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The evolution of transformative communication patterns in 1-to-1 computing classrooms

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THE EVOLUTION OF TRANSFORMATIVE COMMUNICATION PATTERNS IN 1-TO-1 COMPUTING CLASSROOMS

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VITA

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ABSTRACT

This research explores the evolution of communication patterns in 1-to-1 classrooms of teachers who vary in their years of experience teaching in these computer-rich classrooms. The context for this study was classroom observations and teacher interviews in 7 Milwaukee public schools during the spring of 2010 where teachers were implementing a 1-to-1 computer program in which every student was given a laptop. The researcher used an explanatory mixed-methods design in which both quantitative and qualitative data were collected. The researcher compared data collected through classroom observations and teacher interviews from 5 teachers in the first year of the program and 6 teachers who had been in the program for 2 or more years. The overall findings suggested a shift from more traditional forms of instruction toward constructivist teaching styles when comparing the 2 groups. The researcher compared classroom organization, technology use, communication patterns, and student identity in the 2 groups of teachers. Teachers with more experience in the 1-to-1 program structured instruction to allow students to work in small groups more often. They also used technology as a tool more often to mediate communication. The research also revealed that when students have ubiquitous access to real-time formative assessments, new forms of student-centered communication patterns occurred. Another finding was that student identity often changes in 1-to-1 computing environments from a passive role to taking on more responsibility, acting as experts, and becoming more engaged in their own learning. Ongoing professional development was found to be an important factor in helping teachers evolve their teaching practices. These positive findings suggest that

communication patterns in 1-to-1 classrooms do evolve toward more transformational forms of communication over time.

Chapter 1. The Problem

Statement of the Problem

In recent decades, globalization and the rapid spread of technology have drastically changed the skills needed to thrive in the workplace. In addition to traditional literacies, including reading, writing, and arithmetic, students will also need what Warschauer (2006) refers to as a new kind of literacy to be able to compete in the emergence of a new global society. According to Wagner (2008), our schools are out of date. Instead of asking our students to be high-level problem solvers, they are often asked to do work that requires low levels of thinking skills. Jobs that use the types of skills that most schools teach are disappearing. Therefore, "A primary challenge for U.S. education is to transform students' learning in and out of school and to engage student interest in 21st century skills and knowledge. Education must align curriculum and learning to a whole new economic model" (Dede, Korte, Nelson, Valdez, & Ward, 2005).

The U.S. Department of Labor (1991) conducted a study called *What Work Requires of Schools: Secretary's Commission on Achieving Necessary Skills*, or the *SCANS report*. The SCANS report outlines 21st century skills that students need to graduate with to succeed in a globally driven economy. The enGauge framework for 21st century skills is based on the SCANS report. The framework divides these skills into four main categories: digital-age literacy, inventive thinking, effective communication, and high productivity (NCREL & The Metiri Group, 2003).

A recent report of the National Center on Education and the Economy (2007, p. 7) describes what the workforce will be like for our students in a global economy:

> A world in which routine work is largely done by machines is a world in which mathematical reasoning will be no less important than math facts, in which line workers who cannot contribute to the design of the products they are fabricating may be as obsolete as the last model of that product, in which auto mechanics will have to figure out what to do when the many computers in the cars they are working on do not function as they were designed to function, in which software engineers who are also musicians and artists will have an edge over those who are not as the entertainment industry evolves, in which it will pay architects to know something about nanotechnology, and small businesspeople who build custom yachts and fishing boats will be able to survive only if they quickly learn a lot about the scientific foundations of carbon fiber composites.

Constructivist, or student-centered teaching environments, are strongly connected to real life (Tobias & Duffy, 2009) and are compatible environments for teaching students 21st century skills. Laptops, especially when every student has one that is connected to the Internet and that can be used beyond the school day, can serve as powerful tools in these types of environments.

1-to-1 computing. If you attend any educational technology conference today, one of the topics you will undoubtedly hear about is 1-to-1 computing. The number of school districts across the country that have implemented 1-to-1 programs in which students have their own laptops that they take home with them and have access to 24/7 is growing rapidly. According to The Hayes Connection & The Greaves Group's (2008) *America's Digital Schools Report*, 27% of school districts in the nation currently have a 1-to-1 computing program in their district, and another 21.9% are planning to implement

a program in the next 3 years. The decrease in hardware prices and the emergence of new devices such as the $100 laptop indicate that the trend of growth in 1-to-1 computing programs in school districts is likely to continue.

A laptop computer, especially when it is connected to the Internet, is a powerful communication device that has the potential to change the teaching and learning process in dynamic ways. As Warschauer questions, "What happens when one of the most disruptive technologies of communalization in history is place in the hands of every student in a classroom, grade or school?" (2006, p. ix). In 1-to-1 classrooms, communication can transcend time and space. Moreover, when every student has his or her own laptop with access to the Internet, new forms of communication are introduced into the classroom setting. In addition, the decentralized nature of the Internet can allow students to participate in larger networks of individuals.

Communication is no longer constrained to a location. Face-to-face instruction occurs in the same place at the same time. Laptops allow asynchronous modes of communication to occur beyond the classroom, transcending time and space. Asynchronous means of communication can give students more time to reflect instead of having to fit responses into face-to-face time constraints. Asynchronous forms of communication can also allow more students to have a voice in the discussion than in traditional classrooms, where students have to raise their hands and take turns to speak.

The decentralized nature of the Internet. Virtual networks have the potential to change student and teacher roles and support new ways for the co-construction of knowledge to occur. The Internet allows users to bypass the kind of hierarchical structure of traditional classrooms and engage in collective forms of knowledge building. The

decentralized nature of the Web supports distributed models of learning in which all can share expertise and knowledge. Tools such as wikis allow users to collaborate and create content together through shared knowledge structures. Through these web-based vehicles, information can be shared in nonlinear ways.

Technology can allow for a larger network of individuals and thus can make it easy for groups with similar interests to self-organize and have meaningful interaction around a shared practice. Zhao (2007) stated that the "Internet now demands that everyone become an author, just as Gutenberg Press demanded that everyone become a reader." Web 2.0 applications, such as blogs, wikis, and podcasts, are tools that can make student work much more public and authentic. These tools can give students a public voice and power and can legitimize them as experts.

New communication options and traditional teaching styles. Traditional teaching styles and the corresponding communication patterns may be in conflict with the new forms of communication that ubiquitous access to the Internet can provide. Figure 1 shows a diagram of communication patterns in traditional classrooms, while Figure 2 shows communication patterns that are possible with ubiquitous access to the Internet. Distributed learning and collective knowledge-building activities may conflict with traditional styles of teaching in which information is passed down from one central authority. For example, Internet use has the potential to decentralize power and authority, which can challenge traditional styles of teaching in which the teacher is seen as the expert and the main disseminator of information. Additionally, ubiquitous access to the Internet makes it easier to share expertise: increased access to social networks can allow

students to participate in larger communities of practice, resulting in the flattening of hierarchical relationships in the teaching and learning process.

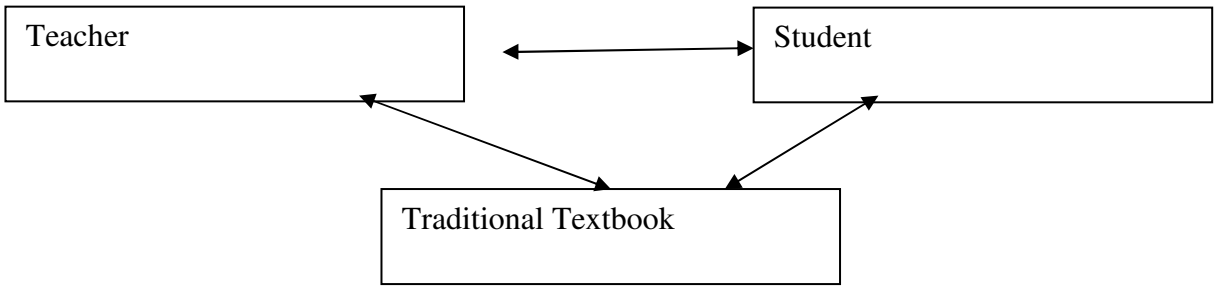

Figure 1. Traditional communication patterns.

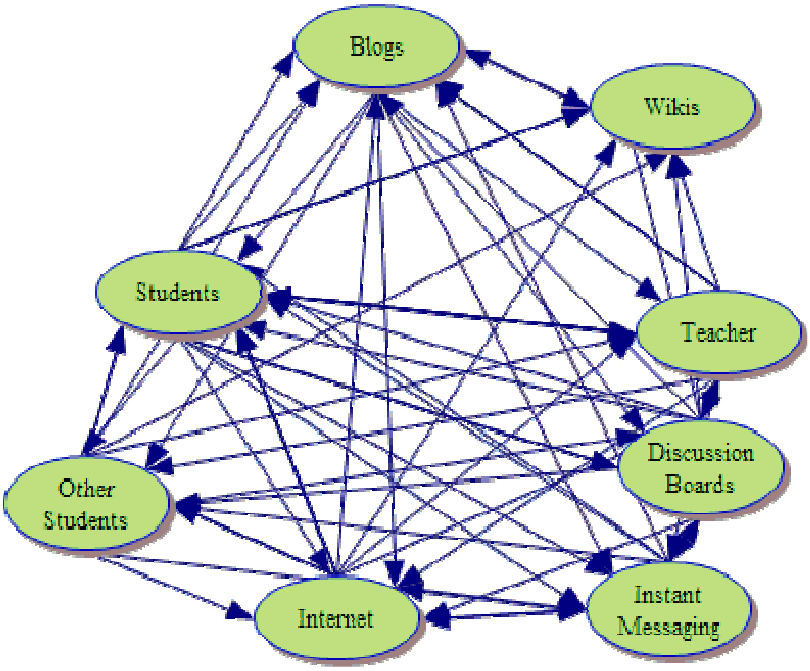

Figure 2. New communication patterns possible with the Internet.

One possible reaction is for teachers to actively work to shut down the technology that is competing with their traditional teaching methods. Interviews of leaders have suggested that the failure of 1-to-1 programs is because the computer is not a good fit with the communication patterns and pedagogy the classroom teacher is using.

Administrators of an unsuccessful 1-to-1 program in New York made the following comments: “The teachers were telling us when there’s a 1-to-1 relationship between the student and the laptop, the box gets in the way. It’s a distraction to the educational process” (Hu, 2007).

However, it might not have been that the laptops were the distraction to learning so much as that the ubiquitous student access to the Internet provided new communication opportunities that conflicted with traditional teaching methods. Studies on 1-to-1 computing show that educators often change their traditional teaching roles into new roles as facilitators, co-learners, collaborators, and designers of constructivist learning experiences in the classroom (Ashmore, 2001; Grant, Ross, Wang, & Potter, 2005; Light, McDermott, & Honey, 2002; Rockman, 2000; Russell, Bebell, & Higgins, 2003; Sargent, 2003). As teachers change their teaching practices, the communication styles used in the classroom environment change as well.

Why More Research on 1-to-1 Computing Is Needed

Often stakeholders in school districts choose to implement 1-to-1 programs with the hopes of increasing student achievement, eliminating the digital divide, and preparing students for the 21st century. These programs are often described as if the mere presence of laptops will allow these dreams to become a reality. However, many 1-to-1 programs do not survive over time. Most of the programs in the Microsoft initiative were not sustainable. Unfortunately, the program had little documentation to help us better understand why.

Most research on 1-to-1 computing is evaluative and has not been peer reviewed. Factors affecting technology integration in schools “are often examined in isolation of

each other or the system in which they interact" (Zhao & Frank, 2003, p. 6). Often the research focuses on studying independent variables such as the availability of new technology, frequency of use, and attitudes toward technology. More research on how 1-to-1 laptops affect instructional practices and the factors that influence them is needed.

While some studies have shown that teacher practices often evolve into more constructivist forms of teaching over time in 1-to-1 environments (Ashmore, 2001; Bebell, 2005; Fairman, 2004; Rockman, 2000), very little research helps us better understand why and how practices evolve. One cannot study communication patterns without also looking at the cultural context of where the communication occurs. To study why certain communication patterns exist, it is necessary to look at the roles participants play as well as their social and cultural norms. As communication theorist Carey (1989) points out, "Culture, in part, determines the kind of communicative world we inhabit" (p. 32). Therefore, the context in which the communication occurs is very important to consider.

In a classroom, the teacher has the biggest impact on the classroom environment. Accordingly, communication patterns are intertwined with a teacher's belief system about teaching and learning. A teacher's belief system, or pedagogy, influences the instructional decisions and patterns of communication he or she uses with students. Stallings and Kaskowitz (1974, p. 1) continue the discussion of the role of communication in the classroom:

> Very little systematic information is available regarding those elements in the classroom that significantly affect child behavior and achievement. Much of what goes on in the classroom—for example, the extent and nature of pupil-teacher

> interactions, the emphasis of specific program elements and approaches, the effects of teacher attitudes and methods—is largely based on intuition or best guesses of what seems to work, rather than based on the results of systemic analysis.

While quantitative data can be collected on the frequency and types of communication patterns used in a classroom setting, these data are insufficient alone to understand how teachers evolve their communication styles. Qualitative data are also needed to explain and build on the initial quantitative results collected in this study.

Purpose Statement

The purpose of the study is to better understand how communication patterns in 1-to-1 classrooms evolve over time. The design of the study is an explanatory mixed-methods approach. The study involved collecting qualitative data after a quantitative phase. Additional qualitative data are needed to add more depth and understanding on what factors contribute to observed changes in communication patterns. In the first quantitative phase of the study, classroom observations were conducted in sixth-grade 1-to-1 classrooms in Milwaukee Public Schools to measure the frequency of transformative communication patterns being used. Classrooms of teachers in their first, second, and third year of the program were observed, and data were analyzed to see whether communication patterns differed based on how long teachers have been in the program. Evidence suggests learning gains were made in these classrooms. In the first year of the program, sixth graders of the teachers participating in professional development had higher mean aggregate local benchmark assessment scores than students of non-participating teachers (Stephens, 2007). In the second year of the program, students in the

program showed greater gains in math from the beginning to the end of the year on aggregate mean local benchmark scores than students of non-participating teachers (Stephens, 2008). However, this study did not focus on explaining learning gains. Instead, it focused on the communication patterns that might explain these gains.

The purpose of the qualitative phase of the study is to understand factors that contribute to the evolution of communication patterns in 1-to-1 classrooms. In this exploratory follow-up, communication patterns in 1-to-1 classrooms were explored with teachers of the 1-to-1 classrooms observed in the quantitative part of the study. The researcher interviewed the teachers whose classrooms were observed. The reason for the exploratory follow-up was to better understand the underlying factors related to the communication patterns recorded in the initial quantitative part of the study.

Research Questions

The study sought to answer the following research questions:

1. Are communication patterns in 1-to-1 classrooms that have existed for 2 or more years different from 1-to-1 classrooms that have existed for a shorter amount of time?
2. If so, how are they different?
3. What factors in 1-to-1 classrooms affect the communication patterns being used?

Context of the Study

The study took place in the Milwaukee Public School District. The Milwaukee Public School District is the 30th largest school district in the nation and the largest school district in Wisconsin, with students from diverse racial, ethnic, and cultural

backgrounds. In 2008–09, Milwaukee served 85,369 students with about 13,000 total staff in over 200 locations. Current district demographics reflect the following student diversity: 57.0% African-American, 22.5% Hispanic, 11.9% White, 4.6% Asian, 0.8% Native American, and 3.1% other Non-White. Within the student population, 18.6% were identified with special education needs and 7.9% with limited English proficiency. As an indicator of the number of children living in poverty, 78% of the students districtwide are eligible for a free or reduced price lunch: 64 schools in Milwaukee Public Schools had rates of 90% or more, and nearly 60% of all school sites had rates of 80% or more.

In 2007, the district initiated a 1-to-1 program in sixth-grade classrooms in seven schools. Twenty-one teachers participated in the program. Schools were chosen based on based on Schools Identified in Need of Improvement (SIFI) status, low academic achievement, free and reduced lunch, special needs students, English language learners, and identified staff development needs in the areas of technology integration and literacy. Teachers met monthly for 9 full days of professional development. The following year, four more schools were added to the program, and 14 teachers attended 9 days of professional development along with teachers who continued in the program from year 1. This year, six more schools were added, and 37 more teachers were added to the program. Only four teachers (three regular education and one special education) have remained in the program for all 3 years. The other teachers have been promoted to technology literacy specialists, technology integration specialists, or math literacy coaches or have moved to other grade levels to help improve student achievement.

The researcher observed classrooms in which the teachers were involved in the 1-to-1 computing program for more than 2 years and classrooms in which teachers were in

their first year of implementation. All of the classrooms observed were sixth-grade classrooms.

