A Virtual Water Cooler: The Ecology of an Online Community of Practice to Support Teachers' Informal Learning

by

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Abstract

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Students with visual impairments require accessible instructional materials and differentiated instruction to meet learning needs that are impacted by vision loss. Teachers of students with visual impairments (TVIs) are responsible for addressing the specialized needs of learners who are blind or visually impaired, which include instruction in the use of technology. This area of instruction is crucial among the other tasks of a TVI, because students who are proficient technology users can more independently access classroom content in a timely fashion and report improved postsecondary and employment outcomes. However, a majority of TVIs remain unprepared to use and teach technology. Although challenges in technology adoption were similarly identified and largely overcome by general education classroom teachers, several barriers remain unmitigated for TVIs.

This dissertation addresses and tackles this discrepancy. Among the many challenges found in TVIs' work, the lack of an organizational space is discussed as a major factor that results in a dispersed practice. Based on this premise, the study reinforces teachers' needs for regular, informal interactions that can support ongoing learning and advancement of basic skills learned in training. The study examines a group of TVIs who communicated in an online forum for one year following a face-to-face technology workshop. Findings of how this forum provided opportunities for learning support recommendations for the use of online communities to deliver ongoing and informal professional development. In carrying out research in this area of study that has been mostly anecdotal to date, recommendations for objective measures were also developed to more accurately evaluate TVI learning and implementation of technology.

The study adopts a mixed methods approach to analyze online informal TVI interactions around what is referred to as a *virtual water cooler* (VWC). The VWC concept was conceived to bridge theoretical constructs in several areas of the literature, including communities of practice, social networks, workplace organization, and computer supported collaborative learning. Initial analyses of online teacher interactions confirmed that this group of teachers indeed behaved as a community of practice according to Wenger's (1998) dimensions—domain of interest, practice, and community. Observational data (messages posted on the Yahoo Group) were coded, and it was found that 68% of the communications exchanged between teachers were characteristic of a CoP. Social network analysis (SNA) noted the ebb and flow of participation and expertise among

members of the group and contributed further evidence that this online forum was a CoP that emulated face-to-face informal teacher interactions. Lastly, interview data were analyzed to identify the mechanisms by which this VWC supported the development of an online CoP and its benefit to developing TVIs' technology proficiency in using the iPad with students. The results included evidence of teacher learning, support and encouragement of colleagues' technology use, along with changes in pedagogy related to how technology was implemented with students.

Regarding practical implications of this research, this VWC was found to overcome barriers of time and professional isolation in learning and using technology as reported in the literature. The VWC provided an avenue for on-demand professional development, moral support, and resources on a case-by-case basis that extended beyond the basic knowledge learned in the iPad workshop. Overall, the VWC served as an online community of practice that advanced knowledge gained in initial technology training, provided informal and ongoing professional development, and ultimately influenced several TVIs' teaching practices.

Implications for research practices were also found in this study. Self-reports of technology use were found to be unreliable and recommendations support use of more objective measures to evaluate TVIs' technology proficiency. Measures to determine the efficacy of technology training also support needs for longitudinal rather than immediate evaluation measures following a workshop. Based on TVIs' implementation of the iPad and changes in their overall practice in the year following the initial training, membership to a CoP was found to be effective in supporting TVIs' technology proficiency.

Keywords: community of practice, visual impairments, technology training, professional development, itinerant teaching

Dedication

To my students,
So that you may reach your dreams and potential free of any disability at all.

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Words cannot possibly express the gratitude and appreciation for all the people who made this work possible. From students to friends and family, I learned that it truly takes a village to persevere through challenging endeavors. My willful independence was humbled so many times into what has become an understanding that despite anyone's greatest ambitions, a community is critical for individual success. This community spirit is what underlies the core of my dissertation.

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Chapter 1: Introduction

A number of federal standards have established and prioritized information technology use in the American school system (Section 504 of the Rehabilitation Act, 1977; No Child Left Behind [NCLB], 2002; Technology, Education and Copyright Harmonization Act [TEACH], 2002; Assistive Technology Act, 2004; Individuals With Disabilities Education Act [IDEA], 2004). Technology is now prevalent and increasingly available across different school and student demographics, shifting the digital divide in education from availability of tools to the ability of a teacher to integrate technology in the classroom (Gray, Thomas, & Lewis, 2010). In addition to the climate of increased technology use in schools, students with disabilities generally have more reliance on more technology than students without disabilities in order to accommodate different learning and communication styles (Lenhart et al., 2003). For students who are visually impaired, the need is even greater to facilitate independent and timely access to instructional materials, mainstream technology, and information in both academic and community settings. Technology skills are directly related to improved postsecondary and employment outcomes (Kelly, 2008), and taught by teachers of students with visual impairments (TVIs) (Hatlen, 1996). However, chronic underuse of technology by TVIs remains a problem (Abner & Lahm, 2002; Edwards & Lewis, 1998; Kapperman, Sticken, & Heinze, 2002; Kelly, 2009, 2011).

Traditional barriers to TVIs' use of technology include: lack of availability of assistive technology (AT), funding, and accessible materials (Abner & Lahm, 2002; Edwards & Lewis, 1998; Kapperman et al., 2002; Parker, 1990); inconsistent training across TVI preparation programs (Smith & Kelley, 2007); and lack of standardized competencies to guide AT instruction in pre-service teaching programs (Safhi, Zhou, Smith, & Kelley, 2009). Since these barriers were identified, federal initiatives have directly addressed the funding and provision of AT and accessible materials (American Printing House for the Blind, National Instructional Materials Access Center, World Wide Web Consortium, U.S. Office of Special Education Programs). Assistive technology competencies have also been developed and validated for adoption into TVI preparation programs (Smith, Kelley, Maushak, Griffin-Shirley, & Lan, 2009; L. Zhou et al., 2012). Unlike similar interventions to improve general education classroom teachers' use of technology, these initiatives have not significantly affected TVIs' use of technology, and students who need direct technology instruction remain undereducated and underprepared for postsecondary education and employment.

This work re-visits the question "How can we improve TVIs' use of technology so that students who are blind or visually impaired are readied for success?" The nature of the problem will be framed within current expectations for technology use in the classroom, and how the shift from paper to digital media provides more challenges *and* opportunities than ever before. Section 2 reviews current trends and practices, including interventions that have been carried out thus far. Areas for improvement are identified for the development of differentiated supports specific to TVIs and itinerant teachers. Section 3 proposes renewed application of a community of practice (CoP) as an operational framework for a model of intervention, and interweaves two theories for grounding this intervention in a virtual space for professional development. Section 4 examines an ongoing virtual community of practice following face-to-face technology training. Section 5 describes a mixed methods approach that investigates whether or not this type of virtual community of practice is an effective substitution for the situated professional learning communities that most itinerant TVIs lack, and if so, probes how this model of professional

development could innovate knowledge gained in initial training for novel application in the classroom. Section 6 discusses if and how this type of CoP effectively changes teachers' practices to finally mitigate the gap between available technologies and TVIs' use of it to prepare students for future success.

Statement of the Problem

Most school-based TVIs teach in an itinerant capacity and maintain caseloads that commonly change from year to year. Their students span from preschool to high school students with varying ranges of vision loss, cognitive abilities, and multiple disabilities (Sacks & Silberman, 1998). TVIs therefore adapt their skills from year to year, depending on student caseload and variable classroom demands as students move through each school year.

In addition to meeting shifting student and classroom needs, TVIs must use various tools to provide accessible instructional materials. While simpler assistive technologies such as Perkins braillewriters and video magnifiers (Figure 1) remain fairly stable, more sophisticated technologies such as mobile devices and specialized braille displays are updated often and new tools developed constantly (Figure 2).

Figure 1. Perkins Braillewriter and Portable Video Magnifier

Figure 2. iOS Accessibility Menu and Refreshable Braille Display with iPad

Consequently, initial technology instruction received in pre-service training might not be applied immediately in the field and also be irrelevant depending on how many years pass until a TVI supports a student with specific technology needs. Regular update of a TVI's technology knowledge is therefore critical to maintain teaching effectiveness. Without ongoing professional development, a TVI's knowledge base quickly becomes obsolete. Outdated technology knowledge leads to inappropriate decision-making when selecting tools for students. As a result,

decisions are driven by technology constraints rather than student learning needs and appropriate representation of the instructional materials (Mishra & Koehler, 2006).

General education teachers also face similar challenges in technology adoption in the classroom, however professional learning communities situate ongoing support and training within a school, and regular staff development days throughout the school year update what teachers are expected to know and implement. For those TVIs who are district employees and not independent contractors, district sponsored staff development is often not relevant because content is unrelated to serving students with visual impairments.

Although professional learning communities abound in general education, there is less availability and connection to a professional learning community for TVIs, especially for those who work in itinerant roles (Kapperman et al., 2002). Itinerant TVIs generally do not belong to the community of any given school, since they merely pass through to provide services to their student and might only collaborate with that student's teachers. Due to the low incidence of students with visual impairments, a TVI may never even encounter another TVI throughout the course of a typical school day, week, or month (Kapperman et al., 2002; Swenson, 1995). It might be difficult to locate another TVI across the physical distances that span school sites, and the sparse availability of TVIs across districts forces connections with colleagues through virtual media such as email, listservs, phone calls, or videoconferencing. For teachers who shy away from using technology, face-to-face interactions with other TVIs may be limited to annual conferences. However, even these activities might be missed if a TVI is not provided adequate time or funding to attend them.

The combination of these factors has contributed to the chronic underuse of technology by TVIs. Infusions of funding, availability of accessible instructional materials, and technology instruction in teacher preparation programs have not proven adequate to prepare TVIs to implement technology in their practice. Emphasizing better connections with a community of practice may be one overlooked solution in developing TVIs' technology proficiency (Siu & Morash, 2014). Although it is difficult for all teachers to engage in professional conferences as professional development, these additional challenges in connecting with a physical community of peers who share the same training needs is unique to itinerant teachers who work with low incidence populations (Correa-Torres & Howell, 2004; Yarger & Luckner, 1999)

Significance of the Problem

The term "digital divide" was initially minted to describe "an economic inequity between groups [at different socioeconomic and demographic levels], in terms of access to...[and] use of information and communication technologies" ("Digital divide," 2013). In general education, the problems of access to technology existed between metropolitan and rural schools, and between students from different socioeconomic backgrounds. As digital infrastructures improved, several federal mandates were implemented to increase overall technology use in the classroom and to encourage classroom teachers' technology integration into their teaching. Two federal reports document outcomes of these efforts and show an increase from 53% of classroom teachers using technology in 1999 (Smerdon et al., 2000), to 69% in 2009 (Gray et al., 2010).

This uptake of technology in classrooms and among general education teachers has resulted in better access to, and more prevalent use of technology by students in general education. As a result, more classrooms use digital educational materials, and students are more likely to navigate technology throughout their day in order to carry out academic activities. As technology use among general-education students has risen to 96% (Interactive, 2010), the

digital divide has receded for this demographic while remaining problematic for students with visual impairments, with only 32% of reported technology users among this population (Kelly, 2009, 2011).

Typical classroom technologies include use of overhead projectors, word processing software, computers, and information access via the internet (Smerdon et al., 2000). While suitable for the typical student, these devices and programs are not designed specifically for use by students with visual impairments. Knowledge of add-on and accessibility options is required for inclusive access to mainstream technologies. Conversely, specialized technologies for people who are blind or visually impaired are not designed for use by individuals without disabilities, including sighted TVIs and classroom teachers. Knowledge of adaptations is likewise required for sighted access to nonvisual technologies. As a result, mainstream tools often require modification for accessible use, and specialized tools require instruction by someone who understands the accessibility needs of someone who is visually impaired. Although students may develop more sophisticated technology skills on their own, most require at least a minimal introduction to a device or program and need school support to procure and implement technology in the classroom. On an educational team, a TVI is the specialist who is charged with providing this differentiated instruction on assistive technology (Hatlen, 1996). In other words, the TVI is a student's gatekeeper to technology; if a TVI does not lobby for the equipment and provide this instruction, others are often not adequately equipped with understanding the nuances of assistive technology and pedagogical needs of students with visual impairments to provide the appropriate tools and support.

Technology affords students with visual impairments independent and timely access to instructional materials, as well as more successful postsecondary and paid employment outcomes (Kelly, 2008). Consequently, the shift from paper to digital media in classrooms allows more opportunities for independent and immediate access to information depending on the accessibility of the materials and technology skills of the student. The modernized nature of digital instructional content now places more emphasis on all students' development of technology proficiency and quickly becomes a barrier to access when a student is not equipped with the appropriate tools. Simple provision of tools is insufficient though. As mentioned earlier, nonvisual access to information requires differentiated implementations of mainstream and specialized technology. Technology users naturally update skills to meet their own needs, but teachers must consciously update their knowledge of tools and implementation in order to attain and maintain technology proficiency. Section 1.5 provides a more in-depth definition of technology proficiency for TVIs.

Relevance of this Study

Given that prior interventions such as increased funding, increased availability of accessible instructional materials, and development of standards in teacher preparation programs have not effectively changed reported usage of technology among TVIs, this study evaluates a different model of intervention for technology training and professional development. Students who are blind or visually impaired cannot afford to wait for future generations of TVIs who are already comfortable with using technology; current teachers need access to resources now, and teaching practices must update to adapt to the current state of digital media and technology use in classrooms.

Membership to a community of practice (CoP) comprised of other TVIs who use technology with students may be a crucial missing link between procedural knowledge (how to

operate a device) and the development of more sophisticated conceptual knowledge that includes understanding of the interplay between technology, student learning, and content matter. If such membership can be associated with building technology proficiency, this model may be an effective form of professional development that supplements a potentially expired foundation of knowledge from pre-service training and update TVIs' practices as student and classroom needs change (Siu & Morash, 2014).

TVIs are typically itinerant teachers and teach in isolation from one another. Due to the lack of shared physical spaces for face-to-face interactions, the most accessible form of CoPs might be those that reside in virtual spaces. This digital iteration of a CoP invites another layer of complexity: How can technology be used to mediate technology instruction, particularly when learners are not already comfortable with using technology in their own practice? This study considers the intricacies of online social networks to probe if and how virtual interactions might be an acceptable substitution for face-to-face professional learning communities. The nature of participants' roles in a virtual CoP is examined for the quality of information that is exchanged and for changes in teachers' practices that result from participation in the virtual CoP. This type of intervention might also serve as an example for learning via peer modeling. In this way, teachers can learn through each others' experiences by presenting case studies to develop skills (Koehler & Mishra, 2005).

If a virtual CoP is found to be an effective model of professional development, TVI preparation programs might infuse instruction on how to find and access these CoPs within university coursework and prepare future teachers to use virtually mediated forums to support their own practice. Technology trainers may also consider facilitation of a virtual CoP to bridge device-specific training to practice and facilitate better implementation of new technologies into the classroom.

Hypotheses

This study rests on three hypotheses:

1. Interactions with colleagues in a virtual space can serve as a community of practice that updates TVIs' technology skills for specific applications not directly taught in training.
2. Teachers who participate in a virtual CoP are more likely to translate device-specific knowledge gained from training to implementation of technology with students.
3. Engagement in a virtual CoP is an adequate substitution for a physically situated professional learning community.

The crux of this research lies in the evaluation of a particular online group, and whether or not this type of social media can be appropriated as a community of practice. Although mediated in a shared space, it is the nature and quality of discussions that defines the forum as a CoP, rather than use of a specific virtual platform (K. Kreijns, Kirschner, & Jochems, 2003). These discussions should reflect exchanges of knowledge that result in changing teachers' practices, and utilize a combination of peer modeling and peer supports to do so in the virtual space. In order to match similar outcomes from physically situated professional learning communities, this virtual CoP should also include information beyond device-specific troubleshooting. Transformation of device-specific knowledge gained in training to classroom applications as dictated by student and classroom demands will provide evidence of an intellectual community that fosters critical thinking and elevates one another's teaching practices, rather than an online support group that provides emotional support but does not build skills (Ching & Hursh, 2014).

Definition of Terms

Assistive technology. The legal definition of assistive technology (AT) is "any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (Assistive Technology Act of 2004, 29 U.S.C. Sec 2202(2)).

AT differs from the more generalized concept of technology because it enables students with disabilities (such as visual impairment, physical disability, or learning disability) access to, and exchange of information. This information may include educational software, computers, the internet, media, and social networks. In this paper and ensuing discussions, AT will refer to a specialized subset of assistive technology, and focus on high tech resources for accessing and communicating visual information to and from students who are visually impaired. This type of AT includes electronic and computer-based technologies such as video magnifiers, braille technology, optical character recognition systems, speech systems, and magnification and other display modification programs for the computer screen. Other examples include software to read text on a computer screen, or hardware (devices) that provide books auditorially or via a refreshable braille device. Students' AT systems often include a combination of both software and hardware to translate visual (print, web, images) information into an accessible format such as large print, auditory output, braille, or both. These systems may also include specialized or mainstream technologies, or a combination of both.

(Itinerant) Teacher of students with visual impairments (TVI). TVIs earn and maintain a professional certification that qualifies them to teach students who are blind or visually impaired. TVIs possess an overall knowledge of the general education curriculum in order to recommend appropriate accommodations, but carry out direct instruction in all areas of the expanded core curriculum (ECC). The EEC includes instruction in: compensatory/functional academic skills, orientation and mobility, social interaction skills, independent living skills, recreation skills, career education, use of assistive technology, sensory efficiency skills, and self-determination (Hatlen, 1996). As of 2011, approximately 89 percent of the population of students with visual impairments was educated within a general education setting. The remaining 11 percent were served in one of the 49 schools for the blind in the United States (Texas School for the Blind and Visually Impaired, http://www.tsbvi.edu/instructional-resources/2785-schools-for-the-blind-in-the-united-states), or in other self-contained classrooms for students with disabilities ("IDEA Data Part B Educational Environments," 2011). By extension, most students with visual impairments are served by itinerant TVIs who travel from between schools through each day, depending on the location of each student on their caseload.

AT proficiency. Several external factors can influence TVIs' technology use, including extent of pre-service training, continued AT training in professional development, and availability of funding sources for AT. AT proficiency might also depend on having a student who requires AT, and perceiving that the specific device is more supportive of a student's learning than other (non-technology) instructional tools (Hu, Clark, & Ma, 2003; Kamei-Hannan, Howe, Herrera, & Erin, 2012). It is only through experience with a student who requires a particular AT that a TVI gains competency and becomes a proponent for using that AT. Because student caseloads can vary from year to year and technology is always changing, it is impossible for a TVI to be competent in all the AT that might be relevant to future students. Therefore, it is more important for the TVI to have a foundational knowledge of what is available, and venues

for support and training. This implies that continued professional development and resources for using AT may be just as important as pre-service training.

The term AT proficiency refers to the combination of skills a TVI requires for effective AT use. These skills include being able to choose an AT, which partly depends on the TVI's prior knowledge of available AT and connection to colleagues for other opinions. The TVI's ability to find funding, use and troubleshoot an AT device, and willingness to integrate AT into lessons also contribute to a TVI's AT proficiency. These skills are common aspects of AT competencies that experts believe should be taught in assistive technology training programs (Smith et al., 2009) and were more specifically delineated along a scaled rubric by myself and Morash (2014) (Table 1).

Table 1. Construct for TVI's AT Proficiency (Siu and Morash, 2014).

Individual's AT Proficiency	**Dimensions**			
	Choosing	**Funding**	**Ability**	**Integration**
	Resources used to choose an AT:	Resources used to fund an AT:	Ability to use AT:	Integration with AT into lessons:
Highest (6)	Chooses AT with or without help from AT experts.	Contacts specific sources at district, state, and federal levels.	Can use AT. Troubleshoots by reaching an expert, or consulting a manual.	Uses AT for designated and other tasks.
High (5)	Chooses AT with help from various colleagues who are not AT experts.	Looks for district, state, and federal funding sources.	Can use AT. Troubleshoots with manual or a colleague.	Uses AT for designated tasks. Is open to using it for other tasks, but doesn't know which ones.
Medium (4)	Chooses AT based on familiar experience.	Ask, then lobby district, local community, or parents.	Can only use with directions or after specific training.	Uses AT only for designated tasks.
Low (3)	Chooses AT based on anecdotal information.	Ask and depend on district.	Can use only with ongoing support from colleague.	Uses AT only for designated tasks, when non-AT solution is unavailable.
Ambivalent	Does not know	Believes	Does not know	Unsure how to

(2)	how to choose AT.	funding is unavailable.	how to use AT.	integrate AT.
Aversive (1)	Believes choosing AT takes too much time and effort.	Believes finding funding would take too much time and effort.	Believes learning to use AT takes too much time and effort.	Believes AT distracts from learning goals.

Accessible instructional materials (AIM). The No Child Left Behind (NCLB) Act of 2001 introduced educational reforms aimed at closing the achievement gap in all American students. These reforms include: setting high standards, developing instruction according to measurable individualized goals, and appropriate assessments for all students regardless of (dis)ability. The re-authorization of the Individuals with Disabilities Education Act (IDEA) in 2004 further mandated States to provide instructional materials to children with disabilities in a timely manner. IDEA charged State Educational Agencies (SEAs) to take all reasonable steps to provide instructional materials at the same time as students without disabilities. In order to meet the needs of students with visual impairments, AIM has traditionally included the provision of braille and/or large print, and tactile graphics (raised line drawings). Shifts to digital content in classrooms now challenge AIM to include image and video descriptions as well, in order to accommodate multimedia instructional materials (D'Andrea & Siu, 2015).

Community of practice. A Community of Practice (CoP) as developed by Wenger, McDermott, and Snuder (2002) describes the relationship between a teacher and his/her professional support network through which he/she receives continuing professional development. This particular conceptualization of a CoP refers to the voluntary and on demand membership, exchange, and dissemination of knowledge in informal professional networks. It includes the concepts of practice, domain of interest, and community. These dimensions are defined as follows:

- ***Domain of interest***. Members invest in a shared collection of knowledge, goals, and purpose to their actions. These mutual interests inform their actions.
- ***Community***. Members interact with one another by sharing ideas, posing questions, and responding to others' issues.
- ***Practice***. Members share the same "toolkit" comprised of tools, information, anecdotes, and resources. The community develops and maintains this body of knowledge, and leverages it to inform the domain of interest.

Chapter three further examines the constructs and detailed definition of a CoP within the context of this study. In the meantime, chapter two reports more information on current trends and practices in the field of visual impairment and technology use.

Chapter 2: Review of Current Trends and Practices

Since the inception of information technology in education, classroom teachers have been scrutinized for their use of technology in carrying out instructional activities. Barriers that affect technology use in the classroom are typically discussed across several domains:

1. Student demographics (e.g., use of computers in the home, percentage of students in free school lunch program)
2. Teacher demographics (e.g., number of years teaching, pedagogical beliefs, amount of pre-service and in-service training)
3. School demographics (e.g., socioeconomic status of school, location (suburban vs. rural), level of district/administrative support)
4. Infrastructure of resources (funding for technology, access to internet, tech support)

These domains have informed many strategies to improve teachers' use of technology. Examples of how barriers to technology use have been mitigated include: Adoption of laptop programs in schools, addition of technology components to teacher preparation programs, and improvement of the physical capabilities of schools to support computers and internet access. Simultaneously, another body of knowledge outside of these domains centers on other contextual factors that affect technology use in the classroom. Situated learning (Lave & Wenger, 1991), professional communities of learning (A. L. Brown & Campione, 1994; DuFour & Eaker, 1998), and communities of practice (Palincsar, Magnusson, Marano, Ford, & Brown, 1998; Etienne Wenger, 2000) are theories popularly applied to improve technology integration and inform interventions that support teachers' use of technology in the classroom.

In the narrower field of special education and the use of assistive technology (AT) with students with visual impairments, the gap between technology and its use has been identified across domains similar to those applied in general education:

1. Students' use of AT at home (e.g., parental involvement)
2. Teacher training in AT (e.g., in teacher preparation programs, ongoing professional development to match evolving technologies)
3. Funding for specialized devices and software

Unlike general education teachers, TVIs are more often considered the gatekeepers of students with visual impairments' use of AT. Use of AT by this population of students requires direct training (i.e., cannot be learned incidentally), is more expensive than typical classroom technology, and is something most parents do not readily understand or can afford to provide at home. As a result, analyses of TVIs' non-use of AT typically focuses on the teacher rather than student and contextual domains (Kapperman et al., 2002). Most strategies aimed at improving TVI's use of AT target teacher preparation programs and expanding TVIs' content knowledge of devices and software programs.

