinations, Brown (2004) asked university students to evaluate their teacher's ability, based on a number of factors, including "hygiene factors" – qualities such as "organized for class," "knowledge of subject area," or "sense of humour" – and compared these with teachers' and students' corresponding meta programme synchronicity (meta programmes are unconscious thinking styles that may cause two individuals to develop a stronger relationship – in the case of a match – or communication problems – in the case of a mismatch). In some cases, the meta programme match between a student and a teacher was powerful enough to outweigh a poor score in hygiene factors, pointing to a potential concern with the typical teacher evaluation process by student feedback. The Brown study shows how important the teacher's personality-based style is to the students' perceptions of the course, when a disorganized teacher with a poor knowledge of the subject area might still receive a positive review based on his or her relationship developed by interactions with the students.

Summary of personality-based teaching styles. In summary, students will often show a preference toward instructors based on a match in personality or learning styles. While some students prefer a student-directed environment, others will choose a teacher-directed classroom based on the perception that it will be less difficult. A student with an instructor that better suits his or her learning style needs may report more satisfaction at

the end of the course, and the importance of a personality match between teacher and student will often outweigh other educational considerations.

Achievement-Based Teaching Styles

Although a teacher's personality is an important factor in determining an instructor's teaching style, teachers may also consciously adapt their styles to accommodate certain student needs or to accomplish intended goals, as in the case of achievement-based teaching styles. As Grasha (1996) stated: "[style] is both something that defines us, that guides and directs our instructional processes, and that has effects on students and their ability to learn" (p. 1). A teacher's goal may be as simple as helping a child remember their multiplication tables, or as complex as developing the right set of skills to become a lifelong independent learner, but a teacher will often access different methods to accomplish these goals. Although achievement-based teaching styles are sometimes also described as teaching methods, to reduce confusion, conscious efforts made by a teacher to affect the achievement of his or her students will herein be described as achievement-based teaching styles.

Based on his research, Zhang (2004a) recommended that teachers be prepared to use a variety of teaching styles to accommodate their students, as certain students exhibited preferences based on their own individual personalities. This supports research conducted by Grasha (1994), in which he observed that university professors were less likely to assume the role of an Expert or Formal Authority in advanced undergraduate or graduate level courses, preferring to deliver instruction as a Facilitator or Delegator instead in order to meet the needs of the students. Grasha noted that "[i]f upper-level classes attract[ed] better prepared students, then the faculty adjusted their styles for the

capability levels of their students” (1994, p. 165). Although not specifically noted by Grasha, it is easy to imagine that the smaller class sizes typical of graduate level courses most likely also had some effect on the teacher’s teaching style.

Other achievement-based teaching styles in the literature include the Models of Teaching (Joyce, Weil, & Calhoun, 2004), the Spectrum of Teaching Styles (Mosston & Ashworth, 1990), Student-directed Teaching (Green, 1998), The School of One, or So1 (NYC Schools, 2012), and the Teaching Styles Inventory (Grasha, 1994). The Teaching Styles Inventory will be discussed in greater detail in the following section.

The Teaching Styles Inventory. The Teaching Styles Inventory (Grasha, 1994) was based on the work of Anthony Grasha, who observed teachers exhibiting five unique teaching styles. Although this method might arguably have been included in the Personality-based teaching styles section, it also has a place among the achievement-based styles because Grasha encouraged teachers to reflect on their own personal styles, be aware of the various relationships between individual teaching and learning styles, and to adjust their teaching to accommodate them (Grasha, 1994; Grasha & Yangarber-Hicks, 2000).

The five styles identified by Grasha (1994) were:

- Expert – emphasis on knowledge, expertise; concerned with preparing students well.
- Formal Authority – emphasis on knowledge, giver of positive or negative feedback, concerned with correct way to do things.
- Personal Model – teaches by personal example, oversees, guides, encourages.

- Facilitator – asks questions, guides students, suggests alternatives, develops students' capacity for independent work.
- Delegator – develops students' capacity to carry on autonomously, focuses on independence, teacher intercedes only at request of student.

For an individual teacher in a typical classroom, Grasha and Yangarber-Hicks (2000) explained that 92% of the student/teacher interactions could be classified into one of the five styles. Grasha noted that each style had inherent advantages and disadvantages and that an experienced teacher could access different styles as the needs of a particular situation may require.

Grasha (1996) identified eight aspects that were used to determine a teacher's style: general modes of classroom behaviour, characteristics associated with a popular instructor, teaching methods employed, behaviours common to all college faculty, roles teachers play, personality traits, archetypal forms, and metaphors for teaching. Grasha did not expect teachers to be firmly classified according to one specific teaching style, as all teachers possess qualities from each category. He explained that teachers each possess some qualities from each of the five styles, and likened teaching style to the colours on an artist's palette – a unique mixture of colours that make up the overall piece of artwork (Grasha, 1996). When a teacher completes the Teaching Styles Inventory, a few styles will present more dominantly than others, resulting in style clusters (Grasha, 1994).

Cluster 1, Expert/Formal Authority. Grasha (1994), explained that this first style combination was popular when classes were large, required for a certain program or degree, designed for younger university students, or when time pressures were present. In

some cases, the instructor accessed this style cluster when he or she did not enjoy the subject material. According to Grasha (1994), university professors were less likely to use Expert and Formal Authority styles with upper level, or graduate, courses. Women tended to use the Expert and Formal Authority styles less than men. The Expert style was generally more prevalent in math, computer science, art, music, theatre, and was less often observed in the humanities and education faculties, while the Formal Authority style was more popular among instructors of languages, business administration and less so in education, humanities, and applied science. Instructional techniques tended to include lectures, term papers, tutorials, guest presenters, and an emphasis on exams and grades.

Cluster 2, Personal Model / Formal Authority / Expert. In Cluster 2, the teacher relied more on personal modeling and coaching, expected a higher level of capability and initiative from the students, and made more of a focus on building relationships. Instructional techniques included demonstrating, coaching or guiding students, and role modelling by illustration or direct example.

Cluster 3, Facilitator / Personal Model / Expert. Teachers in this cluster fostered more collaboration among students in self-directed environments where the teacher was supervising or designing, rather than instructing. Interpersonal relationships were key, with students expected to take more initiative and accept more responsibility for their learning. The Personal Model and Facilitator styles were popular in art, music, and theatre and less so in math and computer science. Instructional techniques in use by Cluster 3 teachers included small group discussion, laboratory projects, self-discovery

activities, and case studies. Grasha observed that the Facilitator and Personal Model style teachers were typically more satisfied with the courses they taught.

Cluster 4, Facilitator / Delegator / Expert. Teachers in this cluster tended to be risk takers, often in upper level graduate courses. Cluster 4 teachers were more willing to give up control. They initiated student-designed group projects, position papers, student journals, cooperative learning activities, and debates.

Changing achievement-based teaching styles. Generally, teachers found it difficult to change their styles, especially from Cluster 1 (Expert / Formal Authority) to Clusters 3 and 4 (Facilitator / Personal Model / Expert and Facilitator / Delegator / Expert) (1994). Grasha hypothesized that teachers were unwilling to give up their control of their classes, especially in the case of a Cluster 1 teacher. Some teachers may have felt that, in making the class more student-centered, the students were disadvantaged by less information coming from the teacher. Training students for effective independent or small group work was another challenge that may have persuaded a teacher to adopt a more teacher-centered style, which was generally less time consuming in terms of delivery of information.

Summary of achievement-based teaching styles. Achievement-based teaching styles, sometimes referred to as teaching methods, have been used by teachers to accomplish certain learning goals in the classroom. Teachers will also adapt their teaching style according to the class makeup such as smaller/larger class sizes, older/younger students, or higher/lower educational needs. Grasha's Teaching Styles Inventory was used to categorize teachers as Expert, Formal Authority, Personal Model,

Facilitator, or Delegator. Each individual teacher will exhibit a unique set of styles known as a teaching style cluster. Expert teachers will adapt their style according to the needs of their students, although some will find this difficult to do, depending on their own teaching style preferences.

The Impacts of Teaching Style

The classroom is like a dance in which one partner leads, and the other follows.

As in a dance, the person leading is not completely in control; how a dance partner responds affects the next move of the person leading. (Grasha & Yangerber-Hicks, 2000, p. 4)

In the dance known to teachers as education, not every teacher is aware of his or her teaching style's impact on aspects of the classroom, whether it is on student achievement, understanding of subject matter, satisfaction, social development, or some other factor. It might be assumed that a teacher is attempting to affect student outcomes by adopting a new teaching method, but a chosen method or style may not always result in the desired effect. Owing to the fact that there is little research on any correlation between teaching style and technology use, this section has been included to demonstrate the impacts that teaching style are known to have. It may therefore demonstrate reasonable grounds for assumption that teaching style is an important consideration when selecting digital technology for the classroom. Later in the chapter, literature concerning impacts of technology in the classroom will be considered.

Teaching style and student achievement. A number of studies have contributed to our understanding of the impact that teaching styles can have on student achievement.

Typically, the authors attempt to demonstrate either that a student-directed classroom environment is beneficial for the students when compared to a teacher-directed one, or that there is no significant observable effect.

A study conducted by Berg et al. (1995) used an active learning approach to supplement regular lecture-style delivery. In this example, university business students participated in a project on capital markets, with a focus on realistic experience, and were found to have performed better than non-participating classmates when assessed at the end of the semester, even after controlling for initial GPA scores. Again, it should be noted that the students in this study nonetheless experienced a limited active learning environment; the majority of their instruction was delivered through university lectures. Yoder and Hochevar (2005) found that university courses with outcomes delivered by active learning (which they defined as class or small group discussion, exercises, simulations, and demonstrations) could result in improved understanding of concepts, and were superior to a lecture-style delivery, based on improved student achievement. It is important to note that the active learning environment experienced by the students was still highly structured and guided, using only active learning activities 13% to 27% of the total class time, so it was perhaps not what some teachers might describe as student-directed. Clearly, more research is necessary on how to make student-directed instruction effective.

A 2010 New York City School of One (So1) report (Research and Policy Support Group, 2010) indicated that students in the program were experiencing academic gains, when compared to other students not in So1. The So1 program matches students' learning styles with various instructional delivery styles, called modalities. For instance, a student

who is not performing well in a lecture setting might be moved to a small group the following day. Other options include remote tutors and computer instruction. The authors reported that students enjoyed the motivational points system for completing work, learning from an online live teacher, working with peers, and the general qualities of the So1 math program. Students did not respond as positively toward the daily formative assessments or working individually on worksheets. Teachers in the So1 program responded positively toward the new skills that they were learning and felt that So1 was effective in supporting students with high and low needs, but they found that the program did not adequately meet the needs of English Language Learners and Special Education students (Research and Policy Support Group, 2010).

Cole, Kemple, and Segeritz (2012) concluded that students in the School of One (So1) program improved their scores on the New York State math test, especially if they were already low achievers to begin with, so the benefits were greater to those students already experiencing difficulty. On the other hand, the report indicated that low ability students were only able to master about 15% of the total number of skills that they were exposed to, while higher achievers typically mastered as much as 85% of the skills that they attempted. This indicated that, while low achievers benefited from the So1 program, it was still unable to bring them up to the level of a high achieving student during the time of the study (for more detailed information on So1, please see NYC Schools (2012)).

It should be noted that a number of researchers have published papers finding no significant correlation between teaching style and student achievement. Spencer (2002) found that teachers teaching in any of the Formal, Mixed, or Informal teaching styles in

primary schools obtained the same academic results. In a broad survey of studies, Kirschner et al. (2006) attempted to find evidence for benefits of minimal guidance instruction (described by the authors as constructivist, discovery learning, problem-based learning, inquiry learning, experiential learning, etc.). They concluded that no such benefit existed and felt that educators using minimal guidance techniques often disregarded human cognition research. The researchers suggested that novice to intermediate learners might perform better in a teacher-directed, guided environment with an emphasis on worked examples, rather than problem solving. In looking at research on constructivist or discovery classroom environments, it was noted that many of the teachers were required to scaffold their lessons in such a way that they were really giving direct guidance in the form of modeling, teaching students to paraphrase, and so on. Discovery-based science classrooms resulted in confusion and incorrect assumptions on the part of the students, due to the minimal feedback from the instructor. In studies where control groups were used, the students in guided classrooms, in which the teacher used frequent examples and demonstrations, showed a greater understanding of the course outcomes than those in discovery classrooms. Kirschner et al. found that some students did perform well in a discovery classroom – those who had been previously guided to a certain level of background knowledge in the subject area in a more structured environment.

Schumacher and Kennedy (2008), found no statistically significant difference in student achievement when comparing a student-centered and a lecture-driven (i.e. teacher-directed) approach at the university level, although the student-centered group did perform modestly better. Similarly, university students in an introductory business course

taught with active learning techniques did not perform better than students in a passive learning environment (Michel et al., 2009). Michel et al. found that the active learners did understand their course specific material better than the passive learning environment, but that the understanding of the broad outcomes was essentially the same between the two groups.

Nevertheless, the idea of the student-centred classroom persists in Alberta's educational climate today. Andrews et al. (2013) stated that a student-centred environment is one where "the child is the centre of all decisions related to learning and education. Teachers are the chief architects of student learning" (p. 19). Citing research from a number of studies, these authors made the conclusion that self-directed learners perform better "in school and in life" (p. 20), and that the increased level of choice is a powerful motivator for students. They also suggested that collaborative work could help learners deepen their understanding of the content matter.

It is possible that a successful discovery classroom could be accomplished by using a teaching method such as the Spectrum of Teaching Styles, a teaching method in which the teacher adapts his or her method of delivery to teach the student to ultimately manage his or her own learning independently (Mosston & Ashworth, 1990). To this end, the styles on the lower end of the Spectrum involve the learner in fewer decisions, while maximizing the decisions required of the instructor. Styles on the opposite end of the Spectrum maximize the decisions made by the learner. The Spectrum of Teaching Styles guides the student from Command to Discovery (Mosston & Ashworth, 1990), but not all students are ready to enter the styles on the Production side of the Spectrum (the teaching styles in which the student makes most of the educational decisions while working) until

they have been raised to a certain level of expertise. Clearly, a discovery, or student-directed, environment requires a great deal of planning on the part of the educator, and more conclusive research into the advantages of a pure student-directed environment are necessary before educators confidently adopt this teaching style.

Student learning preferences and teaching styles. Often, researchers will note a preference, on the part of the students, toward certain teachers' styles. Although an educator may believe that his or her pupils have a desire to learn in a student-directed environment, research sometimes contradicts this line of thinking for a variety of sometimes surprising reasons.

Researchers have pointed to the importance of considering the learning style preferences of the individual learner. Based on a review of research on learning styles inventories of the time, Smith and Renzulli (1984) concluded that students did have individual learning style preferences, and that matching learning styles with teaching styles could have a positive impact on student achievement, motivation, and interest in subject matter. They also recommended, based on their findings, that teachers begin their year with an inventory of student learning styles and an evaluation of the various teaching styles that they use in their classrooms, suggesting that teachers who were able to teach in a variety of styles or methods would be more successful than those who taught exclusively in one modality.