The quantitative part of the study consisted of the researcher using an observation checklist and coding communication patterns that have been identified by the literature at 5-minute intervals. The researcher also collected qualitative data by interviewing the teachers of the classrooms observed to better understand the social and cultural dynamics that affected the communication patterns used in their classrooms.

Significance of the Study

This study is significant because it will provide the educational community with a better understanding of communication patterns that exist in 1-to-1 computing classrooms that support learning and how these patterns evolve. This is important because learning theories suggest that transformational communication patterns support deep learning. Findings from the study can help educational decision makers understand how 1-to-1 programs can influence the teaching and learning process. Data collected from the interviews may also reveal factors that help transformative communication patterns evolve. Knowledge of these factors will help the growing number of educational leaders trying to implement these programs in their schools. Leaders implementing these types of programs can work hard to ensure that factors that help the evolution of positive communication patterns are present. The study will also help decision makers calculate how long it takes for changes in teaching and learning to occur and what types of support systems need to be in place to help teachers successfully implement a 1-to-1 program.

The study will also help stakeholders in Milwaukee Public Schools better understand the factors that led to teachers changing their instructional practices. This information will help them replicate the program in other district schools.

Limitations of the Study

While all of the schools participating in the study were from the same school district, the socioeconomic status of each group is slightly different. One of the considerations the district used for choosing schools for the 1-to-1 program was socioeconomic status and student achievement on standardized tests. Therefore, there were slight differences in socioeconomic status and previous student achievement scores among the groups.

The study did not observe the same teachers over time but rather different teachers at a similar time. The interview questions focused on change over time, but they elicit recollections subject to memory reconstructions. Most importantly, teachers who joined the program in later years had the benefit of learning and receiving curricular resources from teachers who had been in the program for longer amounts and were willing to share what they had learned.

The design of the study was exploratory, and it may be difficult to generalize the findings beyond the schools involved in the study. A limitation of the study was that it focused solely on communication patterns without linkages to student learning outcomes. However, other studies have suggested links to learning outcomes. Another limitation was that participants volunteered to be in the study and may not fairly represent the pedagogical makeup of the entire group of teachers who participated in the 1-to-1 program.

Conclusion

The purpose of the study was to better understand the evolution of communication patterns in 1-to-1 classrooms over time. The study was an explanatory mixed-methods design in which both quantitative and qualitative data were collected. The purpose of the qualitative data was to better explain quantitative findings for the following questions:

1. Are communication patterns in 1-to-1 classrooms that have existed for 2 or more years different from 1-to-1 classrooms that have existed for a shorter amount of time?
2. If so, how are they different?
3. What factors in 1-to-1 classrooms affect the communication patterns being used?

More research on the impact of 1-to-1 computing on the teaching and learning process is needed. Results of the study will be helpful in informing leaders of the educational community and stakeholders in Milwaukee Public Schools whether communication patterns in 1-to-1 environments change over time, and if so, what factors contribute to these changes.

Chapter 2. Literature Review

Introduction

The study's purpose was to find out whether transformative communication patterns increase over time in 1-to-1 computing environments. Although there have been studies on communication patterns in classrooms, there has not been a study on communication patterns in 1-to-1 computing classrooms. Likewise, a number of studies have produced findings that teacher instructional practices in 1-to-1 environments often change into more constructivist forms of teaching over time. However, most of these studies have not examined the factors that contribute to these changes.

The review of the literature is divided into four sections. Part One identifies the literature on communication patterns in classrooms and the impact of these patterns on learning. Part Two examines the literature on the relationship between classroom communication patterns and teacher pedagogy and how these patterns affect the learning environment. Part Three looks at the literature on teacher practices in 1-to-1 environments and how these practices often change over time. Part Four examines the literature on factors that have been shown to help teachers evolve their teaching practices into more constructivist learning environments.

Part One: A Review of the Literature on Communication Patterns and the Impact on Learning

Part One examines the literature on communication patterns often present in K–12 classrooms and the impact of these patterns on student learning. Research on how teacher-questioning patterns affect student learning is examined (Evertson, Anderson,

Anderson, & Brophy, 1980; Good & Grouws, 1979; Stallings & Kaskowitz, 1974). In addition, research on communication patterns that have been shown to help build student understanding and knowledge are also reviewed (Pea, 1994; Scardamalia & Bereiter, 1994).

Research studies on teacher questioning patterns. The literature shows that teacher questioning patterns are important in helping students learn new material. Good & Grouws (1979) found that less effective teachers asked fewer questions. Likewise, Stallings & Kaskowitz (1974) found that more effective teachers asked more questions.

Process communication patterns include simplifying the question, providing hints, or reteaching the material. Good & Grouws (1979) found that more effective teachers asked process questions or gave feedback when students made an error. Less effective teachers were more likely to simply provide students with the answer.

A study conducted by Hiebert & Wearne (1993) compared two types of classroom instruction in second-grade math classrooms. They found that students in the treatment group performed better than those in the traditional classroom in the comparison group. Students in the treatment group solved fewer problems and spent more time with each problem, were asked more questions in which they had to describe and explain alternative strategies, talked more using longer responses, and showed higher levels of performance or gained more by the end of the year on most types of items than students in the traditional classrooms in the comparison group.

Transformative communication patterns. Pea (1994) identified another type of communication pattern, which he calls *transformative communication*. Pea defines transformative communication as occurring whenever learning is transformed through

communication processes. Scardamalia and Bereiter (1994) refer to this as *knowledge building discourse*. In transformative communication, meaning is established through a highly interactive process in which all classroom participants, both students and teacher, have the opportunity to create shared meanings of concepts together.

First and second order communication patterns. Scardamalia and Bereiter (1994) identified two other types of communication patterns that they refer to as first and second order communication. Learning environments that use first order communication patterns have relatively stable systems and routines. Students writing a traditional report for a teacher on an assigned topic would be an example of a first order communication pattern. Students creating a blog and having others comment on it would be an example of a second order communication pattern. Environments that use second order communication patterns are transformative because they are dynamic and require participants to change. This is because second order communication patterns involve a broader community in which expertise is continually being shared, which disrupts traditional systems and routines. As the network's collective knowledge increases, members have to change and adapt. Because participants in second order communication are part of broad social networks, they are forced to consider ideas from multiple perspectives.

Part Two: The Relationship Between Teacher Pedagogy and Classroom Communication Patterns

A teacher's pedagogy, or belief system about the teaching and learning process, affects communication patterns within the classroom. Part Two of the literature review examines transmission and constructivist pedagogy and how they differ in terms of

communication patterns used. Part Two of the literature review also examines teacher and student roles in the classroom and the amount and type of teacher guidance given. Part Two also describes how constructivist educators use specific communication patterns to elicit meaning and create shared understandings with their students. Finally, learning theories that support the social aspects of constructivism are also reviewed.

Predominant pedagogical practices in American classrooms. Two predominant pedagogies have been used within American classrooms: transmission pedagogy and constructivist pedagogy. In the transmission model of learning, students play the role of passive recipients of information while the teacher disseminates information to them (Pea, 1994). In constructivist pedagogy, students co-construct meaning through social activity (Becker & Riel, 2000). Teachers assist students in constructing new meaning by helping them build on their pre-existing knowledge. Table 1, created by Sandholz, Ringstaff, and Dwyer (1997), outlines the differences between transmission and constructivist teaching styles.

Table 1

Activities in Transmission and Constructivist Classrooms

	Transmission Pedagogy	Constructivist Pedagogy
Classroom Activity	Teacher-Centered Didactic	Student Centered Interactive
Teacher Role	Fact Teller Always Expert	Collaborator Sometimes Learner
Instructional Emphasis	Facts Memorization	Relationships Inquiry & Invention
Concept of Knowledge	Accumulation of Factions	Transformation of F acts
Demonstration of Success	Quantity	Quality
Assessment	Multiple-Choice Items	Portfolios and Performances
Technology Use	Drill & Practice	Communication Collaboration, Information

Transmission pedagogy. Educators who subscribe to transmission pedagogy believe their students can learn by having information presented to them. In transmission classrooms, teachers try to help build student understanding of content by focusing on visible demonstrable skills, such as the ability to recall facts. Students often demonstrate understanding through linear communication styles, such as having students raise their hands to answer a question with a predetermined correct answer.

History of transmission pedagogy. Transmission pedagogy became prevalent during the industrial revolution. The transmission model of education replicated the factory model of producing goods. In transmission pedagogy, curriculum is fragmented into parts and time. Thus, in transmission classrooms, there are few linkages between curriculum and the student's real life. As a result, assessments in transmission classrooms are typically unrelated to real-world performance (Caine & Caine, 1997).

Communication patterns often present in transmission classrooms. Pea (1994) calls teachers who use the transmission model of communication *broadcasters of information*. The typical communication patterns in transmission classrooms use linear, one-way forms of communication. For example, the teacher may present information, followed by a discussion in which students are expected to demonstrate reception by giving back the information in response to key questions. The typical pattern is that the teacher asks a question, and students who think they know the answer raise their hands. Next, the teacher chooses one student to answer the question. The teacher then evaluates the answer and decides whether to do another round of questioning. The "questions are premised on known answers and teacher driven activity" (Polman & Pea, 2001, p. 1). Mehan (1978) defined this type of questioning pattern as the reply evaluation pattern

(REP). Over time, this pattern is played out over and over until it becomes a cultural norm (Vygotsky, 1978).

Teacher and student roles in transmission environments. Communication has social and cultural dimensions. The social aspects of communication have to do with the relationships between the people communicating and the roles that they play. Communication theorists associate the transmission model with power and exerting control (Carter, 2003; Ellul, 1964; Freire, 1970). Relationships between teachers and students in classrooms where the teacher subscribes to transmission pedagogy are hierarchical. The teacher is at the top of the hierarchy and plays the role of the expert, resulting in an imbalance of power between the teacher and student in the learning process. Consequently, in transmission classrooms, there is typically "minimal interactivity" between students (Pea, 1994, p. 286).

Constructivist pedagogy. Constructivism is a type of learning theory in which the learner acquires knowledge by actively working to construct meaning in the world around them. Constructivists view learning as an active process on the part of the learner, not a "passive process of information absorption" (Kintsch, 2009, p. 234). Learners "construct essential information for themselves rather than being presented with information" (Sommerfeld Gresalfi & Lester, 2009, p. 266).

History of constructivism. Manus (1996) links the beginnings of constructivism to Socrates. Socrates asked his students directed questions to help them evaluate their thinking. von Glasersfeld (1989) attributes the first constructivist theory to Vico, who lived during the early 1700s. Vico suggested that knowledge had to be constructed by the individual learner.

Jean Piaget and John Dewey contributed to constructivist learning theory through their work on child development. Piaget proposed that humans' conceptual abilities progress in stages of conceptual development until they reach the ability to engage in abstract thought. Dewey suggested that the educational process should be tied to real experiences that are socially constructed.

> As formal teaching and training grow in extent, there is the danger of creating an undesirable split between the experience gained in more direct associations and what is acquired in school. This danger was never greater than at the present time, on account of the rapid growth in the last few centuries of knowledge and technical modes of skill. (Dewey, 1916)

Resnick (1987) furthered this notion by observing how learning is situated in the real world versus how it is often separated from real-world experiences in school. Resnick observed that in real life learning is often a socially shared experience instead of the isolated experience it often is in school. Her research also noted that learners outside of school often use cognitive tools to help them learn.

Vygotsky (1978) contributed to constructivist learning theory by claiming that all learning is social. For example, when children learn to speak, they are surrounded by experts who provide feedback and correction as they are learning. Lave and Wegner's (1991) work builds off Vygotsky's social learning theories through their community of practice model. In communities of practice, experts welcome and interact with individuals new to the practice who are on the community's periphery. As newcomers join and interact with the community, their identity changes as they gradually become more involved and eventually become full participants in all of the community's core

activities. The works of these social learning theorists seem to indicate that teachers will learn new teaching strategies when they are given opportunities to collaborate and form communities of practice together. This idea was supported a study conducted by Windschitl and Sahl (2002) on how teachers learn technology best. They found that teachers learn best when they are given opportunities to co-construct knowledge of how to integrate technology into the curriculum together. Lei, Conway, and Zhao (2008) found that teachers' technology use is directly influenced by the extent of their social connections. Teachers who are more socially connected are more likely to share resources, support one another, find technical support, and put positive peer pressure on one another to change.

Teacher guidance in traditional and constructivist classrooms. Kirschner, Sweller, and Clark's (2006) research revealed that teacher guidance is important in learning. Mayer (2004) found that guided discovery resulted in deeper learning than discovery learning. Kirschner et al. (2006) feel that constructivist pedagogy has minimal guidance from the teacher. However, many constructivist learning theorists, such as Lampert (1998, 2001), McClain (2000), and Schifter (2001) disagree with the assertion that constructivist educators do not provide guidance to their students. As Kintsch (2009) explains, "The tendency has been to lump all these methods (discovery learning, inquiry, constructivism) under the term 'constructivism' and hence to identify constructivism with minimal guidance in instruction" (p. 224). However, in true constructivist classrooms, there is significant teacher guidance, often through meaning-making discussions and questioning strategies.

Transmission and constructivist pedagogy differ in the nature and type of support

teachers provide to their students (Sommerfeld Gresalfi & Lester, 2009; Spiro & DeSchryver, 2009). In transmission classrooms, teachers present students with information. However, in teaching subjects such as creative writing, which requires deep thinking beyond rote memorization of facts, the type of support required is highly personal and different from what a student would receive in direct instruction (Spiro & DeSchryver, 2009).

Constructivist educators often provide students with "feedback, prompts and supports" (Spiro & DeSchryver, 2009, p. 119) as well as ask "questions, prove, redirect and offer explanations" (Sommerfeld Gresalfi & Lester, 2009, p. 267). Teachers in constructivist classrooms try to elicit student thinking on how to solve problems (Sommerfeld Gresalfi & Lester, 2009). Sommerfeld Gresalfi & Lester (2009) call this type of guidance provided by the teacher *intentional guidance*.

How constructivist educators elicit student meaning and shared understandings. Communication is a reflexive process whereby meaning is constantly being reflected back as it is held up to other's beliefs and then changed or transformed through the process (Carey, 1989). Carey further defines communication as "a symbolic process whereby reality is produced, maintained, repaired, and transformed" (p. 23). Graeme Osborne described this when he said, "All human communication represents some kind of exchange with reciprocal effects on everybody involved" (Dwyer, 1999). In other words, communication is an interactive process in which all of the participants have the opportunity to change their belief systems.

In constructivist environments, students act as meaningful participants instead of passive recipients (Polman & Pea, 2001, p. 226) and are seen as legitimate partners in the

knowledge-creation process (Scardamalia & Bereiter, 1994). One way constructivists do this is to support student learning by engaging students in discussions aimed at creating shared definitions of concepts being studied (Sommerfeld Gresalfi & Lester, 2009). Rommetveit (1979) refers to this as *shared situation definitions*. In constructivism, the "work of generating explanations is done by the students" (Sommerfeld Gresalfi & Lester, 2009, p. 279). The teacher uses the students' existing knowledge about a subject to help negotiate a new shared meaning based on shared guided activity. In these exchanges, new meaning is co-developed, and both the teacher and the students are changed or transformed. "Even among constructivists there is often lack of recognition that such communicative interchanges transform not only the child, but the expert in the communicative system—the teacher" (Pea, 1994, p. 289). For students to construct meaning from their experiences, the teacher needs to engage students in highly interactive communication patterns designed to allow participants to explain their thought processes and challenge each other's ideas. Pea (2004) refers to communication activities such as process questioning and creating shared definitions as *scaffolding* instruction. The goal of scaffolding instruction is to eventually remove teacher supports and to "prepare learners to construct knowledge once we no longer orchestrate specific instructional conditions to target specific learning mechanisms and outcomes" (Schwarz, Lindgren, & Lewis, 2009, p. 37). Scaffolding is a strategy teachers use to instruct students in their zone of proximal development.

The purpose of questioning differs in transmission and constructivist pedagogy. The difference in communication patterns associated with each pedagogy is "the form of guidance comes in questions, probes, orchestrations and turns of talk, and decisions of

when to move on" (Somerfeld et al., 2009, p. 274). In constructivist classrooms, questions are a form of scaffolding that allow teachers to check for student understanding. In transmission classrooms, student answers to questions are used to help the teacher check for understanding and determine what information to disseminate next. Constructivist educators use student answers to questions as an opportunity to orchestrate knowledge-building discussions among learners.

The impact of social interactions on the learning process. Social learning theorists subscribe to the notion that learning is a socially constructed process. In other words, "knowledge is distributed among a community rather than sequestered in the minds of individuals" (Jonassen, 2009, p. 17). Knowledge acquisition is not something that happens in isolation, but instead is socially negotiated through interactions with others.