As improved access to and implementation of advanced classroom technology continues to close the digital divide for typically sighted students, the increasingly complex visual nature of this technology simultaneously threatens to intensify the accessibility divide between blind or visually impaired students and their sighted peers.

Classroom trends

Technology use in general education. The United States Department of Education conducted national surveys in 1999 and 2009 in order to assess general education teachers' technology. From this data, the Institute of Education Sciences (IES) reported technology use in

public school classrooms. Applications of educational technology that potentially impact nonvisual learners are summarized in Figure 3.

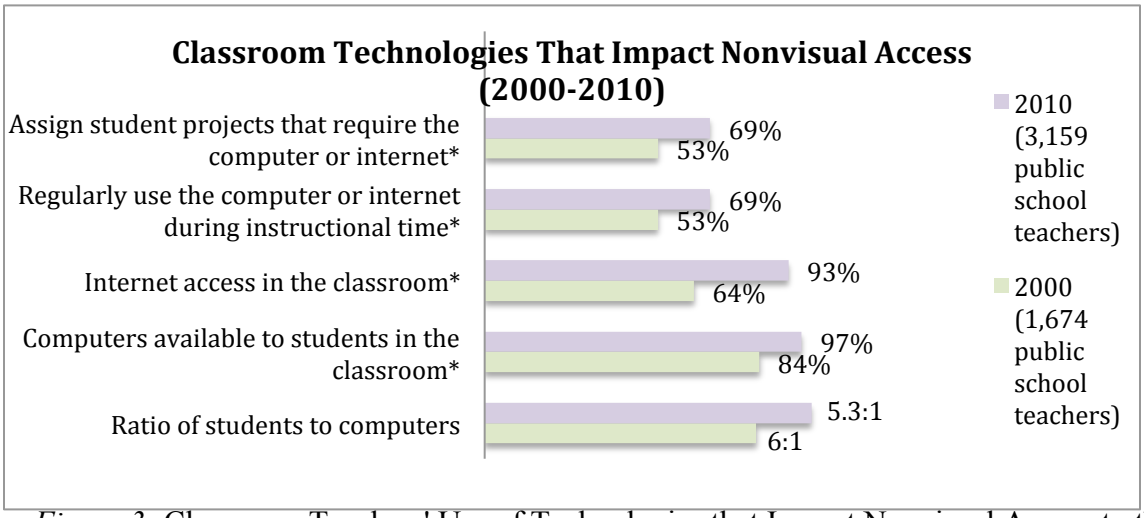


Figure 3: Classroom Teachers' Use of Technologies that Impact Nonvisual Access to the Curriculum (Gray et al., 2010; Smerdon et al., 2000)
* Percentage of public school teachers reporting this feature

Public school teachers in all areas of the country responded to the survey. Of these responses, school demographics covered the spectrum from urban to rural, and encompassed student demographics from all socioeconomic levels. While the report from 2000 showed some differences in technology use across school and student demographics, these variations dissipated in the 2010 report. Therefore, Figure 1 reports technology use as averaged numbers rather than parsing out differences among school and student demographics.

Implications of increased usage of classroom technology. These reports indicate that classroom materials overall are increasingly visual and technology-based. Projected presentations in lieu of paper handouts place students with visual impairments at a disadvantage because they cannot use a low-tech device such as a magnifier to access a projected screen or whiteboard. While these digital presentations could be potentially accessed from a student's desktop via a tablet or laptop computer, the student who is visually impaired is likely to require additional screen magnification or reading software, or braille display to even access the computer. Similarly, use of the internet or the computer to complete assigned projects would require additional assistive technology to access basic classroom technology. In both cases, AT is an essential tool that is needed to access electronic information independently at the same time as sighted peers.

Provision of accessible electronic materials in the classroom. The No Child Left Behind (NCLB) Act of 2001 introduced educational reforms aimed at closing the achievement gap in all American students. These reforms include: setting high standards, developing instruction according to measurable individualized goals, and appropriate assessments for all students regardless of disability. The re-authorization of the Individuals with Disabilities Education Act (IDEA) in 2004 further mandated States to provide instructional materials to children with disabilities in a timely manner. IDEA charged State Educational Agencies (SEAs) to take all reasonable steps to provide instructional materials at the same time as students without disabilities. In order to meet the needs of students with visual impairments under these mandates,

assistive technology and accessible media were urgently needed to access the educational curriculum and assessment materials.

In 2006, A National Instructional Materials Accessibility Standard (NIMAS) was established to mandate high quality materials to people with print disabilities in a timely manner. To support this standard, a National Instructional Materials Access Center (NIMAC) was a created and still serves as a central national repository to "house" digital files from publishers for access by authorized users such as TVIs and their students. Several national private and public accessible book libraries (Learning Ally, Bookshare, Library of Congress) also collaborate with the NIMAC to offer digital talking books (DTBs) and periodicals in addition to textbooks. DTBs have the advantage of being read in multimedia formats including audio, braille, and large print for immediate access by students with print disabilities.

Despite the increased availability of these accessible instructional materials, students who are blind or visually impaired remain at a disadvantage when they are ill prepared to use the technology needed to access educational content.

Teachers' technology use

Over the course of a decade, general education teachers have made observable changes in their use of classroom technology (Figure 4).

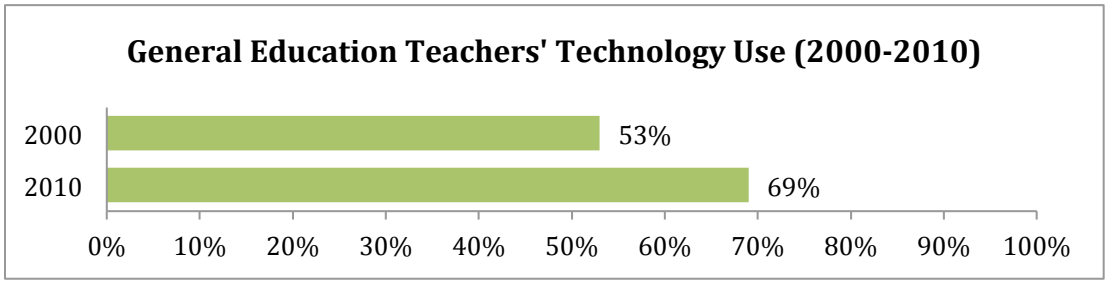


Figure 4. Percentage of general education teachers who used classroom technology in 2000 and 2010. **(Gray et al., 2010; Smerdon et al., 2000)**

In contrast, TVIs technology use has not varied as much between 1990 and 2002. Since the first survey of 120 TVIs reported that less than 50 percent of TVIs used AT (Parker, 1990), other replications in various states have not shown major differences in the number of TVIs who use technology with students (Figure 5). Another analysis of students from a national dataset also implies few changes in TVIs' technology use based on student outcomes (Kelly, 2011).

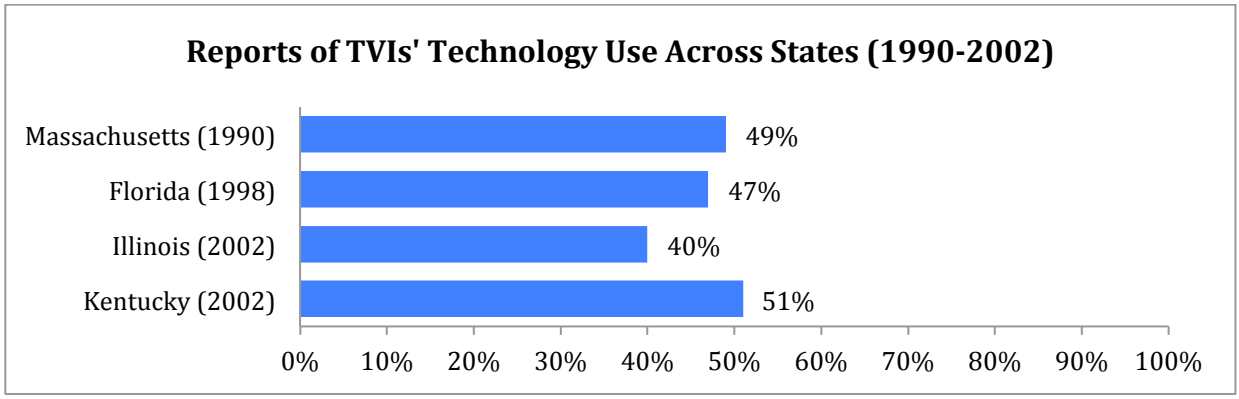


Figure 5. Reports of TVIs' technology use across states from 1990-2002. (Abner & Lahm, 2002; Edwards & Lewis, 1998; Kapperman et al., 2002; Parker, 1990)

Students' technology use

Students without disabilities. At the time of the 2010 report, the IES found that over 50 percent of teachers required students to use educational technology to write, create or use graphics or visual displays, learn or practice basic skills, or conduct research. Outside of the classroom, an astonishing 92 percent of students were found to be socializing online (Interactive, 2010). These findings indicate a high level of technology use for exchanges of information among students within and outside of their educational environment.

Students who are blind or visually impaired. Students with visual impairments require some level of assistive technology for mere access to and exchange of information in both the classroom and community. As a result, the conjunction of technology and accessibility creates a different kind of digital divide between students with visual impairments who can and cannot use assistive technology. From 1999 to 2004, the Office of Special Education Programs (OSEP) of the U.S. Department of Education conducted a large-scale national policy survey of students receiving special education from birth to age 21. Within this dataset, Kelly (2009) used information from the Special Education Elementary Longitudinal Study (SEELS) to evaluate the current use of AT by elementary and middle school students with visual impairments. Spanning three waves of data collection, she found that between 29%-41% of students with visual impairments who could benefit from using AT were actually using it (p. 476). These students were identified as academically oriented, and therefore most likely to benefit from assistive technology to access standard educational content. In a later secondary analysis of the National Longitudinal Transition Study-2 (NLTS2), Kelly (2011) assessed the use of AT by academically oriented high school students with visual impairments, and found that an average of 42 percent were using assistive technology. The data replicated the findings from another study by Kapperman, Sticken and Heinze (2002) that identified a total of 341 students in Illinois who required alternatives to print materials in the classroom. Of these students who required some form of assistive technology to access instructional materials at the same time as their peers, only 40 percent were found to use assistive technology. The authors cautioned that their numbers might not be a realistic representation. Of 103 teachers of the visually impaired who were interviewed via a telephone survey, responses from 43 teachers were eliminated due to their inability to answer questions related to technology. Therefore, the actual percentage of students who needed and were using assistive technology was likely lower due to sample bias (p. 107).

These three studies illustrate a serious gap between assistive technology and use by students with visual impairments. This is important because use of AT by students with disabilities has been found to be a significant predictor of paid employment and successful transition to higher education and life (Freeland, Emerson, Curtis, & Fogarty, 2010; Kelly, 2011; Reed & Curtis, 2011, 2011; Wolffe & Candela, 2002; Yeager, Kaye, Reed, & Doe, 2006).

Assistive technology is a legally mandated tool intended to close the achievement gap for individuals with disabilities. Without AT, students with visual impairments cannot access many of the critical technological resources that have become the norm in student instruction. Nor can these students engage in comparable online social interactions; instead, students who are visually impaired must rely on another person (often an adult) to provide an accessible translation, a scribe to record and relay information, or wait weeks to months for a printed book to be

converted to braille or large print. The secondary and passive reception of information rather than primary access limits a student's own active interpretation of information, and often results in missing instructional content in addition to social isolation. Reliance on a scribe also increases the amount of time and frustration it takes for students to communicate their answers, and risks subjective interpretation of their work. AT affords students who are visually impaired independent and timely access to information, and equalizes opportunities for academic and social achievement with sighted peers.

In addition to optimizing online socialization, AT has been linked to increasing students with visual impairments' self-determination and quality of life. Although it has not been directly correlated to academic achievement (Freeland et al., 2010), AT is strongly linked to improved transition to postsecondary education and employment (Capella-McDonnall, 2005; Mull & Sitlington, 2003).

Interventions to date

Initial steps taken to improve students' use of technology included increased funding and availability of technology and accessible instructional materials. The literature on assistive technology also consistently cites a TVI's lack of AT-specific knowledge as a barrier to using it with their students (Abner & Lahm, 2002; Edwards & Lewis, 1998; Kapperman et al., 2002; Parker, 1990). More recently in 2011, Zhou et al. surveyed 165 TVIs, and found that 58 percent "lacked adequate confidence in teaching [AT]" (p.205). All of the participants reported that "their current levels of knowledge and skills were significantly lower than what they thought teachers of students with visual impairments in general should have" (p.205). These findings continue to report an enormous gap in TVIs' knowledge of AT and suggest needs for interventions in order to increase overall AT proficiency. In a previous study, I and Morash (Siu & Morash, 2014) defined four constructs that comprise AT proficiency in TVIs:

- Ability to choose appropriate AT
- Ability to secure funding for AT
- Ability to use AT
- Ability to integrate AT into lessons

As mentioned in Chapter 1 (Table 1), AT proficiency implies responsive teaching practices based on understanding student learning needs (pedagogy), classroom demands, challenges specific to subject content, and knowledge of the technology itself (Mishra & Koehler, 2006).

Development of AT standards in TVI personnel preparation programs. Insufficient AT training at the pre-service level is a factor that affects teachers' content knowledge of and confidence in their use of assistive technology with students who are visually impaired (Bausch & Hasselbring, 2004; Kapperman et al., 2002; Lesar, 1998; Parker, 1990; Smith & Kelley, 2007; Zhou, Parker, Smith, & Griffin-Shirley, 2011). In order to gauge how TVIs were being trained in AT, Smith and Kelley (2007) surveyed all 34 TVI preparation programs in the United States and found that assistive technology instruction was integrated into the existing curricula. However, methods of instruction and breadth of content differed between programs. AT coursework ranged from distance to hands-on instruction and 1-week to semester long programs. In cases where teachers graduated without this AT-specific course content, students with visual impairments did not use any assistive technology unless the TVI independently took on additional training later to learn the technology. This implies that a teacher without direct, mandatory AT training would have to rely on his or her own initiative to learn AT. This type of self-motivation could be

affected by external factors such as a teacher's own comfort level and interest in technology, availability of free time to pursue additional training, and personal or school district resources to pay for training.

In response to these findings, Smith, Kelley, Maushak, Griffin-Shirley, & Lan (2009) developed and recommended a set of 111 competencies to standardize AT instruction across personnel preparation programs. These competencies have been validated by the field at large, but adoption across programs remains undetermined (Zhou et al., 2012).

Professional development for practicing teachers. Regardless of the extent of preservice training received prior to teaching, most teachers typically rely on professional development to learn and maintain skills. Specifically, in-service trainings typically provide a venue for collaboration among stakeholders, varied learning activities, and mentor support (Rosenberg & Sindelar, 2005). Professional development in AT generally stems from building positive perceptions of usefulness and ease of integration of technology in the hopes of increasing teachers' self-efficacy (Hu et al., 2003). Although this approach influences the likelihood of a teacher to use AT in their practice, ongoing supports are necessary for teachers to overcome learning curves associated with technology (Teo, 2011) and integrate use despite challenges across various teaching environments (Copley & Ziviani, 2004).

Professional networks to support AT training. A great breadth of literature focuses on engagement with professional networks to support teachers' professional development. Often used theories in education include: Professional Communities of Learners (DuFour & Eaker, 1998), Communities of Learners (A. L. Brown & Campione, 1994), Situated Learning (Lave & Wenger, 1991), and Communities of Practice (Palincsar et al., 1998; E. Wenger, 1999). While interventions based on these theoretical frameworks have been applied to mostly general education teachers, similar models have not been developed and applied specific to TVIs. The final two sections of this chapter will discuss why pre-existing models of technology training and professional networks in general education are inadequate for TVIs, pose how other models might be more effective, and identify gaps in the literature that this study will address.

Differentiated Needs of TVIs and Itinerant Teachers.

The teaching environment varies drastically for TVIs, particularly those who teach in an itinerant capacity (Correa-Torres & Howell, 2004). Although students with visual impairments may be educated in different types of classrooms and schools, the Individuals with Disabilities Education Act (IDEA; P.L. 105-17) stresses student placement in the least restrictive environment. As of 2011, 89 percent of students classified as having visual impairments were educated within a regular school setting, with only 11 percent of this population educated in a self-contained environment away from peers without disabilities such as a school for the blind (IDEA Data Part B Educational Environments, 2011).

Challenges of itinerant teachers. Most TVIs therefore work in an itinerant capacity and travel to each school their students attend. Educational vision services are provided according to a student's individualized education plan (IEP), and the TVI may only see a student several times a week or month or only provide classroom support via consultation services. The majority of a student with visual impairment's time in school is spent with school personnel who are not specially trained to work with students with visual impairments. These personnel must rely on collaborations with and direction from the TVI. Features of service delivery in a typical TVI caseload result in a unique set of challenges that include: finding time to teach AT in addition to other areas of needed instruction, relying on non-specialists to implement accommodations and

tools, and limited membership to any given school community. Correa-Torres & Howell (2004) cite many challenges of itinerant teaching that reinforce differences between itinerant and classroom teachers and their teaching environment. In addition to the professional and physical isolation originally discussed by Olmstead (1995) and Yarger & Luckner (1999), those who teach in itinerant settings have also been found to use less AT than counterparts who teach in schools for the blind (Abner & Lahm, 2002; Kapperman et al., 2002).

Challenges in TVIs' technology training and implementation. Because students' needs for AT may vary from school year to school year, a TVI must constantly rotate the skills required for different technologies depending on his or her caseload. Not only does the quickly evolving nature of technology create challenges for teachers to stay current on available technology, but also changes in mainstream technology affect how assistive technologies must be applied. These factors combined potentially render any TVI's preservice AT instruction obsolete, depending on how much time lapses between initial instruction and time until the TVI has a student that necessitates a specific type of access. Consequently, any preservice AT training that focuses on device-specific knowledge may be thought of as a mere introduction to various types of AT, while ongoing professional development is necessary for on demand support to coordinate immediate student needs with implementation of technology into the classroom.

Shortcomings of school-based professional learning communities. As mentioned earlier, traditional professional learning communities (i.e. school inservices and incidental peer mentoring) assume face-to-face collaboration and physically situated shared spaces. However, the nature of an itinerant TVI's teaching practice does not easily lend itself this model because a TVI's presence in a school is often fleeting. District-sponsored professional development activities are also often not applicable to meeting the needs of a low incidence population. A district may not be deliberately unsupportive, but genuinely unaware of what information a TVI needs or how to provide it. Other forms of professional development such as workshops and conference sessions often focus on device-specific knowledge, and teachers rely on incidental peer mentorship such as conversations over lunch to innovate such knowledge to student and classroom application. Without instruction via specific case studies or similar peer modeling in how to apply technology in novel ways, it is difficult for most TVIs to independently develop the proficiency necessary to translate device knowledge to case-based application. Despite negative perceptions of their own competencies in using and teaching AT, TVIs overall feel a high level of confidence in their ability to collaborate (Zhou et al., 2012). It therefore seems like a prime opportunity to re-visit development of professional learning communities that are more tailored to itinerant and TVI needs and take advantage of existing strengths in collaboration.

The challenge in such development rests on the medium this type of professional learning community might take. TVIs typically teach in isolation, and are often separated from other TVIs by physical distances. Consistent communication must therefore leverage affordances of technology, such as connecting to colleagues via email, professional listservs, and social media. How then can TVIs with low confidence in using technology be supported to use technology in order to learn about technology?

Affordances of Social Technologies

Web 2.0 technology is a term used to encapsulate many current and emerging online programs (Alexander, 2006). The nature of these media is inherently social and includes tools such as listservs, blogs, podcasts, and social networking sites like Twitter and Facebook. While

Web 1.0 media are static and closed to exchanges between authors and readers (such as a digital brochure or informational webpage without comment boxes), Web 2.0 technologies are differentiated by multi-directional communications that are dynamic, responsive, and reciprocal. These programs are grounded in open communications, and membership itself can be either open or closed. Many social attributes of Web 2.0 tools facilitate community building and connect people with mutual interests across expansive physical distances and demographics. Benefits of such online communities include: building repositories of information together, sharing and consuming collective resources, and reflecting on others' perspectives that differ from one's own. Contributions on a social media site are also more democratic; members need only volunteer a slice of expertise while building upon others' wisdom. In return, the ensuing collection of knowledge becomes available and searchable upon demand.

Given these affordances of social technologies, I pose that a variety of tools already exist that have the potential to deliver the community and resources that itinerant TVIs lack. However, mere availability of tools is insufficient; evidence-based methods for scaffolding access, engagement, and instruction are necessary to leverage these tools and meet needs for professional development.

Instruction in Computer-Supported Collaborative Learning (CSCL) Environments

Computer-supported collaborative learning (CSCL) environments are one application of Web 2.0 technology and a primary model for distance education. These tools enable colleagues to coordinate and collaborate across physical distances (Kreijns, Kirschner, & Jochems, 2002), and facilitate online interactions as mediated by a combination of social and cognitive processes. Although many tools have been developed specifically for the purpose of online instruction, mainstream social media as mentioned in the Section 2.6 have similar affordances for information exchange, communication, and collaboration (Kreijns, Kirschner, & Vermeulen, 2013). Regardless of the vehicle, CSCL environments re-organize learning in virtual, rather than physical spaces. Online forums allow for more flexible participation by maintaining asynchronous interactions and enable participants to continue various threads of communication at different times. In contrast, instruction in physical spaces assume synchronous attendance and require participants to commit to a shared time and location (Hall, 2014; Harasim, 2000). Given itinerant teachers' disconnect from physically situated professional learning communities, the flexibility of CSCL environments pose great opportunities for providing the professional development and incidental peer mentorship they currently lack. If a CSCL-type environment can foster similar outcomes in maintenance and updating of teachers' skills as a traditional school-based learning community, then tailoring design of CSCL environments may meet a number of needs and finally fill a critical gap in itinerant teachers' practice. These needs include: membership to virtual communities of practice, access to resources to update their practice, and provision of infrastructure to sustain support of a professional community. The remainder of this chapter will identify the different elements of CSCL environments, define those attributes that align with a professional learning community, and consider how a CSCL environment might be appropriated more informally to supplant the school-based community an itinerant TVI lacks.

Features of CSCL environments: Social processes. Kreijns et al. (2013) define the social processes of a CSCL within a framework of sociability, social space, and social presence. Other researchers have also investigated the social aspect of CSCL environments, but Kreijns et al.'s framework is presented here as an encapsulation of all the different variations on social

processes. These elements generalize to construct the social interactions deemed essential for characterizing an online gathering as a CSCL environment.

Sociability is the primary attribute that fosters socioemotional interactions. These interactions are characterized by members who share the same expectations for what needs must be met, have members assigned to different roles, and follow the same rules for operation as other professional learning communities. Social affordances such as informal "shop talk" in a break room or more formalized exchanges in staff training are examples of such socioemotional interactions.

The quality and network of a group's socioemotional interactions dictates the health of the social space a CSCL inhabits. If sound, group members develop a shared sense of identity and belonging, a sense of community, and underlying trust and respect. Activities therefore reflect distributed participation, commitment to shared goals, and receptive and expressive exchanges of information.

The third element of Kreijns et al.'s theoretical framework is social presence. Reminiscent of object permanence, social presence could be thought of as person permanence. That is, members of a group are confident in the presence and engagement of others despite the virtual medium and lack of physical contact. Challenges in developing this area of the framework could be attributed to the usability of a tool to convey members' identities, or it could be tied to the skill of members in crafting messages that carry the same social weight as a face-to-face interaction.

Although other frameworks have been discussed in the CSCL literature, similar themes ultimately circle back to features of interaction and dialogue, mutual trust and engagement, joint attention to a problem, knowledge acquisition, and collaboration as mediated by technology (Järvelä et al., 2014; Lipponen, Hakkarainen, & Paavola, 2004; Stahl, Cress, Ludvigsen, & Law, 2014). These features have informed development of tools within CSCL environments for peer feedback and reflection, and could also specify characteristics of vibrant communities of practice that develop within CSCL environments.