In a study of university students conducted by Hativa and Birenbaum (2000), it was discovered that students indicated a preference for lecture-style delivery. The researchers suggested that this was a result of the students' recognition that a discovery

environment entailed more work on their part. The results of this study evoke the concept of hot and cool media introduced to us by McLuhan (1964). A hot medium requires less participation on the part of the learner, because it dominates one sense, an example being the university lecture, whereas a cool medium involves a greater degree of involvement, such as in the case of a university seminar, where more active participation is expected from students. In the Hativa and Birenbaum (2000) study, students may have perceived the lecture-driven class as easier or less work on their part; despite the current emphasis on constructivist theory in education, students opted for the path of least resistance.

Kulinna, Cothran, and Zhu (2000) explored students' and teachers' perceptions regarding the use of teaching styles, and found the opposite of that reported in Hativa and Birenbaum (2000), that students tended to prefer Spectrum Teaching Styles that allowed them to make more decisions (known as styles I-K on the Spectrum). Conversely, teachers in the same study preferred reproductive styles (known as styles A-E; where the teacher makes most decisions and has a greater part in leading class time). Although this goes against the findings in Hativa and Birenbaum (2000), a variety of differences between the two studies are worthy of mentioning. Hativa and Birenbaum (2000) surveyed undergraduate students in Education and Engineering, while Kulinna et al. (2000) were measuring the opinions of K-12 students, mainly in physical education classes; it is possible that these results are typical of students in these two age groups.

There is evidence that teachers with certain teaching styles are more effective with corresponding student learning styles. Quiamzade et al. (2009) noted that teachers of undergraduate psychology students who were more Authoritative in style were more effective with less independent students. Conversely, teachers with Democratic teaching

styles had more success with students who were more independent. Byra (2000) concluded, based on a review of Spectrum of Teaching Styles research from 1966 until the turn of the century that student achievement was positively influenced by instructors' use of Spectrum Teaching Styles. In most cases, whether in the Reproduction or Production areas of the Spectrum, students with Spectrum teachers learned skills in physical education and other topic areas significantly better than those in control groups, showing that there may be benefit to matching teaching and learning styles.

A teacher's perception of student teaching style preference can also influence a change in his or her teaching style. Emmer, Oakland, and Good (1974) observed that teachers appeared more likely to instruct in an Expository (teacher-directed), rather than a Discovery (student-directed) style, based on the amount of participation or feedback given by students during instruction. As the psychology undergraduate students participated less in class, their professors adapted their styles toward a more Expository style, perceiving the lack of participation as an indication of their inability to foster a Discovery environment. Increased classroom participation by the students reinforced the style in use by the teacher, encouraging him or her to continue teaching in that manner, whether Expository or Discovery.

Also related to student learning style preferences is 21st century students' expectations in educational and personal settings. Prensky (2010) observed that today's students have an aversion to lecture-style delivery. They desire topics of personal interest in lessons, opportunities for creativity using current digital technologies, group work settings, and the ability to connect with others around the world. Prensky (2010) referred to a style of teaching described as "partnering", where the student had responsibility for

identifying what he or she was passionate about. The teacher, on the other hand was more of a question asker, a guider who was helping to put learning into context, explaining, if necessary, and ensuring that the education was of good quality and rigorous enough. By this description, this teacher might have been described by Grasha (1996) as a Facilitator and may be a step out of some teachers' comfort zones, but Prensky (2010) felt that it was the most successful combination for student success.

What these examples illustrate is that student preference should also be taken into account when observing the effects of teaching style, whether personality or achievement-based. Although a teacher may have the students' educational needs clearly in mind, the students' personal learning style preferences may interfere with the teacher's efforts.

Other possible effects of teaching styles. Finally, it is worth mentioning that in certain cases, teaching styles and methods can have an effect on factors other than student achievement, such as student social development, positively as well as negatively.

Wentzel (2002) noted that grade six teachers whose demeanor indicated having high expectations positively influenced their students' perceptions of community, social competence, and their academic achievement. On the other hand, teachers who regularly provided negative feedback had an adverse effect on the same perceptions. Students suffering from anxiety might also be affected by teachers' styles, such as in the study by LaBillois and Lagace-Seguin (2009), where researchers observed that elementary school teachers who used the Expert, Formal Authority, or Facilitator teaching styles increased anxiety in students who already exhibited an inability to self-regulate. Researchers

suggested that the strict environment of the Expert or Formal Authority classrooms could have been the cause of the stress for anxious students, while the Facilitator's classroom may have had an absence of structure and increased freedom that the students had difficulty tolerating.

As indicated above, there are a variety of ways that a teacher's teaching style can affect students. Although this thesis is primarily concerned with the influences of teaching style on technology use and choices, a conscientious teacher or administrator will also keep other possible influences in mind when delivering instruction.

Summary of teaching style literature. It appears that a teacher's teaching style, or choice of method, can affect student satisfaction with the instructor or the course, the academic achievement that a student experiences, or the mental health and comfort of the student. Student teaching style preferences are important considerations when a teacher is planning for instruction. Students in the 21st century classroom have certain expectations for how they learn, and teachers must now come to terms with how new tools influence the delivery and reception of instruction. The next sections will explore various impacts and issues in the realm of digital technology used to support and deliver instruction while pointing out implications for teaching styles.

The Impact of Technology on Classrooms

“We actually live mythically and integrally, as it were, but we continue to think in the old, fragmented space and time patterns of the pre-electric age” (McLuhan, 1964, p. 4).

Like teachers today, Marshall McLuhan, at the time that he was writing, was witnessing a new age, which he named the electric age. Fifty years after *Understanding Media*, educators have observed that our classrooms still bear qualities of the industrial age, although it might be argued that the advent of the personal computer as a common tool in the North American household has shifted us into a new age, which many call the information age. Similarly, the expectations from stakeholders in education regarding teaching style has shifted, in accordance with the needs of the global community. In the following sections, literature that demonstrates how technology has an impact on teachers and students, with a focus on technology that may be used to support a teacher's style or delivery of instruction, will be presented.

Effective technology use. It is probably no surprise that the inclusion of technology in the classroom is not a cure-all or guarantee that academic conditions will improve. For technology to be effective, it must be used effectively. Demetriadis et al. (2003) observed that Greek secondary teachers who used technology in their classrooms did not typically use it to “create innovative learning experiences” (p. 21). Weston and Bain (2010), in a study focusing on United States one-to-one mobile computing projects, pointed out that innovative teaching, facilitated by technology use, might be the answer to true student success. However, they noted an absence of evidence that educational reform to date had resulted in “innovation at significant scale across schools, districts, and states” (p. 8). The authors suggested that efforts to infuse technology so far have been merely a replacement or automation of current practices (instructional practices, assessment, etc.), and explained that, in the future, teachers will need to think in terms of “cognitive tools” (p. 11). Nevertheless, their belief was that technology has the ability to positively

enhance research-based practices, allow for differentiated instruction, and improve project-based learning, which Weston and Bain suggested have been proven to make a noticeable difference in student learning (2010).

Clearly, for the addition of digital technology to be effective, appropriate teaching style must also be considered. Therefore, it is worth exploring the ways in which teaching styles and technology use are connected.

Online learning. Digital technology in the 20th and 21st centuries has enabled teachers to reach remote students more effectively, which, in actuality, is a way of changing the delivery, or method, of instruction. Education by correspondence is not a new innovation, but through the use of digital communication, time in between communications from teacher to students and vice versa has been significantly decreased. Jaffee (1997) suggested that Asynchronous Learning Networks (ALNs; also known as online, distributed, or distance learning) could be useful as an alternative mode of delivery for students who were physically remote or whose work schedules did not allow for them to participate in traditional learning environments. The asynchronous nature of ALNs allowed more students to participate in discussions at their leisure, and also to give more thoughtful submissions than might be obtained in a face-to-face environment, where a quick, less digested response might be offered. In many schools, a blended environment is recommended, allowing teachers to decide what percentage is face-to-face and how much will be presented online. Online learning is a significant development that changes the way teachers interact with their students and has the potential to impact instructors' teaching styles.

Students with special needs and technology. Students who are learning disabled (LD) can also benefit from the use of technology in the classroom (Kumar & Wilson, 1997). LD students typically find it more difficult to read textbooks, listen to or take notes in class, complete written work, or write tests. They may also exhibit slower reasoning strategies, less cognitive energy, lower self-esteem, and lower motivation. Kumar and Wilson (1997) suggested that the use of digital technologies could assist by offering a more individualized classroom environment, allowing for immediate feedback, providing better context in the form of real life examples, reducing cognitive load on working memory by acting as a supplemental memory, and motivating the student. Teachers of certain styles might find this an easy transition, but others may find the change to a different style challenging.

A white paper from Moeller, Reitzes, and Education Development Center Inc. (2011), which explored technology's role in student-centered learning environments, concluded that technology could be useful in personalizing learning for students, providing ongoing or immediate feedback for teachers and students, and adapting instruction to suit students' individual learning needs (D. Thomas & Brown, 2011); G. Thomas (2011) described the addition of interactive digital tools used to facilitate collaboration as part of a new culture of learning. The authors explained that these tools enabled students to learn outside of the traditional school environment, although they did "not argue that classrooms are obsolete or that teaching no longer matters. [Their] goal [was] quite the opposite. [They believed] that this new culture of learning could augment learning in nearly every facet of education" (Thomas & Brown, 2011, p. 18).

What is indicated by these studies is that the teacher may be required to modify his or her teaching style in order to aid in the success of a student. For instance, the use of technology to provide a more individualized classroom environment would conflict with a teacher whose style is more teacher-directed, and a teacher may find this difficult and instead opt for teaching in a style that he or she is more comfortable with.

Game-based learning and technology. With the ready availability of mobile computing and computer tablet devices such as the Apple iPad, a variety of opportunities for game-based learning are now being implemented in 21st century classrooms. Thomas and Brown (2011) explained that children “embrace play as a central part of how they experience the world, and they learn that questioning the world is one of the key ways they can understand it” (p. 19). Designers, educators, and researchers are creating applications intended to allow for more entertaining ways to deliver education, which may have implications for teaching style.

In defence of playing to learn, Shaffer, Gee, University of Wisconsin-Madison, and Academic Advanced Distributed Learning Co-Laboratory (2005) suggested that students in the United States were on the verge of a “crisis”, which is to say that they were being prepared for “commodity jobs” – jobs for workers who produce and sell consumer goods – and not for “innovative work” (p. 3). Shaffer et al. (2005) presented a number of digital games that could be used to teach students educational outcomes, as well as innovation, in a realistic, immersed, and engaging, 21st century-friendly format. Students in traditional school environments, with an unbalanced focus on standardized testing, were not learning the most important skills of all for the future workforce, that

“you have to be able to produce and not just consume, to make knowledge and not just receive it” (Shaffer et al., 2005, p. 7).

A game-based delivery school, Quest to Learn (New York City Department of Education, 2012), is a project that has given education in middle and high school a new spin. The entire curriculum is taught through the use of games, and was developed by educators and members of the game industry. Rather than earn grades, students “level up” by completing missions, which are comparable to assignments. The missions culminate in a “boss level,” which can be roughly considered the equivalent of a midterm exam. Although the games do not necessarily involve technology, they are designed to be engaging, collaborative, and sometimes competitive. Students are also encouraged, in their free time, to take place in secret extracurricular quests that are peppered throughout the school. Once again, the implications for teaching style are obvious; not every teaching style lends itself well to this method of delivery, and it takes a certain style of teacher to seek this environment out as a possibility for his or her classroom.

Giancola (2001) evaluated the success of the implementation of a game-based delivery system in various elementary curriculum areas in Delaware. In all cases, the games were used in conjunction with typical teacher-directed classroom delivery. Students were exposed to the program at school and also had the opportunity to take game systems home to use alone or with parents. Students in grade two saw significant increases in reading and mathematics scores, while students in grade four saw no significant achievement increase in mathematics, when compared to national averages. Scores decreased slightly for reading in grade four. Low-performing students saw the most benefit in terms of achievement.

Although it is difficult to conclude that the software is entirely responsible for the academic gains, Giancola (2001) explained that it likely played a role. The student, parent, and teacher participants were generally positive toward the program, so much on the part of the students that those using it at home were more likely to use it in place of time normally spent watching television. Because the system was used in conjunction with regular classroom instruction, this could be seen as a modification of a teacher's style to deliver content. Teachers who saw themselves as Experts would have had to give up some of the responsibility to individual exploration on the game systems. Many teachers in the study found that they were unable to master the use of the systems as quickly as the students, so those that took a more facilitative approach had more success because they allowed the students to experiment, and didn't have the expectation of themselves to be the formal authorities in the classroom.

McGonigal (2011), writing about the Quest to Learn school, suggested that it is difficult for students to cope with traditional education in today's world when they have grown up playing highly motivating video games that deliver instant feedback. Although she noted that educational games currently in use could be somewhat engaging to students, she wondered if a school environment entirely based on a game might be the possible answer for today's students. In terms of teaching style, it is highly likely that teachers who prefer to teach in a discovery classroom environment would thrive in the Quest to Learn, or similar programs. Since digital technologies frequently feature games-based environments, it is reasonable to assume that teachers' styles in these types of teaching situations would be influenced by the tools, and the teachers' decisions to use them may also correlate to their individual teaching styles.

Technology's influence on teacher interactions with students. Digital

technology can improve the frequency of communication between students and teachers. In Jewels, De Pablos Heredero, and Campbell (2004), researchers evaluating the use of Internet and database technology at two universities concluded that the application of these tools enabled more bi-directional communication between teachers and students. In other words, the technology allowed students and teachers to communicate in new and more frequent ways than previously possible. Potential implications include that certain teachers' teaching styles may not allow for this type of frequent discussion to occur. A teacher who is used to being an Expert or Formal Authority is most at ease when delivering the information to the student, while a Facilitator would find that this method of delivery would allow for the type of discussion that he or she generally attempts to initiate.

In another example where teachers used technology to create a more interactive classroom, Luk, Wong, Cheung, Lee, and Lee (2006) evaluated a computer game called Farmtasia, which was based on the Virtual Interactive Student-Oriented Learning Environment (VISOLE) teaching style. This "learning paradigm" was an attempt to make learning fun and meaningful for students, and typically incorporated an online virtual learning environment. In this particular case, the researchers designed the game to teach students how to manage a farm: planting crops and orchards, and maintaining livestock. Teachers spent time in a traditional classroom environment to teach the background and necessary concepts. After, the students played the game in groups of four, and engaged in a period of evaluation in a classroom setting by using case examples from the game play.

Using this case study, it is easy to see how a teacher might support his or her teaching style by the technology he or she chooses.

Student engagement and technology. It is often anecdotally reported that students are more engaged in their learning when using technology. In terms of connections to teaching style, technology can be a means for delivering course outcomes more successfully by facilitating a deeper sense of motivation from the pupils. Various digital technologies offer the students an opportunity to take control of their own learning by making learning more personalized and by opening up possibilities for research that may have previously been limited to the teacher's expertise, or local resources such as the school library. Technology can also make learning more relevant to students by its hands-on nature.