Theorists such as Lave and Wegner (1991) brought forth the idea that humans co-construct meaning in communities of practice. In communities of practice, meaning is determined through the participants' social negotiation.

Maroulis and Gomez (2008) conducted a study in which they employed social network analysis among tenth-grade students in an urban high school. They were studying the role of social relations with respect to academic performance. They found evidence that students' social networks within and across classrooms affect learning.

Teacher and student communicative roles in transformative constructivist environments. Constructivists think knowledge is co-created among participants in a community of learners. Because knowledge is co-created, it requires two-way communication between two or more individuals. In constructivist environments,

"students interact with peers by presenting their solutions, describing how solutions were reached, and receiving feedback...where student tasks involve interdependence with other students and in particular, where discourse with other students is facilitated" (Ravitz, Becker, & Wong, 2000, p. 2). In transmission pedagogy, teachers act as disseminators of information. In constructivist pedagogy, teachers act as facilitators helping students construct new meaning.

Theorists such as Scardamalia and Bereiter (1994) suggest that teachers need to become social architects who are able to engage students in meaningful learning, create distributed work environments, sustain inquiry over time, and monitor multiple groups.

The potential impact of ubiquitous learning environments on student identity. According to Vygotsky (1978), learning happens through social interaction where newcomers learn alongside experts. In a community of practice, newcomers are welcomed by experts and engage in the practice as legitimate community members. According to Lave and Wenger (1991), newcomers are at the periphery and are considered as beginners in practice of the community. They become experts in the practice as they increase their competencies. Newcomers gradually move to the center of the community, where the experts are located, through social interactions.

In the classroom, the Internet has the potential to allow students to participate in larger networks of experts. This participation has the potential to change students' identity as experts recognize their work as legitimate and comment on it. Herman and Gomez (2009) assert that student identity and motivation are closely associated. As students' identities changes from periphery members to legitimate problem solvers in real-world contexts within a true community of practice, students become more

motivated and engaged in their learning.

How ubiquitous computing environments support constructivist learning. According to Spiro and DeSchryver (2009), ubiquitous computing environments where every student has access to the Internet provide students with a learning environment that supports constructivist pedagogy. The Internet has greater potential to increase the size of collaborative networks than those provided in face-to-face environments because it gives users access to a larger networked community of learners (Pea, 2004). Building collective knowledge is more efficient because it uses the expertise of many (Scardamalia & Bereiter, 1994). In these types of distributed environments, hierarchical learning is dismantled. No longer does information have to pass through an expert down to the masses; instead, it can be shared among all learners. Virtual learning environments can also provide online spaces for learners to co-construct knowledge together in learning domains that are not made up of factual knowledge that learners can memorize (Spiro & DeSchryver, 2009).

Part Three: The Literature on 1-to-1 Computing and Constructivist Teaching Practices

For the purposes of this study, 1-to-1 computing will be defined as ubiquitous computing environments in which all students have access to their own laptop computer 24/7. Part Three of the literature review discusses the history and growth of 1-to-1 computing in K–12 school systems. The literature review also highlights studies that have shown shifts in teacher instructional behavior to more constructivist types of teaching practices over time.

History of 1-to-1 computing. One of the first 1-to-1 computing programs began

in 1990 in an all girls' private school in Melbourne, Australia. Not long after, Microsoft launched its Anytime Anywhere Learning initiative in which more than 1,000 schools participated over 5 years from 1996 to 2001. In 2001, Henrico County Public Schools in Virginia became the largest school district in the United States to implement a 1-to-1 laptop program (Zucker & McGhee, 2005). Over a 3-year period, the district deployed over 25,000 laptops to students and staff in grades 6 through 12. In 2002, Maine embarked on a statewide 1-to-1 program in which all seventh-grade students received a laptop. Michigan instituted The Freedom to Learn initiative in 2003 in which it implemented 1-to-1 computing programs in 15 school districts that were performing the lowest on statewide tests. Other states that have invested significant amounts of money to institute large 1-to-1 programs include Texas, South Dakota, New York, and Ohio.

Today, the number of laptop programs in the United States is steadily growing. A study published by The Hayes Connection & The Greaves Group (2008) found that of the nation's 2,500 largest school districts, one-quarter of the 1,000 respondents already had 1-to-1 computing and one-half expected to be 1-to-1 by 2011. Similar programs are emerging abroad in places such as Ireland, Canada, the United Kingdom, New Zealand, and Australia and spreading to developing countries such as Singapore, China, Argentina, Brazil, Libya, Nigeria, and Thailand.

The evolution in teacher pedagogy in 1-to-1 computing programs. A prevalent outcome often cited in 1-to-1 computing studies is the change in teacher pedagogy. In a study conducted by Russell et al. (2003), teacher practices were compared to traditional classrooms and classrooms that had limited access to laptops on shared carts. Whole class teacher-led discussions were more frequent in the classrooms with shared carts than in

true 1-to-1 environments, where all students had a laptop they could take home with them. Students in 1-to-1 classrooms were observed peer conferencing nearly twice as much as students in traditional classrooms. Teacher interviews indicated that students in 1-to-1 environments were given more opportunities to learn more independently, cooperatively, and collaboratively than students in the traditional classrooms.

Grant et al. (2005) observed four fifth-grade classrooms that used mobile laptop carts in their classrooms. Their observations revealed a number of constructivist strategies being employed in these classrooms. For example, in 89% of classroom visits, teachers were acting as facilitators or coaches. Activities that required students to engage in critical thinking were observed in over 30% of the visits. Cooperative and collaborative learning activities were observed in 33% of the visits. Project-based learning was observed in 100% of the classroom observations.

Ashmore (2001) studied different implementation models of 1-to-1 computing by surveying 356 teachers working in 74 public and private schools nationwide. Her research found that in classrooms with full access to laptops, teachers were more likely to exhibit constructivist strategies in instruction and assessment practices. Specific variables found to be significantly more constructivist in full 1-to-1 implementations included student grouping for instruction, instructional strategies, instructional content/subject matter, teacher and student roles concerning instruction, and instructional activities employed in the classroom.

Research on the Maine laptop initiative indicated a shift in teachers' beliefs and practices over time (Sargent, 2003). A number of teachers involved in the study reported that their role had changed to that of a facilitator. A study conducted by Harris and Smith

(2003) on the Maine laptop initiative revealed that students with disabilities increased their social interactions with other students and their teachers.

Rockman (2000) studied the impact of the Microsoft Anytime Anywhere Learning initiative on teaching and learning. Results of the study indicated changes in teacher practices over time. Teachers in the 1-to-1 initiative were compared with a group of teachers who were not provided with laptops. Teachers involved in the 1-to-1 program for over 3 years were "more frequent users of student-led inquiry and collaborative work, and also included departures from traditional classroom roles and changes in activity structures" (p. vii), while teachers in traditional classrooms showed no changes in their teaching practices over the same 3-year period. "Non-Laptop teachers reported employing direct instruction (a traditional practice defined on our questionnaire as the sequence 'review, teach, guided practice, individual practice') almost every day" (p. vii). In contrast, teachers involved in the 1-to-1 initiative decreased in the amount of direct instruction they provided from almost every day to about once a week. The study also revealed that teachers in the 1-to-1 program attributed the use of computers as a factor in changing their teaching practices.

Project Hiller (Light et al., 2002), a study that looked at the impact of a 1-to-1 program that involved 40 ninth graders and 20 teachers over 3 years, revealed that students in the 1-to-1 program demonstrated increased ownership of their learning. The study also revealed an increase in the occurrence and quality of informal, project-based, and small group interactions between teachers and students participating in the program.

Additional studies that show a shift in teacher practices to more constructivist pedagogy over time include a study of Piscataquis Community High School and a study

of the Michigan Freedom to Learn Initiative. Seventy-three percent of teachers involved in the 1-to-1 program at Piscataquis Community High School reported that their role had changed to more student-centered instruction since the inception of the 1-to-1 program (Mitchell Research Institute, 2004). In the Michigan Freedom to Learn Initiative, the University of Memphis Center for Research in Educational Policy (2007) found that teachers in 1-to-1 programs implemented lessons that were significantly more meaningful than the non-1-to-1 teachers in the study.

While these studies show changes in teacher instructional practices (often showing up in the third year of implementation), none of these studies directly measures transformative communication patterns within 1-to-1 learning environments.

Part Four: Factors Found to Help Teachers Evolve to More Constructivist Forms of Teaching Pedagogy

In a large-scale national survey of teachers' beliefs and practices, Becker and Riel (2000) found a relationship between teachers' collaboration patterns with their peers and their pedagogical beliefs. They identified a continuum of teacher practices consisting of private practice teachers, interactive teachers, professional teachers, and teacher leaders. They found that teachers in the teacher-leader category of the continuum were more likely to use constructivist teaching pedagogy. Teacher leaders were also more likely to integrate technology into their classrooms in ways that supported meaningful thinking and involved collaborative project work and sharing of ideas with peers. One of the biggest differences the researchers found between professionally engaged teachers and private practice teachers was in how frequently they had students use software for electronic mail, multimedia authoring, and presentations. These types of software

applications are used primarily "to communicate with other people and to produce products for an audience—activities closely associated with constructivist pedagogy" (Becker & Riel, 2000).

Another finding of Becker and Riel's (2000) research was that teacher leaders' classroom practice mirrored their professional engagement. They found that teacher leaders use computers to help their students achieve the same level of respect and voice in the classroom that these teachers were experiencing within their professional educational community.

Conclusion

This study builds on the literature on transformative communication patterns and the literature documenting changes toward more constructivist teaching practices of teachers in 1-to-1 environments. This study specifically addresses whether communication patterns in 1-to-1 classrooms evolve over time after a teacher has a few years of experience and if so, what types of changes in communication occur. Understanding whether 1-to-1 computing programs show growth in transformative communication patterns will help stakeholders better understand the potential value of these programs.

Chapter 3. Methods

Introduction

This chapter explains the methodology used to better understand the evolution of communication patterns in 1-to-1 classrooms over time. The chapter begins with a discussion of the research purpose and design. The design section is followed by a description of the data collection strategies, tools, and consideration of human subjects. The chapter concludes with a description of how the data were analyzed.

Research Purpose

The study's purpose was to better understand how transformational communication patterns in 1-to-1 classrooms evolved and to understand what factors teachers identified as important in changing communication patterns they used over time. The study is significant because it provides the educational community with a better understanding of the type of communication patterns that existed in 1-to-1 computing classrooms and how these patterns evolved. The findings provide guidance to educational decision makers in moving forward with 1-to-1 programs.

Previous studies have examined variables related to implementation of 1-to-1 programs such as professional development and technical support in isolation. In addition, while the literature indicates that teachers' styles often change to more constructivist styles of teaching in 1-to-1 programs (Ashmore, 2001; Grant, Ross, Wang, & Potter, 2005; Mitchell Research Institute, 2004; Rockman, 2000; Russell et al., 2003; Sargent, 2003), there has been little research on the factors that contribute to these changes. This study was undertaken to understand what types of communication patterns are being used in 1-to-1 classrooms and how these patterns evolved over time. This will

be helpful information for leaders trying to effectively implement 1-to-1 programs in their schools to improve student learning.

The research study was a 6-month project investigating the evolution of transformative communication patterns in 1-to-1 classrooms in Milwaukee Public Schools. The study compared teachers' communication patterns, students' social dynamics, and the types of mediating communication tools used in 1-to-1 classrooms in their first year of implementation and 1-to-1 classrooms in 2 or more years of implementation.

Research Questions

The study addressed the following three research questions:

1. Are communication patterns in 1-to-1 classrooms that have existed for 2 or more years different from 1-to-1 classrooms that have existed for a shorter amount of time?
2. If so, how are they different?
3. What factors in 1-to-1 classrooms affect the communication patterns being used?

Research Design

This study used a mixed-methods explanatory design to understand communication patterns that existed within 1-to-1 classrooms and how these patterns evolve over time. A mixed-methods study includes both quantitative and qualitative data. "The use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone" (Creswell, 2003, p. 5) .

A mixed-methods sequential explanatory study consists of two phases. Phase One consists of gathering and analyzing quantitative data. Phase Two involves collecting qualitative data. The second, qualitative phase of the study is designed to obtain more detailed about the data collected in the first part of the study.

Table 2 shows what research questions each part of the study addressed and the types of data collected and analyzed for each part of the study.

Table 2

Research Design

Problem	Focus	Type of Data Collection and Analysis
Are communication patterns in 1-to-1 classrooms that have existed for 2 or more years different from 1-to-1 classrooms that have existed for a shorter amount of time? If so, how are they different?	Observation of transmission and transformative communication patterns in a classroom	Quantitative, classroom observations
What factors in 1-to-1 classrooms affect the evolution of communication patterns being used?	Determining factors that contribute to differences in communication patterns in classrooms of varying lengths of time	Qualitative, teacher Interviews

Figure 3 shows the sequence of the data collection and analysis activities in this study:

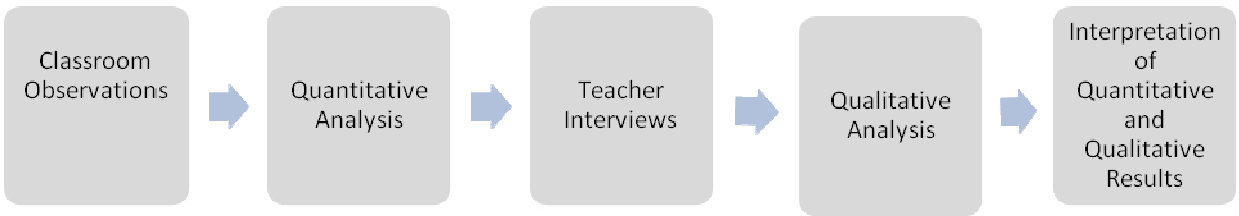

Figure 3. Data collection and analysis activities.

The researcher submitted an application to conduct research in Milwaukee Public Schools in February 2010. The research request was granted. Data collection for the quantitative phase occurred in the spring of 2010. Initial analysis of the quantitative data occurred in March 2010. Qualitative data collection was conducted in the spring of 2010. Two types of data were collected: classroom observation data and teacher interview data.

The researcher worked with leaders from the district's Teaching and Learning Division to contact teachers who were chosen to participate in the study. District leaders in Milwaukee Public Schools wanted more data on the 1-to-1 schools they have initiated to help them to decide whether the implementation has been successful in improving teaching and learning practices and whether to expand the program to include all classrooms across the district. The researcher had already been approved by the Milwaukee Public Schools research board to conduct research in the district.

Sources of data. In 2007, Milwaukee Public Schools started the 1-to-1 program at the sixth grade level. One of the considerations the district used for choosing schools for the 1-to-1 program was socioeconomic status and student achievement on standardized tests. Participation in the program was not voluntary. Twenty-one teachers participated in the district's first 1-to-1 program. Currently, four teachers from this group remain in the program. Three are regular classroom teachers, and one is a special education teacher who team teaches with multiple teachers. Eight participants completed 2 years of the program but are no longer participants. Of these, one is a paraprofessional, and two are special education teachers. Some of these teachers now hold positions as technology integration specialists or math or reading literacy coaches in their building or were encouraged by their principals to switch to grade levels that have higher student

learning needs.

Seven teachers are in their second year of the program. Three of these teachers are special education teachers. An additional seven teachers are in their second year in the program, but their students did not receive laptops until this year because funds from a Microsoft settlement were not received in time. This is their second year with their own laptop and participating in monthly professional development sessions with their peers but the first year that their students had their own laptops. These teachers were treated as having 2 or more years in the program in the study. One of these teachers is a special education teacher. During the 2009–10 school year, 37 more teachers were added to the program.

The district employed a community of practice model of professional development to support teachers in the 1-to-1 implementation. Teachers met with peers in the program for one day each month, or nine times during the school year. Sessions were designed to be collaborative in nature, and participants sat at round tables in small groups and collaborated on lesson plan design, projects, classroom management techniques; learned new applications; set up their own Moodle classrooms for their students; worked on assessment strategies; analyzed local assessment data; and created learning probes, peer review lesson plans, and student work samples. The district used collaboration tools in The Learning Community (TLC), its staff online learning management system, to build community and facilitate the sharing of ideas, curriculum, and innovations between professional development sessions. Each school implementing the program also had an identified school support team that included an administrator, library media specialist, instructional technology leader (ITL), math teacher leader (MTL), and literacy coach who

supported teachers as they implemented the program.

Sample. All teachers involved in the 1-to-1 study were invited to participate in the study. Eleven teachers volunteered to participate, and all 11 volunteers were included in the study. All the teachers taught at the sixth-grade level. Teachers attended a full day of professional development provided by the district one day a month during the school year. Teachers in the program for 2 or more years who had left the program were also invited to be interviewed. Only one teacher who had left the program participated.