Role of collaboration. As intuited by the word "collaborative", social interaction is a mandatory element of CSCL environments (Kreijns, Kirschner, & Jochems, 2003). More specifically, high quality interactions are necessary to ensure true collaboration takes place within a CSCL environment (Kirschner, Beers, Boshuizen, & Gijselaers, 2008) and is not necessarily a given with simple provision of a shared virtual space (Kreijns, Kirschner, & Vermeulen, 2013). Roschelle and Teasley (1995) originally defined collaboration as "…the mutual engagement of participants in a coordinated effort to solve the problem together" (p. 70), but their definition was meant to describe synchronous (and therefore face-to-face) activities only. With more prevalent availability and use of information and communication technologies, an updated definition was necessary to include successful collaborations in asynchronous interactions and consider wider applications of its use. Hall (2014) further defines collaboration as a learning event that "…occurs through joint activity related to the process of solving complex problems or engaging in authentic tasks during which any knowledge, skill, attitude, or attribute is acquired or any product or idea is discovered or created." Although Hall's definition considers collaboration as a social activity mediated by technology, her criteria for successful collaboration emphasize cognitive outcomes rather than social processes. Her modernization of Roschelle and Teasley's definition from 1995 ultimately rests on her allowance of asynchronous activities, but requires further definition to situate collaboration as a learning event. Kuhn's (2015) most current discussion of collaboration also heavily considers it an intellectual activity, but

dependent on what an individual gains as a result of group dynamics. Simply put, collective efforts toward a shared goal are merely a method for problem solving; true collaboration for learning requires resolution of differences between participants' knowledge and perceptions. In other words, what participants gain from collaboration would be otherwise impossible without focused engagement with others. This final point distinguishes Kuhn's definition and highlights precisely what itinerant teachers lack when they are isolated from a community of practice. Ensuing mentions of collaboration will therefore adopt Kuhn's conception.

Cognitive processes. As with any learning activity, efficacy of instruction in CSCL environments is determined based on participants' learning and knowledge gain. In this context, outcomes in individual learning are typically the focus rather than group dynamics (Järvelä et al., 2014). Group processes that underlie social mediation and collaboration are considered more as a vehicle to learning rather than foci of evaluation, and instructional objectives are used to gauge how well a CSCL environment delivers instruction. Consequently, research on group processes is historically more limited to program evaluation rather than informing instructional design (Dede, Nelson, Ketelhut, Clarke, & Bowman, 2004)

With respect to the social aspects required of collaborative learning, more information on the social affordances gained in CSCL environments would extend Kuhn's definition of collaboration to practice and more specifically evaluate individuals' cognitive processes as a function of group processes. The final section of this chapter will identify other opportunities for theory extension and practice building from the current literature, and present my intentions of this dissertation work.

Limitations of the literature

Professional development in virtual forums rather than physical classrooms is quickly becoming a dominant model in education (Cela, Sicilia, & Sánchez, 2014). These virtual media are referred to by a number of different terms in the literature: e-learning, computer-supported collaborative learning, synchronous or asynchronous learning networks, or simply online professional development. Many operational and theoretical frameworks have been developed with these various terms, but differences exist that prevent one framework from unifying and building upon another. Limitations of the literature range from the medium for delivery of professional development content (face-to-face and synchronous versus online and asynchronous), formal versus informal constructions of CSCL, intent of instruction (structured and targeted for knowledge acquisition versus proficiency building), and choice of outcome measures that determine intervention efficacy.

Use of social media to instigate change in teachers' practices. Research on CSCL environments is extensive, and stems from original conceptions of computer supported collaborative work (CSCW) environments (citation). Theoretical underpinnings therefore extend from organized worker behaviors to teacher practices. The CSCW literature includes rich descriptions of how company employees innovate knowledge gained in a staff training in order to re-organize workplace behaviors (Lave & Wenger, 1991), but the CSCL literature tends to focus on cognitive and social processes in creating a knowledge base. Objective evaluations of CSCL environments typically look at snapshots of group dynamics that inform the social processes, and individual participants' attainment of specific knowledge points. More research is needed to describe how participation in a CSCL environment actually changes teachers' practices in the same way that workers re-organize work place behaviors.

A large consideration for learning in a technologically mediated environment rests in the technology itself. Based on CSCL research findings, a number of specialized tools for learning have been developed for different subject areas and varied student demographics. Participants must therefore attain a certain level of mastery in using the software itself in order to access all the benefits a CSCL environment has to offer (citation). Less research has been carried out on CSCL environments using Web 2.0 technologies not specifically developed for learning or teachers' professional development. Given the prevalence of Web 2.0 technologies, these social media have a lower entry point and wider availability without requiring specific resources to access a specialized CSCL environment (Alexander, 2006). The open access nature of Web 2.0 technologies also invites a larger breadth and array of expertise than what might be available in the closed CSCL classroom.

The CSCL literature has also been largely restricted to environments that are intentionally constructed for learning. Extension of this knowledge base to less formal constructions of professional development in social media such as Twitter, blogs, or Facebook is still developing. Although mainstream social media tools have been used as a learning management system (Aghili, Palaniappan, Kamali, Aghabozorgi, & Sardareh, 2014; Meishar-Tal, Kurtz, & Pieterse, 2012; Wang, Woo, Quek, Yang, & Liu, 2012), use in this context remains formal with obligatory attendance and participation. Collaboration as a necessary learning event in CSCL environments may require a different conceptualization in more informal uses of social media to account for information disseminators versus collectors among an online professional community. More research is needed to evaluate the social and cognitive affordances of social media via voluntary and variable participation. Differences in how these media are leveraged might inform a number of constructs that align with or diverge from principles of traditional CSCL environments and physically situated informal professional learning communities.

On demand professional development. Whether professional development occurs on social media, in a specialized CSCL environment, or (gasp!) face-to-face, the primary goal of professional development is to build a specific knowledge base and meet learning objectives. Using Web 2.0 technology (such as with social media or CSCL), learning may occur synchronously (participants meet online at the same time) or asynchronously. Regardless of the delivery mechanism, most models of professional development follow a specific curriculum within a predetermined timeline. Once these prescribed doses of instruction are carried out, the professional development terminates. School-based teachers then rely on casual collaboration with peers in their school's learning community for ongoing support and to translate knowledge gained from prescribed professional development to their own practice. I pose that this link from targeted professional development to casual collaboration with peers is what is often missing in itinerant teachers' work and a contributing factor to isolated practice. This sort of "incidental" professional development might occur via informal exchanges over lunch, walking down the hall to seek a colleague's perspective, or meeting to plan classroom activities for the week. Furthermore, "on demand" professional development might be the missing link in many itinerant teachers' practice, particularly for TVIs who need to apply technology in novel ways than was learned in initial training. On demand access to information and resources can fill gaps in knowledge, and more importantly the embedded collaboration may convert device knowledge to true proficiency as evidenced by adoption into a teacher's practice. Although asynchronous instruction may offer the flexibility needed to accommodate various schedules, it does not quite accommodate itinerant teachers' need for informal and on-demand training, and has not yet been validated as an effective form of professional development under the guise of "drop in"

instruction (Ching & Hursh, 2014). More research is needed to inform how social media might be co-opted for ongoing and incidental professional development, provision of on demand resources, and whether this medium of collaboration suffices for the learning community, or community of practice, that many itinerants lack.

Consideration for hybrid models. As mentioned earlier, well-designed CSCL environments must satisfy a number of social and cognitive processes. Some of the social elements such as trust and mutual respect can be difficult to develop in a virtual environment, especially if members have not otherwise met. Although a critical design element, implementation error due to this limitation is often unaddressed. Face-to-face models of professional development have their own set of pitfalls as outlined earlier in the chapter. Teachers need ongoing support that are adaptable to their schedules, and require minimal investment of personal resources such as time and money.

Although much research exists in the design of online and face-to-face professional development, few studies specifically research a hybrid model that combines the best of both media. Because each type of professional development comes with unique benefits and pitfalls, more research is necessary to identify how the combination of two media might mitigate some of the pitfalls, what design features are necessary, and how a hybrid model can be implemented to affect teachers' practice. The final segment of this chapter will pose ideas for how outcome measures might be conceived to evaluate such a hybrid model for efficacy.

Re-defining outcome measures. One of the strongest criticisms of program evaluation in teacher education is that effectiveness is too often measured by participants' anecdotal survey data immediately following completion of a professional development course (Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2008). Similarly, all of the research on TVIs' AT proficiency (mentioned earlier in the chapter) is based on Likert scale surveys of self-satisfaction. Particularly in the field of visual impairment, little research exists on the efficacy of interventions based on the ultimate measure of teaching effectiveness: student outcomes (D'Andrea & Siu, 2015). If student outcomes are to be considered for measurement, it is impossible for a survey administered upon completion of professional development to capture this sort of data that requires implementation time.

Intentions of this work

As stated in a research agenda published by Dede et al. (2008), more research is needed that target teacher change as a result of professional development as measured by student outcomes. Hybrid models would benefit from further investigation to more clearly identify what works and potential strategies for implementation. This dissertation aims to address these items of Dede's research agenda using a design based approach that "offers tangible examples of powerful learning and better ties between theory and practice, while acknowledging learning in context" (p. 2).

An ethnographic case study of an online Yahoo group comprised of TVIs will build on existing theories of informal professional development as mediated through communities of practice while integrating the use of a social media tool. This online Yahoo group follows a series of face-to-face trainings on how to use an iPad with students who are blind or visually impaired, and in-depth analyses will provide information on how this hybrid model might help TVIs translate device-specific knowledge to technology proficiency. Efficacy measures will center on students' outcomes via reported changes in teachers' practices and work samples.

Chapter 3: Frameworks for Operation and Analyses

Thus far, this dissertation summarized students with visual impairments' needs for technology, current uses of technology in TVIs' teaching practices, and several approaches that support teachers' development of technology skills. The nature of itinerant TVIs' work has also been discussed within the context of challenges that limit easy access to collaboration and professional development with other TVIs.

The heart of the issue is that TVIs (and other itinerant or dispersed professions, really) share an occupational space but not an organizational one. Due to the absence of a shared organizational space such as gathering in a staff room or around a water cooler, TVIs miss the informal interactions with colleagues that classroom teachers are privy to, and are less likely to benefit from the casual professional development that other teachers gain from such interactions. I choose to pinpoint this particular challenge in TVIs' practice because it is a genesis for strategic intervention that sidesteps what TVIs lack while leveraging noted strengths in teachers' learning and modern technologies.

The current study integrates lines of research that are not new. Teacher learning and knowledge innovation via informal social interactions has been analyzed, theorized, and applied in the context of teachers' practices, school reform, and adoption of policy and curricula. These studies have all been situated in physical spaces such as a school site or district (Brown & Campione, 1994; Coburn & Russell, 2008; Penuel, Riel, Krause, & Frank, 2009; Little, 2002). In virtual spaces, teacher learning has also been studied in the context of formal online professional development coursework. These discussions generally focus on the formation of trust among members, group dynamics, and density of interactions (Ching & Hursh, 2014; Kirschner et al., 2008; K. Kreijns et al., 2003). Lastly, discussion of teachers' participation in a learning community and development of resources that sustain and evolve their own practices was derived from Wenger's Community of Practice (CoP) (1999) and most currently referred to as the construction of social capital in a professional learning community (Daly, 2010).

Although this study could be viewed as a general replication of Little's (2002) or Penuel, Riel, Krause, & Frank's (2009) earlier work examining teachers' informal interactions in a school community, the current demographic and context diverges to create new opportunities for theory extension and practice building. TVIs might share similar goals and challenges in serving students with visual impairments, but often lack physically situated professional learning communities that facilitate informal collegial exchanges and teacher growth. Connecting to colleagues online therefore becomes more necessary than supplemental to expand one's learning, professional network and resources. However, informal interactions as mediated by computers and virtual spaces are inherently different from the face-to-face synergy of crossing paths and conversation in a physical environment.

This study situates informal teachers' interactions in a virtual space. I am interested in how an online community might support teacher learning and development of AT proficiency via informal interactions rather than traditional online professional development in formal computer supported collaborative learning (CSCL) environments. This research aims to merge attributes of the CoP framework with characterizations of online learning from CSCL and social network literature. The resulting lens will launch investigation of whether or not informal interactions in an online environment can support and evolve teacher practices to a similar extent as physically situated professional learning communities.

The following discussion describes how these theories intersect in such a way that underpins teachers' professional learning communities and changes in practice via informal interactions in the virtual space. To start, a re-definition of an operational framework is presented to more aptly describe TVIs' occupational space. Next, two theoretical lenses embed the operational framework within a conceptual framework. The chapter will conclude with a strategic plan for approaching data collection and analysis, and present an updated line of research that reflects a summation of ideas that were previously researched in separate contexts. If successful, outcomes will bring about a new perspective that marries affordances of current technologies with longstanding needs in itinerant teachers' learning and development.

An Operational Framework: Wenger's Community of Practice

Alongside wide acceptance that "professional community is an important contributor to instructional improvement…" (Little, 2003, p. 917), specific features of a professional community include: incidental and work-based learning, distributed leadership and expertise among colleagues, communal building of resources and information, and opportunities for self-reflection in response to observing others. One of the main cognitive outcomes as a result of these social processes among a professional learning community (PLC) is the opportunity for individuals to transform general information to personal knowledge (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). Although the benefits of a PLC are attractive, the itinerant nature of most TVIs' practice limits participation due to the systematic requirements of a PLC as listed by Stoll et al. (2006): time, connection with outside help, networking with colleagues, social trust among members, and perhaps administrative leadership at a particular school site (Horn & Little, 2010a).

In contrast, Wenger's conceptualization of a Community of Practice (CoP) as defined for workplace (rather than school-based) interactions better illustrates what a PLC might look like for an itinerant teacher or other worker who must navigate multiple levels of management and derive a custom set of resources that informs practice. Recall that Wenger's CoP is comprised of three dimensions (E. Wenger, 1999):

1. ***Domain of interest***. Members invest in a shared collection of knowledge, goals, and purpose to their actions. These mutual interests inform their actions.
2. ***Community***. Members interact with one another by sharing ideas, posing questions, and responding to others' issues.
3. ***Practice***. Members share the same "toolkit" comprised of tools, information, anecdotes, and resources. The community develops and maintains this body of knowledge, and leverages it to inform the domain of interest.

The "domain of interest" dimension describes TVIs' shared occupational space while the "community" and "practice" dimensions address a potential shared organizational space that is accessible whether it is in a face-to-face (physical) or virtual environment. The CoP framework also fits TVIs' needs to mediate multiple roles and levels of activity and expertise, navigate various levels of administrative involvement, gain informal professional development from the community on an as-needed basis, and build and access resources with variable participation. Given the added fluency of the framework to describe a professional learning community that itinerant teachers can access, it is important to ground it in this context to illustrate TVIs' occupational space.

My previous work with Morash (2014) captures AT proficiency as a related output of belonging to a CoP. This current work aims to capture nuances of how informal interactions with other members of a CoP help TVIs transfer general information about AT to proficiency in implementation. Wenger's CoP encapsulates current constructions of collaboration within the "domain of interest" dimension, allows for shifting levels of participation in the "community" dimension, and recognizes the knowledge transfer that occurs amongst members as a result of distributed leadership and expertise in the "practice" dimension.

Although Wenger's CoP can describe an ideal conception of TVIs' organizational space, it shares the same limitations of the PLC literature in that it does not account for limitations or affordances of informal interactions in the *computer mediated* workplace. Because CoPs can be so generally discussed and applied, Table 2 specifically delineates how different levels of CoP membership might manifest in a TVI's practice and any teacher who accesses their community in a physical *or* virtual space.

Table 2. Construct for TVI's Identification with a Community of Practice That Values AT

	Dimensions		
CoP Identification	**Domain of Interest**	**Community**	**Practice**
	Shared commitment to use/consider AT to enhance accessibility:	Extent of interaction with other members of CoP:	Members share, develop, and maintain a body of AT knowledge:
Strongly identifies with a CoP (5)	Committed to AT use, and confident it can improve access to curriculum	Shares and disseminates information about AT with others.	Leverages familiar resources to learn new AT, such as manuals, the internet, and "techie" colleagues.
Seeks a CoP (4)	Committed to AT use, but unsure of how it can improve access	Looks for, and uses information shared by others	Asks for help to learn new AT, but lacks known resources
Ambivalent (3)	Unsure of AT use, and unsure if it improves access	Only uses information from members of a CoP as an obligation.	Would only learn AT according to a superior's directive
Does not identify (2)	Considers AT use non-essential to learning, does not improve access	Observes members' exchanges of information only if readily present	Would not learn AT, but would work around it
Opposed to	Believes that AT use	Avoids members of a	Avoids learning new

identifying with a CoP that uses AT (1)	will detract from student learning.	CoP.	AT, employs non-AT solutions, or removes reason to learn AT.

Social Network Theory: Group Dynamics and Development of Social Capital

Defining the "what". Previous research reports what types of interactions and behaviors constitute a community of practice in the physical school space (Brown & Campione, 1994; Palincsar, Magnusson, Marano, Ford, & Brown, 1998; Little, 2002). Similarly, CSCL literature emphasizes a number of requisite social and cognitive factors that constitute an online learning environment. In defining TVIs' occupational practice, this study extends Lave and Wenger's theory of legitimate peripheral participation (1991) into the "community" dimension of the CoP framework while taking into account the factors necessary for an online group to become a learning community. This approach considers exchanges of information between members despite varying levels of active participation and different teaching sites in order to validate its role in professional development. Similar to how roles of expertise might shift among teachers in a school, online interactions should ideally reflect how group members jigsaw their knowledge to form a PLC.

In this type of informal PLC, an expert such as a workshop trainer shifts from being the director of resources to a peer of other members of a learning community. Eventually, different members of the CoP might co-opt the expert role at different times and across interactions with different colleagues. In a shared physical space such as a teacher lunchroom, some teachers might be more vocal contributors than others depending on the background expertise of each teacher and what they have to offer in an informal conversation. Likewise, people interacting in a virtual space also demonstrate a variety of levels of activity. Some members of an online community might actively disseminate information at some times and in other instances draw on another's expertise. Other members might never contribute information and instead be habitual spectators (colloquially referred to as "lurkers"), who contribute minimally to information exchanges but benefit from what others share.

Given how interactions and group dynamics might shift in a CoP, social network theory can inform an approach that describes individuals' interactions within a group and how they connect to one another. By illustrating each individual as a node and connecting the nodes as they communicate with each other, social network analysis can reflect the strength of relationships and changes in group dynamics (Figure 6). As applied to how the "community" dimension might be captured, a webbing structure can show how an "expert" might flow in and out of central and peripheral participation as group interactions morph. This lens will be helpful in visualizing how teachers in a virtual space connect with each other, and reflect the movement of a workshop trainer from the central "expert" away to the periphery as members begin sharing their own ideas and expertise.

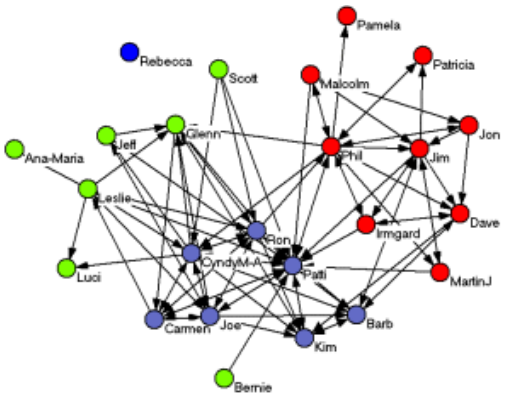


Figure 6. Social network analysis. Sample visualization of how individuals are connected in a group.

Social network theory also affords opportunities to capture the relations among teachers and reflect how dense or sparse interactions are among members of a community. In the scope of social network theory for educational change, nuances in how group dynamics are constructed have been attributed to the success or failure of school wide reform efforts (Coburn & Stein, 2006; Daly, 2010). Social network theory can be focused at the level of individuals (dyads), the location of individuals within the group (nodes), or the group (network) as a whole (Brogatti and Ofem, 2010). This study investigates interactions at the group level. By choosing to also focus on consequences of organization rather than antecedents, social network theory treats the community dimension of a group as a function of density and centralization of activity (Brogatti and Ofem, 2010, p. 22). The next section presents what types of consequences, or outcomes, might arise as a result of a group's activity.

Re-thinking teacher practices as social capital. Another advantage to adopting the social network lens at the group level is that it affords investigation of a group's development of social capital as a primary outcome. In education, social capital has been defined as changes in teachers' practice as a result of relationships that facilitate access to one another's expertise (Penuel et al., 2009). Penuel further emphasizes that without these relationships, access to expertise is otherwise closed. In other words, teachers expand their knowledge and practice via trusted and nurtured relationships with colleagues (Coburn and Russell, 2008; Little, 2003; Penuel et al., 2009).

In applying social network theory to school settings, the concept of "practice" has been situated in face-to-face group efforts that develop a collective body of knowledge, practice and resources. Outcomes have also been primarily limited to reform as a single school community, with changes in practice reported as an aggregate (Coburn & Russell, 2008; Horn & Little, 2010b; Penuel et al., 2009). In this study's context of a virtual community, the network is no longer mediated via face-to-face interactions. As a result, access to expertise could be open to anyone who checks into the community whether they are an active contributor or a habitual spectator. In other words, changes in practice might be better linked to simply relating to a community of practice rather than relating to any specific person. If considered under these terms, the virtual space is potentially more hospitable to learning and innovation of knowledge and practice than a physical space that necessitates person-specific engagement. Mere membership (whether it's active or passive) to such a virtual community could potentially sustain and evolve teachers' resources and practice. The current study aims to more deeply investigate this hypothesis by asking:

1. Do the group interactions in this online collective constitute a CoP as evidenced by group dynamics and development of social capital?
2. What kinds of resources develop from the online group under investigation?
3. Did teacher practices change as a result of membership to an online group? If so, could changes in practice be considered social capital in the same way as those that develop from physically situated CoPs?

Organizational Theory: How a Work Space Informs Changes in Teachers' Practices

If membership to a virtual CoP is effective in developing social capital among teachers, a deeper understanding of the mechanisms involved would inform replication of other virtual CoPs to support teachers' practices. Moreover, identification with a virtual CoP might be an effective intervention that helps TVIs access the ongoing professional development they need to develop and sustain technology proficiency. When discussed alongside transcripts of informal interactions and interviews with participants, social network theory is merely a starting point for understanding the nature and affordances of informal interactions in a CoP. This study goes further and asks: How does the organizational space affect the occupational space? Daly's extension of social network theory (Daly, 2010) to educational reform suggests a holistic approach beyond mere snapshots of network structures, and challenges investigators to probe how relationships ultimately affect change. As suggested by Kreijns, Kirschner, & Vermeulen (2013) and Ching & Hursh (2014), social features, ideas, and trust among members are crucial to building effective online learning environments. Is it possible for these characteristics to develop via informal versus structured interactions in an online space? And perhaps, are these characteristics prerequisite to enabling development of social capital? This study will carry out in-depth analyses of the social and cognitive processes that underlie a particular online group, and evaluate outcomes as evidenced by changes in practice. In the context of this particular study, positive outcomes will be evidenced by TVIs' increased implementation of technology with students. By approaching outcomes with this focus on the development of social capital among members, informal interactions among a group of professionals can be deemed a community of practice regardless of its manifestation in a virtual or physical space.

Ultimately, the idea of itinerant teachers developing a shared occupational space in the virtual environment is a case of professionals re-organizing the nature of their work given challenges in practice and affordances of new technologies (Barley & Kunda, 2001). I hypothesize that standstills in TVIs' learning and development of technology proficiency can be attributed to their lack of organizational space and results in difficulties accessing the social capital necessary to sustain and evolve an effective occupational space. As a result, many students with visual impairments are not armed with the skills they need to access all the multimedia in the modern classroom (D'Andrea & Siu, 2015).