Research into student engagement at the high school level has concluded that students were most engaged while working on activities that were appropriately challenging, relevant, and where they had a certain amount of control (Shernoff, Csikszentmihalyi, Schneider, & Shernoff, 2003). Students preferred individual or group work at school and were the least engaged in lecture-type environments. The researchers provided examples for environments where this engagement might take place by citing other studies that indicated that computer science courses offered an experience for students that was academically challenging and motivating at the same time. This suggests that technology-infused courses, with a more hands-on approach, might be more engaging to students.

Motschnig-Pitrik and Holzinger (2002) explored the benefits of a Student-Centered eLearning (SCeL) environment, where students were free to explore areas of personal interest with the assistance of a teacher-facilitator. In this study, students made use of digital technology for student research, communication, group collaboration, and assignment delivery. Based on their case studies, the researchers observed that students found these types of projects more engaging and enjoyable than conventional classrooms. Teacher-facilitators commented that the students were able to solve many problems on their own, with the assistance of digital technology, and that teachers developed stronger relationships with the students on account of the different types of interactions experienced. It was also noted, however, that SCeL was much more time consuming on the whole, when compared to traditional delivery.

Goble (2013) theorized that teachers could only be as effective as their students were engaged in their learning. She used a New Media course to assess whether high school students were more engaged in a student-centered environment as opposed to a teacher-centered one. She concluded that the students in the student-centered environment perceived the course as more engaging than those in typical classrooms.

As shown above, a variety of researchers have been able to show linkages to student engagement and the use of technology in a hands-on way. Teachers were able to use technology to support a teacher-directed as well as a student-directed approach, and the question this thesis will attempt to answer is whether or not there is any correlation between a teacher's teaching style and the frequency and variety of technology used during instruction.

Some challenges technology brings to the classroom. Technology, however, is not without its challenges. Jaffee (1997) noted that technology issues sometimes present obstacles, as in cases where a class is dependent on the internet and computers, and cannot be conducted successfully in cases where either might fail. Another difficulty arose in the case of students who were less capable writers, as the bulk of the assignments were, due to distance learning, submitted in writing. Finally, it was difficult for instructors to work with struggling distance students individually, as they often could not attend regular office hours on campus for individual attention. All of these difficulties may constitute impacts on a teacher's style, as he or she is required to adapt to the integration of digital technology. For instance, in a distance learning environment, a teacher who is accustomed to an Expert/Formal Authority style might be challenged by an emphasis on online discussion; a Facilitator might be frustrated by the lack of direct contact with the students, having to rely solely on electronic communication.

Wallace (2004) noted that teachers using technology in the classroom needed to have more than a functional knowledge of the tool, which tended to be where most school district training fell short. Teachers required content knowledge for their discipline area, combined, of course, with pedagogical knowledge, and pedagogical content knowledge. In other words, teachers needed to know how that particular tool could be used with particular students to accomplish a certain goal. Compounding this was the constant improvement and eventual obsolescence of technology in our world. As Goble (2013) noted, "[t]he shifting nature of technology [...] means that students, no matter what field they eventually find themselves in, need to be learners more than they need to be experts" (p. 44).

Teachers' and students' perceptions of how technology should be used in the classroom are not always the same, as evidenced in Suda, Bell, and Franks (2011), where student and teacher expectations of techniques for success were sometimes at odds between university pharmacology students and their instructors. Both groups agreed that regular review was the most effective strategy for success, but the types of review engaged in by students differed from what the professors recommended. Students perceived certain technological tools, such as TurningPoint software (used for content delivery, feedback during lectures, attendance, and delivery of grades) and Mediasite (to review recordings of lectures) to be more useful than other more traditional methods preferred by instructors. First-year students were less likely to find the recommended textbooks useful and preferred outside, non-recommended resources. Students expected comprehensive handouts and engaging lectures, but were also more inclined to miss the lectures of professors who provided more complete handouts. Teachers felt that student attendance was of particular importance, pointing out a trend toward less student reliance on teacher assistants.

Although digital technology is often sold as a means to increase student-centered practice, teachers nevertheless frequently continue to teach in a teacher-centered style. Palak and Walls (2009) researched schools with a technology focus in order to determine if digital technology changed teachers' beliefs more toward a student-centered approach. Despite regular availability of technology and technical support provided, teachers were found to use technology primarily to "communicate with parents; to record, assign, and post grades; and to prepare classroom instructional material, regardless of their [philosophical] beliefs" (p. 436-437). This study outlined the importance of teachers

receiving adequate professional development in order to properly integrate digital technology, and that regular monitoring is necessary to ensure that the tools are being used for their intended purposes. Additionally, it shows that, even if technology suited to develop student-centered classrooms is provided, it is not a guarantee that teachers will adapt their styles to suit.

Finally, technology can sometimes be a hindrance to learning. In a study by Chiong, Ree, Takeuchi, and Erickson (2012), researchers compared print books with standard e-books and enhanced e-books, and it was discovered that the co-reading experiences of parents and their 3-6 year old children were noticeably affected. Parents and children who read print or standard e-books together tended to engage in conversations about the storyline, whereas the groups reading enhanced e-books were seen to engage in more non-content related conversations. These children were often distracted by the e-books' enhanced features, to the point that their recollection of story details was considerably less than the children who had read the print or standard e-books. Nonetheless, most children found all book types equally as engaging.

When choosing technological tools for the classroom, teachers need to consider how these will support their teaching styles or encourage them to teach in a style meant to better support their students. Teachers used to using certain teaching styles may find it difficult to implement certain technologies, and no specific tool is a guarantee that a teacher will adapt his or her style. In this next section, literature specific to teaching style and technology choices will be considered.

Possible Links Between Technology and Teaching Style

Do teachers with a certain style choose certain types of technologies? If so, what technologies would support a teacher's style? As previously mentioned by Grasha (1994), teachers generally find it difficult to change their teaching styles, so, if a new technology warrants a change in style, then an internal conflict may result. A teacher, when considering a new tool for the classroom, may be steered toward those that support his or her teaching style, rather than cause a change in instructional delivery.

As initiatives in education change over time, a given teacher might feel pressure to adapt his or her style a number of times throughout a career. Furthermore, the 21st century teacher may be expected to teach in a different style than in previous generations; Daniels, Friesen, Jacobsen, and Varnhagen (2012) noted that teachers today are required to move away from lecture-style instructors toward the role of instructional designers. They explained that the 21st century teacher should be more of a mentor who guides students through project-based inquiry, all the while responding to the various individual needs of the students. Technology may successfully support these new expectations; Kumar and Wilson (1997) suggested that computer technology has the possibility to make it easier for teachers to teach as facilitators, rather than as lecturers, by allowing the students to be more active participants in their learning. While this might seem like a natural fit for somebody who is already a Facilitator or a Delegator, teachers with other teaching styles might have a difficult time adopting a digital technology that moves their class in an uncomfortable direction. In this section, literature investigating the link between teaching style and technology will be explored, from both angles – technology as catalyst for change and teaching style as the driving force for choosing technology.

Teaching style influenced by technology. Grasha (1994) observed that a teacher's style can be impacted by the reality of the classroom environment, and the use of digital technology is no exception. In some cases, researchers have noted a possible connection between the integration of technology in the classroom and a change in teaching style. Grasha and Yangerber-Hicks (2000) reported that university instructors did not necessarily perceive a change in their teaching styles – nor did they feel that student achievement was affected – when using technology in the classroom. The researchers, on the other hand, observed that technology use in the classroom either reinforced a teacher's current style or pushed him or her to modify it. They concluded that courses using technology should make use of a variety of modes of delivery to meet various student learning styles, as certain teaching styles could reinforce student learning styles.

In investigating the benefits of classroom technology use and drawing conclusions from 21 teacher interviews, Cuban (2001) noted that certain teachers did make changes to the way they taught in class as a result of using personal computers in an instructional environment:

[F]our said that they now organized their classes differently, lectured less, relied more on securing information from sources other than the textbook, gave students more independence, and acted more like a coach than a performer on stage. In short, they said that in using technology they had become more student-centered in their teaching; they had made fundamental changes in their pedagogy. (p. 95)

Cuban admitted, however, that it was not clear whether the apparent changes in teaching in the classrooms were as a result of the educational technologies themselves or if the teachers developed these skills as a result of a professional's natural evolution and evaluation of personal practice over time. Furthermore, the small sample size of this study made it difficult to make firm conclusions on the impact that technology really had on the teachers' styles.

In Giancola (2001), teachers whose teaching styles were more facilitative, rather than teacher-directed, were often placed at higher levels on the Concerns-Based Adoption Method (CBAM) Levels of Use (LoU) scale when using a particular software program. The teacher facilitators, rather than be pressured to be experts in and demonstrate the program's use, encouraged their students to explore the software and learn on their own. These facilitator teachers often used the program for centers and integrated the centers with current lessons. Teachers who were considered more teacher-centered were most likely to use the program for whole-class instruction, and very seldom had students working on it alone or in small groups. School administration had little effect on the success of the program in schools; regular use was dependant on the teacher's individual style and comfort level.

Sitkins, writing anecdotally about observations made while implementing a 1:1 iPad project at a school, noted a movement in teacher style toward that of a facilitator:

I see teachers learning more each day about what it means to become a facilitator of student learning. I see teachers who understand that students have access to unlimited numbers and types of educational [technology] resources and teachers

that allow students to take more control of their learning. I'm fortunate enough to work with educators that understand our role is more about developing students that know how to learn than it is about filling their heads with rote knowledge. (Sitkins, 2012, para. 5)

According to Daniels et al. (2012), high school teachers in the province of Alberta felt that they had made changes to their teaching practice on account of their technology use in the classroom, believing their lessons to be more interactive and student-centered. Teachers also felt that it was necessary to change their practice in order to make effective use of technology. The researchers noted, however, that although they believed that digital technology had the potential to change teaching practice, in most cases, the changes observed in Alberta schools were either insignificant or unsustainable.

A limited number of studies point to the possibility of technology influencing a teacher's style, however, many of these observations are anecdotal in nature. Next, literature referring to teaching style as a barrier to technology use will be discussed.

Teaching style as a barrier to technology use. A teacher's style may actually act as a barrier to technology integration. It is no surprise that a wealth of research exists on teacher resistance to technology use, and teaching style may be one element of this resistance. Teachers of a certain style may be threatened by technology's ability to shift the focus from the front of the classroom to the outside world via the internet. Today's students can communicate with and learn from experts around the world, and can reinforce classroom learning through online instructional videos that are freely available and designed for specific course areas or outcomes.

It has become common in the literature on teachers' adoption of technology to refer to writings from other disciplines, such as communication (Rogers, 1962, 2003), business administration (Davis, 1989) and organizational change (Fullan, 2001, 2008). Building on these bodies of work from other subject areas, researchers in education have made observations on the reasons for teacher resistance to new technology in the classroom, a phenomenon that has been observed since the advent of the microcomputer in classrooms at the latter part of the 20th century.

Hannafin and Savenye (1993) suggested that teachers in their study resisted technology integration because they may have been threatened by change, may have perceived that their role was less necessary in the face of new technology, or may have had a preference toward the traditional role of the teacher as the "impartor of information" (pp. 26-27). For the Expert or Formal Authority teacher, who has always been the deliverer of the knowledge that students need, this can be threatening indeed. The authors also observed that "earlier reform attempts failed partly because the reformers underestimated the importance of the teacher's role in a classroom with technology" (p. 27). The authors also surmised that "[i]t may be that a teacher is receptive to technology but resists the accompanying change in learning theory" (p. 28). Hannafin & Savenye saw technology as one possible way to bring about a necessary change in the way learning occurred in a classroom, the shift of responsibility toward the learner, rather than solely on the teacher, and felt that a possible reason for the resistance was that society did not want to see education in this new light. They concluded that "[c]hanges in teaching and learning are necessary before changes in technology can be integrated" (p. 30), and suggested that a move toward constructivist teaching could be a solution that

would assist in the proper integration of technology in the classroom. For non-constructivist teachers, this change might be significantly difficult.

In a study conducted by Ertmer (2005), in which the purpose was to “examine the relationship between teachers’ pedagogical beliefs and their technology practices” (p. 27), it was discovered that conditions for proper technology integration were in place, and that “additional barriers, specifically related to teachers’ pedagogical beliefs, may be at work” (p. 36). The goal of this particular project was to find ways in which technology might contribute to student learning and explore research on teacher beliefs, what might be the cause of their beliefs and the conditions that might have to take place in order to change a teacher’s beliefs. The author suggested that teachers make small changes in their pedagogical beliefs first, in order “to achieve high-end instructional goals” (p. 33), but, understandably, asking a teacher to change his or her style is not a small request.

Lucas (2005) concluded that teachers who were resistant to technology use may have been so on the basis that technology did not fit in with their perceptions of themselves and beliefs as teachers. In other words, the barriers to technology use in universities were likely due to intrinsic, rather than extrinsic factors. Using the Grasha Teaching Styles Inventory, Lucas observed that university professors who self-identified as Formal Authority or Experts were less inclined to use technology in a classroom setting. Delegator and Personal Model instructors were more likely to use technology for a variety of purposes, in the classroom, and outside of the context of instructional spaces.

In summary, the addition of technology to a classroom can be seen as a disruption to a teacher’s preferred way of teaching. Although many students, parents, or administrators see technology as a welcome arrival, evidence points to teachers of certain

teaching styles resisting its use. Further research into this area may be necessary to explore these teaching styles as barriers, and to find possible accommodations for them.

Technology as a support to a teacher's teaching style. Digital technology can also be chosen to accommodate an individual's teaching style. There is some evidence to support that certain technologies may be more appropriate for teachers who show a preference toward either a student-centered or teacher-centered instructional style.

Grasha and Yangarber-Hicks (2000), in an article combining Grasha's background in teaching style and how technology might be used as a support, surmised that Expert/Formal Authority teachers may gravitate toward technologies that allow them to instruct remotely, such as through television or online courses. Student computer use in a classroom with a teacher in the Personal Model/Expert/Formal Authority teaching style cluster might be useful because these teachers prefer to coach, guide, or model while teaching. Teachers in the Facilitator/Personal Model/Expert teaching style cluster may prefer software that allows participation among the students, especially simulation software. Finally, Delegator/Facilitator/Expert teachers might desire to use technology primarily to have students research the web individually. The authors recommended that technology be used carefully with these teaching style / learning style connections in mind.