Table 3

Sample Participants

Group	Description
Group 1	Six out of 11 teachers who have had 2 or more years of experience teaching in a 1-to-1 classroom were observed and interviewed. Five of the teachers were regular education teachers. One teacher was a special education teacher. One math lesson and five reading language arts lessons were observed.
Group 2	Five teachers out of the 37 teachers who just entered the program were observed and interviewed. Three teachers were regular education teachers. Two were special education teachers. Two of the classrooms were bilingual classrooms. Two science lessons, one math lesson, and two reading language arts lessons were observed.

The researcher attended the professional development sessions that teachers in groups one and two in the program attended. The researcher explained the purpose of the study to the group and answered any questions. The researcher distributed the consent form in Appendix C. Teachers who volunteered to participate in the study filled out the form at the professional development session or e-mailed the researcher indicating that they were interested in participating in the study.

The researcher sent each participant an e-mail asking for permission to conduct a

classroom observation and inviting him or her to participate in an interview. The e-mail contained a description of the study, the methods being used, the length of the observations and interviews, the reasons why they were selected, the benefits of the study, and the potential risks. The e-mail also included attachments containing the informed consent forms for the classroom observation and the interview. Participants completed and signed both forms prior to the observation or interview.

Internal reliability. All data were collected from schools within the Milwaukee Public School District. This ensured that the teachers interviewed and classrooms observed were representative of the populations that the district served. The researcher trained a second coder and modified the coding process until 85% agreement was possible. Once inter-coder reliability was set, the researcher coded all of the data.

External validity. External validity was established by having three experts in the field review and give feedback on the data collection tools used in the study. The researcher also solicited feedback on the data collection tools used in the study from Cheryl Lemke, CEO of the Metiri Group, who studies 1-to-1 programs throughout the province of Alberta, Canada; Leslie Wilson, Director of the Freedom to Learn Initiative, which implements 1-to-1 programs in low-performing school districts in Michigan; and Jason Ravitz, Research Director for the Buck Institute for Education.

Data Collection Tools

Data collection consisted of classroom observations and teacher interviews. Following is a description of how these tools were used to collect data to answer the research questions for the study. Observations captured data about classroom dynamics in real time that could not have been captured in an interview.

Classroom observation. The researcher observed classrooms to determine what types of communication patterns were being used. The researcher observed 11 1-to-1 teachers from two separate groups. Each classroom observation lasted 45 minutes. Every 5 minutes, the researcher coded observations of the communication patterns the teacher used, the classroom's social dynamics, and any tools used to mediate communication.

The researcher used a timer on her iPod Touch to track when to record observations. The recorded observations were meant to serve as snapshots "designed to capture relatively static pictures of the distribution of adults and children participating in classroom activities" (Stallings & Kaskowitz, 1974, p. 18). When there was time between the 5-minute intervals, the researcher added ethnographic notes. No names were used to identify students.

The researcher collected quantitative data by looking for predetermined events and recorded the number of times these events, or communication patterns, occurred in a given class period. The researcher was physically present and recorded the events in real time. A copy of the Classroom Observation Protocol is included in Appendix A. A copy of the Classroom Observation Checklist is included in Appendix B.

Teachers whose classrooms were observed were required to sign a statement of informed consent stating that they understood the study, its purpose, and their rights to decline to have their classroom observed and to stop the observation at any time. A copy of the Informed Consent Form for Classroom Observations is included in Appendix C.

Teacher interviews. Phase Two of the research study consisted of semi-structured face-to-face teacher interviews aimed at better understanding how communication patterns in 1-to-1 classrooms evolve. The interviews were semi-

structured using open-ended questions. The interview prompts were designed using the analysis of the quantitative phase and were designed to elicit more in-depth information that the researcher wanted to better understand. One advantage of the interviews was that there was that it allowed for additional insights that could not be captured solely through quantitative data collection (OERL, 2009). Interview prompts were designed to be broad and exploratory. The interviewer used prompts designed to elicit narrative storytelling from participants on how communication patterns had developed in their classrooms since the beginning of the 1-to-1 program.

The researcher requested an interview with the teachers of the classrooms that were observed. Participation in the interview process was voluntary. Interviews were conducted face to face. Participants were asked to sign a statement of informed consent form stating that they understood the study, its purpose, and their rights to decline to be interviewed or to stop the interview at any time. Interviews were approximately 45 to 60 minutes long and occurred after school outside of contract hours. At the beginning of each interview, the following protocol was followed:

1. The researcher reviewed the consent form and asked the interviewee whether he or she had any questions.
2. If the interviewee had not yet signed the consent form, the researcher asked the interviewee to do so. (A copy of the Teacher Interview Consent Form is included in Appendix C.)
3. The researcher stated the purpose of the research.
4. The researcher provided an overview of the interview process.
5. The researcher asked for permission to record the interview.

6. The researcher stated the date, time, and location of the interview.

The recordings were transcribed and will be kept in a secure location for a period of 5 years. Interview responses were transferred to the researcher's laptop, which is password protected. All documents, including the transcription of the interviews, were also password protected. A transcriptionist was hired, and she transcribed the interviews. The researcher and the transcriptionist were the only individuals who had access to the files. The researcher did not record teachers' names during the interview process. The researcher assigned numbers in lieu of names to the transcription.

Consideration of Human Subjects

Pepperdine University's Institutional Review Board (IRB) was contacted, and all requirements were completed for its approval. Based on this researcher's review of Pepperdine University's IRB guidelines, this study qualified for Expedited Review because the study involved human subjects and presented no more than minimal risk to human subjects.

The classroom observation data collection process did not pose any risks to the students. Students present during the classroom observation were required to complete the same assignments and participate in the same learning experiences. No student experienced a risk that was not normally part of the learning that occurred in classroom instruction.

If any teacher participating in the interviews felt that risk to himself or herself was developing, whether psychological, emotional, or behavioral, the participant had the right to withdraw from the study at any time without any negative repercussions. All participating teachers signed an informed consent form to participate in this study.

Teachers were capable of giving informed consent for participation. Participation was voluntary. Data collection was conducted without recording the participants' names. Participants were able to withdraw from the study at any time. There were no consequences of any kind if participants decided they did not want to participate.

Analysis of the Study

This mixed-methods explanatory study had different types of analysis for each type of data collected. Phase One consisted of quantitative analysis of classroom observation data. The researcher used quantitative analysis to inform the qualitative part of the study, which consisted of the teacher interviews. The researcher qualitatively analyzed the interview data. In the final part of the study, the researcher interpreted the quantitative and qualitative results.

Analysis of classroom observation. During the classroom observations, the researcher tallied the number of times identified communication patterns were observed. The researcher calculated the number of tally marks for each item measured on the classroom observation. The researcher coded the ethnographic data by theme and used them to further explain patterns observed in the quantitative data. The researcher also used this data to identify areas for further investigation.

Next, the researcher performed a descriptive analysis of the data collected in the classroom observation. The mean, standard deviation, and variation for each variable group were compared (Creswell & Clark, 2007, p. 130). This was done for each year of implementation. Next, a cross-tab report was run to compare the descriptive statistics for each year of implementation. A narrative of analysis of the descriptive statistics was performed to describe findings from the cross-tab report.

After the descriptive statistical analysis was complete, the researcher ran an Analysis of Variance (ANOVA) report for each type of communication pattern the teacher used, each type of student grouping, and each type of mediating communication tool used to determine whether there was a significant difference between each variable being measured and the year of implementation of the 1-to-1 program. The *p* value was set at 0.05. SPSS software was used to run the quantitative reports. A copy of these reports is included in Appendix E.

The researcher used the analysis of the quantitative part of the study to develop the teacher research prompts for the teacher interviews. The researcher identified areas where the data were interesting or surprising or where the researcher needed more information and wrote interview prompts designed to obtain more information in these areas.

Analysis of teacher interviews. The researcher analyzed interview data for themes that answered the following research question: What types of factors or conditions help teachers change their teaching practices over time? The researcher coded data collected from the interviews according to the identified themes using the Qualitative Data Analysis Approach Method. A copy of the results is included in Appendix F.

Interpretation of results. In the final part of the study, the researcher wrote a summary of the findings from both parts of the study. Patterns and contradictions were recorded.

Validity and reliability of instrumentation. This study was validated by collecting and analyzing multiple sources of data, including classroom observations and

teacher interviews. The researcher piloted the classroom observation protocol using online videos of 1-to-1 classrooms. Data were captured using this method. However, the tool was complex. The researcher simplified the tool by looking at the literature and determining what characteristics were most important to observe. Next, the researcher tried coding the 1-to-1 videos again using the revised classroom observation protocol. The researcher created a panel of three experts to serve on a review panel. They reviewed the classroom observation checklist and teacher interview prompts and recommended modifications. The researcher piloted the classroom observation protocol in two 1-to-1 classrooms in at Indian Trail High School in Kenosha, Wisconsin. Indian Trail High School is in its third year of implementing a 1-to-1 computing program. A ninth-grade English class and a ninth- through twelfth-grade Chinese class were observed. The researcher also practiced interview prompts with two teachers to become more comfortable with this method of gathering data.

Summary. The study's purpose was to better understand communication patterns in 1-to-1 classrooms. The study was a mixed-methods sequential explanatory study. The study methodology consisted of two parts. The first part was quantitative and composed of classroom observations. The second part consisted of teacher interviews designed to better understand how communication patterns evolved in 1-to-1 classrooms.

Data obtained from the classroom observations and teacher interviews were analyzed to better understand the following research questions:

1. Are communication patterns in 1-to-1 classrooms that have existed for 2 or more years different from 1-to-1 classrooms that have existed for a shorter amount of time?

2. If so, how are they different?
3. What factors in 1-to-1 classrooms affect the communication patterns being used?

This study's purpose was to inform educational leaders about the types and evolution of communication patterns in 1-to-1 environments and how they affect the learning process.

Chapter 4. Results

Findings

Introduction. This chapter presents the results from the findings of the study, including a brief review of the purpose of this study and the methodology used to collect the data. The study's purpose was to better understand how communication patterns in 1-to-1 classrooms evolve over time. The design of the study was an explanatory mixed-methods approach that involved collecting qualitative data after a quantitative phase.

The quantitative phase of the study consisted of 11 classroom observations of 1-to-1 classrooms. The researcher used an iPod Touch that gave an auditory signal every 5 minutes. When the signal was heard, the researcher circled any of the following communication patterns that the teacher was using either verbally or through the use of technology at that time:

- Disseminate information: Lectures, transmits information
- Process communication pattern: Simplifying the question, providing hints, reteaching material, offering feedback, giving prompts and supports, scaffolding
- Reply evaluation pattern: Direct questions, questions premised on known answers and teacher-driven activity
- Alternate solution question: Questions in which students have to describe and explain alternative strategies
- Shared situation definitions: Students do the work of generating explanations, meaning is determined through the participants' social negotiation

Sometimes multiple communication patterns happened simultaneously. This often happened if technology was being used as a mediating tool and if students were working in pairs or small groups. In these types of environments, communication patterns were less linear and multiple streams of communication sometimes happened at the same time. The observer also took ethnographic notes during the observations. Tables 4 and 5 are two examples of two separate classroom observations. The observations include the predominant communication patterns coded as being used by the teacher at 5-minute intervals. Next to the communication patterns were the ethnographic notes the researcher took between the 5-minute intervals. There is not necessarily a direct correlation between the ethnographic notes and the patterns coded. In other words, communication patterns coded were those patterns present at the sounding of the alarm. The ethnographic notes are about the context the researcher observed in the gap between the coding that just occurred and the next alarm. The qualitative phase consisted of interviews of the teachers of the observed classrooms. A copy of the codebook and results that were developed to code the interviews is included in Appendix F. Table 4 shows the number of teacher participants and the number of years that they had participated in the 1-to-1 computing program.

Table 4

Study Participants

Year in Program	Number of Participants
First year in the program	5
2 or more years in the program	6

The study sought to find out whether classrooms of teachers who have been implementing 1-to-1 computing programs for 2 or more years differ from classrooms of teachers who are in their first year of implementation. The researcher looked at classroom organization, how technology is being used, the communication patterns being used, and changes in identity. The researcher was also interested in finding out what factors may have contributed to the differences between these two groups.

The following sections contain an analysis of quantitative and qualitative data collected on each area the researcher wanted to examine. Each section concludes with a summation of the major findings that came out of the study.

Findings Related to Classroom Organization

Physical structure. Quantitative analysis of classroom observation data showed no changes in how teachers in their first year of the program arranged their classrooms compared to teachers who had been in the program for longer amounts of time. The researcher e-mailed teachers who participated in the study to find out whether the physical layout of their classroom had changed since the beginning of the program. Four teachers responded that it had not. Two teachers organized their classrooms in rows, and two organized desks in small groups. An additional teacher who had left the program reported no change in her arrangement (small groups). One teacher who organized her classroom in rows wrote, “I tried putting desks in groups but it is easier for students to see the smartboard in the front of the room if they are organized in rows.”

Therefore, the first finding was that there was no difference in how teachers organized their classrooms based on the number of years a teacher participated in the program.

Social structure. Analysis of the quantitative data showed very little difference in the amount of time students spent working by themselves based on how long a teacher was in the program. There was also little difference between the groups in how often they worked in pairs or triads.

There were differences, however, between the two groups in how often students worked in small groups and how often teachers used whole group instruction. No students in any of the classrooms of teachers in the first year of the program worked in small groups. The mean percentage of students working in small groups observed in classrooms of teachers in the program for 2 or more years was 16.35%. Teachers observed in the first year of the program used whole group instruction more often (mean percentage of students working in whole group instruction = 70.77%) than teachers who had been in the program for longer amounts of time (mean percentage of students working in whole group instruction = 56.39%).

The researcher coded the percent of students working individually, in pairs and triads, in small groups, or involved in whole group instruction in each classroom at 5-minute intervals. The researcher compared the mean of the percentages of students working in whole group, individually, pairs and triads, or in small groups between first-year teachers and teachers who have been in the program for 2 or more years. Figure 4 shows the differences in the percentages of students grouped in different ways for instruction based on the amount of time teachers had participated in the 1-to-1 computing program.

Student groupings prevalent *Student groupings prevalent in*

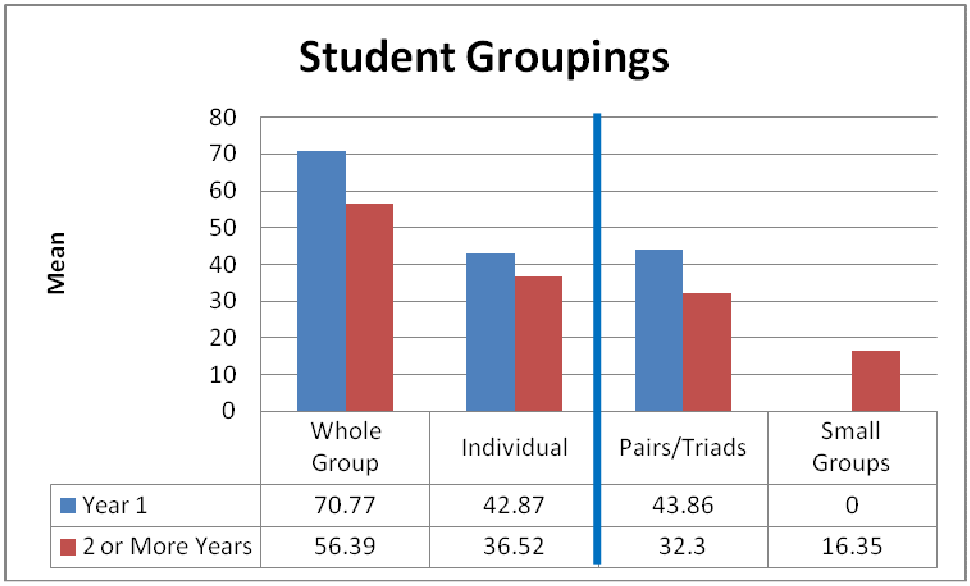

Figure 4. Differences in mean percent of students grouped in different ways for instruction between first-year teachers and teachers in the program for 2 or more years.

Teachers in the first year of the program had students work individually, do whole group instruction, or grouped students in pairs or triads more often than teachers who were in the program for longer amounts of time. Teachers who were in the program for 2 or more years had students work in small groups more often than teachers in their first year of the program. This finding suggests that the social structure of the classroom was organized to encourage collaboration and distributed learning.

Therefore, the second finding was that quantitative data suggest that the way teachers group students may shift from individual and whole group instruction to an increase in small group work over time.

Findings Related to Technology Use

Frequency of technology use. Classrooms in which teachers had been in the program for longer amounts of time used more technology than classrooms of teachers in

the first year of the program. The mean percentage of laptops in use in classrooms of teachers in the first year of the program was 33.4%. The mean percentage of laptops in use in classrooms of teachers in which the teacher had been implementing 1-to-1 computing for 2 or more years was 60.5% or almost twice that of first-year teachers.