An Updated Conceptual Framework: The Virtual Water Cooler (VWC)

This chapter reflects upon the practical challenges of TVIs' occupation and considers appropriation of tools in new applications to affect teaching practices. Existing Web 2.0 technologies are already readily available, and can offer better access to much needed support and development of technology proficiency. Mindful use of these technologies might finally provide a virtual water cooler (VWC) for colleagues to commune around that mimics physical

ones that have been shown to nurture professional development and learning communities (Figure 7).

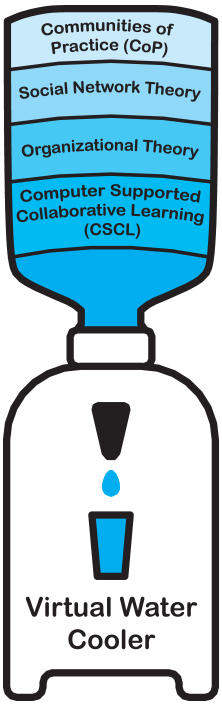


Figure 7. The Virtual Water Cooler (VWC). Four areas of thought (CoP, Social network theory, Organizational theory, and CSCL) funnel through a drawing of a water cooler labeled "Virtual Water Cooler" and fill a glass of water.

In order to determine the validity of such a VWC environment, this study will apply coding schemes to an online group's transcripts. If themes emerge that align with social and cognitive processes known to facilitate teacher learning, findings will relate to processes previously reported in the CoP and CSCL literature and can be used as a means to certify this online collective as a true learning community. Final determination of whether or not an online gathering of teachers constitutes a VWC will depend on the development of social capital that results from membership to a group. Ideally, resources and changes in practice around a VWC would be equitable to the social capital that emerges from physically situated water cooler spaces.

Interviews with several participants will enrich illustrations of group dynamics as reported by social network analysis. These participants will be chosen based on their various positions within the online community and range from teachers who were active participants to those who were habitual spectators. Deeper understanding of what these teachers gained as a result of membership to this online group might challenge current perceptions that social capital can only be gained through direct relationship with a colleague. Data collection and analyses will concentrate on the intersection of community, social capital, and affordances of relationships in the virtual rather than physical space. Ultimately, understanding changes in teachers' practice as a result of engaging around a VWC might help re-define the notion of social capital given available technologies for nurturing organizational spaces in a digital era. An updated conceptualization of itinerant TVIs' practice is necessary to understand needs that remain

underserved due to lack of a community, and develop effective supports that overcome longstanding challenges in sustaining skills for technology proficiency. The next chapter more specifically presents methods for data collection, coding, and analyses.

Chapter 4: Methods

Previous research at the intersection of Communities of Practice (CoP), Computer Supported Collaborative Learning (CSCL) environments, and social network and organizational theories informs the concept of a Virtual Water Cooler (VWC) as applied to itinerant teachers' practice. The intention of this work is to validate the VWC as a much-needed form of professional development that can sustain and update TVIs' technology skills after a face-to-face training. The purpose of this study is multi-layered: First, this particular case of online and informal learning requires determination of whether or not it can be characterized as a CoP. If so, the primary purpose of the study is to investigate the nature of information exchange and group dynamics that define the VWC as a CoP and better understand how this resource supports TVIs' technology use.

Although the conceptual underpinning of this research is in Little (2003), Coburn (2008), and Penuel's (2009) work in locating teachers' learning in informal workplace interactions, the overall approach to data collection differs given the nature of observations made in the virtual rather than face-to-face environment. This study also draws from Hew and Hara's (2007) methodology in studying teachers' knowledge-sharing online, but the goals of my research differ such that other approaches to analyses were needed. Ultimate, I chose to follow Dede's (2008) recommendations for design-based research by selecting analyses that answer questions based on a combination of evaluation and empirical work: Did this intervention design have an effect, and if so, why? Logistics for investigating online social networks and CoPs are also well documented among a variety of professions (Baker-Doyle & Yoon, 2011; Borgatti & Ofem, 2010; Daly, 2010; Hara, 2008; Hew & Hara, 2007; Penuel et al., 2009; Sparrowe, Liden, Wayne, & Kraimer, 2001), but in the case of TVIs' need for a shared organizational space, locating learning in an online CoP becomes less about *why* a teacher might engage (Hew & Hara, 2007), and more about *whether* and *how* it supports practice. This distinction is important because members of other online CoPs might otherwise have physically situated spaces for organization and informal learning, but choose to engage online as a supplementary tool for professional development. For TVIs and others who work within an itinerant model, an online CoP might be the only type of organizational space in an otherwise isolated profession (Yarger & Luckner, 1999). Although the benefits of engagement in a CoP are well recognized (J. S. Brown & Duguid, 1991; Lave & Wenger, 1991), this type of model for professional development has not yet been consistently implemented or recommended in training and practice in the field of educational vision services.

This chapter will present the research questions, describe the role of the researcher and study procedures, and provide an overview of strategies for data analyses.

Research Questions

This study aims to validate an online group as a CoP and build evidence that this type of model can be a tool for ongoing and informal professional development. The demographic is TVIs who lack an organizational space. The following research questions guide this work:

1. Does this particular online group constitute a Community of Practice?

If so:

2. How can technical skills and knowledge learned in face-to-face training be consolidated and further developed by participation in an on-line CoP?

3. Can an online CoP facilitate incidental and informal learning as effectively as face-to-face informal professional learning communities?
4. Can an online CoP serve as a VWC around which there are informal interactions that support a TVI's practice?

Role of the Researcher

I am a TVI with 14 years of experience working with students who are blind or visually impaired, and have been particularly concerned about the low level of technology proficiency that has been reported among my colleagues over the course of a decade (Abner & Lahm, 2002; Edwards & Lewis, 1998; Kapperman et al., 2002; Parker, 1990). Given the rise in use of digital instructional materials and media in the modern classroom, students now more than ever need technology skills for independent and timely access to information (D'Andrea & Siu, 2015). From my experience as a technology trainer and belief that technology is crucial for equal access, students need immediate training in using the tools necessary to achieve their potential. They cannot afford to be limited by a TVI who does not have the resources (or fortitude) to evolve his or her knowledge base as technology changes. Unfortunately, TVIs have long been critiqued for underutilizing technology while less research exists to develop effective interventions.

My engagement with this study stems from insider experience that I share with the participants. Although I was an outsider while observing this group of TVIs' online interactions, I am otherwise a full participant in other online CoPs and the field of educational vision services (Glesne, 2006). The benefit of my insider status is that even while acting as an observer, I had a personal understanding of the challenges and successes specific to TVI work and the terminology that was used. When collecting interview data, my insider knowledge was also useful in building rapport with participants and allowed the interviews to immediately focus on each participant's experiences rather than first needing to understand background information and topics specific to the field at large.

As a currently employed TVI, I attribute much of my own engagement in online CoPs to my own needs for ongoing professional development and commitment to maintain a certain level of technology proficiency. Knowing how much CoPs support my own practice, it was impossible to approach this study and data with an unbiased eye. Grounded theory (Glaser & Strauss, 1967) emphasizes identification, categorization, and exploration of elements and their connections (Tesch, 1990, as cited in Miles & Huberman, 1994) without a formal structure to dictate these actions. Although my personal case is one that includes active engagement and benefit via a VWC, this experience might not be the same for other TVIs. This approach helped to minimize the effect of my own experiences and maintain an open mind over whether a VWC is indeed a tool that benefits others' practices, uncover evidence on overall strategies that help TVIs sustain their practice, and be open to surprise findings that were perhaps different from my experiences. For example, what if there were other supports that TVIs found more useful than a VWC? What if other TVIs did not experience substantive support or gain resources from a VWC? Codes were therefore developed organically as a result of themes that emerged. Similarly, I generally preferred gathering interview data with open-ended questions rather than closed lines of questioning in order to gather personal opinions and perspectives that might be different from my own (Spradley, 1979).

Research "site"

Description of the iPad training course. The iPad course was carried out over the course of seven months and included a combination of four face-to-face trainings and three synchronous virtual class discussions according to the following schedule:

- May 15: Face-to-Face Day 1 "Introduction to iPad Accessibility Features for Blind and Low Vision Students"
- May 16: Face-to-Face Day 2 "Introduction to Reading, Writing and Research on the iPad"
- August 21: Virtual Session Class Discussion #1
- September 19: Face-to-Face Day 3 "Bluetooth keyboard Commands with VoiceOver on the iPad"
- October 3: Face-to-Face Day 4 "Using a Refreshable Braille Display with an iPad"
- November 13: Virtual Class Discussion #2
- December 18: Virtual Class Discussion #3

The training materials were designed for TVIs and addressed accessibility features of the iPad for low vision and nonvisual access. Course objectives included instruction in how to use a suite of apps with these features and included strategies for how TVIs would teach a student how to use those features and apps. Each participant was expected to have access to two students on or close to grade level for case studies: one student with low vision, and one student who required braille. Participants were also required to have access to an iPad with the suite of apps installed, a Bluetooth keyboard, and a refreshable braille display. The students they selected were also expected to have access to the same equipment in addition to internet at school and an email address. Might be nice to have a list of the apps chosen. Why these and not others?

Selection of the group. An optional online messaging forum using Yahoo Groups was available throughout and after the duration of the iPad course. Both of the training facilitators were also members of the Group. Although participation in the Group was voluntary and ungraded, all twenty training participants were automatically subscribed and received posts via email. This setup allowed for asynchronous communication (people could communicate without being online at the same time) and enabled less active participants to be habitual spectators (colloquially referred to as "lurkers"). The Yahoo Group was chosen because of its connection with a targeted face-to-face training and specific focus on the iPad as a tool for assistive technology. This delivery of formal professional development followed by informal interactions is similar to how other researchers have investigated the role of teachers' communities of practices in schools (Palincsar, Magnusson, Marano, Ford, & Brown, 1998) when reforming teaching practices. Stringent pre-requisites for available equipment and students also mitigated barriers of access to the technology as well as challenges due to major pedagogical differences between students. Discussion topics narrowed to academic use of the iPad also enabled better control over how participants conceptualized implementation (Shulman & Sherin, 2004). This allowed for more focused analyses on teachers' learning of a specific technology with less variability in implementation challenges due to different uses of the iPad based on curricular content and students' cognitive development. Lastly, I am a close colleague with both training facilitators, who solicited participation from the group on my behalf and enabled direct and immediate access to the data once participants' consents were collected. Beyond granting access to observation data of these participants in an online environment, the training facilitators otherwise functioned no differently than a school administrator allowing a researcher to enter a

school and observe informal teacher interactions. No changes in the online environment or instructional design were made as a result of my research; in fact, the observation data already existed prior to the launch of this study.

Description of the participants. All 20 participants were currently employed TVIs who maintained a caseload of students with visual impairments. Of these, 4 of the TVIs taught at a state school for the blind, and the remaining 16 TVIs taught in a public school district or county that also educated students without disabilities. The participants ranged in age and experience. The iPad training course was not required for any of the TVIs, and tuition was either paid out of pocket or by a teacher's school district. (I find myself curious about how much was paid and for what – apps, iPads, instructors salaries or fees, transport/fares, etc. How were the face-to-face sessions managed? All in the same place at the same time? Were all participants from within the one region? Was the face-to-face instruction given by you alone? Or how much were the other two facilitators involved?

Research Design and Data Collection

Grounded theory and mixed methodologies were chosen to address the many dimensions of questions that inspired this work. Grounded theory allowed for more open-ended exploration of data in order to test the fit of TVIs' online activities as a CoP. Empirical methods provided information about the infrastructure of an online network and specific participants' activities. Online observations were carried out to capture the nature of information exchanged within the network, and four interviews enriched these observations by capturing uniqueness and similarities among participants. In total, data collection and analyses included 20 participants, 112 online observations in the form of message threads, and 4 phone interviews with 1 follow-up questionnaire.

Observations of the TVIs' online interactions were documented in the form of messages they posted to the Yahoo Group listserv. Messages were posted between May 2014 and April 2015 and accessed April 2015. A tool called *DownThemAll* facilitated a batch download of all the messages posted to the Yahoo Group. In order to reduce replication of messages that garnered replies, the messages were re-organized by threads as determined by the original (parent) post and dates of replies. All threads were numbered, then ordered sequentially by date.

The phone interviews were carried out four to five months after the training course finished and after all online observations were downloaded from the Yahoo Group listserv. At the point of the interviews, the Yahoo Group listserv had been largely inactive for several months.

All participants' names were immediately replaced with a pseudonym to maintain their anonymity and confidentiality. Any participants in this study will therefore be referred to by his or her pseudonym rather than their real name.

The participants' Yahoo Group messages supplied data for two of the methodologies. First, the participants' overall activity as reflected by their message posts was encoded for social network analysis (SNA). Next, the content of the messages was examined as records of online observation data. Finally, interview data was collected and analyzed in parallel with data taken from the Yahoo Group. This section will provide more detail on how the data were organized for each methodology.

Social Network Analysis (SNA): SNA methods provide a general overview of a network's density and snapshots of participants' activity at various points in time (Baker-Doyle & Yoon, 2011). In this case, SNA begins to address the first research question by investigating

the structural composition of participants' interactions in the Yahoo Group. Connectedness among participants provides evidence that this collective of people can be considered a meaningful group[1]. This determination is the first step in showing that the Yahoo Group had an effect on connecting otherwise dispersed TVIs.

The Yahoo Group messages were re-organized in an Excel document for import into *Gephi* (Bastian, Heymann, & Jacomy, 2009), a tool for SNA and data visualization (Borge & Goggins, 2014; Goggins, Mascaro, & Valetto, 2013). Each message thread was numbered and organized according to the parent post (labeled "source"). The parent posts were recorded according to participants' ID numbers. Each reply to a parent post was also recorded according to participants' ID numbers and labeled "target". Table 3 shows an excerpt of how the data were organized so that each target within a message thread represents a reply to the parent post. By organizing the data in this way, the degree of central versus peripheral participation could be visualized for each participant depending on how often they posted or replied.

Table 3
Excerpt of Raw Data for SNA

Source	Target	Type	Id	Date Start	Date End
1	12	Directed	27	2014-08-20	2014-08-21
1	5	Directed	27	2014-08-20	2014-08-21
1	3	Directed	27	2014-08-20	2014-08-21
1	1	Directed	27	2014-08-20	2014-08-21
1	5	Directed	27	2014-08-20	2014-08-21
1	1	Directed	27	2014-08-20	2014-08-21
1	5	Directed	27	2014-08-20	2014-08-21
11	1	Directed	36	2014-08-22	2014-08-22
11	17	Directed	36	2014-08-22	2014-08-22
11	11	Directed	36	2014-08-22	2014-08-22
5	4	Directed	40	2014-08-27	2014-08-27
5	14	Directed	40	2014-08-27	2014-08-27
5	5	Directed	40	2014-08-27	2014-08-27
5	1	Directed	40	2014-08-27	2014-08-27

Connections between participants were not weighted by significance of message content, but were visualized according to the number of connections between participants. Those

[1] SNA stems from observable relationships between actors within a network. SNA therefore considers collectives of actors as a *network* with the understanding that groups only emerge [as a meaningful construct] as a result of connections between actors (Monge, 1987, as cited in Haythornthwaite, 1996, p. 325). These relationships are considered without prior classification or labels. In contrast, non-network analyses are carried out based on pre-determined groups comprised of members who are classified according to similarities (Bates & Peacock, 1989, as cited in Haythornthwaite, 1996, p. 325). For this reason, references to the Yahoo Group will retain capitalization to differentiate it as the medium/tool used to host the network, and a general collective of participants will be referred to as a *network.*

participants who interacted more often with each other are connected with a thicker edge than participants who interacted very rarely with another. For example, Figure 8 shows the participant Kathryn minimally connected to Dani and Anna Molly, more connected to Kelly, and the most connected to the trainer Erin. Because it was more important to see the density of connections in order to validate this network as a group, the Gephi settings were set to *Directed,* which enabled detection of both strongly and weakly connected participants (rather than *Undirected*). For the same reason, directionality (who replied to whom) was not considered a factor; two participants were considered connected if one posted to another.

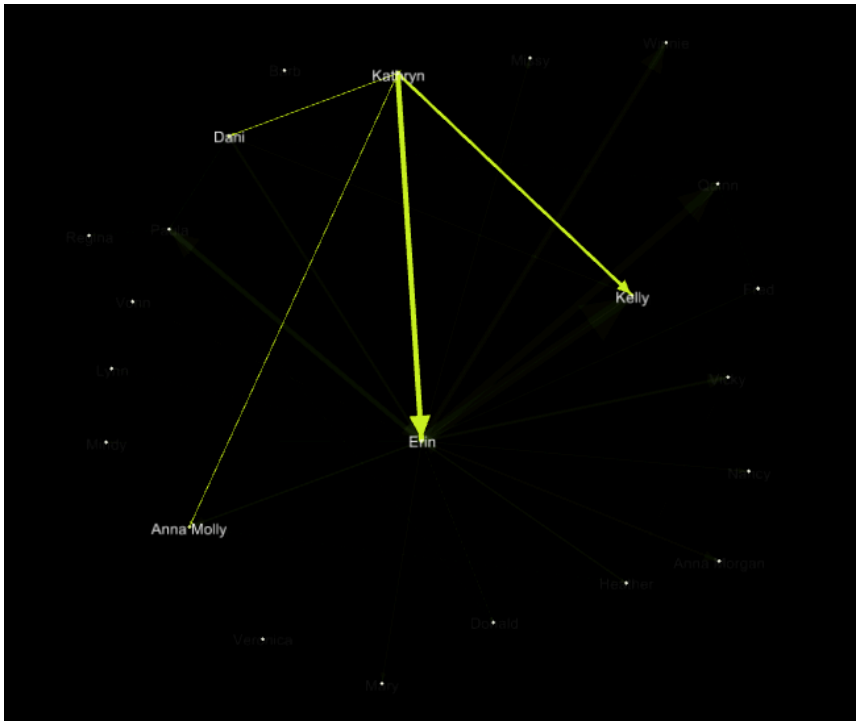


Figure 8. Different levels of connectedness for participant "Kathryn"

Online observations: Real-time observations of TVIs' informal interactions were obviously impossible to carry out in this asynchronous virtual space. Instead, messages downloaded from the Yahoo Group served as records of online interactions. These data afforded opportunities to go beyond whether or not the Yahoo Group had an effect on teachers' connectedness ("Did it work?") and provided more information on what those effects were ("How did it work?").

The messages were read and reviewed many times in order to get a sense of the information that was exchanged. Throughout this process, I maintained a notebook to record emergent questions and thoughts in reaction to the messages. Threads that seemed particularly interesting were marked and noted in a memo. These memos were aggregated in an online document. I made notes that included my impressions of the types of information I observed. I was most curious about resources that were shared among the teachers, and excited when threads included various participants acting as experts rather than just reaching out for help. I also found instances of socioemotional processes interesting, because I imagined it would be similar to social exchanges that typically occur around physical water coolers. These sentiments included phrases such as "I have that problem too", "I am so frustrated with…", or "Thank you for

sharing that resource". The combined processes of learning, knowledge exchange, and social affirmations have been well-documented in physically situated CoPs. Cognitive and social processes are also well-established expectations and measures in computer supported collaborative learning (CSCL) environments as well as in other contexts that include informal and incidental learning.

The messages were uploaded to *Dedoose*, a tool for qualitative data analyses (Moylan, Derr, & Lindhorst, 2015). In following a grounded theory approach, I developed codes according to recurring themes that emerged from my notes. A preliminary codebook was created within Dedoose. Although I kept an open mind to identify these initial codes, I sought to categorize them according to the CoP dimensions. I created parent codes for two of the CoP dimensions, as well as parent codes for other aspects commonly found in professional learning communities. Because all participants inherently shared a domain of interest (using the iPad with students with visual impairments), this dimension was not included in the coding scheme. The combination of developing codes as derived from the data and applying an already established organizational framework served two purposes: (1) to capture the nature of information exchange in this network, and (2) to establish whether this network could be considered a CoP. The codebook is presented in the following list, with child codes nested under the corresponding parent code:

- Demographics and General Data
    - Institute Logistics
    - Month (each month was given a number weight 1-12)
    - Workshop Participant (each participant had a unique number code)
    - Workshop Trainer (each trainer had a unique number code)
- Community Dimension (interaction with others, shared roles of expertise)
    - Connect to others outside of this Yahoo Group (link to other networks, share an opportunity to contribute to field at large)
    - Participant as expert (creates a resource, trains others, offers to help another through a process)
    - Answers a question, provides a solution (provides expertise)
    - Asks a question, request for information or help (seeks expertise)
    - Provides information to meet up or gather in person (reaches out)
- Practice Dimension (build/share a toolkit of tools, information, resources)
    - Introduce a new tool
    - Share a resource or provide information on a topic
    - Report a bug
    - Give instruction (share a new way to something, provide how-to, list step-by-step directions on how to do something a certain way.
    - Vet something that was suggested, support/confirm information that was shared
- Legitimate Peripheral Participation (learn from others' case studies, others' experiences that differ from own)
    - Describe something from his/her own practice
    - Describe something from another colleague's practice
    - Share a story about a student
- Outcomes
    - Demonstrate a change in perspective or attitude

    - Share about a change in own teaching practice
- Socio-Emotional Processes
    - Affirmation, “thank you”, “it helped me too”
    - Commiserate, empathize with a shared struggle
    - Co-identification (use of “we”, “us”)

After I developed the codes, I applied them to all of the messages using Dedoose. This dissertation serves as a pilot for the development and use of this coding scheme. Future publication in a peer-reviewed journal will require inter-rater reliability measures. For this purpose, a second person will apply the same coding system to the same data set, and the level of agreement will be quantified.

Interviews. Semi-structured phone interviews were carried out with four of the Yahoo Group participants. These participants were chosen in order to fulfill the following types of participant in this online group: Highly active contributor, average contributor, and two habitual spectators (“lurkers”). Two habitual spectators were ideally selected in order to include one whom the trainer considered to be a proficient technology user and another who was considered a less proficient technology user. However, due to availability, only one habitual spectator (a participant) was interviewed and instead of a second habitual spectator the trainer recommended a participant whom she considered to be a “low tech” teacher (someone who was not very highly proficient in using technology). Table 4 lists demographic information for the participants selected for interviews.

The interview protocol (Appendix A) was developed in order to gather information on these participants’ personal experiences with the Yahoo group including benefits and shortcomings, how they typically access resources for technology in their teaching, and availability of a CoP in their regular professional community. The semi-structured format was utilized to generally focus the topic of discussion while allowing flexibility to explore a participant’s response and facilitate a flow of conversation (Morse & Richards, 2002; Patton, 1990). Throughout the interviews, participants’ responses were re-stated or paraphrased to check that the intents of their messages were understood correctly. All four participants were interviewed between May and June 2015. Each interview lasted about thirty minutes, and a follow-up email was sent out to gather short responses to several background questions:

- How long have you been working as a TVI?
- How much assistive technology coursework did you receive in your TVI program?
- How many years has it been since you graduated from your TVI program?
- Do you use social media in your personal life? If so, what do you use (example: Facebook, Twitter, blogs, Meetup Groups) and how often do you check your social media (how many times per day/week/month)?

Excerpts from these interviews were transcribed and coded using the same codebook that had been applied to the observation data. Other excerpts that were interesting or surprising were

Table 4

Interview Participants' Demographic Information

TVI	Years Working As TVI	Placement	Amount of AT Coursework Received in TVI Program	Years Since Graduated from TVI Program	Total Number of Posts in Yahoo Group network
Donald	3.5	Itinerant	1 class, 1 semester	1	3
Quinn	37	Resource room	None	34	13
Paula	15	Itinerant	None	28	12
Dani	13	Itinerant	1 class, 1 semester	13.5	14

also transcribed for the purpose of discussion. Themes that arose across interviews were also noted. Transcripts of the full interviews will be made available following the completion and filing of this dissertation.

Data Analyses

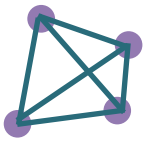
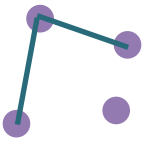
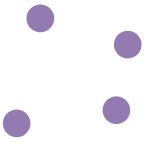
In order to show how the network fluctuated over time, the data were cut and analyzed by month. SNA and qualitative methods were applied to the observational data and compared and contrasted along the same timeline in order to provide a richer view of the evidence at each point in time. Interview data was analyzed alongside the observational data to provide depth and explanation to enrich findings.