Looking at quantitative studies since Grasha and Yangarber-Hicks (2000), it appears that some researchers are making connections that link certain styles of teaching and the use of technology. For example, in a study that investigated teachers' technology use and constructivist practice, Rakes, Fields, and Cox (2006) found a correlation

between grade four and eight teachers who were already comfortable with technology, and the use of technology to support constructivist learning in their classrooms. These teachers had received training through their district on new technology initiatives. Rakes, Fields, and Cox (2006) also observed a correlation between levels of technology use and teachers' level of constructivist, or student-directed, teaching. However, technology may not necessarily influence a change in teaching style. Palak and Walls (2009) researched whether teachers in a digital technology-rich environment changed their teaching styles to student-centered from teacher-centered paradigms. Despite teachers' existing beliefs in the benefits of a student-centered classroom, the researchers' data indicate that teachers continued to "use technology in ways that support[ed] their already existing teaching approach[es]" (p. 436). In other words, because there was no focus on student-centered pedagogy and technology use in the schools, teachers continued to use digital technology to support a teacher-directed classroom.

If technology does not influence a change in teaching style, there is evidence to support that teachers might select technologies that reinforce their existing styles. Türel and Johnson (2012) observed that grades 6-12 teachers who used Interactive Whiteboards (IWB) in class were satisfied with IWB use and saw them as a useful instructional, educational, and motivational tool. Evidence was found, however, that teachers were not able to create a highly student-centered or collaborative environment using IWBs. Most teachers felt that the IWB made their instruction more efficient, but they were still unable to find time for students to use the IWB, indicating that the tool was largely used by the teachers, as opposed to the students. Survey results in a report by Daniels et al. (2012) indicated that high school students most frequently observed their teachers, rather than

students themselves, using IWBs in a classroom setting. The researchers' own observations noted that teachers made frequent use of presentation software and that most class time was spent in teacher-directed or whole group activities.

It is important to note that not all studies indicate a connection between teaching style (practice) and attitudes toward technology use. Judson (2006) found no statistically significant relationship between self-identified constructivist teachers in primary and secondary schools and their classroom technology use, although, in his literature review, he noted other authors who had found a link (Ravitz, Becker, Wong, & Center for Research on Information Technology and Organizations Irvine CA., 2000). This study also pointed out the limitations of teachers' self-reporting when it comes to teaching style attitudes – although teachers reported a high level of support toward constructivist teaching, classroom observations showed that there was, in fact, less constructivism happening in reality. Judson (2006) did however note that the small sample size in his study made the results less conclusive, but pointed out that other studies that had found contrary results were not based on actual classroom observations. These limitations further illustrate a need for more investigation in this area.

Although sparse, there is some research that indicates a connection between teaching style as a barrier and as a support to technology use. Some literature also supports the possibility that technology can support a teacher's existing teaching style.

Summary

In Chapter 2 we have explored a definition of digital technology, as categorized by Orr and Mrazek (2009) in their *Revised List of Technologies for Teaching*. Summaries

of selected teaching style philosophies demonstrated a variety of ways to categorize a teacher's teaching style, whether personality-based or student achievement-based, with a deeper exploration of Grasha's Teaching Styles Inventory. The literature on the impact of teaching style on students showed that teachers' teaching styles can affect students in a variety of ways, including academic achievement and preferences. Combinations of teacher and learner styles, effectiveness of teaching styles, and other effects on students from teaching styles were considered.

There appears to be some evidence to support the theory that particular digital technologies may have an influence on teachers' teaching styles, thereby causing teachers to gravitate toward certain types of technologies to support their teaching styles or sometimes causing a change in teaching style in teachers. Barriers and supports to technology adoption, specifically pertaining to teaching style, are potential issues.

Finally, the existing university level research in the area of teaching style and technology use indicates the need for this same type of research in the elementary and junior high grade levels. This will better support these school communities in making decisions when integrating digital technologies in classrooms for the benefit of the students.

Chapter 3: Methodology and Research Design

Purpose and Rationale

The purpose of this study was to determine if a correlation could be found between kindergarten to grade nine (divisions I, II, and III) teachers' teaching styles and the frequency and variety of classroom digital technologies used in instructional settings. Survey responses for each teaching style and digital technology type were analysed using bivariate analysis. It was hoped that the information gathered might be useful to school administrators and teachers to better understand how frequently teachers might make use of various digital technologies in an instructional setting, based on their individual teaching styles. Additionally, administrators may be able to predict which teachers would require specialized support during the implementation stage, depending on if their teaching styles were associated with infrequent and less varied technology use.

The null hypothesis was that a teacher's teaching style did not have a significant effect on teachers' frequency and breadth of technology choices for instruction. The independent variable for the study was therefore the teacher's teaching style (Expert, Formal Authority, Personal Model, Facilitator, or Delegator), and the dependent variable was the technology frequency of use and variety of technology categories used by the teacher.

Subjects and Sampling Procedures

The subjects for this study consisted of a sample of kindergarten to grade nine teachers from the overall kindergarten to grade nine teacher population of about 2,400 in a large urban school district in Alberta. Teachers voluntarily responded to the online

survey request. At the time of the survey, the school district consisted of 105 schools in total, 94 of which were eligible for the study (kindergarten to grade nine). Of the 94 schools, 50 included elementary grades exclusively, 36 were designated as elementary / junior high, two were junior / senior high (one included all divisions), and five had strictly junior high students. Out of an estimated total population of nearly 2,400 teachers, it was hoped that over 330 teachers would respond to the surveys in order to obtain a sample size with a confidence interval of 95% with a margin of error of 5%.

To state that the sample has a confidence interval at the 95% confidence level means that there is a 95% probability that the confidence intervals from future samples using the same survey contain the true value of the actual population (population parameter), or that there is a probability of 5% or less that the values obtained occurred by chance. A larger sample size has a higher probability of resulting in values similar to that of the population parameter.

Procedures

Following approval from the Human Subjects Review Committee at the University of Lethbridge in September 2013, and from the school district Educational Research Committee in mid-October, 2013, a request was forwarded by mail to all elementary and junior high principals (see Appendix D: Invitation Letter to Principals) to distribute paper invitations to teachers inviting them to participate in the author's graduate thesis study (see Appendix E: Invitation Letter to Teachers). The letter included a link to an online version of the Teaching Styles Inventory (see Appendix A: Teaching Styles Inventory Version 3.0) and the Technology Inventory (see Appendix C: Revised

Questions for Teaching Style Survey and Technology Inventory). The two questionnaires were administered at the same time in December 2013.

The Teaching Styles Inventory measured the teachers' individual teaching styles in five areas: Expert, Formal Authority, Personal Model, Facilitator, and Delegator; the Technology Inventory determined which technologies for teaching had been adopted by the teacher for instructional use and also for students' use in the classroom. The Technology Inventory also asked teachers to estimate approximately how frequently an individual tool was used.

Instruments and Instrument Reliability & Validity

An essentially unchanged instrument designed by Grasha (1996), the Teaching Styles Inventory was used to categorize teachers' teaching styles, and the Technology Inventory adapted from the Level of Adoption Survey (Mrazek & Orr, 2008) was used to determine technology use.

Teaching Styles Inventory. Teacher participants answered the Grasha Teaching Styles Inventory online, using a series of seven-point Likert-style responses to 40 statements, selecting to which degree he or she agreed with the statement from Strongly Disagree to Strongly Agree. The teachers' responses were tabulated to determine the teachers' numerical scores for each teaching style (Expert, Formal Authority, Personal Model, Facilitator, Delegator). Each of the 40 statements was categorized by Grasha as being part of the philosophy of one of the teaching styles. A strongly disagree earned the respondent a score of one for that statement, while a strongly agree was valued at a seven. The sum of the scores in statements from each category resulted in the teacher being

placed somewhere on the spectrum for each teaching style. Teachers whose philosophies matched the Personal Model style would receive a score closer to seven, however high, medium, and low ranges for each teaching style vary, as determined by Grasha (1996).

For more information, please see Appendix A:

Teaching Styles Inventory Version 3.0.

Grasha's work on teaching and learning styles is often cited in the literature on teaching style. His own research found the Teaching Styles Inventory to have acceptable reliability and validity (Grasha, 1996). LaBillois and Lagace-Seguin (2009) also used the Teaching Styles Inventory in their research and found results "similar to those of Grasha" (p. 308). For more information on the Teaching Styles Inventory, please refer to Achievement-Based Teaching in Chapter 2.

Technology Inventory. Immediately upon completion of the Teaching Styles Inventory, teachers completed a Technology Inventory adapted from the Level of Adoption Survey (Mrazek & Orr, 2008; Orr & Mrazek, 2009). The purpose of the Technology Inventory tool was to better understand the types and frequency of use of technology that teachers had adopted for use in the classroom by themselves and by students. The Level of Adoption Survey was originally developed using the Levels of Use of an Innovation and Stages of Concern from Hall, Loucks, Rutherford, and Newlove (1975), in order to help educators measure their personal level of adoption of technological tools in their professional practice and also to help generate discussion for future use of technology at the school level. The tool was developed to be used at various points of a teacher's career, and has been modified gradually as new digital teaching tools were introduced and others fell out of fashion. The Level of Adoption Survey was not

intended to be used as an evaluative tool (Mrazek & Orr, 2008). Rather, the purpose of the survey data was to show teachers' professional growth over a period of time, especially in the areas of integrating educational technologies (Orr & Mrazek, 2009). Although the Level of Adoption Survey was tested on graduate students (Orr & Mrazek, 2009), the researchers felt that they were not able to make conclusions on reliability due to the self-reported nature of the responses and the low sample size. Orr and Mrazek (2009) attempted to address issues of content validity in the careful design of "accurate and focused descriptors" (p. 6).

Changes made to Level of Adoption Survey. In order to improve internal validity for this study, the Level of Adoption Survey was adapted in a number of ways. First, teachers responded to each category twice to distinguish clearly between the teacher's instructional use and students' class time use of technology. Second, in its original form, the Level of Adoption Survey borrowed Hall's Levels of Use of the Innovation (Hall et al., 1975) to measure teachers' Levels of Use (LoU) on the technology implementation bridge. These eight levels were described as non-use, orientation, preparation, mechanical, routine, refinement, integration, and renewal by Hall et al. (1975). As the LoU do not specifically refer to a frequency of use, they were not considered valid for this thesis' research question, and were instead replaced with a five level Likert-style list. This approach made it possible to measure how often teachers and students used the individual digital technologies in class in a more quantifiable way. Although not specific enough to indicate exactly how many times a tool was used in an instructional setting, the Likert-style responses allowed for a general sense of how often a technology was used in comparison to other tools.

For each question, teachers were asked to respond to the following prompts:

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

The survey questions were worded to indicate flexibility with where the instruction could take place. For instance, in some cases, teachers use a blended style of delivery, such as a “flipped” classroom (where instruction takes place the evening before at the student’s home). In these cases, a learning (or content) management system is often used, thereby extending the “classroom” outside of the physical location. In such a case, the teacher may have assigned instructional videos as homework prior to introducing a new topic and, although taking place at home, this is an instance where a video is being used instructionally to accomplish classroom outcomes. The research question asked which

technologies were being used during instruction, so teachers were not asked to report on how digital technologies were being used during course preparation.

Since some tools were experienced simultaneously by the teacher and the students, the inventory was adapted to measure teacher and student use at the same time for certain questions. These categories included Interactive Classroom Response Systems, Learning Content Management Systems, Large Group Video-Conferencing Technology, and Interactive Desktop Web-Conferencing Technology, and teachers responded in the following manner to these categories:

Students in my classes and I use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

A third change was in the addition of one category to the Revised List of Technologies for Teaching in the Level of Adoption Survey to allow for teachers to respond for use of office suites such as Microsoft Office. Orr and Mrazek (2009) decided to omit this category from their list of technologies as they felt that the use of these tools were typically exclusive to the areas of communication, information, or research, rather than as educational technology tools. The researchers pointed out that this was a possible area of debate. This category was added to the Technology Inventory for this thesis as it was felt that in divisions I, II, and III, sufficient instructional use of these tools merited

their inclusion. Naturally, a case may exist for inclusion of other technologies on this list, since educational technology is a field that changes constantly. For instance, a category was not added for mobile computing devices such as laptops or Chromebooks, since the use of many of the other categories implied the use of mobile computers (e.g. using Video Production Software requires the use of a personal computer).

Finally, a fourth significant difference between the intended use of the Level of Adoption Survey is the manner in which it was administered. The original tool was administered as a series so that teachers could track changes in their Levels of Use over time, but for this study only one survey was conducted. This decision was made for logistical reasons – it ensured teachers’ anonymity in not having to contact them for subsequent surveys – and it was also more suitable for a study in which a sense of the general use of digital technologies was being measured, rather than an increase of technology use over time.

In summary, Grasha (1996) and LaBillois and Lagace-Seguin (2009) found the Teaching Styles Inventory to have acceptable reliability and validity. On account of the above mentioned modifications made to the Level of Adoption Survey, any claims to its reliability or validity made by the authors (Mrazek & Orr, 2008; Orr & Mrazek, 2009) are not applicable for the Technology Survey developed for this thesis, however attempts have been made to make the survey more internally valid for this specific study in the following changes. The Hall et al. (1975) Levels of Use were traded for a Likert-style response in an effort to make the results more quantifiable, the Revised List of Technologies (Orr & Mrazek, 2009) were used as the authors intended, with the addition of a new category, “Office Software Suites”, and instead of multiple administrations of

the survey, only one administration was given to obtain a general sense of teachers' technology use for that time.

Analysis

The teachers' responses to the Technology Inventory were compared to the teachers' teaching styles using bivariate analysis (using JMP statistical software) to see if there was any correlation between certain teaching styles and the frequency and variety of teachers' technology use, thereby answering the research question: Is there a correlation between teachers' teaching styles and the frequency and variety of digital technologies they use in their instructional settings?

The independent variable, teachers' teaching styles, was converted to continuous data using the calculation method developed by Grasha (1996). Each teacher's responses to the forty statements resulted in five scores that fell in between one and seven – each number representing the degree to which that individual identified with that teaching style (Expert, Formal Authority, Personal Model, Facilitator, Delegator). A higher score in an individual style represented a tendency for that teacher to lean toward that style's philosophy, but the styles were not mutually exclusive, in that a teacher might score in the high range for more than one.

The Technology Inventory data, being Likert-style, would typically be classified as ordinal data, because it had categories that fell into a certain order. To facilitate a bivariate analysis, however, each category (Frequently, Often, Sometimes, Occasionally, Rarely) was assigned a number (4, 3, 2, 1, 0), where four represented frequent use and zero indicated infrequent use. The sum of these numbers therefore approximately

represented each teacher's frequency and variety of technology use as an instructor and by the students. A teacher who made more frequent use of multiple technologies in the classroom, by him or herself or by the students, would have a higher score than a teacher who rarely used technology.

The numerical sum of the teacher's Likert-style responses was then used as the y axis, or dependent variable, for the analysis. The bivariate analysis resulted in a Pearson's correlation coefficient, which indicated a positive or negative association between each teaching style and the sum of the teacher's technology frequency and variety of use. A *p* value was also calculated, indicating the probability of obtaining the same results by chance.

Subsequently, the teachers were sorted according to their highest teaching style value, and the average technology score for each of the Technology Inventory categories was calculated. This gave a general idea of whether or not that category was in high use by all of the teachers that were assigned high scores in each teaching style. A list of the technology categories that were used Frequently, Often, and Sometimes was created to see if certain teaching styles could be associated with the use of certain technology types.