Therefore, the third finding was that classrooms in which teachers were in the program for longer amounts of time used more technology than classrooms in which teachers were in their first year of implementation.

Types of technology being used. Technology makes more forms of communication possible. This section analyzes the data on different types of mediating tools being used during the classroom observations.

Teachers in the program for longer amounts of time used mediating tools more often (mean number of mediating tools observed = 13.50) than teachers in the first year of the program (mean number of mediating tools observed = 11.20). Teachers who had been in the program for longer amounts of time used interactive communication tools, productivity tools, digital media tools, and interactive whiteboards more often than teachers who had been in the program for shorter amounts of time.

Observation data revealed that teachers who had been in the program for 2 or more years used interactive communication tools more often (mean number of times first-year teachers used interactive communication tools = 1.40, mean number of times teachers in the program for 2 or more years used interactive technologies = 2.17).

No classrooms in either group were observed using graphic organizers or expression tools.

Teachers in the first year of the program used textbooks (both physical and

online) to disseminate information more often. The mean number of times a teacher was observed using a textbook out of eight possible data collection times in a 45-minute class period equaled 6.4. Teachers in the program for longer amounts of time were only observed using textbooks on average 2.83 times in a 40-minute class period. About one-third (four out of 11, or 36%) of teachers who had been in the program for 2 or more years reported that interactive communication technologies were part of the everyday teaching process and that it would be difficult for classroom instruction to happen without them, while only two teachers in the first year of the program reported this level of dependence on these types of tools.

The interactive communication technology mentioned most often during the teacher interviews was the Student Learning Community (SLC). The SLC was a learning management system that all teachers in the 1-to-1 program had access to and were given professional development on. The learning management system the district was using was Moodle; however, the district called it the SLC. Three-fourths of teachers (eight out of 11, or 73%) mentioned using the SLC for instruction in their interviews. Of the three teachers who did not mention using the SLC, two were in their first year of the program. Almost half (5 out of 11, or 45%) of the teachers talked about using the SLC to post resources and activities and as a portal for students to turn in work and give students access to online formative assessments to receive feedback on. Teachers talked about how much more efficient the SLC has made managing student work and how their classrooms use less paper. They also talked about how their role changed from transmitting information to placing greater emphasis on maintaining the SLC environment. “I have to maintain the SLC classroom, I have to check their work online

now, and I am constantly trying to keep up on sites that are appropriate and links that are broken." Another teacher said, "You do need to be very smart about your use of time. Why are you spending twice the amount of time developing content? You need to be very specific about the tools in the SLC that you use." Over one-half of the teachers (two teachers in the first year of implementation, four teachers who have been in the program for 2 or more years) talked about how they are using the SLC as a place for students to publicly construct knowledge within a learning community of their peers. Two teachers talked about using it as a portal to help students learn in alternative ways.

Teachers described their use of the SLC as evolving over time. One teacher described it in this way: "It is extremely important to me. I have had the SLC, the Student Learning Community, up and running since I was introduced to it 3 years ago. Every year I use it more and more. This year I'm using it in almost every subject."

Teachers in the program 2 or more years used productivity tools to communicate with students more often than teachers in the first year of the program. The mean number of times teachers in the first year of the program were observed using productivity tools out of a possible eight data collection times equaled 2.40. The mean observations of teachers in the program for 2 or more years using productivity tools was 3.

There was a difference in the use of digital media tools. The mean of classrooms in which teachers were in the 1-to-1 program for 2 or more years using digital media tools as a form of communication was 1.83 out of a possible eight data collection times. None of the classrooms in the first year of implementing the 1-to-1 program was observed using digital media tools. Teachers who had been in the program for longer amounts of time also used the interactive whiteboards more frequently (mean of first-year

teachers = 1.00, mean of teachers in the program for 2 or more years = 2.33).

Figure 5 shows the differences in the mean number of times each type of mediating tool was observed in the classrooms of teachers in the first year of the program compared to teachers in the program for 2 or more years.

Tools that support traditional instruction

Tools that can be used to support both traditional and constructivist types of instruction

Tools that support constructivist classrooms

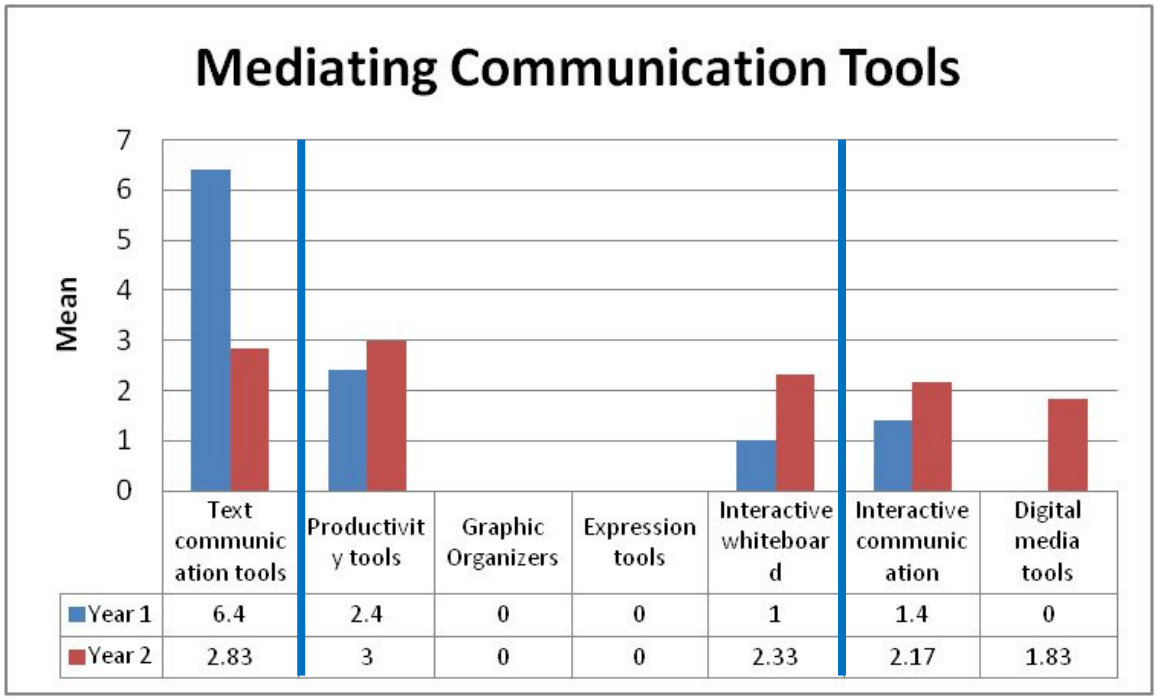

Figure 5. Differences in the mean number of times each mediating tool was observed between first-year teachers and teachers in the program for 2 or more years.

The data shows that teachers in the program for longer amounts of time used more technologies in their classroom. They used interactive communication tools, productivity tools, digital media tools, and interactive whiteboards more often than teachers in the program for shorter amounts of time. These technologies required students to present information and demonstrate their learning. Teachers reported that they were becoming

more dependent on these types of technologies and felt it would be difficult for classroom instruction to happen without it.

The placement of the interactive whiteboard supported the teachers' pedagogy. The researcher found that the placement of the interactive whiteboard changed based on how traditional or constructivist a teacher's pedagogical style was. If a teacher used transmission pedagogy, the interactive whiteboard would be situated at the front of the classroom and was usually turned on to aid the teacher in disseminating information to students. Less traditional teachers were more likely to have the interactive whiteboard off to the side of the classroom, often with a table for small group and differentiated instruction. Teachers who had the most constructivist teaching styles had the interactive whiteboard at the back of the classroom, opposite of where transmission teachers place it. Often, the interactive whiteboards were turned off, unplugged, and used for other purposes such as holding art smocks or to display student artwork taped to it like a bulletin board. In these classrooms, students occupied all different spaces and were often not all doing the same exact thing at the same time. In constructivist classrooms, students were often sitting on window ledges, under desks, at small tables, or in the hallway working together on projects or assignments. Placing the interactive whiteboard at the front of the classroom would have taken up too much valuable classroom real estate for active learning groups and would not aid teachers in moving around the classrooms and engaging students in conversations aimed at co-constructing knowledge.

Therefore, the fourth finding was that teachers who were in the program for longer amounts of time used technology as a tool to mediate communication more often than teachers in the program for shorter amounts of time.

Findings Related to Communication Patterns

Number of communication patterns observed. Analysis of quantitative data shows a slight difference in the number of communication patterns observed based on the number of years a teacher has participated in the program. The mean number of communication patterns observed in first-year teachers was 18.2. The mean number of communication patterns observed for teachers who had been in the program 2 or more years in the program was 16.50.

However, the majority of teachers (10 out of 11, or 91%) interviewed reported that communication practices in their classroom had changed from what they were prior to participating in the 1-to-1 computing program. About one-third of teachers (three out of 11, or 27%) who indicated there was a change described the changes as positive and could cite detailed examples of how technology was being used to improve communication in the classroom setting. For example, teachers described situations in which students reluctant to participate in face-to-face discussions were more likely to participate online. One teacher described it in the change in communication in the following way:

> I think it is extremely different. I think the kids are more open to discussion because the can see everybody else's report and they're not afraid to show their own work because they can see what everybody else is doing and they go, "Oh, I can do that" and they don't feel so bad about it. When you just have paper and pencil or worksheets, the kids really don't get a chance to share and I think, especially with SLC (Student Learning Community), everything is up there. They can see everything and it really does bond us a little bit more.

Teachers also talked about how the addition of the laptops has made conversations become more focused and content driven:

> If everyone has the opportunity to do it yourself then you have a lot more to talk about…when you have 1-to-1 their attention is totally focused, they have a strong stimulus on the screen and they comment as they go, and it's just like bringing them to the real place whatever that is. But everyone is participating. I think that everyone is constructing knowledge at this time. There are no side conversations because everybody is engaged. Everybody is focused so the conversation is always about the content. Nobody is sidetracked. It has made a huge difference.

Therefore, the fifth finding was that teachers interviewed reported that communication patterns changed as a result of the 1-to-1 program.

Differences in classroom communication patterns. During classroom observations, the researcher coded communication patterns occurring in the classroom at 5-minute intervals.

There were slight differences in the number of times teachers disseminated information and used process communication patterns or alternative solution communication patterns among teachers in their first year of implementation compared to classrooms who had been implementing the program for 2 or more years. Teachers in the first year of the program disseminated information and used process communication patterns slightly more than teachers in the program for longer amounts of time. Teachers who had been in the program for 2 or more years used alternative solution communication patterns slightly more often than teachers in the first year of the program.

There were larger differences among the two groups in the number of REPs and shared situation communication patterns observed. REP occurs when a teacher asks a question, students raise their hand to answer the question, the teacher chooses someone to answer, evaluates the answer, and decides whether to do another round of questioning. This communication pattern is consistent with transmission pedagogy in which the teacher is seen as an expert who helps students learn facts. Teachers in the first year of the program used REP communication patterns more often than teachers who had been in the program for longer amounts of time. The mean of REP communication patterns of first-year teachers observed was 4.40. The mean of REP communication patterns observed in classrooms of teachers in the program for 2 or more years was 2.50.

In shared situation communication patterns, the teacher asks questions that allow students to construct the meaning of concepts they are studying. The teachers view students as legitimate partners in the knowledge-creation process (Scardamalia & Bereiter, 1994). This type of pattern is consistent with more constructivist pedagogy. In classrooms of teachers in the first year of implementing the 1-to-1 program, the mean of shared situation communication patterns was 0.60. In classrooms where the teachers were in the program for 2 or more years, the mean of shared situation communication patterns observed was 2.17.

Figure 6 shows the differences in the mean number of communication patterns observed between teachers in the first year of the program and teachers in the program for 2 or more years.

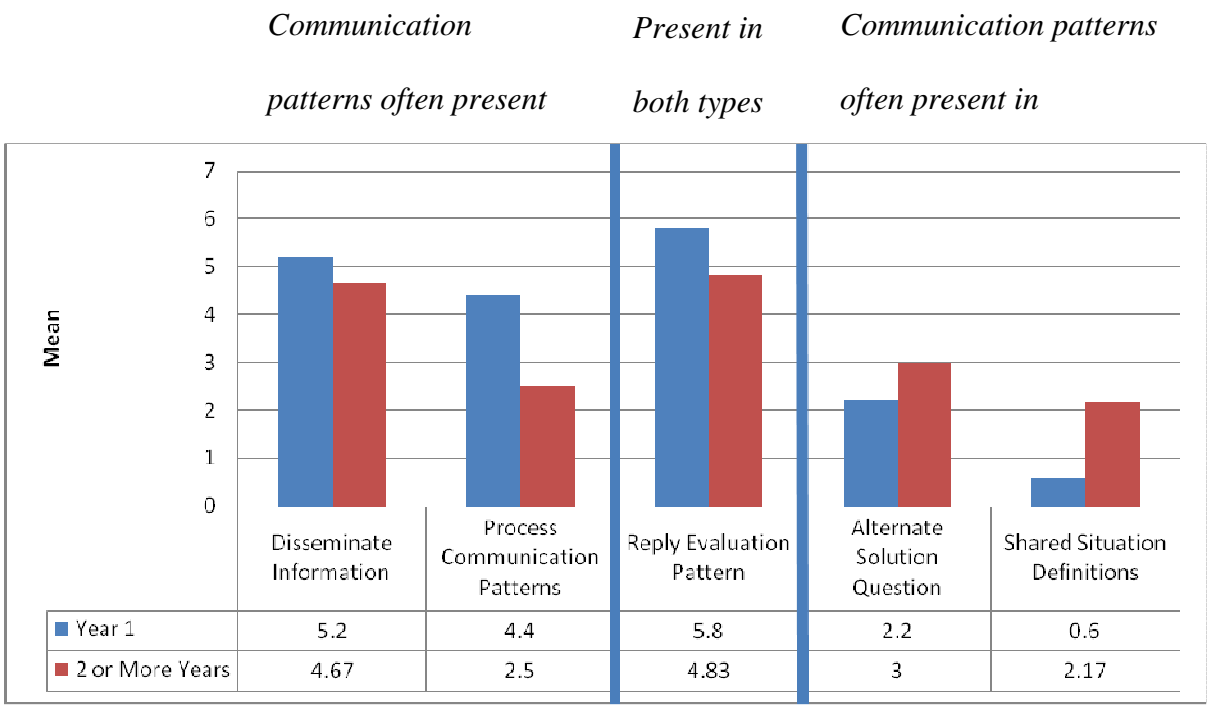

Figure 6. Differences in the mean number of times each communication pattern was observed between first-year teachers and teachers in the program for 2 or more years.

First-year teachers more often exhibited communication patterns typically found in transmission classrooms, while teachers in the program for 2 or more years exhibited communication patterns typically found in constructivist classrooms. Teachers who had been in the program for 2 or more years asked questions that allowed for alternative solutions more often than teachers who were in the first year of the program. In this type of communication pattern, the teacher asked questions that allowed students to construct the meaning of concepts being students. Students were seen as legitimate partners in the knowledge-creation process.

Therefore, the sixth finding was that quantitative and qualitative data suggest that teachers who participate in 1-to-1 computing programs used more transformational forms of communication over time.

Differences in communication related to formative assessment. The majority

of teachers (seven out of 11, or 64%) talked about differences in classroom assessment practices that occurred since the laptops were added. Seven teachers talked about how every student having access to a laptop made online formative assessments such as My Access, SLC discussions, teacher-created online assessments, benchmark assessments and probes, links to other assessments and games, and writing on wikis and blogs more accessible. My Access is a computer-generated program in which students submit their writing. The program scores student writing and gives students immediate feedback on their writing. Teachers talked about this increased access to formative assessments changing the teaching and learning process in the following ways:

- Teachers having conversations with students about their online assessment results and collaboratively deciding on next steps they will take
- Students monitoring their own progress and making decisions about their own learning
- Students peer reviewing one another's work
- Students demonstrating what they know to others in presentations or public forums using technology
- Teachers talking about using data collected from formative assessments to change their teaching practices

Using ethnographic notes recorded during the classroom observations, the researcher found that some assessments appeared to operate as a form of communication. In summative assessment, the grade is meant to communicate student understanding of a concept and is typically final. However, in online formative assessments in which students and teachers have immediate access to data on their performance, the

communication pattern is very different from that of summative assessments. When students have access to online formative assessment tools, they have choices. They can access online resources to help them improve and take the assessments multiple times to improve their performance. Much of the student talk in these environments had to do with assessment. These conversations did not necessarily involve the teacher and were often student driven:

- "I got 83% the first time, then I went back and re-read some parts of the book, and the next time I got 93%. What did you get?"
- "The first time I got 72%, then I studied the vocabulary on the SLC and I got a 100% the next time."
- "I got My Access score. I can do better. I'm going to try again."