SNA. Recall that in SNA, participants in a network are referred to as *actors* and represented as a *node* on a visual display (Figure 6, Chapter 3). When actors communicate with one another, their nodes are connected by a line and referred to as an *edge* in a visual display (Haythornthwaite, 1996). Network density refers to how well connected the participants are within a network and is calculated as:

$$\text{Density} = n / (N \times (N-1) / 2)$$

where n is the number of actual lines, and N the number of actors in the network (Haythornthwaite, 2005). A measure of density = 1 means that every actor within a network is connected. Table 5 provides a sample comparison of different density measures given a network with four actors.

Table 5
Density Comparisons in a Network with Four Actors

			
Number of connected points	4	4	4
Number of lines (edges)	6	2	0
Density measure	1	0.3	0

Given that a participant could post information and receive a number of responses independent of how connected the overall network is at that time, a density measure might not necessarily provide adequate information. A density measure would depict the prevalence of connectedness in a moment in time, however an edge count helps to complete a network view by reporting the quantity of connections and overall.

When viewing a snapshot of the overall Yahoo Group network as compiled over a year, Figure 9 depicts Erin (the course trainer) as highly connected because her edge count reflects that

she made 49 direct connections to people in the network. The visualization shows Erin as if in the center of a wheel with spokes.

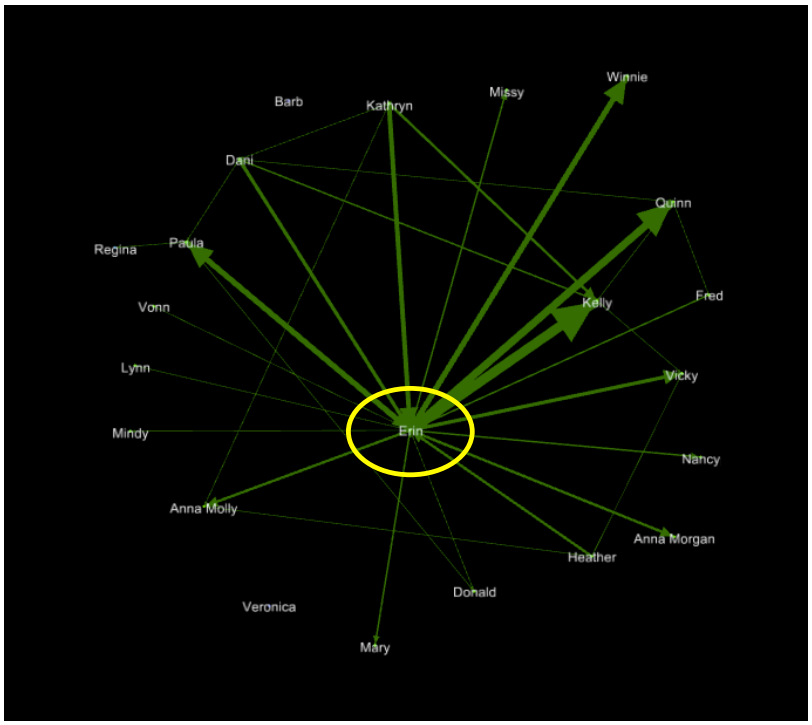


Figure 9. The workshop trainer as a highly connected actor within the Yahoo Group network (Density=0.106, Edges=49).

In contrast, habitual spectators are those participants who have minimal or no connection to another within a network. Although the overall network connectedness (density measure) remains the same as in Figure 8, a closer look at the participants along the periphery shows two habitual spectators (Barb and Mindy). In contrast, these participants have edge counts equal to zero, which indicates that they had no connection to any node (participant) in the network (Figure 10).

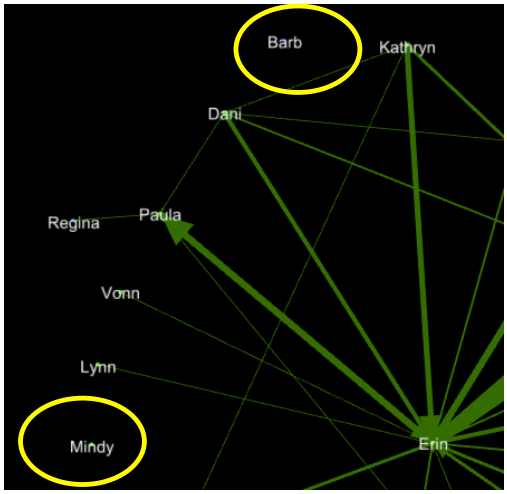


Figure 10. Habitual spectators within the Yahoo Group network.

(Density=0.106, Edges=0)

In addition to connectedness, density measures and edge counts can be used to illustrate central versus peripheral participation of different actors within a network. Recall that in the CoP framework, the *community* dimension describes interactions among members due to members taking on fluctuating roles of expert and learner. Expertise is therefore dispersed among members, with different people taking on a centralized role of an expert as the topics of conversation fluctuate based on each individual's experiences. In this case, a participant who exhibits more connections at a given time could be considered to have a more central role than another participant who has few or no connections. The movement of participants between peripheral and central roles can be interpreted as a demonstration of the *community* dimension of a CoP, and contribute evidence to characterize this network as a CoP. For example, Figures 11 and 12 compare how the trainer Erin moves from a central to peripheral role as participants Paula and Dani take on more central roles.

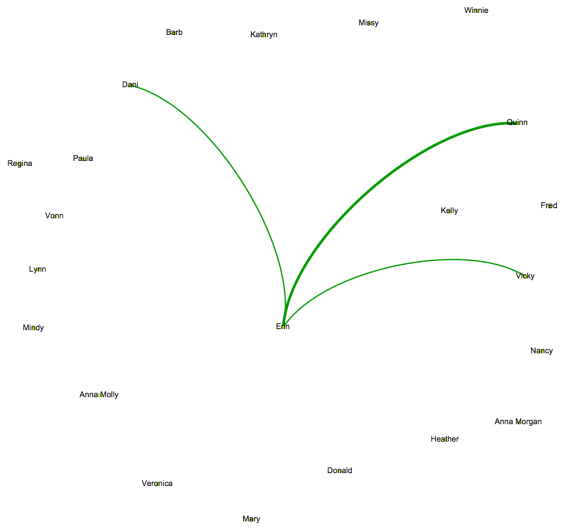


Figure 11. Erin in a central role.

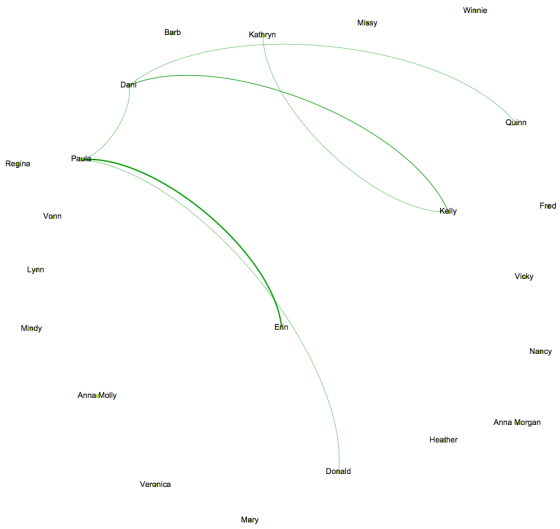
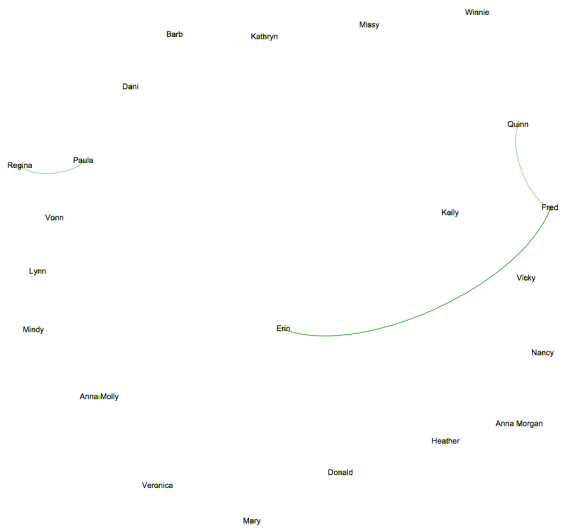
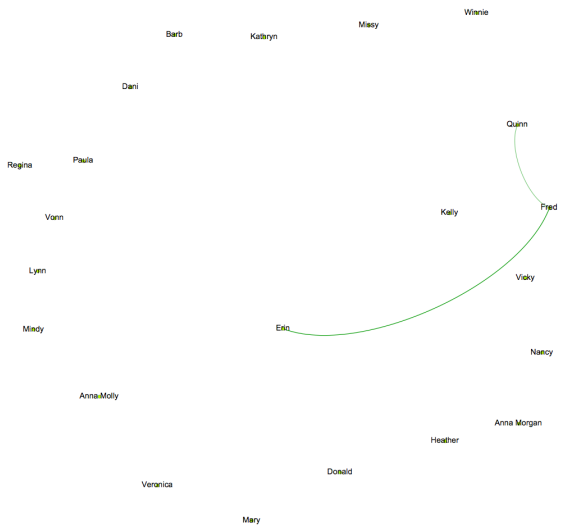


Figure 12. Paula and Dani in central roles.

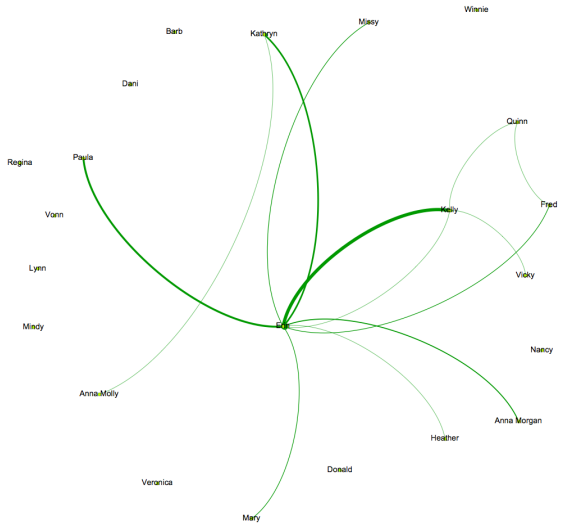
In a CoP, one could expect that other participants would demonstrate a similar pattern of centrality at different points in time while Erin shifts between the center and periphery of the network. Figure 13 shows how the connectedness and position of participants within the Yahoo Group network changes over the course of the year.



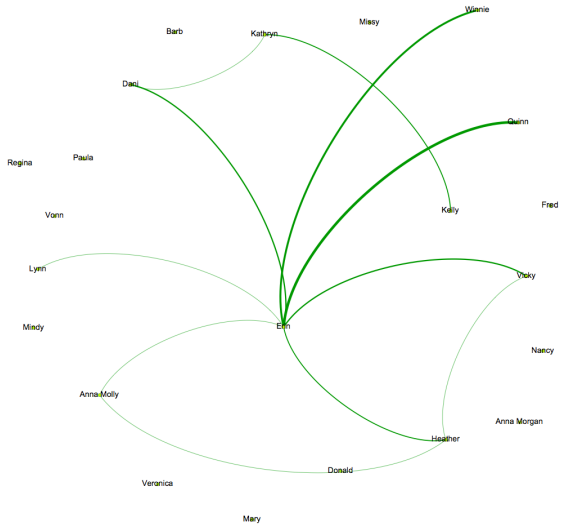
May through June 2014



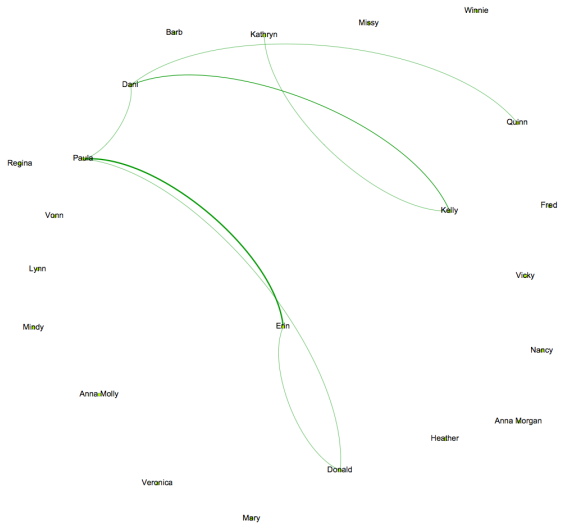
July 2014



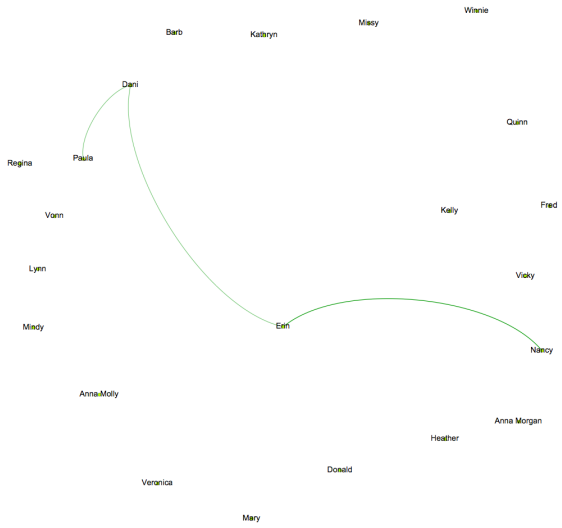
August 2014



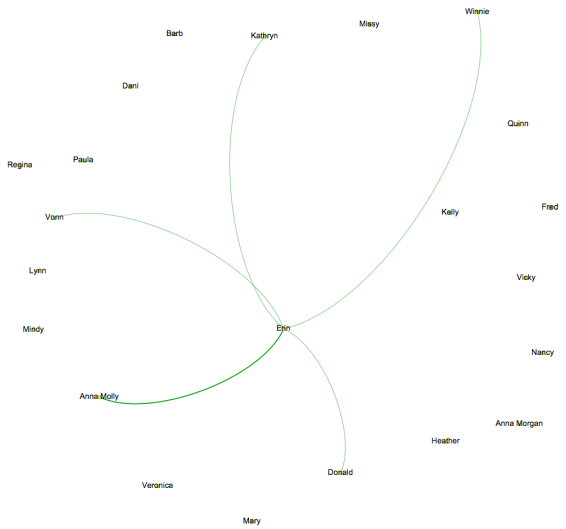
September 2014



October 2014

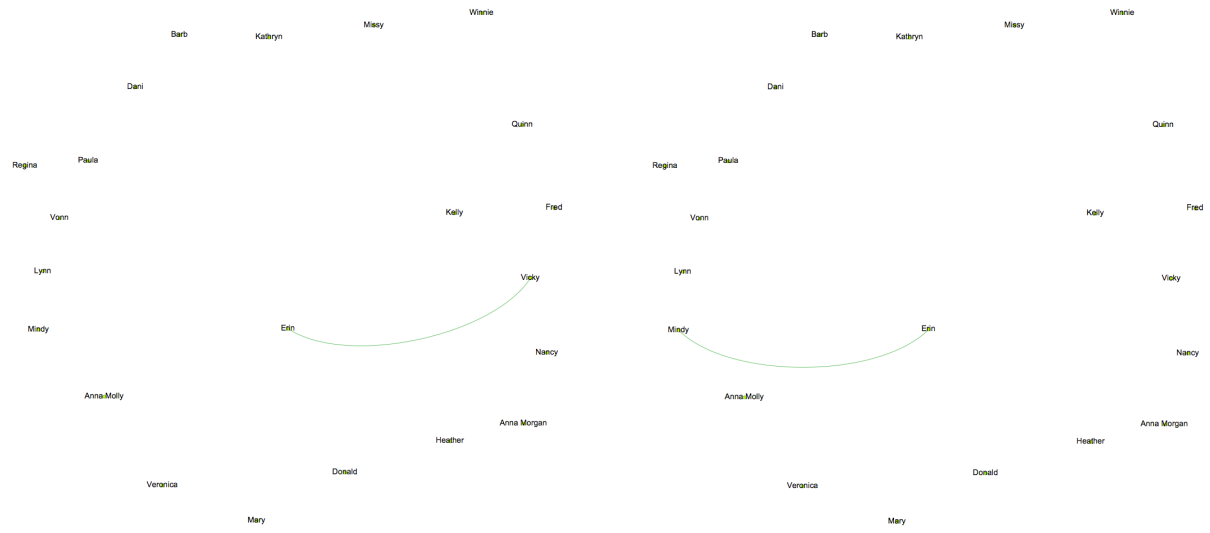


November 2014



December 2014

January through February 2015



January through February 2015 March 2015

Figure 13. Yahoo Group network's activity from May 2014 to March 2015.

Network activity over the course of the year was analyzed using frequency counts of the number of posts and number of connections made per month. Although density measures and edge counts provided an indication of connectedness among participants within a given time frame, the number of overall posts per month was also important to account for the level of activity within the network. Fluctuations of activity could provide a snapshot of how much people activated the Yahoo Group network along the course of a year, regardless of whether participants were a central or peripheral contributor.

Although SNA provides measures of density, connectedness, and activity, it can only provide evidence that a collective of people is a meaningful group and intuit characteristics of participation. Given that this network of TVIs constitute *a priori* an actual group, further analyses are warranted to substantiate the group as a community of practice.

Online observations. Analyses of observation data allowed for a more complete answer to research question number one: Does this particular online group constitute a Community of Practice? Recall that codes were developed from themes that emerged from the Yahoo Group messages and provided description of the nature of information exchanged in the Yahoo Group. In order to analyze whether or not these codes characterized the group as a CoP, the codes were organized according to the CoP framework to determine whether or not the codes aligned with dimensions of a CoP. This initial analysis was presented earlier in this chapter as the complete codebook.

The online observations also supported other analyses of the Yahoo Group's activity including how different types of information engaged various dimensions of the CoP framework. In my pilot study with Morash (2014), we established a positive connection between TVIs' membership to a CoP and their AT proficiency. This study assumes the connection and seeks to strengthen the hypothesis by identifying the mechanisms that support the relationship (research question number two). In addition to the codebook, Participant IDs were also coded along with message dates. Including this information in the Dedoose code structure enabled analyses of code co-occurrences in addition to reports of code counts. Although SNA visualized a

participant's position within the network at a given time (either central or peripheral), running a query for a participant in the same month showed the types of information he or she exchanged and how the information reflected his or her status as an information provider (expert role) or seeker (learner role). For example, Winnie initially posts questions to the group and solicits help, but later in the year she actually develops a resource and shares it from an expert role. This change in accessing versus disseminating expertise is a critical characteristic of the *community* dimension of a CoP and exemplifies what changes in participants' roles could be nurtured and expected in a CoP.

Another aspect of investigation is whether a VWC can support processes that enable teachers' incidental learning in informal interactions (research question number three). Learning from others' experiences, also known as legitimate peripheral participation (Lave & Wenger, 1991), and socio-emotional processes are well reported to occur in physically situated professional learning communities (such as in a school). For this network to be considered an adequate (virtual) simulation of a professional learning community, analyses of observations needed to include to what extent the Yahoo Group facilitated these processes. Reports of code counts helped to identify which posts characterized the group as a CoP and which posts further substantiated the Yahoo Group as a VWC. However, more in-depth information was needed to better understand if and how this network acted like a VWC to support teachers' practices.

Semi-structured interviews. Online observations provided data to support analyses of the Yahoo Group as a function of the information that was exchanged and how participants took on different roles at different times. In order to understand if and how this type of CoP served as a VWC for informal professional development, (research question number four), semi-structured interviews were carried out with four of the participants. These data provided insight on different participants' motivations to engage with colleagues on the Yahoo Group, how helpful of a resource it was to them, and their perspectives on a virtual CoP as a tool for ongoing professional development and teaching support. Analyses included detailed descriptions of these participants' experiences and facilitated documentation of unique and shared accounts across participants.

Roadmap for Interpretation of Data

The next chapter will present the results of these multiple methods for data collection and analyses. Overall, this study aims to expand the theoretical underpinning of a CoP framework for improved application in the online environment. Evidence from each method will align according to participants' activities along a timeline of the Yahoo Group listserv. Analyses of multiple sources and views of the data will provide a rich cross section of this network's role as a CoP and potential to act as a VWC. Results will include these teachers' uses of the Yahoo Group as a CoP and if or how they derived benefit from it. Lastly, results will report to what extent the Yahoo Group fulfilled teachers' needs for an organizational space, and identify areas for potential construction of and access to a VWC. In summary, the research questions will be answered using the following sources of evidence:

Research question #1: Does this particular online group constitute a CoP?

- SNA will provide an overview of participants' shifts between central and peripheral participation within the Yahoo Group network.
- Initial review of codes developed from the observation data will determine how well participants' online messages align within CoP constructs
- Analyses of observation data will detail how participants co-opt learner and expert roles at different times within the Yahoo Group network.

- **Research question #2:** How can technical skills and knowledge learned in face-to-face training be consolidated and further developed by participation in an on-line CoP?
  - Building on the assumption that membership to a CoP that values AT is related to increased AT proficiency, analyses of observation data will seek to strengthen the hypothesis and identify the mechanisms that support the relationship
- **Research question #3:** Can an online CoP facilitate incidental and informal learning as effectively as face-to-face informal professional learning communities?
  - Analyses of observation data will determine whether this Yahoo Group serves as a VWC that supports cognitive and socioemotional processes that enable teachers' incidental learning in informal interactions.
- **Research question #4:** Can an online CoP serve as a VWC around which there are informal interactions that supports a TVI's practice?
  - Analyses of interview data will provide an understanding of if and how this type of CoP serves as a VWC for informal professional development,

Chapter 5: Results

Evidence from this research aims to characterize an online network as a community of practice (CoP) and examine the underlying mechanisms that establish an online CoP as a virtual water cooler (VWC) space. These determinations are important to consider whether this environment can host teacher interactions that support informal professional development and sufficiently meet the needs of teachers of students with visual impairments (TVIs) who have an otherwise dispersed practice.

This chapter reports on the results of the study based on analyses of two data sources: observation data comprised of online messages posted between May 2014 and April 2015 in a Yahoo Group listserv, and interview data from four participants who represented different levels of technology expertise and activity level online. The following sections are organized according to each research question so that evidence from both sources can be corroborated for more well-rounded evaluation and discussion.

Research Question #1: Does This Particular Online Group Constitute A CoP?

Social network analyses (SNA) and observation data were used to answer research question number one. The results are driven by the development of a codebook, illustrated with SNA to show participant relationships and network infrastructure, and embedded within concrete examples selected from the observation data.

Fulfillment of Wenger's CoP Framework. In order to satisfy the requirements of a CoP, a group's activities must align with three dimensions:

4. ***Domain of interest***. Members invest in a shared collection of knowledge, goals, and purpose to their actions. These mutual interests inform their actions.
5. ***Community***. Members interact with one another by sharing ideas, posing questions, and responding to others' issues. Roles of expertise and levels of participation shift among members without formal structure. This dimension assumes legitimate peripheral participation as members learn from each others'experiences that might differ from their own.
6. ***Practice***. Members build a shared "toolkit" comprised of tools, information, anecdotes, and resources. The community develops and maintains this body of knowledge, and leverages it to inform the domain of interest.

The observation data were analyzed using a grounded theory approach and without any preconceived codebook. There were a total of 112 message threads that included 223 individual posts. The codebook was developed as themes emerged from the data. Twenty codes were developed in total. As codes were organized according to overarching themes, 13 of the codes reflected constructs from the *community* and *practice* dimensions. Recall from Chapter 4 that this group inherently had a domain of interest simply by selecting to take a class on the iPad and sharing the same investment and goals to use this technology with their students with visual impairments. The remaining codes that emerged related to group demographics and logistics (3), outcomes (1), and socio-emotional processes (3). Table 6 summarizes frequency counts for each code type.