Consent

The initial letter to teachers explained that their participation was voluntary. The survey began by explaining that consent was assumed upon the teacher's continuation past the first page. Teachers were encouraged to complete the survey in one sitting, but were also given the ability to withdraw from the survey at any time if they chose to do so. It was explained, at the beginning of the survey, that if the survey was incomplete, it

would not be useable for the study and would be discarded. Due to the nature of the tool used to administer the two surveys (Google Forms), teachers' responses were automatically not collected if the "Submit Responses" button at the end was not clicked.

Anonymity and Confidentiality

The anonymity of the participants was protected. Respondents were notified that only partial anonymity was possible for those that provided their email addresses in order to receive more information following the completion of the study. At the beginning of the survey tool it was communicated that the participants' confidentiality would be ensured, as the data would only be accessible to the author on a password protected account.

Results and Uses of Data

The initial letter to teachers and the online consent form outlined the use of the data from the surveys. It was explained that the results would be used for the author's thesis and may be used in the future in journal articles and public presentations. The data was stored electronically on the author's Google Drive and would be erased within five years of the completion of the study.

Contact Information

The initial letter to principals and teachers included contact information for the author in the event of participant inquiries. Contact information for the author's supervisor was also provided. No other data gatherers or researchers were required.

Summary of Methodology and Research Design

The purpose of this study was to determine if a correlation could be found between kindergarten to grade nine (divisions I, II, and III) teachers' teaching styles and the frequency and variety of classroom digital technologies used in instructional settings. Subjects were volunteer respondents from divisions I, II, and III teachers in the school district. Teachers responded to an online survey consisting of a Teaching Styles Survey and a Technology Inventory. Responses were analyzed using bivariate analysis to compare each teaching style preference with the approximate value of frequency and variety of technology use. Results also indicated whether certain teaching styles used individual technology categories more frequently or not.

Respondents' consent was received by their completion of the survey, and anonymity and confidentiality were maintained. Survey data was to be used for the purposes of the thesis, with the possibility of future scholarly presentations or publication. Contact information for the author and thesis supervisor was provided in the event that a respondent required more information.

Chapter 4: Results

Overview

Approximately 2,300 letters were sent by mail to 96 elementary, junior high, and schools including a combination of K-12 grades in December 2013. The packages sent to schools included an introduction letter to the principal, along with the approximate number of teacher introduction letters required, already printed to facilitate distribution. A follow-up email was sent to the principals to remind them to distribute the handouts to teachers. During the week that the letters were mailed, the city experienced a heavy snowfall, delaying traffic, mail delivery, and several other services in the city. An additional email was distributed to principals later in the week, explaining that the deadline to complete the survey would be extended by an additional week for teachers that might have had a difficult time answering in the allotted time span.

It is not possible to know how many surveys were started and not completed, as the responses were only recorded if every question was completed and submitted on the final page. 61 surveys were completed, representing approximately 2.65% of the total number of eligible teachers for the study. Although the actual number of respondents was fewer than was initially hoped for, analysis was conducted and findings were reported nonetheless, while keeping in mind that the results would not necessarily be as conclusive as in the case with a larger sample size.

Teacher Demographic Information

At the time of the survey, most of the respondents (85% of the total number of teachers) had been teaching between zero and 20 years (*Figure 2. Years of Teaching*

Reported by Respondents.). There was representation from the four quadrants in the city (*Figure 3. Geographical Quadrant of City Reported by Respondents.*) as well as the three grade level divisions (*Figure 4. Educational Division Level of Respondents.*), with only one respondent reporting that he or she also taught in division IV (high school level; since the division categories were not mutually exclusive, respondents were able to indicate that they taught in more than one category). 62% of the teachers identified themselves primarily as general or core subject teachers, 21% identified themselves as specialist subject teachers and 17% identified themselves as administrators. Administrators' teaching loads might range in between 0-90% for assistant principals and vice principals, and a smaller percentage for principals (*Figure 5. Topic Area or Role of Respondents.*), although specific teaching load data was not gathered. 75% of the respondents were female (*Figure 6. Gender of Respondents.*).

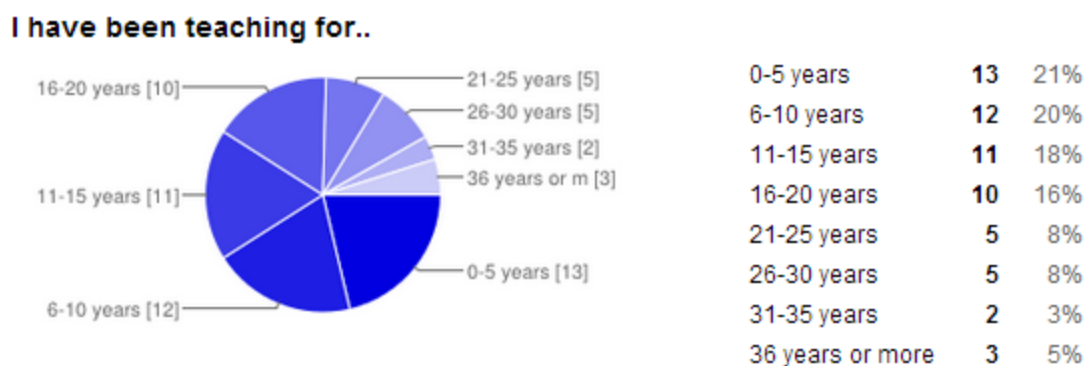


Figure 2. Years of Teaching Reported by Respondents. Graphic generated from Google Forms Summary of Responses.

I teach in the...

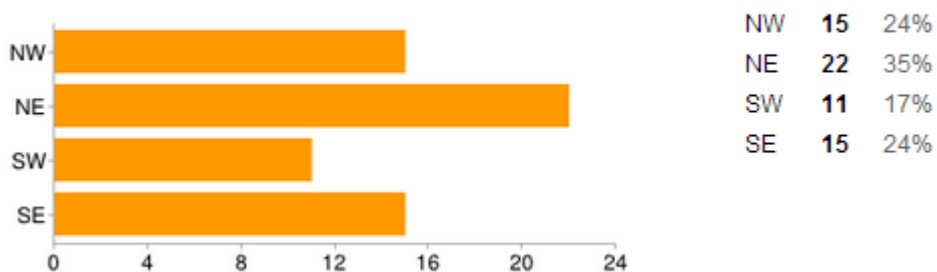


Figure 3. Geographical Quadrant of City Reported by Respondents. Graphic generated from Google Forms Summary of Responses.

I teach primarily in...

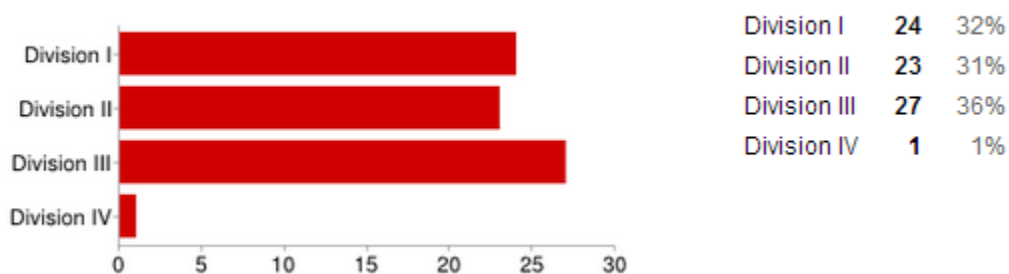


Figure 4. Educational Division Level of Respondents. Graphic generated from Google Forms Summary of Responses.

For the most part, I identify myself as a(n)...

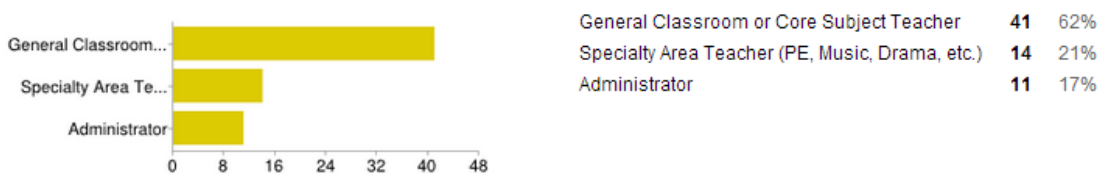


Figure 5. Topic Area or Role of Respondents. Graphic generated from Google Forms Summary of Responses.

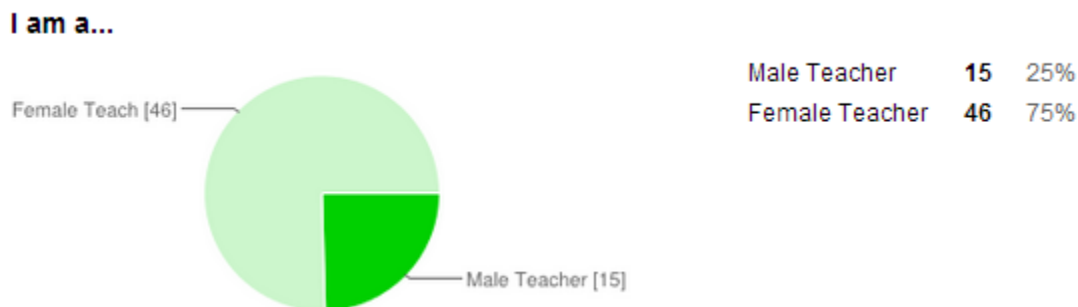


Figure 6. Gender of Respondents. Graphic generated from Google Forms Summary of Responses.

Teaching Styles Inventory Results

Teachers' responses to the survey were calculated using the Teaching Styles Inventory (Grasha, 1996) and teachers were assigned a numerical representation of the degree to which they exhibited each of the five teaching styles. Of the respondents, 25 scored in the high range for Expert (4.9-7.0), one scored in the high range for Formal Authority (5.5-7.0), 20 scored in the high range for Personal Model (5.8-7.0), 43 identified with the high range for Facilitator (5.4-7.0), and 52 scored in the high range for Delegator (4.3-7.0). Again, these scores are not necessarily mutually exclusive, so teachers are able to score in the high range for more than one category.

The range for low, moderate, and high teaching style scores were defined in Grasha (1996) and were also used to identify teachers who scored highly in a given style for this study. For the Teaching Styles Inventory, teachers usually obtain high scores in more than one teaching style category, and may therefore fall into one of the teaching style clusters. All of the teacher respondents for this study received high scores in two categories, but none scored in the high range in three categories. After establishing

teachers' scores in each teaching style category, the scores were then compared with the frequency and variety of technology indicated by the Technology Inventory.

Grasha (1994) identified four teaching style clusters that he observed teachers falling into by scoring in the mid to high range for three styles. Although the school district teachers' teaching style clusters were not used to find a correlation with technology use, the respondents nevertheless could also be categorized into these clusters. Survey responses indicated that 42 teachers received scores that placed them in the Delegator/Facilitator/Expert cluster, 11 teachers scored high in Facilitator/Personal Model/Expert, seven could be identified as Personal Model/Expert/Formal Authority, and only one teacher was able to be classified as Expert/Formal Authority. The decision to not take teaching style clusters into account was based on the methodology used for finding a correlation between teaching style and technology use. For bivariate analysis, continuous data (numerical data on a scale) is required, so a teacher's style must be measured numerically, in this case as a number in between one and seven. Similarly, a continuous numerical data set for frequency and variety of technology use was calculated by using a sum of the reported frequency of use of the various technology categories in the Technology Inventory. The teaching style clusters, although interesting, could not be used to analyze the data in this manner.

Technology Inventory Survey Results

For the survey, teachers identified which technologies they used and their approximate frequency of use on a five point Likert-style scale, where the number four represented Frequently (most classes, or almost every day), three corresponded to Often (many classes, or a few times a week), two was used for Sometimes (some classes, or on

a monthly basis), one represented Occasionally (a few classes a year), and zero was indicated for Rarely or Never (as much as one time a year or less).

In many cases, the decision to use or not use a certain technology category in the classroom was based on availability in the individual teacher's school. For a list of technologies and their approximate availability in the school district, refer to Appendix F: Technology Availability at the School District.

Comparison of Technology Inventory and Teaching Styles

Each numeric value for a teacher's teaching style was compared against the total sum of the frequency of technology use categories for that individual using a fit x by y bivariate model. This model plotted the teaching style value on the x axis (independent variable) and the frequency of technology use value on the y axis (dependent variable). The software (JMP) then calculated a fit line and a density ellipse to show any correlation between the two measurements.

Table 2 shows the teaching style in the variable column, followed by the mean (M), the standard deviation (SD), Pearson's correlation coefficient (r), the p value (p), the "R squared" (R^2) and the sample size (n). The software-generated p value is an indication of the level of chance in the data. A low p value (less than 0.05) is generally considered significant, or that the null hypothesis (in this case, that there is *no* relationship between the teaching style and technology use) is not true (a high p value does not necessarily mean, however, that the null hypothesis is true). Only cases where the p value is lower than .05 are considered significant when reporting possible associations. Positive Pearson's correlation coefficient values indicate that there is a possible influence from the

Table 2.

Bivariate Fit of Sum of Technology Use by Teaching Style

Variable	<i>M</i>	<i>SD</i>	<i>r</i>	<i>p</i>	<i>R</i> ²	<i>n</i>
Expert Level	4.809426	.625253	-.22052	.0877*	.048628	61
Formal Authority Level	4.067623	.648456	-.27248	.0336**	.074244	61
Personal Model Level	5.366803	.588461	-.14542	.2635	.021147	61
Facilitator Level	5.60041	.648544	.431765	.0005***	.186421	61
Delegator Level	4.743852	.630982	.392548	.0018***	.154094	61
Sum of Tech. Use	67.68852	14.68621				

Note. *indicates $p < .10$, ** $p < .05$, and *** $p < .01$.

teacher's teaching style to use technology, whereas a negative association might indicate that teachers of that style prefer not to use technology as an instructional tool. The R^2 value is used to indicate a goodness of fit between the x and y variables; a higher R^2 (closer to one) suggests that the variance in the y variable is described by the variance in the x variable.

Expert technology choices. Technology use was negatively correlated with the Expert teaching style, but a higher p value (.0877) makes this less statistically significant. The R^2 value for the Expert teaching style indicated that only about 5% of the variability in the technology use could be accounted for by this teaching style.

Formal Authority technology choices. Technology use was negatively correlated with Formal Authority teachers, with a significant ($<.05$) p value. An R^2 value of approximately .07 indicated that only 7% of the variation in technology use could be explained by the Formal Authority teachers' teaching style.

Personal Model technology choices. Technology use was negatively associated with Personal Model teachers; a high p value (.2635) made this association less significant than in the other categories.

Facilitator technology choices. A significant positive correlation was calculated between technology use and Facilitator teachers, with an R^2 value of close to 19%. The p value was extremely low in this case at $<.01$.