Teachers described online formative assessments as motivating for students. Students were observed high-fiving each other, spontaneously stating their scores aloud during work time, and clapping for other students in multiple classrooms.

Therefore, the seventh finding was that when students have ubiquitous access to real-time formative assessments, new forms of student-centered communication patterns occurred.

Factors that Affect the Evolution of Communication Patterns

Access to real-time formative assessments. The study revealed that when students have ubiquitous access to real-time formative assessments, new forms of student-centered communication patterns occurred. Ten out of the 11 teachers interviewed (91%) talked about how assessment practices had changed since the start of the 1-to-1 program.

Teachers talked about students utilizing and creating their own online formative assessments. They talked about how having online assessments was much more efficient because they did not have to do the grading. One teacher explained "I am not taking their papers home and writing on them." Another teacher explained the benefits of online assessments this way, "It has given me more time for instruction with the kids definitely. That has changed the look of their portfolio, there is more information than I could ever put in."

Teachers also talked about how it provided instant feedback to students. One teacher said this about My Access, a program that gives students instant feedback on their writing. "They write, they post their writing into My Access, it immediately scores and it is not just feedback but it is divided feedback. It shows your strengths and weaknesses. It evaluates grammar, voice, organization. It is just incredible."

Teachers also talked about how the online assessments were helping them make instructional decisions. "It really held, you know, just, figuring out where they are and what I still need to focus on to help them all, in separate groups, where I'm going to need to work." They also talked about the benchmark data they receive is helpful in individualizing instruction.

Teachers talked about how online assessments were helping students monitor their own progress and make decisions about their own learning using online formative assessments. For example, they can take quizzes more than once.

Teachers talked about how their students were more engaged in their work and how they want talk about their progress. Teachers also talked about how students now

expect to be able to access their data and want to see their own progress and grades online.

Since every student had a laptop, the immediacy of real-time feedback made these teaching and learning experiences easier than in a traditional classroom, where a teacher would have had to grade each assessment. It also allowed students to engage in formative assessments multiple times and on their own terms more often, gauge their own progress, and make decisions about next steps for continual improvement. Access to technology also made it easier for students to post their work for others to give feedback on. Technology makes it easier for students to make changes and for the teacher and peers to give feedback on. More time can be spent on improving content as opposed to manual labor involved with pencil/paper drafts.

Findings Related to Identity

Student identity. The majority of teachers (eight out of 11, or 72%) interviewed gave one or more examples of how their students' identity had changed after the 1-to-1 program had been implemented. One teacher talked about how the program made her students more confident. She said, "I think they feel more powerful." She also talked about how students were more proud of their work and often went back to look at their work. Two teachers talked about how students were more open to discussing educational concepts on the discussion boards as opposed to talking out loud in front of the class. Four teachers talked about how students used distributed knowledge by sharing knowledge with their peers online more than they did prior the laptop program:

> This is between them. They're actually judging each other's work, and I have seen some of my students who have been really not disrespectful but just kind of

like a matter of fact. They've gone to actual teacher mode, and they're really trying to help the other kids get better.

Another teacher made a similar comment: "It is a constant helping and working together and making sure that this one understands and we are all doing this together." One teacher talked about how students take pride in taking care of the laptops. Another teacher said her students were more engaged and will talk about their own progress.

Therefore, the eighth finding was that teacher interview data suggest that students in 1-to-1 computing environments take on more responsibility, act as experts, and become more engaged in their own learning.

Professional identity. The way district leaders have structured professional development for the program has also evolved over time. During the first year of the program, they hired Dell computers to do all of the professional development. The district leaders also spent a lot of time doing walk-through observations and team teaching with the 1-to-1 teachers. In the second year, they decided it would be more effective to deliver the professional development themselves because they could better tailor it to local needs. They also invited curriculum support specialists to co-teach professional development sessions with them. Over time, the professional development began to focus more on lesson plan design, assessment practices, and sharing interactive resources that supported the curriculum. District leaders created a TLC in the Moodle environment and began to model best practices for using the online courseware in the professional development sessions. For example, they might link three interactive websites that could support the curriculum in the online community and then ask teachers to offer ideas of how these resources might be useful to them on an online discussion

board. In the third year of the program, teachers were asked to bring lesson plans and student work samples for peer review at monthly professional development sessions. At first, teachers were reluctant to share lesson plans and student work. However, participant feedback surveys revealed that by the end of the year, teachers reported sharing to be one of the most important parts of the program.

When teachers were asked what advice they would give to educational leaders in other districts considering implementing a 1-to-1 computing program, all but one teacher interviewed mentioned professional development as an important component of the program. Eight referred to establishing a teacher community of practice to share resources, strategies, and expertise as important. One teacher described the monthly professional development sessions provided by the district in this way: "I think it is a good collaborative place to be and what's nice about it is it focuses on some of the research that I would have to be doing. I like that because I would have to be looking through all of that stuff anyway."

Therefore, the ninth finding was that ongoing professional development is an important factor in helping teachers evolve their teaching practices over time.

The role of community in informing practice. The researcher is also the evaluator for the 1-to-1 program and has been observing and reporting progress on this program for over 3 years. Observations have revealed a progression in how professional development has evolved as well. The program began at the same time the district implemented the SLC, the online course management system. The first group had no models of how to use the SLC. A lot of time was spent exploring how this system might benefit the program. A lot of time was also devoted to the technical mechanics of setting

up online courseware, and there seemed to be a lot of confusion and frustration about how the SLC would be useful. At first, it was seen as a place to store files. Students were often the ones who suggested how to use it. Slowly, more effective models, such as using discussion boards and using it as a portal to aid in personalize instruction, began to emerge and were shared among participants. Today, when teachers enter the program, they are given an already-created class shell in the SLC that includes activities, discussion boards, and resources created by teachers who have been in the program for longer amounts of time. Teachers in the program who are at the same grade level and share the same curriculum can have instant access to resources and activities that they can use the very next day. At the professional development sessions, they sit next to teachers who have been in the program for longer amounts of time who show them how to use the SLC and modify it for their own purposes. The teachers in year 1 were truly the pioneers. They had no other go-to people in their schools or at the professional development sessions who had more experience that they could go to for help. In addition, many teachers who were the early pioneers in the program have been promoted to leadership positions such as technology integrators and reading and math specialists who support newcomers to the program.

Summary and Conclusions

When analyzed independently, none of the quantitative variables was significant. The closest variable to significance was the use of text communication tools ($p = 0.11$). This was partially due to the small sample size. While no variables were significant when analyzed independently, a number showed a positive change toward more constructivist teaching and learning strategies. The researcher combined the quantitative variables in

SPSS to create an overall *z* score. This resulted in an overall *p* score of 0.08, as shown in Table 5.

Table 5

Differences in Quantitative Constructivist Measures

Quantitative differences (means)	Year 1 (N=5)	2 or More Years in Program (N=6)	Total	Total S.D.	Effect Size	*p* <
Number of laptops in use	6.40	15.33	11.27	12.54	0.71	0.26
Number of communication patterns	18.20	17.17	17.64	5.18	-0.20	0.76
Alternative solution questions	2.20	3.00	2.64	2.62	0.31	0.64
Shared situation definitions	0.60	2.17	1.46	2.25	0.70	0.27
Increased use of digital media	0.00	1.33	1.00	2.49	0.53	0.24
Increased use of productivity software	2.40	3.00	2.73	3.47	0.17	0.79
Increased use of interactivity software	1.40	2.66	1.82	3.19	0.40	0.71
Increased use of assessment software	0.00	1.70	0.64	1.43	1.19	0.19
Overall (on above scores)	0.74	1.19	0.99	0.43	1.05	0.08

Some of the quantitative data also revealed that teachers employed traditional teaching strategies less frequently. These variables were combined and analyzed in SPSS to get an overall *z* score. This resulted in an overall *p* score of 0.10, as shown in Table 6.

Table 6

Differences in Quantitative Traditional Measures

Traditional practices (means)	Year 1 (N=5)	2+ Years in Program (N=6)	Total	Total S.D.	Effect Size	*p* <
Dissemination pattern	5.20	4.66	4.91	2.51	-0.22	0.75.0
Reply evaluation pattern	4.40	2.50	3.36	2.29	-0.83	0.18.0
Use of text	6.40	2.83	4.45	3.64	-0.98	0.11.0
Overall (on above scores)	1.92	1.24	1.55	0.67	-1.01	0.10.0

Table 7 summarizes the qualitative variables that showed a positive change toward more constructivist teaching styles.

Table 7

Counts of Qualitative Differences

Qualitative Differences (% observed/reported)	Year 1 (N=5)	2+ Years in Program (N=6)	Total Percent
Rooms arranged for groups	20%	50%	36%
Change in communication practices	80%	100%	91%
Use of interactive whiteboard	40%	33%	36%
Ubiquitous use of interactive whiteboard	40%	17%	27%
Use of e-mail	20%	33%	27%
Learning management system	60%	67%	64%
Interactive communication technologies	40%	67%	55%
Teachers talk about using formative assessments	80%	50%	64%
Teachers have conversations with students about their online assessment results and collaboratively determine next steps	0%	33%	18%
Students use assessment data to monitor their own progress	20%	33%	27%
Teachers use alternative assessments (e.g., performance-based assessments)	0%	17%	9%
Teachers use assessment data to inform their instructional practices	20%	0%	9%
Teachers talk about students collaborating and learning within a community of peers and experts	60%	83%	73%

Table 8 summarizes the overall qualitative differences out of 13 possible differences.

Table 8

Overall Count of Qualitative Differences

	Year 1 (N=5)	2 or More Years in Program (N=6)	Total Mean	Total S.D.	Effect Size	$p <$
Overall count of qualitative differences (out of 13 possible)	4.6	5.3	5.00	2.45	0.29	0.65

This study yielded findings related to the classroom organization, technology use, communication patterns, and student identity. Each finding is summarized in Table 9.

Table 9

Summary of Findings

Major Finding Areas	Findings
Findings Related to Classroom Organization	Finding 1: Classroom Organization *There was no difference in how teachers organized their classrooms based on the number of years a teacher participated in the program.* Finding 2: Social Organization *Quantitative data suggest that the way teachers group students may shift from individual and whole group instruction to an increase in small group work over time.*
Findings Related to Technology Use	Finding 3: Technology Use *Classrooms in which teachers were in the program for longer amounts of time used more technology than classrooms in which teachers were in their first year of implementation.* Finding 4: Use of Mediating Tools *Teachers who were in the program for longer amounts of time used technology as a tool to mediate communication more often than teachers in the program for shorter amounts of time.*
Findings Related to Communication Patterns	Finding 5: Frequency of Communication *Teachers interviewed reported that communication patterns changed as a result of the 1-to-1 program.* Finding 6: Differences in Communication Patterns *Quantitative and qualitative data suggest that teachers who participate in 1-to-1 computing programs used more transformational forms of communication over time.*
	Finding 7: Formative Assessment *When students have ubiquitous access to real-time* *formative assessments, new forms of student-centered communication patterns occurred.*
Findings Related to Identity	Finding 8: Student Identity *Teacher interview data suggest that students in 1-to-1 computing environments take on more responsibility, act as experts, and become more*

Major Finding Areas	Findings
	engaged in their own learning.
	Finding 9: Professional Development *Ongoing professional development is an important factor in helping teachers evolve their teaching practices over time.*

The researcher looked for changes in how teachers organized their classrooms based on the amount of time they were involved in the 1-to-1 program. Quantitative analysis of observation data revealed no difference in how teachers organized their classrooms based on the number of years a teacher participated in the program. Data seemed to indicate that teachers organized the physical layout of their rooms in ways that support their current pedagogical styles. Teachers who had been in the program for longer amounts of time decreased the amount of time they had students work individually or conducted whole group instruction and increased the amount of time students worked in small groups. This appears to be a shift from more traditional types of instruction to more collaborative learning environments. In traditional learning environments, the teacher is seen as the expert disseminating information and instruction is typically organized as whole group instruction or students working independently. Data from the study seemed to indicate that teachers were organizing instruction by having students work in small groups in more collaborative distributed learning environments more often.

Classrooms in which teachers were in the program for longer amounts of time used a little more technology than classrooms in which teachers were in their first year of implementation. Teachers in the program for longer amounts of time used interactive communication tools, productivity tools, digital media tools, and interactive whiteboards more often than teachers in the program for shorter amounts of time. Teachers in the first

year of the program used textbooks (both physical and online) to disseminate information more often. Teachers in the program for longer amounts of time gradually become more comfortable with integrating technology into instruction, and the range of tools and frequency of tools used for instruction increased. They also used more textbooks less often to disseminate information and increased uses of productivity, interactive communication tools, and digital media tools that allow students to present information and demonstrate their learning.

Communication patterns changed to more transformational forms of communication over time. The study also revealed that when students have ubiquitous access to real-time formative assessments, it allows new forms of student-centered communication patterns to occur.

The study revealed evidence that both student and teacher identity changed as a result of the 1-to-1 program. Student identity often changes in 1-to-1 computing environments to students taking on more responsibility, acting as experts, and becoming more engaged in their own learning. Teacher identity also changed as teachers engaged in a community of practice in which they shared ways of incorporating the laptops into instructional practices.

Chapter 5 includes conclusions, implications, recommendations, and areas for further study based on these findings.

Chapter 5. Conclusions

Introduction

The purpose of the study is to better understand the evolution of communication patterns in 1-to-1 classrooms over time. The study was an explanatory mixed methods design in which both quantitative and qualitative data was collected. The study was conducted at Milwaukee Public Schools during the spring of 2010. Eleven teachers participated in the study. The researcher compared data collected through classroom observations and teacher interviews from teachers in the first year of the program and teachers who had been in the program for 2 or more years.

This chapter will outline the conclusions from the study, implications of the study, recommendations for school districts considering implementing 1-to-1 computing programs, and areas for further study based on these findings.

Conclusions

Communication patterns are a quantifiable indicator of teacher pedagogy that can be observed and measured. All of teachers involved in the study reported that the addition of laptops into their classroom did change the teaching and learning environment. In total there were 24 indicators that were measured in this study that showed positive trends to more constructivist learning environments the longer teachers were in the program.

When every student has ubiquitous access to the Internet, it allows new learning opportunities that would not be possible if every child did not have an Internet-enabled device. This is especially true in changing assessment practices. When all students have access to a device, they can participate in online assessments that provide them real-time data on their results. When students have real-time access to their results, this empowers

them to take more ownership for their learning. Students in this study had more discussions about their own progress and made decisions such as improving their work, rereading or reviewing instructional resources and retaking formative assessments to improve academic achievement.

Teachers in the study also changed how they organized instruction to encourage more social interaction among students. There were changes in the types and frequency of technologies being used to facilitate communication. Communication patterns became more collaborative, distributed, and constructivist centered over time. These shifts are all supported by research as changes that will support deep learning and are seen as positive changes.

The study also contributed to the body of research on 1-to-1 computing by identifying factors that are necessary for these types of changes to occur. Professional development models that encourage communities of practice to emerge was seen as an important factor in the success of this program. Factors that led to the formation of these communities included ongoing collaborative professional development opportunities that mirrored constructivist learning where important. Sharing of resources and strategies by district content experts and peer review of instructional practices also led to the success of this model.

The study provides evidence that the addition of laptops for every child can be very beneficial in creating new learning opportunities such as empowering learners to have access to their own assessment data, providing mediating tools to provide new types of communication avenues and authentic audiences, and supporting distributed learning and collaboration. The addition of the laptops with the support of a professional

development that supports the emergence of communities of practice was conducive to helping teachers shift the teaching and learning environment to more constructivist forms of instruction over time.

Implications

New learning opportunities not possible in non one-to-one classrooms. One implication of this study is that when every student had a laptop with access to the Internet, it allowed powerful learning opportunities to become available that were not possible in traditional classrooms where students did not have ubiquitous access to the Internet. In 1-to-1 classrooms, students could communicate more frequently than they could in traditional classrooms. Online discussion boards and other interactive technologies made it possible for multiple conversations to occur asynchronously and beyond the walls and time frames of the classroom. New forms of real-time formative assessments were also possible. This changed the conversations in classrooms to be more about the learning. When students had access to real-time assessment data, it allowed for new communication patterns to emerge in which students were at the center and where they had power and ownership over their own learning. Technology also makes the peer review process easier. Student work becomes more public and transparent and provides students with an authentic audience of their peers to share their work and thinking. When every student has a computer instruction can also be reorganized. For example, some schools are experimenting with the concept of flipping. Students may watch a video of a lesson prepared by their teacher at home and do their homework at school.

Supporting Teacher Change

Professional development models that mirror desired instructional changes.