Table 6
Total Code Counts Over One Year

Demographics and General Data

Institute logistics	74
Workshop participant	113
Workshop trainer	110
Subtotal	*297*
Community Dimension	
Connect to others outside of YG	7
Provide expertise (answers a question, provides a solution, creates resource, trains another how to do something)	37
Seek expertise (asks a question, requests help or info)	54
Provide info to meet up in person	6
Describe something from his/her own practice	13
Describe something from another colleague's practice	8
Share a story about a student	2
Subtotal	*127*
Practice Dimension	
Introduce a new tool	21
Share a resource	58
Report a bug	20
Provide instructions, "how-to"	47
Vet something that was suggested, support/confirm information that was shared by another	21
Subtotal	*167*
Outcomes	
Share about a change in own teaching practice	1
Subtotal	*1*
Socio-Emotional Processes	
Affirmation, "thank you", "it helped me too"	49
Commiserate, empathize with a shared struggle	5
Co-identification (use of "we", "us", “our”)	12
Subtotal	*66*
TOTAL	658

For the purpose of analyzing message content, codes for *Workshop Trainer* and *Workshop Participant* were omitted from further comparisons between code types. With this in mind, Table 7 shows the percent distribution of the codes across organizational categories.

Table 7
Percent Distribution of Codes Across Categories Over One Year

Code category	%
Workshop Logistics	17.01%
Community Dimension	29.20%
Practice Dimension	38.39%
Outcomes	0.23%
Socio-Emotional Processes	15.17%

Overall, codes in the community and practice dimension categories comprise 294 of the 435 content-specific code counts. This equates to 67.59% of the codes that reflect CoP dimensions, which is a strong indication that the Yahoo Group network could be considered a community of practice.

Distributed expertise within a CoP. Another defining characteristic of CoPs is shared expertise among members. That is, no singular member is the expert; rather, various participants contribute expertise depending on their areas of knowledge. For this reason, the code *provide expertise* was organized under *community dimension* and referred to instances where an individual acted as an expert by answering a question, creating a resource, or training someone else. These actions differ from codes in the *practice dimension* that refer to sharing information about an existing resource or tool.

Using Dedoose, a cloud-based qualitative data analysis tool, a query was run on the co-occurrence of two codes: *workshop participant* and *provide expertise*. 22 instances occurred where a workshop participant provided expertise in the form of answering a question, providing a solution to a problem, creating a resource, or training another colleague in how to do something. Although the Yahoo Group was established in May 2014, only 6 posts in 5 message threads were made from May through July 2014 (Figure 14). In August 2014, the network became more active as teachers returned to the school year (Figure 15). Message thread #18, dated August 27, shows the first instance of a participant posing a question, other participants answering and sharing expertise, and finally the workshop trainer "Erin" confirming the information that was discussed:

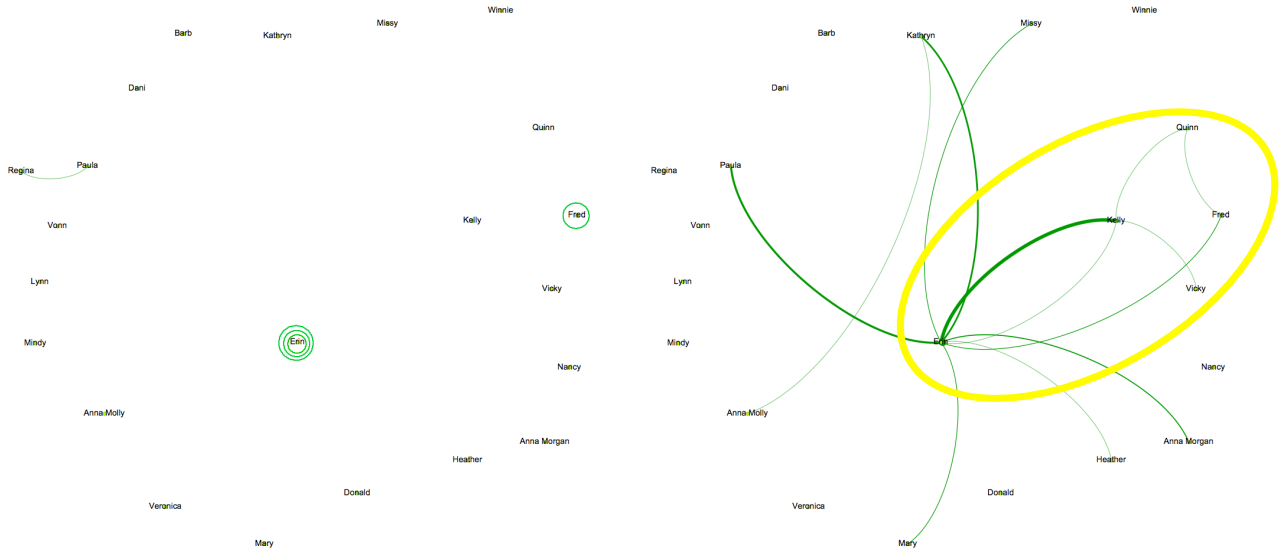


Figure 14. YG network May-July 2014

Figure 15. YG network August 2014, message thread #18 activity circled

----- Message 18: -----

Kelly wrote (Aug 27, 2014):

Hi Everyone, My district is refusing to use the Join Me app. Has anyone used the app Splashtop for Classroom? Kelly

Quinn wrote (Aug 27, 2014):

My district would never have approved the full JoinMe App which includes two-way sharing of screens and data, but they did approve the free version which is a one way. Has it been explained as such? Quinn Bergman

Vicky wrote (Aug 27, 2014):

We use join me all the time. We just use the free version which only gives the student the ability to view not to make changes. We've never had an issue.

Kelly wrote (Aug 27, 2014):

Yes, they will not let us use it at all.

Erin wrote (Aug 27, 2014):

I believe (but have not checked recently) that Splashtop allows the student to change the teacher's screen. (That means when the student zooms in on his iPad, he is also making the big screen Zoom in.) If that is not the case, then Splashtop should be fine. There are several other apps out there that do basically the same thing. We recommend Join.Me specifically, as it works the way we want it to work and there is not a monthly fee. (Make sure that your school realizes you only want the FREE version!) If Splashtop works the way you want it to, that is fine with me! I thoroughly agree with Quinn's comment about the FREE version of JoinMe. I suggest finding out WHY the school does not allow Join.Me and then educate the IT department or whoever makes the decisions about apps.

This message thread shows two participants, Quinn and Vicky, who reply to an initial question posed by Kelly. They both bound their expertise within their own practice in order to recommend a solution for Kelly. The last post on the message thread is from Erin, who adds to the community dimension of the network when she answers the original question and provides expertise on the topic. Next, she adds to the practice dimension of the network when she confirms and vets Quinn's information. By contributing such a multi-layered post, Erin perpetuates and contributes to the development of a CoP.

As the network evolves, other participants take on more active roles and begin to initiate message threads. A snapshot of network activity from October 2014 shows several instances of participant-initiated activity, including activity from message thread #54 (Figure 16). This particular thread includes an example of how another participant, Donald, co-opts the role of "expert".

Figure 16. YG network October 2014, message thread #54 activity circled

Prior to this, the first post on a message thread was usually carried out by Erin (the workshop trainer) in order to share a resource or give instructions, or by a workshop participant with a question or call for help. In this instance, Donald initiates a new thread, shares information he discovers from his own practice, provides instruction on how to use a feature on the iPad, and finally offers to serve as a resource for anyone who requires more support:

> ----- Message 54 -----
>
> On Oct 29, 2014, at 10:15 AM, Donald wrote:
>
> I don't recall Zoom behaving this way on 7, so I thought I would mention this for when you brave souls do decide to take on 8. Pre-iOS8: You simply use the three-finger triple tap and move your fingers up to zoom in and back to zoom out.iOS8: You still use the three-finger triple tap, but there are now two variations that get different results. Three-finger triple tap and hold your fingers down on the iPad on the third tap will still zoom in. The same gesture will cause the screen to zoom out. Three-finger triple tap and then quick release will bring up the new feature: the Zoom Controller. The Zoom Controller is a menu that allows you to adjust the Zoom level up to 15x, filter the display (i.e. grayscale, invert colors, low light), and an option to Zoom only part of the screen (Window Zoom). With Window Zoom, you can re-size the window to fit whatever part of the screen you want enlarged. I'm certainly not advocating everyone run out and download 8.1 just to check out this cool new feature, but when it is time to update, play around with the Zoom features and see what you think. If you have any questions, I'll be happy to try to answer them. Thanks, Donald
>
> Erin wrote (Oct 29, 2014):
>
> Thanks for sharing Donald! You are right - there is a cool new Zoom feature in iOS 8. There are more options than what you described below, so be sure and play

around with this. Please note that if you open the Zoom Window (which is when part of the screen is zoomed and the rest of the screen is normal sized), if you select Window Zoom in the popup menu, then three finger triple tap will open/close the zoom window. In order to get back to the full screen zoom when the window is open, you have to select Full Screen Zoom. Then the three finger triple tap will zoom the entire screen in/out.

At the time of this message thread, Apple had implemented an update of their mobile operating system for iPads and iPhones (iOS 8.1). Erin had posted multiple threads about known "bugs" inherent to this update, and strong recommendations were made for the participants not to update their students' iPads until accessibility problems were resolved. Some of the participants expressed distress when another staff member accidentally updated a device, and Donald had commiserated about receiving his new iPads from the district with the update already installed. This message thread is a more hopeful one that reflects what Donald discovered in the update and some potential benefits. Erin confirms and expands on the information he shares.

In comparison, a similar query was run on the co-occurrence of *Workshop Trainer* and *Provide Expertise*. Given the nature of how this Yahoo Group was created following a workshop with an official trainer, it was surprising that only 23 instances reported the workshop trainer in a role of providing expertise in the online space. The near equal number of posts between participants and workshop trainer that provide expertise convey that expertise was indeed shared among this group and contribute further evidence that this Yahoo Group network functioned as a CoP.

Mandated versus informal participation in a CoP. Aside from message content, a key distinction between a computer supported collaborative learning (CSCL) environment and a CoP is how the learning environment is structured. In a CSCL, the trainer holds a primary position of expertise within a formalized structure to meet specific learning objectives. Participation is usually mandated and follows guidelines for input. In a CoP, there is no official trainer position and participants naturally co-opt roles of expertise at different times. Overall participation in a CoP is also informal, not mandated, and unregimented regarding if or how often participants contribute. In this case, participation in the Yahoo Group was an option for participants following face-to-face iPad training. Activity in the group was not tracked or rated for evaluation measures and equally supported participants who chose to be a contributor or spectator at different times.

Building on the determination that this Yahoo Group was indeed a CoP, the next research question addresses how this CoP helped teachers implement technology learned from training and develop proficiency from basic device knowledge.

Research Question #2: How can technical skills and knowledge learned in face-to-face training be consolidated and further developed by participation in an on-line CoP?

Analyses of observation and interview data were integrated to answer research questions two and three. Excerpts of message threads from the observation data helped define various concepts that contribute to answering these questions, and interview data enriched these findings by exemplifying the concepts within several participants' personal experiences.

Description of interview data. Four participants were selected for individual phone interviews followed by individual email contact for basic background information. Recall from chapter four that the participants were chosen in order to fulfill the following types of participant in this online group: Highly active contributor, average contributor, and two habitual spectators ("lurkers"). Two habitual spectators were ideally selected in order to include one whom the

trainer considered to be a proficient technology user and another who was considered a less proficient technology user. However, due to availability, only one habitual spectator was interviewed and instead of a second habitual spectator the workshop trainer, Erin, recommended a participant whom she considered to be a "low tech" teacher (someone who was not very highly proficient in using technology). Among the group of twenty participants in the iPad workshop, the ones selected for interviews included three itinerant and one resource room teacher. Their years teaching ranged from 3.5 to 37 years of teaching experience. Two of the TVIs who graduated 28 and 34 years ago had received no AT coursework in their TVI program, while the remaining two TVIs each took a 1-semester AT course. The variation in experience, teaching placement, and years since graduating from a TVI program were a representative range amongst many TVIs in the field. However, because all participants had submitted applications to attend this iPad workshop, these interviewees likely represent a group of TVIs who share an interest in learning about and using technology with students. Considering the multitude of previous research on TVIs' underuse of technology, this characteristic is one that is not necessarily shared by all TVIs. The following paragraphs briefly describe each interviewee including consideration based on impressions provided by Erin.

Dani. Dani was considered a high activity contributor and posted 14 times in the Yahoo Group. She had just completed her 13th year as an itinerant TVI and taken one AT course in her TVI program. Unlike the other TVIs who were interviewed, she was the only who shared an office with several other TVIs in her district and therefore had regular contact with colleagues. Despite the regular face-to-face contact, she nonetheless felt isolated in using technology with students because her colleagues were less familiar with technology and relied on her for troubleshooting support. Similar to what other interviewees reported, Dani expressed frustration that oftentimes the district technology personnel would order equipment or software for their students with visual impairments but provide no training upon delivery of the equipment. As a result, Dani often taught herself how to use the technology by checking online training manuals, searching for YouTube videos, checking company websites, and experimenting with the technology herself to learn and become familiar with its usage. She in turn supported her colleague's use of technology with students. According to the rubric developed to gauge AT proficiency, Dani was considered highly proficient in AT use due to her ability to search for solutions, obtain the technology her students needed, independently use and troubleshoot AT, and use AT for a variety of applications. She valued the Yahoo group network for the connection to other colleagues who shared and could support her interest in technology, and appreciated the delivery of announcements regarding software updates.

Donald. In contrast, Donald was considered a habitual spectator and posted only 3 times in the Yahoo Group. He had taught for 3.5 years as an itinerant TVI and also taken one AT course in his TVI program. Donald's day-to-day practice was isolated, and he typically only interacted with other TVIs and technology experts at the annual state conference. Like Dani, he also took on the role of trainer to others in his district when he was asked to share the information he learned from the workshop. Along the AT proficiency rubric, Donald was also highly proficient in AT use due to his ability to find accessibility solutions and secure technology for his students, independently use and troubleshoot AT, and independently combine a variety of AT for various student activities. Donald also cited the group as a resource for information on technology and found information about software updates helpful. He particularly valued the access to expertise and connection to Erin, with whom he appreciated "bouncing ideas and

problems" back and forth. Overall, this Yahoo Group seemed to be one of many resources he used to keep up with technology and troubleshoot.

Paula. Paula was considered an average activity contributor and posted 12 times to the Yahoo Group. Similar to Dani, she had taught for 15 years but graduated from a TVI program 28 years ago where she received no AT coursework in her program. Both Dani and Donald taught for a number of years similar to years graduated from a TVI program Confusing senetence. Paula also expressed feelings of isolation in her practice and cited the annual state conference as the primary event where she crossed paths with another TVI. Like all the other interviewees, she expressed unfulfilled needs for training in technology and lacked time to stay up to date. Although she subscribed to a state listserv comprised of other TVIs in the state, she found the listserv was more focused on administrative issues related to grading or testing rather than a resource for technology. Instead she cited the Yahoo group as a newer resource for locating technology-related information, and confessed to "Google everything" in order to find information, training videos, and how to figure out new technology. Although she demonstrated some level of AT proficiency by independently seeking AT solutions, she did not consider herself to be tech savvy. Along the AT proficiency rubric, she was considered one level lower in proficiency than Dani and Donald because she needed more guidance in order to incorporate AT into her practice. However, once she had more specific direction in student lessons that could include AT, she was willing and able to enhance her students' workflow with technology. Like Dani and Donald, she also appreciated the Yahoo group for its connection to peers, but wished for more extensive participation so that she could learn more from what others were doing and get more of her questions answered.

Quinn. Quinn was also an average activity contributor and posted 13 times to the Yahoo Group. Of all the interviewees, she had the most years of teaching experience (37). Like Paula, she also did not receive any AT coursework in her TVI program. Quinn was the only interviewee who was not an itinerant TVI and instead taught in a resource room for students with visual impairments. Despite being based at a school site, Quinn also cited isolation in her practice and lack of time and support in mastering technology that her students needed. Unlike the other interviewees, Quinn did not prefer internet searches for troubleshooting and finding information. Instead, she relied on calling companies for tech support and reading device manuals. Interestingly, she expressed a wish for the Yahoo Group to be less listserv based and be available as a searchable forum. She reported a lack of email storage that made it difficult to save all the messages she received from the Yahoo Group. Quinn admitted to being "pretty confident" in her abilities to troubleshoot technology, because "if [she] couldn't figure it out, [she] could find somebody who could figure it out". She ultimately relied on the tech support of the companies who made the devices her students used. Despite her confidence, Quinn's actions placed her on a lower AT proficiency level due to her need for direct instruction in "finding quality teaching sequences" to implement technology for different learners. She was clearly willing to troubleshoot problems independently, but needed help differentiating technology use and had difficulty securing funding for updating technology. Like the others, Quinn also valued the Yahoo Group as a resource for information on updates, but she often found that the group could not supply timely answers to questions that required immediate responses. She also viewed her colleagues as fellow novices and relied on Erin to provide expertise to the Yahoo Group.

Use of interview data. While the observation data informed hypotheses about participants' intentions and benefits of engagement in the Yahoo Group, the interview data solicited actual evidence of participants' motivations and feelings about engagement. The

interviewees' data provide more in-depth examination of the role and impact of the Yahoo Group on four participants' use of technology after training. Although their mutual interest in technology differentiated them from other TVIs who do not use technology with students, the interviewees encompass a range of teaching experience and AT proficiency. The results of these data are presented in the following sections in order to complement observational data.

Development of AT proficiency. In earlier work, we found a positive relationship between AT proficiency and membership to a CoP that values technology use (Siu & Morash, 2014). The current study builds on this finding and utilizes online observation data to identify the underlying mechanisms that support this relationship. Specifically, what kinds of information do teachers gain from a CoP that help them translate general device knowledge to differentiated applications in the classroom? Identifying the highest levels of AT proficiency is based on several dimensions (Siu & Morash, 2014), including an individual's ability to: (1) select an appropriate tool for specific use; (2) locate resources to secure provision of AT; (3) troubleshoot and operate AT; and (4) integrate AT use within designated and novel tasks. In other words, AT proficiency is achieved when an individual understands a tool well enough to use it appropriately in novel situations that were not specifically taught in training. In the case of participants in this Yahoo Group, they attended a face-to-face training with the following learning objectives (Brauner & Summers, 2014):

1. Use the accessibility features of the iPad including low vision features and the Voiceover screen reader with a Bluetooth keyboard and a refreshable braille display.
2. Use a core suite of apps that are commonly used by students in mainstream classrooms.
3. Teach a student how to use the accessibility features of an iPad and the core suite of apps.
4. Set expectations for the support required from general education teachers, administrators, and IT staff.

Note that these learning objectives mostly focus on the technical aspects of learning a device including how to operate it and how to teach a student to do the same. Although it is unknown how many use cases were employed in the training curricula, it is unlikely that each participant learned every designated task needed in order to apply the technology for each unique student case and accessibility need. Effective technology use requires understanding how a tool can be flexibly utilized based on needs of the student and content he or she needs to access (Mishra & Koehler, 2006). For students with visual impairments, no two students have the same functional vision abilities even if they share a diagnosis. In addition, different classroom tasks and subject matter have particular accessibility challenges for nonvisual learners. For example, a totally blind student may require a screen reader to read literal text and image descriptions but require an alternative method to read complex equations in math problems. Given all the possible combinations of student need, subject matter and classroom contexts, it is challenging if not impossible to cover all the scenarios in any given training. Therefore, TVIs who participate in a technology training must subsequently evolve the device knowledge gained in a training by applying it to their specific use cases in order to achieve AT proficiency. Sentence looks a bit clumsy

Dispositions of situated learning. In the context of this study, the term *situated learning* is used to characterize how teachers learn from examples of practice. Described as legitimate peripheral participation by Lave & Wenger (1991), this style of learning in a CoP occurs through social engagement when members access one another's expertise via shared experiences. In this study, every iPad workshop participant was required to select one student with low vision and one student with no vision to focus on throughout the year. These students were used as case

studies and the teachers often referenced activities with their students in online discussions. By doing so, the participants learned from each other's experiences and demonstrated learning acquisition when they became mini-experts in differentiating how they used the iPad with a student. Several aspects of the community dimension describe how colleagues might interface with each other's work and access a wider breadth of expertise beyond their own practice. Reflecting back on the codes that arose from the online observations, 127 of the 435 content-related code counts (29.20%) were categorized under the *Community Dimension*. Of these, 91 codes related to seeking or providing expertise while the remaining 36 codes (28.35% of the community dimension) relate to instances of situated learning (as indicated by an asterisk in Table 8).

Table 8
Codes Under Community Dimension

*Connect to others outside of YG	7
Provide expertise (answers a question, provides a solution, creates resource, trains another how to do something)	37
Seeks expertise (asks a question, requests help or info)	54
*Provides info to meet up in person	6
*Describe something from his/her own practice	13
*Describe something from another colleague's practice	8
*Share a story about a student	2
Subtotal	*127*

In message #27, Erin describes how one of her students uses the iPad's accessibility features differently from how it was taught in the training:

> On September 23, 2014, Erin wrote:
>
> My student today has [cerebral palsy] and only some use of his right hand. Typing text is challenging for him; however, he is fascinated by cool facts and exploring websites. These are the steps that I taught him: Hold the Home button to activate Siri then say, "Google Search". Siri says, "What would you like to search for?" Quickly say, "S A S accessibility Education". (Be sure to say each letter "S-A-S" not the word "sas". (Website options appear.) Change the rotor to Headings (this student uses the [refreshable braille display] to do this as he cannot physically swipe with his finger). Swipe down stopping on "Accessible technology in Education - SAS." Activate. Swipe down (rotor is still on Headings) stopping on "Research and Development". Change rotor to "links". Swipe down stopping on "Gallery of accessible data visualizations". Activate. Read text or swipe down (rotor is still on Links) to view the choices. Locate the desired choice (such as Census Map or Periodic Table) and activate. Once you are in the desired data visualization, drag your finger around the screen to explore. Activate to drill down for more data. Enjoy! Erin

As the trainer, Erin sets an example of how to define a use case, what the accessibility challenge is, and how she used the technology differently from how it was taught in training. She provides detailed instruction on how to use the features for this specific case while integrating the basic skills that were covered in training (such as using the refreshable braille display with an iPad and using the rotor function).

In message #83, a question is posed about an app called "Quizlet" and whether or not other teachers have found it to be useful for students. This app was not taught in training. A participant named Winnie replies that one of her students uses this app, and offers to create a training video on how her student uses the app with the VoiceOver screen reader feature on the iPad. The message segment was coded as *Describes own practice* because it is an instance of a participant sharing a personal case study. The post also intuits that the participant will create a tool for others to learn from her experience. Winnie therefore shared her own use of the app as a sample use case, and thus she might be seen by others as having expertise in using this app, and actively contributing to building a resource for the community. As a case study, the message thread applies the basic iPad features learned in training to a differentiated application in one TVI's practice. This example presents an instance of situated learning that supports other participants' learning about an application in a context that is perhaps different than how they currently use the iPad. By doing so, the case study potentially expands one's concept of iPad use beyond a single participant's own experience.

Development and maintenance of a professional toolkit. Of the 435 content-related codes, 167 (38.39%) fell under the *practice dimension* (Table 9). These include observations where teachers shared information relevant to their practice, found new ways of doing things that were not covered in the training, or confirmed another colleague's solution that was not explicitly taught in training.

Table 9
Codes Under Practice Dimension

Introduce a new tool	21
Share a resource	58
Report a bug	20
Provide instructions, "how-to"	47
Vet something that was suggested, support/confirm information that was shared by another	21
Subtotal	*167*

The following excerpt from message #78 includes an example of how the participant Kathryn shares an app she uses for optical character recognition (OCR). OCR is important for converting images of text (such as an image-based PDF document) into actual text that can be read by screen reader software such as VoiceOver on the iPad:

> On Dec 1, 2014, Kathryn wrote:
>
> The OCR scanner app allows you to convert from pdf, copy to clipboard, and paste formatted text into Pages or Word for iPad. I use it for single page documents as a quick way to convert, and it does surprisingly well.