Delegator technology choices. Similar to the Facilitator teaching style category, there was a significant positive correlation found between technology use and the Delegator teaching style. An R^2 value of just over .15 indicates an approximate 15% explanation for the variation. Again, the p value was extremely low in this case at $<.01$.

Average Technology Category Use by Teaching Style

It is important to keep in mind that teachers typically receive high scores in more than one category of the Teaching Styles Inventory, rather than falling neatly into one category alone. In Table 3, a list of teaching styles is given with the number of teachers that chose each as his or her first, second, third, fourth, and fifth highest score. The digital technology category scores for the teachers' highest teaching styles were averaged in each category to give a general idea of which technologies were being used most frequently (Table 4). The average, based on response numbers from zero to four, indicated a general frequency of use for various technology categories. It should be noted that only two teachers' highest scores were in the Delegator style, only six teachers scored highest as Experts, and no teachers' scores were the highest in the Formal Authority category.

Table 3.

Teachers' Highest Teaching Style Scores for Each Style

Teaching Style	1 st Highest	2 nd Highest	3 rd Highest	4 th Highest	5 th Highest
Expert	6	12	15	24	4
Formal Authority	0	1	4	13	43
Personal Model	16	25	15	4	1
Facilitator	37	9	11	4	0
Delegator	2	14	16	16	13

Overall Technology Use by Category

A general picture of the overall distribution of technology use may be viewed in Table 5. Each technology category is divided into teacher use and student use, where applicable, and the frequency of use (frequently, often, sometimes, occasionally, or rarely) among all respondents is shown as a percentage.

Table 4.

Average Use of Digital Technologies by Teaching Style

Technology Category	Expert	P. Model	Facilit.	Deleg.
Presentation Software (T)	2.5	2.0	1.9	3.0
Presentation Software (S)	1.5	1.4	1.6	2.0
Office Suite (T)	2.3	2.1	2.6	3.0
Office Suite (S)	1.8	1.8	2.2	2.5
Video (T)	2.8	2.9	2.8	3.0
Video (S)	1.0	1.9	1.9	1.5
Concept-Mapping (T)	1.5	1.2	1.8	.5
Concept-Mapping (S)	.3	1.1	1.4	.0
IWB (T)	1.8	3.3	2.8	4.0
IWB (S)	.8	2.2	2.3	3.0
Video Imaging (T)	.0	.1	.6	.0
Video Imaging (S)	.0	.2	.4	.5
Interactive Classroom Response	.8	.4	.9	.0
Visual Image (T)	1.0	.6	1.7	2.5
Visual Image (S)	.5	.6	1.4	.5
Video Production (T)	.7	.2	.9	.0
Video Production (S)	.5	.3	.8	.5
Mobile Devices (T)	1.5	.7	1.6	.0
Mobile Devices (S)	1.7	1.3	1.3	1.0
Learning/Content Management	2.2	2.3	1.3	1.5
Podcasting (T)	.8	.4	.6	.0
Podcasting (S)	.5	.3	.5	.0
Website Development (T)	.0	.1	.5	.0
Website Development (S)	.0	.1	.3	.0
Wiki/Blogging (T)	1.0	.3	.8	.0
Wiki/Blogging (S)	.8	.3	.5	.0
Social Networking (T)	.5	.1	.4	.5
Social Networking (S)	.2	.1	.2	1.0
Virtual Worlds	.0	.0	.1	.0
Gaming (T)	.3	.7	.7	1.0
Gaming (S)	.3	.8	.9	1.0
Video Conferencing	.0	.0	.3	.0
Desktop Conferencing	.0	.1	.1	.0

Note. Averages were calculated for teacher's highest teaching style score. As no teacher scored highest in the Formal Authority category, this column was omitted. Delegator category based on two teachers' results.

Table 5.

Distribution of Technology Types and Overall Frequency of Use

Technology Category	Freque.	Often	Someti.	Occasi.	Rarely
Presentation Software (Teacher)	18%	20%	26%	18%	18%
Presentation Software (Student)	5%	18%	28%	26%	23%
Office Suite (T)	25%	28%	25%	13%	10%
Office Suite (S)	13%	25%	30%	18%	15%
Video (T)	18%	49%	30%	3%	0%
Video (S)	8%	15%	36%	30%	11%
Concept-Mapping (T)	11%	10%	28%	23%	28%
Concept-Mapping (S)	8%	8%	21%	16%	46%
IWB (T)	46%	21%	16%	8%	8%
IWB (S)	23%	18%	28%	13%	18%
Video Imaging (T)	0%	2%	13%	10%	75%
Video Imaging (S)	0%	0%	7%	18%	75%
Interactive Classroom Response	5%	7%	10%	13%	66%
Visual Image (T)	13%	10%	18%	20%	39%
Visual Image (S)	5%	7%	20%	30%	39%
Video Production (T)	0%	5%	16%	18%	61%
Video Production (S)	0%	2%	15%	28%	56%
Mobile Devices (T)	7%	18%	18%	11%	46%
Mobile Devices (S)	8%	11%	25%	18%	38%
Learning/Content Management	21%	18%	7%	11%	43%
Podcasting (T)	0%	0%	21%	10%	69%
Podcasting (S)	0%	0%	13%	15%	72%
Website Development (T)	2%	5%	3%	3%	87%
Website Development (S)	0%	2%	5%	7%	87%
Wiki/Blogging (T)	0%	8%	16%	11%	64%
Wiki/Blogging (S)	0%	5%	11%	7%	77%
Social Networking (T)	0%	3%	5%	10%	82%
Social Networking (S)	0%	0%	7%	10%	84%
Virtual Worlds	0%	0%	2%	0%	98%
Gaming (T)	0%	2%	20%	21%	57%
Gaming (S)	0%	7%	20%	20%	54%
Video Conferencing	0%	3%	0%	8%	89%
Desktop Conferencing	0%	0%	2%	5%	93%

Chapter 5: Discussion

Summary of Findings

The purpose of this study was to determine if there was a correlation between teachers' teaching styles and the frequency of technology use in an instructional setting. As this was a correlational study, the findings cannot be used to imply causation. However, the data seem to suggest that certain teaching styles do correlate with a teacher's frequency of technology use while teaching. Technology use was negatively associated with the Expert teaching style ($p < .10$) and the Formal Authority teaching style ($p < .05$). Technology use was positively associated with the Facilitator and Delegator teaching styles ($p < .01$), but no significant correlation was found between technology use and the Personal Model teaching style.

Expert teachers. Grasha noted that Expert teachers were “concerned with transmitting information and ensuring that students are well prepared” (1996, p. 154). They are primarily concerned with the “facts, concepts, and principles” (Grasha, 1994, p. 147). As school district respondents identified themselves increasingly as teachers using the Expert teaching style, they reported teaching with technology less frequently. Although significant ($p < .10$), the correlation was not as significant as in other teaching styles. Furthermore, the R^2 value suggests that only 5% of the variance can be accounted for by the Expert teaching style. Nevertheless, the findings may have been a symptom of these teachers' desire to move toward a more traditional style of teaching, where the teacher is the center of the classroom. There is little need for the students to access information from other sources, such as websites, when the Expert teacher is able to provide all of the knowledge and expertise required.

Technologies favoured by teachers whose teaching style scores were the highest in the Expert category included Video and Presentation Software, which were used often (many classes, or a few times a week), Office Suites, Learning Content Management Systems, IWBs, and Concept-Mapping Software sometimes (some classes, or on a monthly basis). Their students used Office Suites, Mobile Devices, and Presentation Software sometimes. It should be noted, however, that these results were based on only six teachers, and may not be consistent with other Expert teachers inside or outside of the school district. Nevertheless, it appears that the most frequently used digital technologies listed above show that the teacher's choices lean toward teacher-directed delivery modes, such as classroom videos and PowerPoint presentations. This is supported by findings made by Grasha and Yangarber-Hicks (2000), who noted that, through the use of certain digital technologies, Expert and Formal Authority teachers would "find the information transmission capabilities useful" (p. 6). The students also used Presentation Software, but it was promising to note that the Mobile Devices category was seen more frequently, which shows that, at least sometimes, students in Expert teachers' classrooms might be engaging in activities that are more student-directed.

Formal Authority teachers. As teachers identified themselves increasingly as Formal Authority teachers, they also showed less use of technology in the classroom. Grasha observed that Formal Authority teachers tended to be "concerned with the correct, acceptable, and standard ways to do things," often establishing a "rigid, standardized, and less flexible" classroom environment (1996, p. 154). Formal Authority teachers are "concerned with providing positive and negative feedback, establishing learning goals, expectations, and rules of conduct for students" (Grasha, 1994, p. 143). The negative

correlation was significant ($p < .05$), but the R^2 was only slightly higher than the association noted for Expert teachers (approximately 7%).

The lack of a positive association with technology use in the Formal Authority teaching style, also considered a more traditional style, may suggest that students in these teachers' classrooms were expected to produce work in a manner more consistent with other students in the class, possibly with less differentiation using technology. It may be that these teachers saw technology as a loss of control in the classroom. For instance, when students are using cameras to take photos for a project, a certain amount of mobility is required, and a bit of chaos should be expected as students work in groups and travel around the school or the learning environment.

As no teachers received a highest score in the Formal Authority category, no specific digital technology categories were clearly identified with this style. It should be noted that this does not mean that teachers did not score as Formal Authority teachers at all, only that they scored the highest in the four other categories. One teacher received a Formal Authority score of 5.625 out of seven on his or her Teaching Styles Inventory, a score that is considered a high score by Grasha, but scored even higher in the Expert and Personal Model categories. Several other teachers scored in the moderate range for Formal Authority but, again, received their highest scores in other categories.

Personal Model teachers. Teachers who identified strongly with the Personal Model teaching style did not show as conclusive a fit line with technology use. A small negative association was noted, but the high p value (.2635) made this far less statistically significant than in the other teaching style areas. One of the qualities of a Personal Model

teacher is that he or she tends to demonstrate a mode of thinking or behaviour that the students are meant to emulate. These teachers teach by example and “establish a prototype for how to think and behave” (Grasha, 1994, p. 143). Demonstrations of this type can take place in a variety of modalities, and it seems that Personal Model teachers in the school district are not choosing technology consistently for this purpose. Grasha and Yangarber-Hicks (2000) felt that Personal Model teachers would find digital technology useful in showing virtual demonstrations or in coaching or role-modeling. Nevertheless, it is possible that Personal Model teachers, at least those who responded to this survey, did not use technology themselves, and so they did not demonstrate technology use as an instructional tool.

Personal Model teachers reported being well distributed between the years of experience categories, so the lack of technology use was likely not related to age. Also, it was not the case that Personal Model teachers were completely avoiding technology use, it was simply that the variety and frequency of technology use was more limited. Grasha (1994) noted that Personal Model teachers are known for “[t]he ‘hands-on’ nature of the approach” and “[a]n emphasis on direct observation and following a role model” (p. 143). It seems that the Personal Model teachers in this study did not see technology as an avenue for demonstration, or possibly that there was more of a focus on the teacher demonstrating, rather than the students using, technology, resulting in a lower sum of frequency and variety for these teachers. Digital technology seems like an excellent way to get students actively engaged, typically in a hands-on way, but again, if the Personal Model teacher is not comfortable using technology, then he or she will not model this

behaviour to the students. It is worth noting that there are other ways, besides the use of digital technology, to engage students in their learning.

Teacher respondents in the school district who scored the highest in the Personal Model style used the least amount technology, on average. Personal Model teachers did not use, nor did they have their students use any digital technologies, on average, frequently (most classes, or almost every day). They used the IWBs and Video often (many classes, or a few times a week). Learning Content Management Systems, Office Suites, and Presentation Software were sometimes (some classes, or on a monthly basis) used. Their students sometimes used IWBs, Video, and Office Suites. All other types were used occasionally (a few classes a year) or rarely/never (as much as one time a year or less). These technologies are similar to those listed in the Expert category, and are generally suitable for teacher-directed lessons. The Personal Model teachers' students did seem to use the IWB more frequently than in other styles, and they did have some exposure to Office Suites, which can be a more individual and hands-on activity. However, other more individually engaging technologies do not seem to have been used by teachers of this style.

Facilitator teachers. Teachers who considered themselves Facilitators chose the most technologies overall, on average, and also demonstrated the highest positive correlation with technology use ($p < .01$). The R^2 value was the highest in this category, indicating that 19% of the variance in digital technology use may be accounted for by the teaching style. It is possible that this relatively high use of technology was due to the Facilitator's desire to increase students' "capacity for independent action, initiative and responsibility" (Grasha, 1996, p. 154). Facilitators are known for emphasizing critical

thinking and group discussions; they guide “students by asking questions, exploring options, suggesting alternatives, and encouraging them to develop criteria to make informed choices” (Grasha, 1994, p. 143). It is easy to imagine this type of teacher using technology frequently in a project-based scenario, where concept-mapping software is used in the planning stage, followed by visual imaging capturing technologies, video production software, podcasting, and website development as the avenues for the creation of the student projects. Grasha also identified Facilitators as known for focusing on student needs and goals and for being willing to provide students with multiple avenues for submitting work. Although the Technology Inventory was not designed to gather data on when teachers were differentiating for student needs using different types of technologies, it is conceivable that these Facilitators reported using so many different technology types because they were using digital technologies in this way.

Facilitator teachers typically used IWBs, Video, and Office Suites often (many classes, or almost every day). Presentation Software, Concept-Mapping Software, Visual Image Capturing Technologies, and Mobile Devices were used sometimes (as much as one time a year or less). Their students used IWBs, Office Suites, Video, and Presentation Software sometimes, on average. Looking at the types of technologies used by these teachers, we see some similar categories to those used in other teaching styles, but also more variety. Students were actually using IWBs and Video, rather than just watching the teacher use them, a finding supported by Grasha and Yangarber-Hicks (2000), where it was suggested that Faciliators would find that digital technology could assist in making the students more actively involved. Indeed, based on the results from the sample of

teachers from the school district, the Facilitator's classroom appears to be more actively engaging for the student.

Delegator teachers. Teachers who identified themselves as strong Delegators were also positively correlated with classroom technology use ($p < .01$). The second highest R^2 value was found in this teaching style, at .15, showing that 15% of the variance in technology use may be accounted for by this teaching style. Delegators are noted for encouraging students to become autonomous (Grasha, 1996, p. 154) and, similar to the Facilitator, the Delegator teacher is often more of a resource person, rather than the deliverer of information, as is typically seen in the Expert and Formal Authority styles. Grasha explained that the Delegator has students "work independently on projects or as part of autonomous teams" (1994, p. 143). Certain types of digital technology can be used to support the classroom of the Delegator, with the ability to collaborate easily using shared documents, creating video, and so on. Digital technologies can also be used to allow individuals to work at an individual pace, and therefore more autonomously, with the use of Learning/Content Management Systems.

Only two teachers received their highest scores in the Delegator category. However, it is very interesting to note that *all but two* teachers from the school district respondents scored what Grasha considers to be a high score in the Delegator category (4.3 out of seven). This certainly speaks to how common this style is in use by teachers of the school district, even though it is only a part of the mix with other more dominant teaching styles.