Not only did teacher practices evolve into more constructivist teaching styles over time, put the professional development model used for the program evolved over time as well. In the beginning the district hired an outside vendor who was associated with the hardware purchase to do the professional development. The professional development was very hierarchical in nature and teachers sat in rows and did what the instructor told them to do step by step. District leaders decided that this model was not very effective and decided to do their own professional development. They invited different district content specialists in to show teachers how they could utilize the laptops to improve instruction in different content areas. They also had district assessment specialists show them how to set-up their own formative assessments and how to reconfigure their grade books to allow more standards based grading and to make it easier to grade projects. Over time, they organized the room differently so that teachers sat in groups and worked on tasks collaboratively. They began sessions by having teachers share ideas of how they were using their laptops. Later, teachers were asked to bring lessons to peer review. The first time this was tried no one admitted to bringing a lesson, so the leaders asked teachers to just talk to their peers about a lesson they tried with the laptops. By the end of the session, teachers produced a stack of lesson plans they had brought to submit to district leaders that no one would admit they had at the beginning of the session. As time evolved, the peer review process became one of the most valued parts of the teacher professional development program. Teachers would be offended if there was not enough time to have their lesson reviewed. Teachers would practice before their sessions with

principals and peers and that the feedback they received from their peers was very valuable to them. The implication of this example, is that in order for teachers to create transformative learning environments for their students, they first need to experience similar learning experiences on their own.

Conditions needed for communities of practice to form. Another implication that has emerged from this study is that it takes time for communities of practice to form. In the first year or two of the program, participants were pioneers and did not have experts who went before them to show them the way and share resources and best practices. Given time to experiment and vehicles to share resources and best practices, expertise begins to emerge, and newcomers can be welcomed into the community, allowing changes in teaching and learning practices to occur at a faster rate. The TLC or Moodle environment served as the vehicle in which teachers could easily share teaching practices and resources with one another electronically. It also takes time for participants to build trust within the community so that they are willing to take new risks and take steps to change their identities.

Recommendations

Professional development recommendations. The U.S. Department of Education's (2010) National Education Technology Plan recommends that school districts move away from episodic professional development models. In the Milwaukee Public Schools' 1-to-1 computing program, teachers received one day of professional development every month of the school year, or 72 hours of face-to-face professional development per year. For teachers to evolve their teaching practices over time, they need access to communities in which they can share resources and learn from experts. This

needs to occur on an ongoing basis over multiple years. School districts planning 1-to-1 implementations need to budget funds to pay for professional development to occur. In addition, teachers need job-embedded professional development in which district- and school-level integrators and curriculum specialists can work side by side with them, especially in the first year of the program. Providing online means such as the TLC is also necessary for ongoing support.

District leaders need to understand that it takes time for communities of practice to form. Pioneers need time to experiment and become experts in the practice. They need to provide time for teachers to share with one another over multiple years for this to evolve.

Recommendations on technologies to promote constructivist learning in 1-to-1 computing environments. Interactive technologies such as the SLC were important in increasing communication and evolving teaching practices. Districts need to plan for and provide online courseware and other interactive technologies that teachers and students in 1-to-1 environments can use. Online assessment programs such as My Access, which allows students to submit their writing and receive feedback are also important in empowering students to take responsibility for their own learning. Teachers need time and opportunities to share how they are using these technologies with one another.

In these tough budgetary times, districts may want to consider investing in interactive whiteboards at the beginning of the 1-to-1 program. As teachers progressed to more constructivist teaching styles, they used them infrequently.

Further Study

Observation protocol. The study revealed a strong link between communication

patterns used in a classroom and teacher pedagogy. Communication patterns are observable in a classroom setting and work well as a way to quantify a teacher's pedagogy. The observation protocol can be useful in other future studies in which researchers want to quantify a teacher's pedagogy.

Sample size. The study was made up of 11 teachers, which was a relatively small sample. Replicating the study with a larger sample of 30 or more teachers would allow researchers a better sample from which to test for significance.

Methodology and study design. Teachers entering a 1-to-1 program are likely to have different teaching styles that fall on a continuum from transmission to transformative pedagogy. In this study, all teachers in the first study were grouped, and teachers who were involved in the program for 2 or more years were grouped together regardless of what pedagogy they had at the beginning of the study. It would be more effective to determine where a teacher falls on the continuum at the beginning of the program and track changes in individual pedagogy and communication patterns over time.

Teacher leadership behaviors. The Milwaukee Public Schools' 1-to-1 computing program has had a number of teachers transition out of the program. Of the original 21 teachers in the program, only three remain in the classroom. Some teachers have been promoted to leadership positions such as technology integrators and math and reading specialists. Some have been transferred to other grade levels, usually eighth grade. The district has a high dropout rate in high school, and eighth grade is viewed as an important grade level in helping students acquire the skills needed to succeed in high school. What is interesting about this is that eighth grade is not part of the 1-to-1

computing program in Milwaukee Public Schools. District and school administrators report that teachers who have gone through this program are highly sought after not only because of their technology skills but also for their skills as instructional leaders. Administrators describe it as wanting to place them where they can have the greatest impact. It would be important for the district to identify what elements of this program have led to the transformation of teacher practices and replicate these factors in other programs designed to improve student achievement outside of the 1-to-1 program.

Longitudinal study. This study, as well as four evaluations funded by a grant, has enabled the researcher to collect extensive data on this program. The grant evaluations are driven by protocols determined by the Wisconsin Department of Public Instruction. The protocols have a heavy focus on quantitative data, especially student achievement data reported out in yearly increments. The evaluator believes the next stage of this research could encompass a longitudinal case study that takes a more holistic view of how the program has evolved over time. This would provide valuable evidence for district leaders on the impact of the program over time instead of looking at short, isolated increments. This would be helpful in determining whether to continue the program or replicate and scale findings to other grade levels and initiatives that the district is working to accomplish.

Summary

The study addressed the following research questions:

1. Are communication patterns in 1-to-1 classrooms that have existed for 2 or more years different from 1-to-1 classrooms that have existed for a shorter amount of time?

2. If so, how are they different?
3. What factors in 1-to-1 classrooms affect the communication patterns being used?

The study revealed differences in how teachers who have been in the program for 2 or more years deliver instruction compared to teachers in their first year of the program. They tend to organize their students in small groups more often, rely less on textbooks, use technology more often, use more transformational types of communication more often, and encourage students to take more responsibility for their own learning and to act as experts. Teachers identified the ongoing collaborative professional development they received throughout the program as an important component in helping them change their teaching practices over time.

Two central implications emerged from the data: when students have ubiquitous access to the Internet, new forms of communication are possible, and when students have real-time access to their own formative assessment data, it empowers them to have more autonomy over their own learning.

One recommendation that came out of this study is that districts planning 1-to-1 implementations should budget for ongoing professional development to occur across multiple years. The professional development model should allow time for teachers to collaborate and share their resources, best practices, and expertise. Districts should also plan to provide access to technologies that encourage interaction and to new forms of communication, such as online courseware.

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APPENDIX A: CLASSROOM OBSERVATION PROTOCOL

Each classroom will be observed for 45 minutes. Every 5 minutes, the researcher will stop and code what is happening in the classroom. Between observations the observer can record ethnographic notes as time permits.

Three types of observations will be coded. The first will be the type of communication patterns being used by the classroom teacher. The second observation coded will look at with whom students are working in the classroom. The researcher will record the percentage of students working in each category. The third observation records what type of mediating communication tools are being used.

What communication patterns are being used by the teacher?

Code	**Code Key**	**Type of Communication**
D	**Disseminate information-** *Lectures, Transmits information*	Transmission
REP	**Reply Evaluation Pattern-** *Direct Questions, Questions are premised on known answers and teacher-driven activity*	Transmission
PCP	**Process Communication Pattern**- *Simplifying the question, providing hints, reteaching material, feedback, prompts, supports, scaffolding*	Transformational
ASQ	**Alternate Solution Question-** *Questions in which you have to describe and explain alternative strategies*	Transformational
SSD	**Shared Situation Definitions-** *The work of generating*	Transformational

	explanations is done by the students, meaning is determined through social negotiation of the participants	

With whom are students working?

Code	**Code Key**
Self	Students are working by themselves
Pair/triads	Students are working in pairs or triads
Sml grp	Students are working in small groups of 4-8 students
Lg grp	Students are working in large groups of 8 or more students
Whole grp	Everyone in the class is listening or working together as a whole group

What tools are being used to mediate communication?

Code	**Code Key**
IC	Through interactive communication technologies (e.g., blogs, wikis, discussion boards)
Prod	Productivity tools such as word processing, databases, or spreadsheets
Exp	Through using technology as a form of self-expression
GrOrg	By using a graphic organizer
DM	Through digital media produced by the student
Txt	Printed text, student writing

APPENDIX B: CLASSROOM OBSERVATION CHECKLIST

<table>
<tr><td colspan="4">Date:</td></tr>
<tr><td colspan="4">Year of 1-to-1 Initiative:</td></tr>
<tr><td colspan="4">Number of teachers:</td></tr>
<tr><td colspan="4">Number of aides:</td></tr>
<tr><td colspan="4">Number of volunteers:</td></tr>
<tr><td colspan="4">Number of students:</td></tr>
<tr><td colspan="4">Physical environment:
□ Movable chairs and tables for seating purposes
□ Stationary desks
□ Stationary desks and rows
□ Tables or desks arranged for small groups
□ Other:</td></tr>
<tr><td colspan="4">Number of student laptops in use:</td></tr>
<tr><td>Time</td><td>Communication patterns being used by the teacher</td><td>Students are working:</td><td>Mediating communication tools</td></tr>
<tr><td>5 min.</td><td>D REP PCP
ASQ SSD</td><td>__% Self
__% Pair/triad
__% Sml Grp
__% Lg Grp
__% Whole Grp.</td><td>IC Prod Exp GrOrg
DM Txt</td></tr>
<tr><td>Notes:</td><td colspan="3"></td></tr>
<tr><td>Time</td><td>Communication patterns being used by the teacher</td><td>Students are working:</td><td>Mediating communication tools used by students</td></tr>
<tr><td>10 min.</td><td>D REP PCP
ASQ SSD</td><td>__% Self
__% Pair/triad
__% Sml Grp
__% Lg Grp
__% Whole Grp.</td><td>IC Prod Exp GrOrg
DM Txt</td></tr>
<tr><td>Notes:</td><td colspan="3"></td></tr>
</table>

Time	Communication patterns being used by the teacher	Students are working:	Mediating communication tools used by students
15 min.	D REP PCP ASQ SSD	__% Self __% Pair/triad __% Sml Grp __% Lg Grp __% Whole Grp.	IC Prod Exp GrOrg DM Txt
Notes:			
Time	Communication patterns being used by the teacher	Students are working:	Mediating communication tools used by students
20 min.	D REP PCP ASQ SSD	__% Self __% Pair/triad __% Sml Grp __% LgGrp __% Whole Grp.	IC Prod Exp GrOrg DM Txt
Notes:			
Time	Communication patterns being used by the teacher	Students are working:	Mediating communication tools used by students
25 min.	D REP PCP ASQ SSD	__% Self __% Pair/triad __% Sml Grp __% LgGrp __% Whole Grp.	IC Prod Exp GrOrg DM Txt
Notes:			

Time	Communication patterns being used by the teacher	Students are working:	Mediating communication tools used by students
30 min.	D REP PCP ASQ SSD	__% Self __% Pair/triad __% Sml Grp __% LgGrp __% Whole Grp.	IC Prod Exp GrOrg DM Txt
Notes:			
Time	Communication patterns being used by the teacher	Students are working:	Mediating communication tools used by students
35 min.	D REP PCP ASQ SSD	__% Self __% Pair/triad __% Sml Grp __% LgGrp __% Whole Grp.	IC Prod Exp GrOrg DM Txt
Notes:			
Time	Communication patterns being used by the teacher	Students are working:	Mediating communication tools used by students
40 min.	D REP PCP ASQ SSD	__% Self __% Pair/triad __% Sml Grp __% LgGrp __% Whole Grp.	IC Prod Exp GrOrg DM Txt
Notes:			

Time	Communication patterns being used by the teacher	Students are working:	Mediating communication tools used by students
45 min.	D REP PCP ASQ SSD	__% Self __% Pair/triad __% Sml Grp __% LgGrp __% Whole Grp.	IC Prod Exp GrOrg DM Txt
Notes:			

APPENDIX C: TEACHER INFORMED CONSENT FORM

You have been invited to participate in a study on communication patterns in 1-to-1 computing classrooms. The study is a mixed-methods explanatory study. The researcher will observe classrooms and conduct follow-up interviews. Classroom observation and interview data will be coded and analyzed.

Participation will include a 45 minute classroom observation and a 45 minute follow-up interview. Nothing special is required. I do not need to interact with you or the students during the observation. I will be coding communication patterns that are normally part of learning that takes place in classroom instruction. This is an independent study and is not sponsored by Milwaukee Public Schools. The study is being conducted by Tammy Stephens, a graduate student of Pepperdine University, Graduate School of Education and Psychology under the supervision of Dr. Margaret Riel. Tammy Stephens is also an evaluator for the district EETT and ARRA grants. This study is unrelated to this work. There is no compensation for participating in this study. Participation in interviews must occur outside of the school day. Participation in interviews must occur outside of the school day.

The study poses minimal risks to participants. The only risk is loss of time. Your participation, classroom observations and interview responses will be kept confidential and your identity will not be revealed in any publication that may result from the study. Interviews will be recorded and only the researcher and the transcriber will have access to the recordings. The recordings will be transcribed and kept in a secure location for a period of five years. Interview responses will be transferred to the researcher's laptop, which is password protected. All documents, including the transcription of the interviews, will also be password protected. A transcriber will be hired to transcribe the interviews. The researcher and the transcriber will be the only individuals who have access to the files. Teacher’s names will not be recorded by the researcher in the interview process. A number in lieu of his or her name will be assigned to the transcription. Any copies of the transcriptions will be kept in locked files in the primary researcher's home when not in use. All other related documents, such as Letters of Informed Consent, will likewise be maintained in locked files at the primary researcher's home. The subject’s anonymity will be protected. Data will be kept for the required amount of time before it is destroyed.

Possible benefits of the study include helping the education community gain a better understanding of how communication patterns evolve in 1-to-1 classrooms over time and to better understand what factors impact the type of communication patterns being used.

Participation in the study is voluntary and you are free to discontinue at any time. Your participation and interview responses will be kept confidential and your identity will not be revealed in any publication that may result from the study.

If you have questions or concerns about the study you can contact Dr. Margaret Riel at [redacted] ([redacted]). If you have questions about your rights as a research participant you can contact Dr. Doug Leigh, Chairperson, GPS Institutional Review Board at [redacted].

After receiving the information provided above and answers to my questions. I

_____

(please print your name)

agree to participate in the activity described. I further understand that additional information regarding the study will be available to me on request and that I may withdraw my consent at any time.

I understand that my participation is voluntary and that I may refuse to participate and/or withdraw my consent and discontinue participation in the project or activity at any time without penalty or loss of benefits to which I am otherwise entitled.

Your signature indicates that you have read and understood the above information, that your questions have been answered to your satisfaction, and that you have decided to participate based on the information provided. A copy of this form will be given to you.

Signature of Participant	Signature of Witness
Signature of Principal Investigator	Date

APPENDIX D: TEACHER INVITATION E-MAIL

You have been invited to participate in a study on communication patterns used in 1-to-1 computing environments. This is an independent study conducted by Tammy Stephens, not the school district of Milwaukee.

Participation in the study will consist of a classroom observation in which the researcher will code communication patterns in your classroom and a follow-up 45 minute interview. Interviews will need to be conducted outside of the contracted school day. Interview responses will be kept completely confidential and your name or identity will not be used in the study.

There is no compensation for participating in this study.

Participation in the study is voluntary and you are free to leave the study at any time. Participants will be grouped by the amount of time they have been in the program and teachers from each group will be randomly selected. You can indicate willingness to participate in the study in one of three ways: 1) fill out and give me the form below 2) e-mail me at [redacted] or 3) call me at [redacted]

Sincerely,

Tammy Stephens

APPENDIX E: PARTICIPATION FORM

___ Yes, I'd be willing to participate in this study. I realize that interviews will need to occur outside of the school day.

Name: _____ School you work at:

Check which applies:

___ I have been teaching in a 1-to-1 classroom for two or more years

___ I have been teaching in a 1-to-1 classroom for less than two years

Best way to contact you:

Telephone: E-mail:

Best dates and times for an interview outside of the contracted school day:

APPENDIX F: QUALITATIVE RESULTS

Code Book

Change in Teaching Practices = CHG

Instructions: Read through the whole interview. Determine whether there has been any discussion of changes in teacher practices over time. If so, code the entry once with the highest appropriate code.