This was another app that had not been explicitly taught in training, but is a tool that Kathryn found helpful in her own practice. She introduced it to the community and brought awareness to its existence and usefulness. Erin replies and confirms that the features provided by the app are indeed helpful:

> Erin wrote (Dec 1, 2014):

> Sounds good. There are several different ways to scan . . .having the ability to scan on the fly with the iPad is always good!

These types of exchanges of information and feedback supplement the knowledge gained in training, and help members of a CoP continually update their professional tools as resources become available. In this case, attaining and evolving skills might help TVIs sustain their teaching practice as caseloads and technology change.

Crowdsourced information and technology support. The itinerant nature of most TVIs' practice generally limits immediate support when troubleshooting is needed. Troubleshooting might include problems that arise in using a device or questions in how to use technology in a situation that was not directly covered in training. In the case of Vicky, she did not have a person in her local community to ask for help and was unsuccessful finding a solution to her problem. Message #106 shows her frustration and how she finally reached out to the Yahoo Group network for help:

> On Mar 17, 2015, at 2:07 PM, Vicky wrote:
>
> Hi, Erin! I hope you are well. How can you access dictation when using the braille display? I have googled and googled again, but I can't find the answer! Vicky

Although Vicky could have emailed Erin directly, she instead chose to post her plea for help in the communal online space. Given the iPad workshop's focus on using a refreshable braille display with the iPad, Erin was likely considered the expert in this area. Thus, Vicky addressed the post to her. However, Vicky maintained an awareness of the potential in accessing her colleagues' expertise by posting her question publically on the Yahoo Group.

Although this excerpt is an example of how a participant used the online CoP to solicit help, other analyses were needed to enrich the snapshot and further explore how such a community could effectively crowdsource information and technology support to help a TVI develop technology proficiency. In order to gain a deeper understanding of the role of this CoP in developing AT proficiency, each interviewee was asked: *Was there information you gained from the Yahoo Group that you did not receive during the face-to-face training?* Overall, each participant cited how the Yahoo group provided broader access to information, teaching strategies, and problem-solving. Donald admitted,

> I was one of the cocky ones who, when [I] first got into the tech class, I was like, 'I don't know why I'm doin' this, I'm already gonna know it', [but] this was different... I was just blown away [with all the] things that I didn't realize I didn't know.

Donald's confession reflects how these TVIs gained perspectives on technology uses that were perhaps different from what they were familiar with or what was covered in the face-to-face training. Through their online interactions, they engaged in situated learning through each others' case studies and accessed a wider breadth of expertise in using the iPad with students. By exposure to all the differentiated applications of the iPad not explicitly taught in the face-to-face training, these teachers were able to move beyond basic knowledge of device features and actually implement the iPad for various classroom activities with students with wide-ranging needs. These differentiated iPad applications were not covered explicitly in the face-to-face training and instead shared through the teachers' informal online interactions.

When discussing overall challenges in using technology, all of the interviewees mentioned the lack of support from the school or district information technology staff. They found that the general technology personnel were unfamiliar with visual impairments or related assistive technology in this area of disability. As a result, these personnel were limited to ordering equipment and installing software but unable to provide TVIs with training to operate the technology. For Quinn, her experience with technology in her district was having someone "walk [her] through the steps [to use a device] once, and have the student do it once." She expressed a wish to have more explicit instruction in how she could use the technology for different ages and abilities of students. In essence, she alluded to having difficulty in taking basic device skills and becoming flexible in applying the device with proficiency. Dani echoed these sentiments and reported that the Yahoo group "gave her more strategies to use as well as [how to make recommendations] to other teachers who have kids who [would benefit from] technology". She shared an example of how she worked with another TVI in her district with a blind student on her caseload but did not use technology. By the end of the year, Dani helped this student implement use of an iPad in the classroom.

Thus far, quantitative and qualitative analyses of the observation data show that this Yahoo Group network functioned as a CoP. With the addition of analyses from the interview data, hypotheses that emerged from observational data were confirmed for the four participants who were interviewed: The Yahoo Group also helped TVIs develop AT proficiency via situated learning opportunities and greater access to resources and expertise. The following research question re-frames how an online CoP might be viewed as a VWC that supports ongoing professional development.

Research Question #3: Can an online CoP facilitate incidental and informal learning as effectively as face-to-face informal professional learning communities?

This research question relates to the organic professional development that occurs around physically situated teacher spaces such as a teachers' break room. Informal interactions around such "water cooler" spaces foster communities of practice that enable teachers' incidental learning. In addition to characteristics of the emergent codebook that indicate this Yahoo Group network is a CoP, 15.17% of the content-related codes were filed under *socio-emotional processes* (Table 10). This relationship-building component is one that might also be found in a water cooler space and contributes to the development of trust among members of an effective CoP. This aspect deserves consideration in examining this online network as a metaphorical virtual water cooler (VWC) space.

Table 10
Codes Under Socio-Emotional Processes

Affirmation, "thank you", "it helped me too"	49
Commiserate, empathize with a shared struggle	5
Co-identification (use of "we", "us", "our")	12
Subtotal	*66*

Navigating challenges in practice. Many of the themes in this study's codebook have been found to play a role in schoolwide adoption of new curricula or policies (Coburn, 2001; Palincsar, Magnusson, Marano, Ford, & Brown, 1998). In this case, a segment of messages from

the Yahoo Group was reminiscent of how a group of teachers might informally gather to communicate about challenges brought on by district wide changes to classroom software.

As mentioned previously, in September 2014, Apple released version 8.0 of their iOS software for mobile devices such as iPads and iPhones. Although the update did not affect generic device functionality, the major software changes had deleterious effects on accessibility compatibility with third party applications (colloquially known as "apps"). Erin immediately informed the participants not to update their iPads until the issues were resolved, but some of the participants received their iPads already updated or worked with paraprofessionals who unknowingly updated the students' devices. The next several online observations include instances of teachers sharing their frustrations or information on how to manage the update ([…] denotes deleted text):

> ---- Message 30:----
>
> Anna Molly wrote (Sep 25, 2014):
> Erin, you may have more info on this...but thought I'd pass it along...Our AssistiveTech dept shared that if you've […] updated and having trouble, you can go to a itunes, back up the phone and reinstall the previous version.
>
> Erin wrote (Sep 25, 2014):
> Hi Everyone, Anna mentioned that you CAN go back to iOS 7 after you have updated to iOS 8. Interesting! So, what did I do? An Internet search! Here is just one of many articles about going back to iOS 7.1http://www.tapscape.com/downgrade-ios-8-ios-712/ So, if you updated to iOS 8 and you want to go back to iOS 7.1, it sounds like you can! E

Note that a participant had heard of backdating the software and shared the information by initiating message thread #30. It is evident that this information is new to Erin (the workshop trainer), and she does an excellent job of confirming the information by sharing how she located further resources. By doing so, she incidentally teaches the participants how to do an internet search and find information for themselves. The follow-up? exchange shows how she implements this strategy again by referring a teacher to an internet search rather than answering a question directly. In a face-to-face community, this might be similar to how teachers might tell each other how to find answers to problems when they only have a moment in passing:

> ---- Message 32:----
>
> Dani wrote (Sep 29, 2014):
> Hello All […] my iPad updated ITSELF to IOS8 today […] Has this happened to anyone else? If so, is there a setting that I have on that is making it do automatic updates? […]
>
> Erin wrote (Sep 29, 2014):
> I hope you keep your iPad backed up! [Provided information on how to back up] Yes, there is a way to turn OFF automatic update. Do an Internet search - "How to turn off automatic software update on iPad". There are several articles on how to turn it off.

Finally, message thread #46 is an online observation that could easily be mistaken for an observation of face-to-face interactions in an informal teacher space.

> ---- Message 46:----

Paula wrote (Oct 20, 2014):

Hey guys! My para- professional updated one of my student's iPad to the iOS 8.0 by accident. I read that I can downgrade to 7.1.2 again but that APPLE does not recommend this to be done. My student is so frustrated right now...and me too. Any suggestions?....

Erin wrote (Oct 20, 2014):

I do not believe that there is an option - NOW - to downgrade to 7.1.2. There was a way to downgrade earlier, but I do not believe downgrading is still an option. IF YOU HAVE iOS 8, please update to 8.1 IF YOU ARE RUNNING iOS 7.1.2, DO NOT UPGRADE YET! iOS 8.1 came out today. It has fixed some of the accessibility issues - so it is better than 8.0.2

Donald wrote (Oct 21, 2014):

As some of you may remember, I was given my iPad Airs with iOS8 already uploaded. I attempted to restore 7 on them (without taking drastic measures i.e. jailbreaking) and was eventually told that I needed to get a certified Apple dealer to complete this process. I haven't tried the new release, so hopefully it 8.1 will alleviate some of our issues

Paula wrote (Oct 21, 2014):

Thank you guys!! I will update it to 8.1 and see how it works :(My poor para feels so sorry and frustrated. We were working smoothly till yesterday :(IMPORTANT: Do we have new commands for [Refreshable Braille Display]/iPad use with 8.1? Another question: If the student is a low vision student and does not use Braille/RBD, should that iPad be updated?? Parent is asking me it's so nice to have a support group like you guys :) Take care, Paula

Erin wrote (Oct 21, 2014):

The same commands for iOS 7 will work with iOS 8 […].

Overcoming professional isolation. In Paula's post dated October 21, she signs off by mentioning how nice it is to have a support group such as the Yahoo Group network. Earlier in the year, message thread #31 includes observations of participants' gratitude for the Yahoo Group and its role in providing a means for the teachers to connect with and learn from each other:

[Heather posts a question about a problem she has with an app, and Erin replies with answer. Anna Molly follows with her post, which changes the topic for the remainder of the thread.]

---- Message 31:----

Anna Molly wrote (Sep 29, 2014):

Thank you for sharing with us all. This info is very helpful both as a reminder and as to how to work […] I'm still struggling trying to keep up. Fall/beginning of the school year is a tough time. So many changes-- systemwide with the new testing and establishing baselines […] so much info presented on the PRomethean Board; technology failing or not ordered in timely manner […] new students transitioning into the system; and a new TVI who needs lots of support… the list goes on...but I'm sure each of us must be experiencing such challenges. […] Thank you for sharing your wisdom and knowledge with us. I really, really, really hope that we won't [lose] connection with you and Fred once we reach Dec. Is there another such "list-serv" for those who've completed the classes to communicate/exchange ideas/problem solve...or do we maintain our current…site to communicate and assist each other?

Erin wrote (Sep 30, 2014):

Let's talk about this! Anna asked if we have a list-serve for teachers who have completed the iPad Institute. Currently, we have been maintaining each separate list serve; however, I love the idea of combining the groups into one … what do you think?

Vicky wrote (Sep 30, 2014):

I think that is an excellent idea--we can all keep learning from each other!

Heather wrote (Sep 30, 2014):

Love the idea. A large number to refer to always helps :-) Heather

The interview protocol for the four Yahoo Group participants included the following question that more specifically identified how the online group supported teachers' learning: *Do you feel that participation in this Yahoo Group provided you with further professional development outside of the face-to-face trainings?* Three out of four participants were itinerant teachers and the remaining fourth taught in a resource room for students with visual impairments. All cited isolation in their professional practice and expressed a lack of connection with colleagues who used technology with students with visual impairments. One of the TVIs, Dani, was the only interviewee who reported regular contact with other TVIs in her district. However, although they shared an office space, they did not share a community of practice because she was the only teacher who prioritized using technology with students. As a result, she remained isolated in accessing supports for technology. In her case, the online space remained an alternative to the lack of CoP around technology in her face-to-face environment. The other teachers cited the state's annual conference as the only time they engaged in face-to-face interactions with other TVIs. Although they gave the impression that they consistently attended every year, another recurring theme was that they felt the Yahoo Group enabled them to keep in better touch with other colleagues. Donald stated,

> I would say that I know these TVIs a lot better than I do the ones that I just casually see at our state conference... It [created] a better relationship -- more meaningful relationships where if I have a problem I have someone else I can [get in touch with] and who may have had that problem before.

Supplemental learning in an informal professional community. Although the observation data provided a general sense of the tools, information, and resources exchanged online, the interview data provided more specific insights on how the Yahoo Group fit into a TVI's overall professional development. In discussing what they gained from the Yahoo Group network, all interviewees reported that the most significant value was being able to keep up with changes in the technology including software updates and new apps. This benefit echoes the exchange that occurred online regarding the iOS update, but also extends to other postings about new apps that teachers found helpful in their practice. Although this aspect of keeping current was highly valued, the teachers also recognized the virtual space as a supplement, not replacement for face-to-face training. The following quotes encapsulate how each interviewee considered the Yahoo group's role in their professional development:

- **Donald**: "I'm not gonna say that if I didn't have it…I would be lost or anything like that. [But] it's a nice resource…one of many that I will go to for information on technology."
- **Quinn**: "[It gave me an] awareness of other people having issues with updates or versions of things… I think the Yahoo group for that was… pretty significant."
- **Dani**: "With the Yahoo group, I felt like it was more supplementary and follow-up…information. 'Cause -- you know how tech changes so rapidly…it's like a continuation of the training. So it's good for announcements…like, casting a wide net and saying 'alright, let's [make sure] everyone on this group will get…the information."
- **Paula**: "It's mainly keeping up with new apps and ways to use the iPad…bugs that have been happening because of upgrades."

Differentiated uses of a water cooler space. Observational data was also extricated for each of the interviewees in order to investigate how these four participants used the Yahoo Group. One expectation was that a participant's use of the Yahoo Group might change over time. For example, it was expected that earlier in the year, a participant might use the group to solicit help but then later use the group to "give back" and share resources. However, no trends in the message codes emerged when the four interviewees' messages were ordered by date. Instead, it became apparent that much like physically situated water cooler spaces, different interviewees used this virtual CoP in different ways (Figure 17).

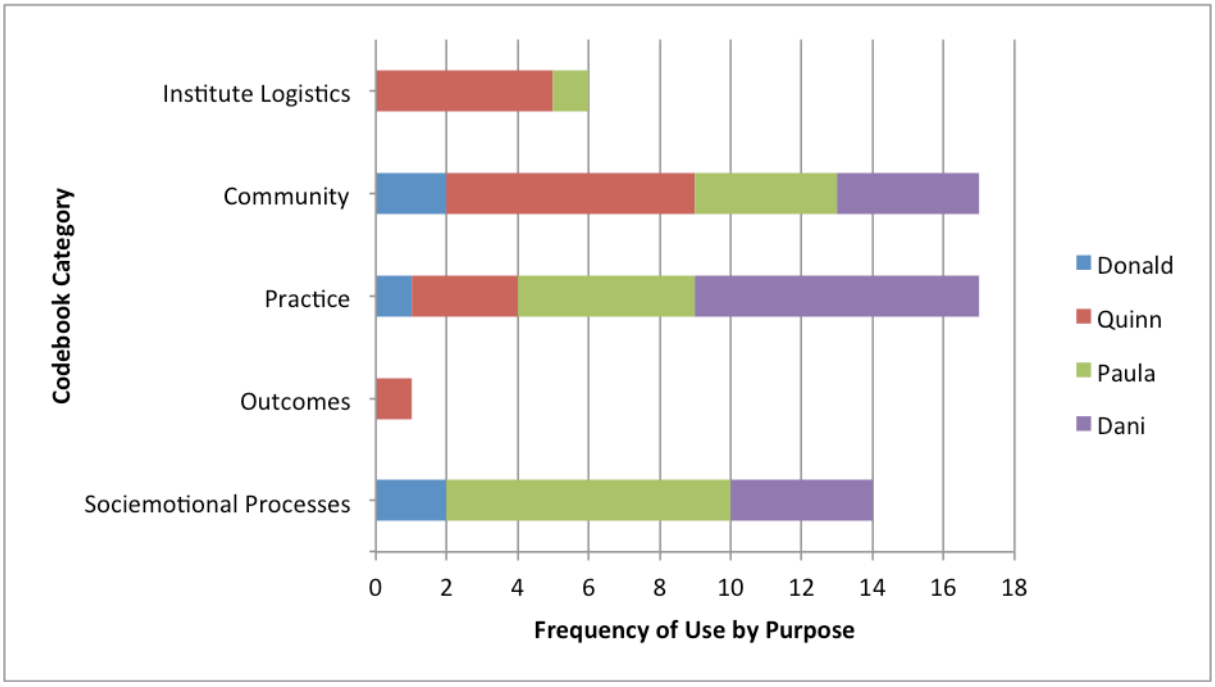


Figure 17. Comparison of interviewee message content by code category

When the interviewees' message content was compared across codebook categories, it became apparent that Paula contributed eight posts related to socio-emotional processes while Quinn did not use the Yahoo Group for that purpose at all. However, Paula and Quinn both used

the Yahoo Group to discuss or ask about workshop logistics such as assignments or how to use the listserv. Neither Donald nor Dani utilized the Group for information related to logistics.

In her local teaching environment, Dani was accustomed to playing the role of expert and in the online space seemed to carry out a similar role. Eight of her posts were in the *practice* category and related to sharing a resource or information, or to vet someone else's information. From her day-to-day experiences working with colleagues to alleviate fear in using technology, she provided similar reinforcements to colleagues online by posting several "affirmation" messages in response to others' contributions. Four of Dani's posts were in the *socio-emotional processes* category.

In general, evidence of socio-emotional processes, discussion of challenges and solutions related to immediate technology use, improved connectivity among some participants, and the differentiated uses of the Yahoo Group support qualification of this CoP as a virtual water cooler (VWC) space. The many activities and conversations that occurred online are similar to those that take place in face-to-face informal professional communities. Given that the Yahoo group network is a CoP and appears to have met participants' needs as a VWC, the final research question investigates the group's impact on teaching practice.

Research question #4: Can an online CoP serve as a VWC around which there are informal interactions that supports a TVI's practice?

This research question relates to the efficacy of a VWC as a space for informal professional development that enacts positive change in a teacher's practice following "intervention." Although online observation data only included one code count under *change in own teaching practice*, interview data provided drastically different outcomes. Therefore, analyses of interview data provided better understanding of the mechanisms underlying how such a VWC changed teachers' practices.

Shift in teaching practices. Interestingly, Donald (the TVI who self-reported as having very little to learn at the beginning) was the most forward in sharing how much this VWC changed how he taught, despite having a low frequency count of message posts. When asked *Has being a part of the Yahoo Group changed how you think about or use technology with students? If so, how?* Donald answered, "It really has greatly affected how I've been teaching my students the past year and a half now. It's made a significant change." He goes on to describe how, as a result of learning about the device in training, having a direct line to Erin, and seeing how others leveraged the iPad with students, his participation resulted in the use of much less paper with his students. Before, he relied more on the use of large print and embossed braille media; now, although there are times when the paper medium is still needed, he finds that implementing a more digital workflow with his students helps them with organization and efficiency in completing work independently. He specified:

> The bluetooth keyboard [connected to the iPad] did definitely encourage me…to go…as paperless as possible…once I saw what [digital media] we would be capable of. And that's what the Yahoo group is gonna help me with, is creating that dynamic… And so, with this paperless, I can get 'em to be more organized…. I think it's making things easier and, again you'll hear me say, "efficiency," a lot, and that's my goal, is to be just efficient as possible -- that's what technology is allowing us to do.

In response to the same question, Dani replied,

> Prior to the Yahoo Group, utilizing refreshable Braille devices with the iPad…was my greatest deficit. Now, I feel like I'm more proficient and I also have access to the resources that will allow me to teach that to the students.

Shift from novice to expert. Both Donald and Dani also expressed how their membership in the Yahoo Group helped them move from workshop attendee roles to trainer roles in their local teaching communities. In other words, they learned from the VWC how to turnkey knowledge to other colleagues outside of the Yahoo Group. As mentioned earlier, Dani successfully mentored a colleague to implement the iPad for a blind student who previously had used no technology. An exchange with Donald further expressed his shift from learner to trainer:

> *Researcher*: Has something like this [Yahoo Group] been helpful?
>
> *Donald*: Well, you know, not too long ago—actually I think it was about a month ago, I was asked with a couple of my colleagues to give a re-delivery of what we learned from this Yahoo group…And this was my first…usually I attend these things -- I don't give them… And so, that was a very good experience that I got from this group…I learned how to present information to peers.
>
> *Researcher*: Yeah, that's always such a different experience when you go from being the attendee to the presenter.
>
> *Donald*: *laughs* Exactly. *laughs*

Shift in professional perspective. In addition to supporting Donald's shift from technology learner to trainer, the Yahoo Group made an impact on his teaching pedagogy. A general myth that perpetuates among assistive technology conversations in the field of visual impairment is that braille literacy has been declining due to the availability and prevalence of text-to-speech technology. In another interview excerpt, Donald exemplifies how technology actually enhances and supports access to braille and literacy rather than supplanting it:

> If the student can type and if they can hear-- then I'm finding that, you know, you give them a bluetooth keyboard and some earbuds, and they're on their way. For me, VoiceOver and braille are going to start going hand-in-hand. [In] my instruction, I'll probably start braille just a couple years earlier. But, I will start the VoiceOver instruction at a young age as well.

This exciting testimony has great potential in spreading a different mindset among peers who might fear technology's impact on student learning. Clearly, this belief and teaching habit did not previously exist, but Donald's participation in the Yahoo Group facilitated access to a perspective different from his local community's. The connections he made and observed online helped Donald broaden his own views on technology and literacy as well as help him disseminate this updated view with colleagues when he provided professional development for others.

Donald and Dani are two TVIs from those who were selected for interviews who described changes in their practice as a result of membership to this VWC. Because only four participants were interviewed, it is unknown how many other participants also experienced changes in their teaching practice due to participation in the Yahoo Group. However, Donald and Dani's testimonies illustrate the potential effect of membership to a CoP in a VWC space on a TVI's practice.

Summary of Findings

The results of this study come from quantitative and qualitative analyses of observation and interview data. Social network analyses (SNA) and observation data were presented in such a way to infer characteristics of the Yahoo group's structure. To enrich the hypotheses that a VWC can support teachers' informal learning and our understanding of the Yahoo group's structure, the interview data helped by identifying specific experiences with and mechanisms of the community that related to TVIs' professional development.

Research question #1: Does this particular online group constitute a CoP? The first intention of this study was to evaluate whether or not this Yahoo Group network constituted a CoP. The participants in this group inherently shared a domain of interest due to their commitment to taking a course on iPad usage with students. Using a grounded theory approach to categorize or code the observation data, the resultant codebook aligned with the remaining two dimensions of Wenger's CoP: community and practice. Various participants besides the workshop trainer Erin also co-opted roles of expertise at different times. Evidence of these shifts in participation and expertise were evident using SNA to show connections between participants and excerpts of observation data that were coded *provides expertise*. The voluntary and informal nature of participation in the Yahoo Group was also exemplified by the range in number of various participants' posts and the presence of several habitual spectators in the group. Together, these characteristics support the conclusion that this particular online group is indeed a CoP.

Research question #2: How can technical skills and knowledge learned in face-to-face training be consolidated and further developed by participation in an on-line CoP? Next, this research question aims to examine the mechanisms that underlie a CoP and how the CoP can support TVIs in developing technology proficiency. Interviews with four workshop participants enriched the observation data and helped answer the remaining research questions. These interviewees were reasonably representative of a group of people interested in using the iPad with students. Although the objectives of the iPad workshop were focused on operational tasks of using the device, this research question addresses whether or not participants were able to take these basic skills and extend them in order to develop true proficiency with the iPad. AT proficiency was evaluated based on 4 dimensions of abilities (1) to select an appropriate tool for specific use; (2) to locate resources to secure provision of AT; (3) to troubleshoot and operate AT; and (4) to integrate AT use within designated and novel tasks. Several behaviors were analyzed as processes that facilitated the development of AT proficiency:

- *Situated learning.* Through sharing case studies from their own practice, participants had greater access to expertise in iPad implementation that differed from their own applications. This supported their learning methods to integrate the iPad into student activities that were not explicitly taught in the face-to-face training. Some excerpts from the observation data included exchanges where participants shared strategies in securing certain AT for students and provided resources for others to share with their district personnel.