Keeping in mind that that only two teachers are being considered, the teacher-used technologies used included IWB (frequently), Presentation Software, Office Suite, Video, and Visual Imaging Technologies (often). Students used IWB and Office Suite often, and Presentation Software, Video, and Learning/Content Management Software sometimes. Although the bulk of the technology still appears to be have been used by teachers, it was certainly more varied than in other styles, and there was more variety in the types of technologies used by students directly.

Limitations

Sample size. Most importantly, it should be noted that a larger sample size would have been preferred for this study. Although significant p values ($< .05$) were obtained in three of the teaching style categories, the low R^2 values throughout suggest that further research is necessary to make more decisive conclusions on the relationship between teaching style and technology choices. The data were collected from kindergarten to grade nine teachers from a variety of schools in the same district, but a sample size of only 61 teachers is not ideal. It was estimated that there were approximately 2400 teachers at the elementary and junior high levels in the school district that should have received a copy of the invitation to participate in the study; a sample size of about 330 teachers would have provided a confidence interval at the 95% confidence level with a margin of error of 5%. In the case of this study, with a sample size of 61 teachers, the margin of error would be approximately 12%.

Some suggestions for how to increase participation by teachers, based on the lessons learned in this study are the following.

- Include an incentive to encourage teachers to participate, even as simple as a gift card of some value.
- Time the release of the survey to fall within a part of the year that is not too busy for teachers.
- Allow for more time than two weeks for teachers to complete the survey.
- Attempt to release the survey directly to teachers, if possible, rather than rely on principals to forward the survey invitations.
- Have the researcher personally stand in front of teachers to explain the importance of the study, such as through school visits or the like.
- Provide the survey link digitally (although a shortened link was used, typing in the survey link from the paper invitation may have been difficult for some teachers).

A new initiative in the 2013/14 school year at the school district was a weekly newsletter emailed to all teachers through the Instructional Services Department. This avenue was not explored for this thesis, but would have been an effective and economical way to distribute the link in a digital fashion directly to the teachers who were being sought out for participation.

Survey method vs. classroom observations. The data collection method for this thesis, specifically teacher-completed online inventories, was chosen giving careful consideration to the teaching constraints of the author, but an observational method may have been more accurate. Having an observer placed in the classroom, noting the various instances where teachers instructed students using a certain teaching style and how often

they used a particular digital technology might have been a more reliable way to identify teaching styles and frequency of technology use.

Additionally, a survey method may have opened the door to the possibility that teachers responded in the manner in which they were expected to respond in today's educational climate. Because of this, teachers might have had a bias toward certain teaching styles; perhaps evidenced by the greater number of teacher respondents who identified themselves as Facilitators or Delegators, styles that are more commonly identified as student-centered rather than teacher-centered. From the literature, specifically Kirschner et al. (2006), it was reported that teachers and teacher education programs have lately made an emphasis on discovery, rather than teacher-directed methods. School district teachers may have been hesitant to answer that they preferred to teach in Expert or Formal Authority styles, thinking that the expectation was that they use Facilitator or Delegator styles more regularly. A greater number of respondents on the Teaching Styles Inventory for this thesis scored themselves higher in the Facilitator (n=43) or Delegator (n=52) categories, so it appeared that, at least from those that took the time to complete the survey, teachers did not identify as strongly with the Expert or Formal Authority styles. It is entirely possible that teachers today teach in a different style than in previous generations but in an attempt to delimit the possible bias toward currently expected teaching styles, if any existed, it was clearly stated at the beginning of the survey that the results were being collected anonymously and could not be used by the teachers' supervisors to evaluate them in any way.

Also, the technology survey responses were completed by the teachers themselves, and may have suffered from inaccuracies due to bias (a desire to report use of

a certain technology with more frequency because of a perception that its use is expected or more desirable). For example, a teacher may not have used the interactive whiteboard in their classroom with regularity, but when asked, thinking that it should have been used daily, may have indicated that they used it more often than they actually did. It was hoped, however, that by stating that the survey results were anonymous and that principals would not be able to use the information to evaluate teachers in any way that this would be somewhat delimited. Additionally, teachers may not have correctly recalled their actual technology use on account of poor memory or accidental omission.

Finally, whenever a population is conveniently sampled, the possibility of self-selection bias exists. Teachers would have had a variety of motivations to complete this survey. No incentive was given, but the technological nature of the topic may have attracted teachers who were already interested in technology, thereby skewing the data toward more technology use. Additionally, all teachers were selected from the same school district, so conclusions cannot be made for the overall teaching population of the city, the province of Alberta, Canada, or even North America. These factors, in addition to the small sample size, should be kept in mind when considering this sample as representative of the overall technology use of any population of teachers.

Possible power-over relationship. Another conceivable limitation is the possibility that some teachers who responded to the survey were teachers from the school where the author was working as the assistant principal. This could have resulted in a power-over relationship that may have impacted the data, even though the responses were collected in an anonymous manner, in an attempt to delimit this effect.

Available technologies in the School District. There are, and were, a limited number of digital technologies available to teachers in the school district. The school district Information Technology Department recommends that schools purchase equipment from the district's approved vendors so that there is some consistency between schools to lessen the variety of training required for technicians and the Help Desk. However, principals manage their own budgets and can purchase equipment that is not on the approved list if they are prepared to arrange for their own technical support for those tools. As such, not all of the technologies on the Technology Survey would have been available to all teachers at all schools, and so a teacher not using a particular digital technology may not necessarily be an indication of the choice to not use the tool so much as an indication of the lack of its presence.

Technologies commonly in use in the school district school district at the time of the survey included those listed in Appendix F: Technology Availability at the School District. It was assumed that, since there were a variety of digital technologies available, teachers would select and use technologies that supported their individual styles while teaching, but in many schools the technologies listed in the Technology Survey may not have been available as a choice. This study may have been enhanced by including an option for teachers to indicate if a particular technology was not available at the school. This additional information may have provided further insight into the connection between teaching styles and technology choices.

In studies similar to this thesis, some researchers have excluded technologies where the students did not physically use the tool, such as in Lucas (2005), where presentation software was not considered, since the author felt that these types of tools

were often used to replace older technology like overheads. For this thesis, however, these tools were still considered pertinent as their use speaks to the observer about aspects of the teacher's style (i.e. teachers who tend to use presentation software may regularly teach in a more lecture-driven style). Similarly, different technologies may actually lend themselves particularly well to certain teaching styles, leading teachers to select them over others.

Specific use of technologies. Finally, the manner in which the technology was used was not measured in this study. For example, presentation software can be used for more dynamic purposes than to simply "make a presentation"; it is possible to use PowerPoint to make simple animations, for digital storytelling, and probably in many other ways. However, as teachers were asked to self-report on their instructional technology use in general, it was not expected that asking for specific uses over the span of a school year would be accurate enough to make conclusions. For this data to be meaningful, classroom observations over a certain timespan would have been most reliable, but this was not logistically possible for this thesis.

Recommendations for Future Study

One of the specific areas that should be investigated in the future is if teachers prefer certain types of technology over others, based on their teaching styles, and why they prefer these types of technologies. Administrators may also be interested in learning how to encourage Expert and Formal Authority teachers to make more frequent and varied use of technology in their classrooms. The influence of technology on a teacher's teaching style is also of possible interest, as certain technologies may cause a teacher to move out of his or her comfortable teaching style.

Conclusion

After investigating the possible correlation between teaching styles and technology, a few tentative observations can be made. Primarily, a significant positive relationship exists between teachers who were identified as Facilitators or Delegates and the frequent and varied use of technology while instructing students, including more relatively frequent and varied use of digital technologies that were used directly by students. Clearly, technology was being used to support Facilitators' and Delegates' instruction in the classroom. This may have enabled students to be more involved and engaged in an increasingly student-directed environment, but does not necessarily mean that students in classrooms with other teaching styles were not themselves engaged and active in their learning.

The negative relationship between frequency and variety of technology use and teachers who identified as Expert, Formal Authority, or Personal Model seems to indicate less consistent use of technology as instructional tools by teachers of these styles. This supports conclusions made previously by Lucas (2005). It is possible that these teachers were using less technology in the classroom, and were leaning toward the more traditional delivery style that is commonly associated with their teaching styles. What this means for administrators is that, if technology use is an expectation, a teacher's teaching style may dictate, or at least have an effect on, the level of adoption of technology as an instructional tool. School administrators and districts should be aware of this influence and should be ready to support Expert, Formal Authority, and Personal Model teachers by accommodating for their hesitations with using digital technology by leveraging comprehensive professional development, mentorship arrangements, or other methods. A

great deal of the responsibility, of course, rests on the teacher, who should develop a better understanding of his or her personal teaching style and how that style influences his or her choices of digital technologies.

Today's students have an expectation that they will be taught using the digital technologies that are already integral to their lives. Similarly, it is expected that these same tools will be leveraged to deliver curriculum in Alberta to future graduates. Although teachers possess individual teaching styles, they must nevertheless come to terms with the fact that digital technology should be infused into the classroom tools for demonstration, exploration, and to meet the individual needs of students.

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Appendix A:

Teaching Styles Inventory Version 3.0

Respond to each of the items below in terms of how they apply to your teaching, in general. Try to answer as honestly and as objectively as you can. Resist the temptation to respond as you believe you “should or ought to think or behave” or in terms of what you believe is the “expected or proper thing to do.” Use the following rating scale when responding to each item:

1	2	3	4	5	6	7
Strongly Disagree		Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree		Strongly Agree
<i>Very Unimportant Aspect of My Approach to Teaching this Course</i>				<i>Very Important Aspect of My Approach to Teaching this Course</i>		

1. Facts, concepts, and principles are the most important things that students should acquire.	
2. I set high standards for students in this class.	
3. What I say and do models appropriate ways for students to think about issues in the content.	
4. My teaching goals and methods address a variety of student learning styles.	
5. Students typically work on course projects alone with little supervision from me.	
6. Sharing my knowledge and expertise with students is very important to me.	
7. I give students negative feedback when their performance is unsatisfactory.	
8. Students are encouraged to emulate the example I provide.	
9. I spend time consulting with students on how to improve their work on individual and/or group projects.	
10. Activities in this class encourage students to develop their own ideas about content issues.	
11. What I have to say about a topic is important for students to acquire a broader perspective on the issues in that area.	
12. Students would describe my standards and expectations as somewhat strict and rigid.	

13. I typically show students how and what to do in order to master course content.	
14. Small group discussions are employed to help students develop their ability to think critically.	
15. Students design one or more self-directed learning experiences.	
16. I want students to leave this course well prepared for further work in this area.	
17. It is my responsibility to define what students must learn and how they should learn it.	
18. Examples from my personal experiences often are used to illustrate points about the material.	
19. I guide students' work on course projects by asking questions, exploring options, and suggesting alternative ways to do things.	
20. Developing the ability of students to think and work independently is an important goal.	
21. Lecturing is a significant part of how I teach each of the class sessions.	
22. I provide very clear guidelines for how I want tasks completed in this course.	
23. I often show students how they can use various principles and concepts.	
24. Course activities encourage students to take initiative and responsibility for their learning.	
25. Students take responsibility for teaching part of the class sessions.	
26. My expertise is typically used to resolve disagreements about content issues.	
27. This course has very specific goals and objectives that I want to accomplish.	
28. Students receive frequent verbal and/or written comments on their performance.	
29. I solicit student advice about how and what to teach in this course.	
30. Students set their own pace for completing independent and/or group projects.	
31. Students might describe me as a "storehouse of knowledge" who dispenses the facts, principles, and concepts they need.	
32. My expectations for what I want students to do in this class are clearly stated in the syllabus.	
33. Eventually, many students begin to think like me about course content.	
34. Students can make choices among activities in order to complete course requirements.	
35. My approach to teaching is similar to a manager of a work group who delegates tasks and responsibilities to subordinates.	
36. There is more material in this course than I have time available to cover it.	
37. My standards and expectations help students develop the discipline they need to learn.	
38. Students might describe me as a "coach" who works closely with someone to correct problems in how they think and behave.	

39. I give students a lot of personal support and encouragement to do well in this course.	
40. I assume the role of a resource person who is available to students whenever they need help.	

Instructions on Analysis of the Data:

Copy the ratings you assigned to each item in the spaces provided below.

1.	2.	3.	4.	5.
6.	7.	8.	9.	10.
11.	12.	13.	14.	15.
16.	17.	18.	19.	20.
21.	22.	23.	24.	25.
26.	27.	28.	29.	30.
31.	32.	33.	34.	35.
36.	37.	38.	39.	40.

Sum the ratings for each column and place the total in the spaces below.

--	--	--	--	--

Divide each column score above by 8 to obtain the average numerical rating you assigned to the items associated with each teaching style. Place your average rating to the nearest decimal point in the spaces below.

Expert	Formal Authority	Personal Model	Facilitator	Delegator

The teaching styles that correspond to each column are shown above.

Range of low, moderate, and high scores for each style based on the test norms.

	Low Scores	Moderate	High Scores
Expert	1.0-3.2	3.3-4.8	4.9-7.0
Formal Authority	1.0-4.0	4.1-5.4	5.5-7.0
Personal Model	1.0-4.3	4.4-5.7	5.8-7.0
Facilitator	1.0-3.7	3.8-5.3	5.4-7.0
Delegator	1.0-2.6	2.7-4.2	4.3-7.0

Note. Although attempts were made to obtain permission to reprint this material from the publisher, it was not possible to reach Alliance Publishers (International Alliance of Teacher Scholars, Inc.) by phone or email.

Appendix B:

Original Level of Adoption Survey

Ten-level Level of Adoption Matrix

Ø	I don't have enough information about this technology to assess whether or not it would be useful in my teaching.
Ø	I am familiar with this technology but do not think that it would be useful in my teaching.
Ø	I have enough information about this technology to consider whether or not it might be useful in my teaching.
Ø	I am preparing to use this technology in my teaching.
Ø	I am using this technology now in my teaching and I am primarily focused on learning the skills necessary to use it properly and effectively.
Ø	I use this technology regularly in my teaching and my use of this technology is fairly routine.
Ø	I use this technology regularly in my teaching and I am implementing ways of varying its use to improve the outcomes derived from it.
Ø	I am collaborating with colleagues to develop ways in which we can use this technology to better meet common instructional objectives in our teaching.
Ø	I still use this technology in my teaching but I am exploring other technologies to replace it that may better meet my objectives for my teaching.
Ø	I no longer use this technology in my teaching and have replaced its use with other technologies which better meet my objectives for my teaching.

Revised List of Technologies for Teaching

- Presentation Software
- Classroom Video
- Concept-Mapping Software
- Interactive Whiteboard Technology
- Interactive Classroom Response System
- Visual Image Capturing Technologies
- Visual Imaging Technologies
- Video Production Software
- Mobile Devices
- Learning/Content Management Systems
- Podcasting
- Website Development
- Wiki / Blogging
- Social Networking
- Virtual Worlds
- Gaming / Simulations

- Large Group Video-Conferencing Technologies
- Interactive Desktop Web-Conferencing / Bridging Technology

Note. Level of Use Survey used with permission from Dr. Rick Mrazek, University of Lethbridge.