CHG.0 = No mention of change in practice or negative change

First Year of the Program	2+ Years in the Program
0	0

CHG.1 = Mentions change but does not specify what has changed, just change has occurred

First Year of the Program	2+ Years in the Program
1	0

CHG.2 = Mentions positive change, gives details or an example of how technology is being incorporated to enhance instructional methods that were in place prior to the laptops being added

First Year of the Program	2+ Years in the Program
1	2

CHG.3 = Teacher talks about radical changes to instruction due to inclusion of the laptops and feels that teaching and learning in the way it occurs now would not be possible without the laptops.

First Year of the Program	2+ Years in the Program
3	4

CHG.X = Discussion does not include any of the descriptions above. Please describe the discussion.

First Year of the Program	2+ Years in the Program
0	0

Use of the Interactive Whiteboard = IWB

Instructions: Read through the whole interview. Determine if there has been any discussion of how teachers are using the interactive whiteboard (IWB). If so, code the entry once with the highest appropriate code.

IWB.0 = The teacher does not use or does not mention use of the IWB

First Year of the Program	2+ Years in the Program
3	4

IWB.1 = The teacher talks of use of IWB in terms of using it for whole group instruction while students follow along individually doing teacher directed activities. The IWB is

key in how the teacher disseminates information to students and is an important tool to them in how they use organize instruction.

First Year of the Program	2+ Years in the Program
0	0

IWB.2 = Teachers talk about using the IWB to create a range of other resources that enhance the learning process through a more inquiry-based approach, with learners becoming centrally involved in its use where they actively construct knowledge through interaction.

First Year of the Program	2+ Years in the Program
2	2

IWB.X = Discussion does not include any of the descriptions above. Please describe the discussion.

First Year of the Program	2+ Years in the Program
0	0

Frequency & Range of Use = FREQ

Instructions: Read through the whole interview. Determine if there has been any discussion of what types of technologies and how frequently they are using these technologies for teaching and learning. If so, code the entry once with the highest appropriate code.

Type of Technology	**0) Not using technology or did not mention it**	**1) Occasionally, using it when assigned or for a specific assignment**	**2) Ubiquitous: it is part of the everyday teaching and learning process. The teaching and learning process is dependent on use of this technology and it would be difficult for classroom instruction as it occurs now to happen without it.**
1) Interactive Whiteboard (IWB)	FREQ (IWB).0 1st Year: 3; 2+ Yrs.: 4	FREQ (IWB).1 1st Year: 0; 2+ Yrs.: 0	FREQ (IWB).2 1st Year: 2; 2+ Yrs.: 1
2) E-mail	FREQ (E-mail).0 1st Year: 4; 2+ Yrs.: 4	FREQ (E-mail).1 1st Year: 0; 2+ Yrs.: 0	FREQ (E-mail).2 1st Year: 1; 2+ Yrs.: 2
3) Learning Management System (SLC) - *e.g., Moodle, Student Learning Community*	FREQ (SLC).0 1st Year: 1; 2+ Yrs.: 0	FREQ (SLC).1 1st Year: 1; 2+ Yrs.: 1	FREQ (SLC).2 1st Year: 3; 2+ Yrs.: 4
4) Interactive Communication Technologies (ICT) - *e.g., Discussion boards, Blogs, wikis*	FREQ (ICT).0 1st Year: 2; 2+ Yrs.: 2	FREQ (ICT).1 1st Year: 1; 2+ Yrs.: 0	FREQ (ICT).2 1st Year: 2; 2+ Yrs.: 4
5) My Access- *Students submit writing samples electronically and the computer scores it and returns feedback on areas in need of improvement*	FREQ (MyAccess).0 1st Year: 1; 2+ Yrs.: 2	FREQ (MyAccess).1 1st Year: 3; 2+ Yrs.: 3	FREQ (MyAccess).2 1st Year: 1; 2+ Yrs.: 1
6) Discovery Learning (DL)- *online videos*	FREQ (DL).0 1st Year: 5; 2+ Yrs.: 5	FREQ (DL).1 1st Year: 0; 2+ Yrs.: 2	FREQ (DL). 2 1st Year: 0; 2+ Yrs.: 0
7) Benchmark Assessments (Probes)-	FREQ (Probes).0	FREQ (Probes).1	FREQ (Probes).2

Online assessments linked to state standards	1st Year	2+ Yrs.		1st Year	2+ Yrs.		1st Year	2+ Yrs.	
	4	2		0	0		0	0	

8) Presentations (Ppt)	FREQ (Ppt).0 1st Year: 4 2+ Yrs.: 5	FREQ (Ppt).1 1st Year: 0 2+ Yrs.: 1	FREQ (Ppt).2 1st Year: 1 2+ Yrs.: 0
9) Intel Online Thinking Tools (Intel)	FREQ (Intel).0 1st Year: 4 2+ Yrs.: 6	FREQ (Intel).1 1st Year: 0 2+ Yrs.: 0	FREQ (Intel).2 1st Year: 1 2+ Yrs.: 0
10) Online Textbooks (OT)	FREQ (OT).0 1st Year: 5 2+ Yrs.: 6	FREQ (OT).1 1st Year: 0 2+ Yrs.: 0	FREQ(OT).2 1st Year: 0 2+ Yrs.: 1
11) Math Tutorials	FREQ(Math).0 1st Year: 5 2+ Yrs.: 6	FREQ(Math).1 1st Year: 0 2+ Yrs.: 1	FREQ(Math).2 1st Year: 0 2+ Yrs.: 0
12) Accelerated Reader Quizzes	FREQ (AR).0 1st Year: 2 2+ Yrs.: 6	FREQ (AR).2 1st Year: 1 2+ Yrs.: 0	FREQ (AR).3 1st Year: 0 2+ Yrs.: 0

SLC

SLC stands for Student Learning Community. It is the Moodle platform (learning management system like D2Learn, Blackboard, etc.) teachers in the 1-to-1 program use. It includes discussion boards, blogs, wikis, allows teachers to make online quizzes, post resources, upload assignments etc.

Instructions: Read through the whole interview. Determine if there has been any discussion of how the Student Learning Community (Learning Management System) is being used. If so, choose the codes below that apply.

SLC.0 = SLC is not being used

First Year of the Program	2+ Years in the Program
2	1

SLC.1 = SLC is being used to post resources and activities. For example, the teacher may have math games that the student can play linked in the SLC.

First Year of the Program	2+ Years in the Program
3	2

SLC.2 = SLC is a portal for tutorials and other resources to help students learn in alternative ways. For example, the teacher may link the reading story in which the students can put on headphones and listen to it read aloud, or links to worksheets translated into Spanish, or an online math tutorial that explains a concept that the teacher

has just taught in class that students can view. The teacher creates these links for students to choose to use as needed.

First Year of the Program	2+ Years in the Program
1	1

SLC.3 = SLC is being used as a portal to turn in work, return work and have the teacher give feedback to students.

First Year of the Program	2+ Years in the Program
3	2

SLC.4 = SLC is being used for formative assessment. Students may take a quiz that the teacher has linked or created to check for understanding or they may be asked to respond to a question to demonstrate understanding of what was covered in class.

First Year of the Program	2+ Years in the Program
2	3

SLC.5 = SLC is being used as a way for students to publically construct knowledge within a learning community of their peers.

First Year of the Program	2+ Years in the Program
2	4

SLC.X = SLC is being used in ways not described above. Please describe.

First Year of the Program	2+ Years in the Program
0	1

Teacher Community of Practice = T-CoP

Instructions: Read through the whole interview. Determine if there has been any discussion of how teachers interact and support one another. If so, choose any of the codes below that apply.

T-CoP.0 = Teachers do not talk about getting help from their peers.

First Year of the Program	2+ Years in the Program
1	1

T-CoP.1 = Teachers talk about getting ideas and support from other teachers

First Year of the Program	2+ Years in the Program
2	5

T-CoP.2 = Teachers talk about the district person in charge of the program coming to their classroom and team teaching with them when they started the program.

First Year of the Program	2+ Years in the Program
1	0

T-CoP.3 = Teachers talk about sharing ideas, resources asking for help on the Teacher Learning Community (TLC) – Moodle area set up for teachers and district personnel to share strategies and information.

First Year of the Program	2+ Years in the Program
1	1

T-CoP.4 = Teachers talk about going to teachers who have been in the program longer for help and support.

First Year of the Program	2+ Years in the Program
1	0

T-CoP.X = Teachers are interacting and supporting one another in ways not described above. Please describe.

First Year of the Program	2+ Years in the Program
1	0

Assessment Practices = AP

Instructions: Read through the whole interview. Determine if there has been any discussion of assessment practices. If so, choose any of the codes below that apply.

AP.0 = Teachers do not mention technology in relation to assessment practices

First Year of the Program	2+ Years in the Program
1	1

AP.1 = Teachers ask students to record scores to online games or record their online activity *(e.g., today I listened to a story online)* and describe it as having students be accountable for their time online.

First Year of the Program	2+ Years in the Program
0	0

AP.2 = Teachers talk about creating their own formative assessments using technology to measure student understanding

First Year of the Program	2+ Years in the Program
0	0

AP.3 = Teachers talk about students utilizing online formative assessments *(e.g., My Access, teacher-created online assessments, Benchmark Assessments, Links to other online assessments or games that give results, SLC discussions or online wikis, blogs)*

First Year of the Program	2+ Years in the Program
4	3

AP.4 = Teachers talk about conversations they have with students about their online assessment results and how they collaboratively determine next steps based on results.

First Year of the Program	2+ Years in the Program
0	2

AP.5 = Teachers talk about students monitoring their own progress and making decisions about their own learning using online formative assessments *(e.g., My Access, teacher-created online assessments, Benchmark Assessments, Links to other online assessments or games that give results, SLC discussions or online wikis, blogs).* Typically the students determine when and how often they will take the assessments to monitor their own learning and understanding or have choices in how to demonstrate their own understanding and have additional resources available to them that they can utilize on their own to improve.

First Year of the Program	2+ Years in the Program
1	2

AP.6 = Talk about students peer reviewing one another's work

First Year of the Program	2+ Years in the Program
0	1

AP.7 = Alternative assessments such as students presenting information that they have learned to the class using technology is described

First Year of the Program	2+ Years in the Program
1	0

AP.8 = Teachers talk about using data to change their teaching practices (e.g., using data to group students differently)

First Year of the Program	2+ Years in the Program
2	2

AP.X = Teachers talk about assessment practices in ways that are not described above.

Please describe.

First Year of the Program	2+ Years in the Program
0	0

Student Community of Practice = S-CoP

Instructions: Read through the whole interview. Determine if there has been any discussion of how students collaborate and lean within their community of peers and experts. If so, code the entry once with the highest appropriate code.

S-CoP.0 = Teachers do not talk about students collaborating and learning from a community of peers and experts

First Year of the Program	2+ Years in the Program
3	1

S-CoP.1 = Teachers talk about students collaborating and learning from one another as episodic and teacher directed. For example, there may be a group project as part of a unit that they assign.

First Year of the Program	2+ Years in the Program
0	1

S-CoP.2 = Teachers describe students as constantly engaged in collaborating and co-constructing knowledge within their community of peers and experts.

First Year of the Program	2+ Years in the Program
3	5

S-CoP.X = Teachers talk about students collaborating and learning within a community of peers and experts in ways not described above. Please describe.

First Year of the Program	2+ Years in the Program
0	0

Change in Communication Practices = C-Com

Instructions: Read through the whole interview. Determine if there has been any discussion of how communication practices have changed over time. If so, code the entry once with the highest appropriate code.

C-Com.0 = no mention of change in communication or negative change

First Year of the Program	2+ Years in the Program
0	0

C-Com.1 = Mentions change but does not specify what has changed, just change has occurred

First Year of the Program	2+ Years in the Program
1	1

C-Com.2 = Mentions positive change, gives details or an example of how technology is changing communication in the classroom

First Year of the Program	2+ Years in the Program
3	3

C-Com.X = Mentions change in ways not described above. Please describe.

First Year of the Program	2+ Years in the Program
0	0

Troubleshooting = TS

Instructions: Read through the whole interview. Determine if there has been any discussion of troubleshooting occurs. If so, choose any of the codes below that apply.

TS.0 = No mention of troubleshooting

First Year of the Program	2+ Years in the Program
3	5

TS.1 = Teacher describes how they handle technology problems primarily themselves

First Year of the Program	2+ Years in the Program
0	0

TS.2 = Teacher describes getting help from outside of the classroom

First Year of the Program	2+ Years in the Program
2	1

TS.3 = Teachers allow and encourage students to help them troubleshoot and/or describe students helping one another troubleshoot

First Year of the Program	2+ Years in the Program
0	0

TS.X = Teachers talk about troubleshooting in ways not described above. Please describe.

First Year of the Program	2+ Years in the Program
0	0

Professional Development = PD

Instructions: Read through the whole interview. Determine if there has been any discussion of professional development experiences related to the 1-to-1 program. If so, code the entry once with the highest appropriate code.

PD.0 = Professional development is not mentioned or is seen as a negative factor

First Year of the Program	2+ Years in the Program
0	1

PD.1 = Professional development is mentioned as an important factor

First Year of the Program	2+ Years in the Program
3	3

PD.2 = Professional development is seen as an extremely important factor and teachers feel that they could not have effectively implemented the program without it.

First Year of the Program	2+ Years in the Program
2	2

PD.X= Professional development is mentioned in ways not described above. Please describe.

First Year of the Program	2+ Years in the Program
0	0

Technical Support = TSup

Instructions: Read through the whole interview. Determine if there has been any discussion of technical support teachers received. If so, code the entry once with the highest appropriate code.

TSup.0 = Technical Support is not mentioned or is seen as a negative factor

First Year of the Program	2+ Years in the Program
4	4

TSup.1 = Technical Support is mentioned as an important factor

First Year of the Program	2+ Years in the Program
1	2

TSup.X = Technical Support is mentioned in ways not described above. Please describe.

First Year of the Program	2+ Years in the Program
0	0

Administrative Support = AdminS

Instructions: Read through the whole interview. Determine if there has been any discussion of administrative support teachers received. If so, code the entry once with the highest appropriate code.

AdminS.0 = Administrative Support is not mentioned or is seen as a negative factor

First Year of the Program	2+ Years in the Program
4	4

AdminS.1 = Administrative support is mentioned as an important factor

First Year of the Program	2+ Years in the Program
1	2

AdminS.X = Administrative support is mentioned in ways different than listed above. Please describe.

First Year of the Program	2+ Years in the Program
0	1

Student Technical Skills = S-TechSk

Instructions: Read through the whole interview. Determine if there has been any discussion of students' technical skills. If so, code the entry once with the most appropriate code.

S-TechSk.0 = Teachers do not mention differences in student technical abilities

First Year of the Program	2+ Years in the Program
3	3

S-TechSk.1 = Teachers mention differences in student technical abilities as a challenge

First Year of the Program	2+ Years in the Program
0	0

S-TechSk.2 = Teachers talk about strategies they use to help students with different technical abilities.

First Year of the Program	2+ Years in the Program
2	0

S-TechSk.X = Teachers talk about differences in student technical abilities in ways different than described above. Please describe.

First Year of the Program	2+ Years in the Program
0	2

Teacher Identity = T-Id

Instructions: Read through the whole interview. Determine if there has been any discussion of changes in teacher identity as a result of the 1-to-1 program. If so, code the entry once with the highest appropriate code.

T-Id .0 = no mention of change in teacher identity is given

First Year of the Program	2+ Years in the Program
4	2

T-Id.1 = Teachers describe the 1-to-1 program as a way to manage traditional practices more efficiently *(e.g., easier to do worksheets online, turn in papers and manage traditional student work, using the IWB to effectively disseminate information)*

First Year of the Program	2+ Years in the Program
0	2

T-Id.2 = Teachers describe their role as different or changed since the beginning of the program *(e.g., more time to do one on one conferencing, more time spent giving feedback on discussion boards instead of delivering direct instruction, more time setting up their SLC at home and then circulating and monitoring learning or answering student generated questions instead of disseminating information)*

First Year of the Program	2+ Years in the Program
1	1

T-Id.X = Teachers talk about their identity changing in ways not described above. Please describe.

First Year of the	2+ Years in the

Program	Program
0	2

Student Identity = S-Id

Instructions: Read through the whole interview. Determine if there has been any discussion of changes in student identity as a result of the 1-to-1 program. If so, code the entry once with the highest appropriate code.

S-Id.0= no mention of change in student identity is given

First Year of the Program	2+ Years in the Program
0	3

S-Id.1 = teachers mention change in student identity *(e.g., students are more responsible, engaged in their own learning, assess their own progress, actively help others, are seen as experts by their peers or others outside the classroom)*

First Year of the Program	2+ Years in the Program
5	3

S-Id.X = Teachers mention student identity in ways that are different than the descriptions above. Please describe.

First Year of the Program	2+ Years in the Program
0	0