Appendix C:

Teaching Style Survey and Technology Inventory

Consent Section

Correlation Between Elementary and Middle School Teachers' Teaching Styles and Choice of Digital Technologies

You are being invited to participate in a study entitled Correlation Between Elementary and Middle School Teachers' Teaching Styles and Choices of Digital Technologies that is being conducted by Andreas Berko. Andreas Berko is a graduate student in the Faculty of Education at the University of Lethbridge and you may contact him if you have further questions by email (andreas.berko@uleth.ca).

As a graduate student, I am required to conduct research as part of the requirements for a degree in Education (Information Technology Leadership). It is being conducted under the supervision of Marlo Steed, (marlo.steed@uleth.ca or 403-329-2189).

The purpose of this research project is to study teaching styles and teacher technology choices in kindergarten to grade nine classrooms. Research of this type is important because it will help teachers and administrators understand the relationship between a teacher's teaching style and the choices of technologies that he or she makes. It may also assist administrators in predicting when teachers might find it difficult to adopt new digital technologies.

You are being asked to participate in this study because you are a kindergarten to grade nine teacher and you integrate technology in your classroom. If you agree to voluntarily participate in this research, your participation will include the completion of an online survey, outside of instructional time, and at your leisure. Participation in this study may cause some inconvenience to you, including the approximate time of completion, 15-30 minutes. There are no known or anticipated risks to you by participating in this research. It is expected that the results of this study will benefit the state of knowledge in the area of teaching styles and technology use.

As your participation in this study is entirely voluntary, there will be no incentives provided for you to participate. By completing the surveys, you are giving consent. If at any time while you are completing the surveys, you decide to withdraw from the study, you may do so without any consequences or explanation, and your data will not be included in the study. Once you have completed the surveys and you have submitted the final page, it will not be possible to withdraw from the study data, as there will be no way to identify your individual responses.

The researcher may have a relationship to potential participants as he is an assistant principal with the _____ School District. To help prevent this relationship from influencing your decision to participate, your responses will be kept anonymous and confidential and will not be able to be used by your supervisors to evaluate you professionally in any way.

In terms of protecting your anonymity, your anonymity will be preserved, as names are not included in the data collection; the information that will be distributed publicly will not link data to any named individuals. Your data will be stored on the author's password protected Google Drive account, which is accessible only to him. The data will be kept for five years following the completion of the study and then will be deleted or destroyed. Results will be disseminated in the thesis oral defense and paper and at scholarly meetings or published articles, should the opportunity arise.

In addition to being able to contact the researcher and his supervisor using the contact information above, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Chair of the Faculty of Education Human Subjects Research Committee at the University of Lethbridge (403-329-2425).

By clicking "Continue" below and therefore proceeding with the survey, you indicate that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researchers.

Demographic Information

The following information is used only to categorize your responses.

I have been teaching for...

- 0-5 years
- 6-10 years
- 11-15 years
- 16-20 years
- 21-25 years
- 26-30 years
- 31-35 years
- 36 years or more

I teach in the...

- NW
- NE
- SW
- SE

I teach primarily in...

- Division I
- Division II
- Division III
- Division IV

For the most part, I identify myself as a(n)... *

- General Classroom or Core Subject Teacher

- Specialty Area Teacher (PE, Music, Drama, etc.)
- Administrator

I am a... *

- Male Teacher
- Female Teacher

OPTIONAL: For More Information:

If you would like to receive the results of the study, provide an email address in the text box below. Please note that, by providing your contact information, only partial, rather than complete, anonymity can be guaranteed for this study.

Teaching Styles Inventory

The first set of questions is the Anthony Grasha Teaching Styles Inventory. Respond to each of the 40 items below in terms of how they apply to your teaching, in general. Try to answer as honestly and as objectively as you can. Resist the temptation to respond as you believe you “should or ought to think or behave” or in terms of what you believe is the “expected or proper thing to do.”

For each question, please select the item from the pull-down menu that most closely matches your opinion, as a teaching professional:

- 1 represents Strongly Disagree
- 2 represents Somewhat Strongly Disagree
- 3 represents Somewhat Disagree
- 4 represents Neither Disagree or Agree
- 5 represents Somewhat Agree
- 6 represents Somewhat Strongly Agree
- 7 represents Strongly Agree.

While on this page, you may change any of your answers at any time.

1. Facts, concepts, and principles are the most important things that students should acquire.
2. I set high standards for students in this class.
3. What I say and do models appropriate ways for students to think about issues in the content.
4. My teaching goals and methods address a variety of student learning styles.
5. Students typically work on course projects alone with little supervision from me.
6. Sharing my knowledge and expertise with students is very important to me.
7. I give students negative feedback when their performance is unsatisfactory.
8. Students are encouraged to emulate the example I provide.
9. I spend time consulting with students on how to improve their work on individual and/or group projects.

10. Activities in this class encourage students to develop their own ideas about content issues.
11. What I have to say about a topic is important for students to acquire a broader perspective on the issues in that area.
12. Students would describe my standards and expectations as somewhat strict and rigid.
13. I typically show students how and what to do in order to master course content.
14. Small group discussions are employed to help students develop their ability to think critically.
15. Students design one or more self-directed learning experiences.
16. I want students to leave this course well prepared for further work in this area.
17. It is my responsibility to define what students must learn and how they should learn it.
18. Examples from my personal experiences often are used to illustrate points about the material.
19. I guide students' work on course projects by asking questions, exploring options, and suggesting alternative ways to do things.
20. Developing the ability of students to think and work independently is an important goal.
21. Lecturing is a significant part of how I teach each of the class sessions.
22. I provide very clear guidelines for how I want tasks completed in this course.
23. I often show students how they can use various principles and concepts.
24. Course activities encourage students to take initiative and responsibility for their learning.
25. Students take responsibility for teaching part of the class sessions.
26. My expertise is typically used to resolve disagreements about content issues.
27. This course has very specific goals and objectives that I want to accomplish.
28. Students receive frequent verbal and/or written comments on their performance.
29. I solicit student advice about how and what to teach in this course.
30. Students set their own pace for completing independent and/or group projects.
31. Students might describe me as a "storehouse of knowledge" who dispenses the facts, principles, and concepts they need.
32. My expectations for what I want students to do in this class are clearly stated in the syllabus.
33. Eventually, many students begin to think like me about course content.
34. Students can make choices among activities in order to complete course requirements.
35. My approach to teaching is similar to a manager of a work group who delegates tasks and responsibilities to subordinates.
36. There is more material in this course than I have time available to cover it.
37. My standards and expectations help students develop the discipline they need to learn.
38. Students might describe me as a "coach" who works closely with someone to correct problems in how they think and behave.
39. I give students a lot of personal support and encouragement to do well in this course.

40. I assume the role of a resource person who is available to students whenever they need help.

Technology Inventory

You have now completed the first part of the study. The next section is the technology inventory, and will measure the types of digital technologies that you are currently integrating in your instruction while students are learning.

For each question, choose the option that represents your frequency of use for that particular digital tool, in the classroom while instructing students. If you teach multiple subject areas, or if you use different technologies for different subject areas, please answer for the subject area that you most frequently teach, or take an approximate average across all of your subject areas. Although you may use a certain tool outside of class to prepare for instruction, please only consider the technologies that you use to instruct students with, either in the classroom, or virtually (distance learning, for homework, and so on). Take care to note that most questions are two-part: one is for your use of the tool as an instructor and the other part is for the frequency of use that the students experience.

Presentation Software

Such as Microsoft PowerPoint, Prezi, or Apple Keynote.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Office Software Suites (Word Processor or Spreadsheet Software)

Such as Microsoft Word, Open Office, iWork, Google Drive, or Wordperfect Office.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)

- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Video

Such as VHS, DVD, Learn360, YouTube, or other streaming video tool.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Concept-Mapping Software

Such as Inspiration or SMART Ideas.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Interactive Whiteboard Technology (IWB)

Such as the SMART Board.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use this tool to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Interactive Classroom Response System

Such as the SMART Response PE.

Students in my classes and I use this tool to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Visual Image Capturing Technologies

Such as digital cameras or document cameras.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Visual Imaging Technologies

Such as Adobe Photoshop or Corel Photo Paint.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Video Production Software

Such as Windows Live Movie Maker, iMovie, or Adobe Premiere.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Mobile Devices

Such as cellular phones, iPads, iPod Touches, or GPS receivers.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Learning/Content Management Systems

Such as Desire2Learn (D2L) or Moodle.

Students in my classes and I use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Podcasting

ie. Recording or listening to podcasts using digital audio or video devices.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Website Development

*Such as using Dreamweaver or Google Pages to **create** websites.*

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Wiki / Blogging

*Such as using Wikispaces, Blogger, WordPress, or Google Drive to **create** wikis or blogs.*

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Social Networking

Such as Facebook, Twitter, or MySpace.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Virtual Worlds

Such as Second Life.

Students in my classes and I use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Gaming / Simulations

Such as Sims brand games, CD-ROM software games, or other.

I personally instruct classes with these tools:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Students in my classes use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Large Group Video-Conferencing Technologies

Such as Adobe Connect, Skype, iChat, FaceTime, Google Hangout, or other video-conferencing suites.

Students in my classes and I use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

Interactive Desktop Web-Conferencing / Bridging Technology

Such as Bridgit, Blackboard, or ooVoo.

Students in my classes and I use these tools to accomplish course outcomes:

- Frequently (most classes, or almost every day)
- Often (many classes, or a few times a week)
- Sometimes (some classes, or on a monthly basis)
- Occasionally (a few classes a year)
- Rarely or Never (as much as one time a year or less)

FINAL PAGE:

Thank you for your participation, the survey is now over.

The Level of Adoption Survey was used and modified with permission from Dr. Rick Mrazek and Rick Orr at the University of Lethbridge.

Appendix D:**Invitation Letter to Principals**

[Date]

Dear Elementary or Junior High Principal,

I am requesting your assistance with my MEd. thesis, which I am completing through the University of Lethbridge on a possible correlation between teachers' teaching styles and their choices of technology in the classroom. I intend to survey a sample of _____ School District teachers in order to gather data. The actual survey is expected to take in between 15 and 30 minutes to complete.

It is hoped that the information gathered may be used by school administrators and teachers to better understand the types of technologies that teachers might adopt most frequently in an instructional setting, based on their individual teaching styles. Additionally, administrators may be able to predict which technologies will be challenging for teachers of specific styles to adopt during the implementation stage.

If you agree to allow your staff to participate, please distribute, at a time that is convenient for you, the attached letters to your instructional staff at the elementary or junior high level. It is sufficient to hand them out at a staff meeting or to place them in teachers' individual mailboxes by Friday, November 15, 2013, for a survey completion date before Friday, November 29, 2013.

Thank you, in advance, for your assistance,

Andreas Berko
andreas.berko@uleth.ca

Appendix E:
Invitation Letter to Teachers

Dear Elementary or Junior High Teacher,

I am requesting your assistance with my MEd. thesis, which I am completing through the University of Lethbridge on a possible correlation between teachers' teaching styles and their choices of technology in the classroom. I intend to survey a sample of _____ School District teachers in order to gather data. The actual survey is expected to take in between 15 and 30 minutes to complete.

It is hoped that the information gathered may be used by school administrators and teachers to better understand the types of technologies that teachers might adopt most frequently in an instructional setting, based on their individual teaching styles. Additionally, administrators may be able to predict which technologies will be challenging for teachers of specific styles to adopt during the implementation stage.

Responses will be kept anonymous and confidential. The data will only be accessible to the author and will not be used as an evaluative tool by your supervisor. Results will be disseminated in the thesis oral defense and paper; and possibly at scholarly meetings or published articles.

Should you agree to participate, you need only follow the following link and answer the questions by Friday, December 6, 2013: [link to survey]. You should be able to access the survey through any Internet-connected computer's web browser.

Should you have any questions about this study, please feel free to contact me or my thesis supervisor. Thank you, in advance, for your assistance,

Andreas Berko
andreas.berko@uleth.ca
(403) 208-4698

Thesis Supervisor: Marlo Steed, marlo.steed@uleth.ca

Appendix F:

Technology Availability at the School District

Table 6.

Technologies for Teaching Widely Available in the School District

Technology for Teaching	Notes
Presentation Software	PowerPoint was installed on all District computers; Prezi was available as a web-based tool for teachers that chose to use it
Classroom Video	All District teachers had access to Learn360, YouTube, school-based libraries, and an instructional media lending library
Concept-Mapping Software	The District had licenses for SMART Tools and had previously purchased licenses for Kidspiration and Inspiration; online options existed
Visual Image Capturing Devices	All schools had digital cameras and video cameras available, but quantity varied between locations
Video Production Software	Windows Movie Maker was available to all teachers on the standard District computers
Website Development	All District teachers had the option to access to Google Accounts for Education and could use Google Pages with students; junior high and high schools may have had access to other software for related option classes
Wiki / Blogging	All District teachers had the option to access Google Accounts for Education and could use Blogger with students

Table 7.

Technologies for Teaching Available to Most Teachers in the School District

Technology for Teaching	Notes
Interactive Whiteboard Technology	Most classrooms in the District had a SMART Board installed; those that did not have one, usually had an LCD projector in place
Interactive Classroom Response System	The IMC had sets that could be loaned out to teachers and many schools had purchased a few sets to share between teachers at their locations
Mobile Devices	All teachers were assigned a laptop for professional use; most schools had at least one set of laptop computers or Google Chromebooks shared between homerooms; other mobile devices, such as iPads, iPods, and cellular phones were in limited use
Learning / Content Management Systems	All junior high teachers were expected to use D2L with their classes; elementary teachers did not have access to D2L for use with students, except blog
Podcasting	All teachers should have access to recording devices that may be used for podcasting-type projects, which may have included PC computers, Chromebooks, iPads, cassette tape players, and others
Virtual Worlds	Teachers could access virtual worlds by using a web browser and the existing PC computers, but it is not known how common this was
Gaming / Simulations	A variety of games were available to teachers for purchase, but decision to purchase software was up to individual school so not consistent between schools; schools could access a variety of web-based games through their PC computers

Table 8.

Technologies for Teaching Less Commonly Available at Time of Study

Technology for Teaching	Notes
Visual Imaging Technologies	Schools could purchase this software at a significantly reduced rate, but typically only junior highs and high schools made use of it for Career and Technology Studies or other option classes
Social Networking	The District did not provide social networking accounts such as Facebook or Twitter, but was developing policies for their use by schools; teachers had Google Accounts for Education available to them and could use the Blogger feature with students
Large Group Video-Conferencing Technologies	The District had video-conferencing equipment available for schools to borrow; applications such as Skype or FaceTime have had limited functionality on the District network
Interactive Desktop Web-Conferencing / Bridging Technology	These types of software were not commonly used in the District and were not made available to teachers in the standard PC computer image