- *Development and maintenance of a professional toolkit.* Throughout the observation data, there were several instances where TVIs shared resources or tools they came across that were not introduced in the face-to-face training. As a result, members of the Yahoo Group were able to cultivate a wider choice of tools depending on student needs or classroom activities. In addition to tools, participants also shared links to other resources that provided further information and instruction on implementing technology with students.
- *Access to information and technology support.* Overall, the participants appreciated access to the most up-to-date information regarding software updates. Based on interview data, this type of information was often lacking in TVIs' practice. On-site technology support was also reported as a general challenge, and the Yahoo Group provided a forum for participants to gather and collectively troubleshoot issues that arose. Some participants even created their own training videos as resources to help others troubleshoot and operate AT.

Altogether, these behaviors contribute to each dimension of AT proficiency and support the hypothesis that a CoP can develop and expand basic technology skills learned in training to develop proficiency in use.

Research question #3: Can an online CoP facilitate incidental and informal learning as effectively as face-to-face informal professional learning communities? Face-to-face "water cooler" spaces have been found to support teachers' informal learning and professional development. This question extends existing research and seeks to establish whether or not an online forum could be considered a virtual iteration of a physical water cooler space. Determination rests on whether or not the virtual space supports activities similar to those that occur in a physical space. Again, observation data provided interesting snapshots of teacher interactions but the interview data provided more details on some participants' personal experiences in interactions with peers online. Overall, membership to this virtual CoP helped teachers navigate challenges in teaching practice, overcome professional isolation, and provided supplemental learning through informal exchanges. When the interviewees' observation data were compared across code categories, it became evident that participants utilized the online space in different ways and for different purposes. These characteristics are similar to CoPs that occur in a physical school space and contribute strong evidence that this virtual CoP functioned as a virtual water cooler (VWC) for supplemental professional development

Research question #4: Can an online CoP serve as a VWC around which there are informal interactions that supports a TVI's practice? This final question addresses the possibility and efficacy of a CoP in impacting a TVI's practice. Due to the virtual nature of the Yahoo Group, consideration of this question inherently ties to justification of the virtual media as a space for informal professional development (i.e., a VWC). Because discussion of changes in practice is longitudinal and nuanced, it was impossible to convey any changes in practice in one snapshot of time. For this reason, interview data was used exclusively to investigate this question. Two of the four interviewees mentioned lasting changes in how they used technology with students. They reported positive shifts in how they implemented technology in the classroom and also experienced moving from a novice to expert role in their local community. Lastly, one interviewee reported a profound change in his professional perspective on the positive influence of technology on literacy development in young students. Although only a few of othe Yahoo group were interviewed in depth, the examples of positive changes reported by two of the TVIs' teaching practice points towards the potential impact of such a virtual CoP.

Overall, it was exciting to find that this online network functioned as a CoP, supported teachers in developing AT proficiency, served as a VWC for informal and supplementary professional development, and affected positive changes in some teachers' practice and pedagogical stance. These findings build efficacy for this model of professional community for TVIs and contribute evidence that a VWC can provide support and resources that are currently lacking in TVIs' practice. The next and final chapter will discuss the implications of these findings and how the results contribute and extend existing bodies of literature.

Chapter 6: Discussion

This chapter presents an interpretation of the study findings, implications for practice and research, limitations of the current work, and recommendations for future research. Four research questions guide the following discussion:

1. Does this particular online group constitute a Community of Practice (CoP)?
2. How can technical skills and knowledge learned in face-to-face training be consolidated and further developed by participation in an on-line CoP?
3. Can an online CoP facilitate incidental and informal learning as effectively as face-to-face informal professional learning communities?
4. Can an online CoP serve as a VWC around which there are informal interactions that supports a TVI's practice?

Hypotheses

R1. The current study builds upon previous work (Siu and Morash, 2014) that suggests a relationship between membership to a CoP that values assistive technology (AT) and AT proficiency. In order to further investigate this overarching hypothesis, the first research question sought to establish whether or not a particular online network using Yahoo Group meets criteria that distinguish it as a CoP. Using grounded theory, the emergence of a codebook for analyzing observation data determined that this network exhibited characteristics of Wenger's CoP framework. Social network analysis and excerpts taken from the observation data showed group dynamics that reflected distributed expertise among participants. Lastly, workshop participants were offered the Yahoo Group but contributions were completed voluntary without following any formal structure. Because these results indicated that the online network was indeed a CoP, the remaining research questions were developed to investigate *how* this group functioned as a CoP and what role it played in the professional development of group participants.

R2. The second research question probed the hypothesis that a CoP can help a TVI develop proficiency in using AT in their practice. In essence, this question tested the relationship originally posed in previous work and sought to identify underlying mechanisms that contribute to the formation of such a relationship. Observation data provided evidence of situated learning (Lave & Wenger, 1991) among participants and the collaborative development and maintenance of a professional toolkit. These data included examples of teachers applying their learning in novel ways that had not been covered in the initial face-to-face training. Such instances marked the development of AT proficiency from basic device knowledge. Interview data enriched these findings by illustrating how a CoP facilitated greater access to expertise and technology support. When participants' behaviors within the CoP were gauged along a construct of AT proficiency ranging from low to high tech users, the results bolstered evidence for the relationship between CoP membership and AT proficiency.

R3. Aside from investigating the relationship between CoP membership and AT proficiency, the third research question focused on whether or not membership to a CoP can function as ongoing and informal professional development for TVIs. This question addresses my supposition that most TVIs lack an organizational space, which results in a dispersed practice that limits opportunities for incidental and informal learning in the workplace. Interview and observation data were again threaded together to portray this online forum indeed as a virtual water cooler (VWC) space that supported interactions similar to those found in face-to-face informal professional communities in a school. The CoP was found to help teachers navigate

challenges in practice, overcome professional isolation, and supplement incidental learning through informal exchanges. These findings showed that the Yahoo Group network helped to mitigate several of the challenges reported by TVIs and other itinerant professionals (Correa-Torres & Howell, 2004; Gray, 2004; Olmstead, 1995; Swenson, 1995; Wenger, 2001; Yarger & Luckner, 1999) as contributing to a dispersed practice. This result supports the hypothesis that a VWC can provide the organizational space that many TVIs lack.

R4. The final research question targeted the efficacy of such a model for professional development. It builds on the determination that a VWC provides a much-needed organizational space and sought to replicate findings that informal interactions can support teacher learning (Little, 2002). Although only four participants were interviewed, two of these interviewees reported changes in their teaching practice as a result of engaging in the Yahoo Group. Analyses of their input demonstrated the potentially positive impact of a VWC space on a TVI's practice. In addition to changes in teaching practices, these two TVIs reported a shift from being a workshop attendee to taking on a role of trainer in their local community, and one TVI even exhibited a major shift in teaching pedagogy. These findings support the hypothesis that a VWC space can impact teacher's learning and practice similar to those cases previously reported in physical water cooler spaces.

Theoretical and Methodological Underpinnings

This research unites theoretical concepts from several areas of the literature. Wenger's CoP framework provides an initial reference point that defines the group's structure, while social network and organizational theories address the relationships and behavior among members of a CoP. These characteristics nurture cognitive and socio-emotional processes related to professional learning in computer supported collaborative learning (CSCL) environments. When analyzed together, a revised concept of a virtual water cooler (VWC) space (Figure 7) provides a modern view of workplace organization that situates teachers' learning within informal online interactions.

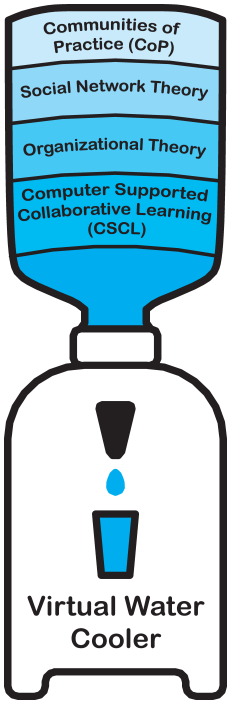


Figure 7. The Virtual Water Cooler (VWC)

The premise of this work is to build evidence that membership to a CoP that values AT is effective in helping TVIs develop, sustain, and improve AT proficiency in their teaching practice. Because an online CoP assumes a VWC space, previous methodologies that situated teachers' learning in informal interactions were employed to replicate findings in a virtual, rather than physical, space. Quantitative code count statistics and qualitative methods including analyses of observation and interview data comprised a mixed methods approach.

Interpretation of Findings

The Yahoo group network as a CoP. 20 TVIs were accepted to participate in a two-day face-to-face iPad workshop. The training was sponsored by a nonprofit organization and offered to any TVI in the state. Applicants were accepted on a first come first served basis, excluding individuals who had signed up and neglected to attend previous trainings. In the subsequent year, all participants were subscribed to a Yahoo Group listserv that was created as a resource for the workshop attendees. Their shared motivation in taking the course prior to communicating online likely predetermined them to engage collectively as a CoP and provided a mutual starting point. The codes that emerged from the observation data categorized various online interactions under the *community* or *practice* dimensions of Wenger's CoP framework; additionally, this network was fundamentally bound by a common interest in using technology with students. The participants' shared *domain of interest* not only solidified determination of this group as a CoP, but was also critical in establishing the online interactions as such.

The importance of aligning the group's actions along all three dimensions of Wenger's CoP became apparent during Dani's interview. Of the four TVIs who were interviewed, she was the only participant who shared an office (organizational space) with other TVIs and maintained weekly face-to-face contact with colleagues. However, similar to other participants, she also reported isolation in using technology because her colleagues did not share the same commitment or interest. This segment of Dani's interview data was surprising because the regular opportunity to interface with other TVIs is very uncommon and often envied. Several online posts as well as the other three interviewees all commiserated about how isolated the participants felt in their practice and expressed gratitude for the Yahoo Group in facilitating connections to colleagues outside of the annual state conference. Despite having a physical space that she shared with colleagues, Dani, regardless, felt like she was on her own. It appears that whereas Dani shared an organizational (office) and occupational (served students with visual impairments) space with these TVIs, she did not share a CoP regarding technology use because they did not share a *domain of interest.* This finding suggests that having both an organizational and occupational space is insufficient in supporting a teacher in using technology. In summary, uniting along all of Wenger's CoP dimensions is necessary to effectively support professional development in a specific area such as technology use.

Professional development in a CSCL environment. Interactions and learning among colleagues contribute to ongoing professional development, but the nature of these actions differs in a face-to-face versus online environment. Similar to determination of a group as a CoP, a CSCL environment requires evidence of cognitive and socio-emotional processes among participants. In this case, findings related to teacher practices, use of tools, and changes in pedagogy were all considered evidence of cognitive processes that occurred due to learning about technology and developing proficiency. Although not every participant contributed posts

that were coded *socio-emotional*, 15% of the codes fell under this category and provided evidence that socio-emotional processes did occur. These processes online were likely facilitated by the initial face-to-face training. From these interactions in a physical space, participants entered the online space with a preconceived context and trust in relating to one another. With prior impressions of one another's personalities, nuances in online communication could have supported socio-emotional processes that might otherwise have been lost in the virtual space. The participants' unique collective history of having met face-to-face prior to engaging online perhaps delimits the validity or generalizations to be drawn from this study yet nevertheless may have played a significant role in the development of an online CoP and forum for professional learning.

The actions of the workshop trainer, Erin, might have also contributed to the role of the Yahoo Group in furthering participants' professional development. The participants already viewed Erin as an expert from their face-to-face training; in the online space, she modeled the types of information that could be shared as well as the tone of interactions. This pattern departed from other reported CoPs because this particular group already had preconceived roles of expert and learners, versus more naturally occurring groups where no one participant carries that official title. Although the initial structure of the Yahoo Group was unique in this way, visualization of the online observational data showed several instances of other participants taking on ad hoc roles of expertise and serving more central roles in the network. In these interactions, Erin receded more into a role of participant. Overall, the evolution of group dynamics appeared to overcome the initial formal trainer-participant structure. The ebb and flow of expertise among members of the Yahoo group also matched the organizational patterns as described in Wenger's CoPs.

The Yahoo Group listserv as a VWC. Although each participant was automatically subscribed and received emails of new posts, active participation was not mandatory. Likewise, it is unknown how often these posts were read or deleted. The Yahoo Group listserv was available and utilized according to each participant's preference. Of 20 subscribed workshop participants, half posted less than 3 times over the course of a year. Three participants did not post at all. The range in activity from active to habitual spectator was akin to how various teachers in a school might choose either to engage or avoid informal interactions with each other around a water cooler. Similarly, examination of the interviewees' Yahoo Group posts yielded variations in the type of information they shared online. 17% of TVIs used it for logistical purposes to determine what assignments were due; 15% focused on the socio-emotional aspect of building and maintaining relationships; all four interviewees and almost 68% of total posts aligned with the *community* and *practice* dimensions. These variations in engagement might also be comparable to a physical water cooler space where colleagues can determine the nature of their socialization. The similarities in informal interactions among teachers in the online versus physical space suggest that a virtual forum such as a Yahoo Group could host similar variations in engagement as does a face-to-face forum.

Provisions of this research. Given that a VWC can host collegial and informal teacher interactions, this study sought to investigate how a CoP can function in such a setting and what role it might play in teachers' professional development. One of the outcomes of CoP membership in this case was its effect on helping teachers translate basic knowledge gained in an iPad workshop to proficiency in using the device with students. Based on observation data, teachers discussed and exchanged tools and resources that had not been discussed in training and thus added to each other's professional toolkits. Based on Donald's and Dani's interview data,

other outcomes of their CoP membership involved changes in teaching and mentoring practices including a major shift in teaching pedagogy.

Overall, these findings suggest that an online forum such as a Yahoo Group has potential to deliver an accessible space to teachers who otherwise experience a dispersed practice that results in limited opportunities for informal professional development. However, in order for a VWC to host an online CoP, all dimensions of Wenger's framework must be met: community, practice, and domain of interest. Like physical school spaces, a CoP can dictate contingencies for teacher learning via informal learning when located around a VWC. This type of model for professional development must be differentiated from those categorized as computer supported collaborative learning (CSCL) environments due to the nature of informal and unregulated interactions. CSCL on the other hand focuses more on formal interactions that follow a structure for learning and grading. Further implications for practice and research are discussed in the following sections.

Implications for Practical Applications

Teaching is a craft that requires maintenance and honing as tools and environments evolve over time. In the field of teacher education, many terms have been used in the literature including but not limited to: peer modeling, situated learning, and learning communities (Ching & Hursh, 2014; Lave & Wenger, 1991; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). These concepts reflect that social interaction is inherent to collaborative learning and critical for teachers' ongoing professional development. In addition to attaining continuing education units for teaching licensure, longstanding practices in student teaching and peer mentoring bear witness that the development and maintenance of high quality teaching stems from formal and informal learning experiences with colleagues.

Despite acceptance that teachers rely on social communities to support one another's practice, TVIs and other professionals who work in an itinerant capacity often have limited interactions with colleagues and therefore limited collaborative learning. This section presents several affordances of a VWC that can overcome challenges of a dispersed practice.

Time and professional isolation. Among several common themes across interviews, time was cited as a barrier to locate training, resources, and professional networks. All of the interviewees recognized the need to connect with professional organizations and listservs, going so far as naming several groups they knew of. They all conceded the value of connecting to professional networks yet none were members of any of the groups they cited due to the time required to attend meetings and check postings.

The interviewees also discussed strategies they used to remain connected to the field. Donald cited the annual state conference as his primary source for keeping current. At each conference, he spends time at vendor booths, requests technology demos, and learns about emerging technologies from the display area. Although he reported benefitting greatly from the annual conference, he otherwise felt limited in having time throughout the year to engage with vendors and technology to the same extent. Quinn, too, cited the annual state conference as a main source for information, except her focus was on picking up flyers to read. Like Donald, she otherwise lacked time throughout the year to locate and read literature so as to stay up to date.

In addition to having limited time to keep up with technology updates and attend trainings, TVIs in this group also had limited time to connect with colleagues. The itinerant nature of most of the TVIs' practice resulted in little to no interactions with other TVIs outside of the annual state conference. Even for those who re-connected with familiar colleagues at the

state conference, the interactions were more social in nature and insufficient as a sustained professional network throughout the year. A common sentiment amongst participants in the Yahoo Group was that the online forum provided a deeper sense of connection and support than meeting face-to-face once a year at the annual conference. Many of the teachers expressed gratitude for the collegiality of the Yahoo Group as it overcame longstanding feelings of isolation in their professional practice. Lastly, participants also appreciated the ongoing access to information and resources throughout the year rather than just the annual dose at the conference.

The Yahoo Group hosted asynchronous communications among the workshop participants for one year following the face-to-face iPad training. Because posts were delivered directly to teachers' email inboxes, no additional actions needed to be taken in order to access the interactions. Although it is unknown how many of the habitual spectators actively read the posts, participants who did could do so at their leisure and selectively read only what was relevant to their own professional needs. Teachers were able to ask and answer questions in as little time as it took to compose and send a message similar to an email. In this way, the nature of interactions in this online forum fit naturally into a workflow most teachers already engaged in such as checking email. Given that teachers already have limited time to prepare student lessons, access to colleagues via a VWC should be as easy as informal engagement around a physical water cooler.

Development of AT proficiency. Some of the greatest challenges in implementing technology with students who are visually impaired hinge on two things: the variation in student needs and accessibility challenges of different instructional content, and nuanced uses of technology given these variations. Given the range in age, number of years teaching, and availability or breadth of technology training received in teacher preparation, all the participants in this study had varied backgrounds and teaching experiences. With this in mind, the Yahoo Group brought together varied expertise as well as professional needs in learning how to use the iPad. Various teachers probably had different needs or objectives in using the iPad with their students. The face-to-face workshop simply taught usage of the iPad with accessibility features for low vision or nonvisual access. Given the many permutations of solutions possible to meet varied student needs and accessibility challenges, it was likely practically impossible to also teach how each teacher needed to translate the device knowledge to unique applications with every student.

At the highest level of AT proficiency, a teacher can ideally select from a variety of tools, use known tools for designated and novel tasks, and contact an expert when consultation is needed (Siu & Morash, 2014). Herein lies the challenge of TVIs' implementation of technology: following training focused on building device knowledge, teachers typically rely on interactions with colleagues to situate their learning in practice. Teachers learn from each other's experiences, troubleshoot, and gain understanding of different uses of the same technology. Shared student scenarios, therefore, provides case studies that exemplify differentiated implementation of a specific technology application. For TVIs without a CoP, limited access to colleagues and collaborative learning is therefore liable to become a major barrier in developing and maintaining AT proficiency as it conforms to this definition.

Similarly, AT coursework in personnel preparation programs cannot fully anticipate how a future teacher will use technology with an unknown student. Upon entering the workforce, a teacher might use a specific device or application immediately or not at all until years later when it is needed for a specific student and accessibility need. Meanwhile, the technology and instructional media might change, rendering initial training in a personnel preparation program

obsolete. For example, this study included two interviewees who reported having had no AT training at all in their personnel preparation programs (due to the number of years since graduation), and another had received some AT training but no longer used the technology that had been taught. Because these teachers remained in the field while tools and technology evolved, they all needed to learn newer AT to keep up with student and classroom needs. In cases such as these, it is of utmost importance that teachers in the field have access to ongoing professional development to supplement AT training received in a teacher preparation program.

On demand professional development. Similar to how it is nearly impossible for an AT training to teach each situation in which a device might be used, it is challenging for every TVI to maintain proficiency in every possible application of a device. Instead, TVIs typically possess expertise in smaller areas of instruction based on the caseloads they manage. For example, one teacher who serves many students with multiple disabilities including low vision might develop expertise in using magnification and switch-controlled devices, whereas another teacher with a caseload of academic braille students would have more experience in using screen reading technology and less in using the same device with switch control. Considering the aforementioned time constraints that many TVIs cite, efforts to learn and implement technology are often best directed towards maintaining proficiency in what is most immediately needed.

So what happens when a student's needs or the nature of instructional media change? What if a TVI is assigned to support a student with very different needs than what the TVI has become accustomed to? Suddenly, new expertise is required and the TVI does not have the time or resources to attend training and develop the proficiency he or she needs in a timely manner that meets their student's immediate needs. In this case, it might be most beneficial to know just enough to stay abreast of current technology options and search for resources as needed. This *on demand* professional development supports a teacher in maximizing limited resources and securing targeted training as needed. Subscription to this concept of ongoing professional development can serve to break down the formidable plethora of technology tools to digestible chunks that are immediately relevant to a teacher's practice.

However, this approach assumes that teachers have enough of a foundational knowledge to know what and how to search for resources as needed. Basic knowledge of the types of technology is necessary, as well as the affordances and limitations of each tool and different modes of access. Knowledge of available types of media and instructional formats is also integral to understanding how content can be presented in various ways for differentiated learning and accessibility needs. Lastly, teachers must also know the relevant vocabulary in order to conduct an effective search, ask appropriate questions when seeking expertise, and advocate for accessible tools and learning environments. Additional peripheral skills might include how to use online tools such as listservs, run search commands to find training videos and resources, manage blog subscriptions, and access online learning programs.

In the current study, the interviewees utilized different strategies for ongoing and informal professional development. When asked, "How do you typically stay current or problem-solve technology challenges that come up?", all four participants referenced attempts to problem solve independently first. This was due to the immediacy with which they could find the solution, rather than having to find someone and wait for an answer. Dani and Paula were self-professed "Googlers." They both used Google to find information, search for online tutorials, YouTube videos, and check product websites. Dani added that in addition to her online searches, she often plays with the software and visually tests it out.

In contrast, Quinn mostly referenced perusing device manuals and calling companies' tech support in her troubleshooting strategies. Quinn admitted to dislike using the internet and YouTube as a resource and much preferred to talk to someone over the phone directly. She rarely carried out internet searches and approximated its use to only about a quarter or half of her time spent troubleshooting. However, she expressed awareness of some strategies for accessing help:

> If I had more time to focus on it, then I would probably stay on top of some of the user groups, whether it's Kurzweil, ZoomText, or JAWS, or, you know, whatever, I'd stay on top of what those User groups are doing—but I don't. I don't have that much time.

It was clear that each of the interviewees had developed their own strategies for obtaining help and information as needed. These strategies reflect each teacher's preferences for engaging with people using technology as well as their comfort level with using technological tools to engage online. Overall, the diversity of the interviewees' responses throughout provokes discussion on the reliability and validity of participant data when conducting research in technology and training efficacy. For example, reliability can be questionable when based on subjective measures such as self-report. Participants might rate their understanding of a measure and skill level based on personal rather than objective interpretation. Validity also becomes questionable when a training evaluation tool is given prematurely before a teacher's integration of new knowledge into practice can possibly be known. The following section delves into the nuances of research in this area and considerations for practice.

Implications for Research Practices

Research in TVIs' technology use carries several challenges, including: locating members of a dispersed practice, utilizing valid measures to evaluate training efficacy, and development of reliable measures that accurately capture teachers' learning and behavior. Furthermore, rigorous research practices continue to evolve as teachers' professional development occurs online. More informal learning might develop new skills that are not necessarily be limited to one application, and instead meet a variety of needs that require design-based approaches that emphasize situated learning (Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2008). Although quantitative measures such as how to operate a device can more easily quantify some aspect of learning, data that truly reflects the learning process are not as easily objectively evaluated. As such, educational researchers might be tempted to quantify behavior but meaningful evaluation of training efficacy requires case studies that incorporate design-based learning approaches and more nuanced data captures. In addition to proposing potential solutions for overcoming challenges of a dispersed practice, this study explores approaches to carrying out research in this area of inquiry.

This study utilized a mixed methods approach including quantitative code count statistics and qualitative analyses of observation and interview data. Code count statistics categorized the types of information teachers exchanged online, observation data provided insight on the role and relationship among members of the community, and interview data deconstructed practices and mechanisms of behavior as related to each interviewee's engagement in the Yahoo Group. In order to determine the overall effectiveness of the Yahoo Group in providing effective professional development, several other considerations were necessary.

Use of objective measures. Historically, evaluations of TVIs' technology skills and comfort levels are based on self-reports using Likert-scale surveys (Abner & Lahm, 2002; Edwards & Lewis, 1998; Kapperman, Sticken, & Heinze, 2002). Although competencies for technology use in TVI preparation programs were developed (D. W. Smith, Kelley, Maushak, Griffin-Shirley, & Lan, 2009), they have not been adopted across every TVI preparation program and are recommended to guide course curricula rather than skill evaluation in the field. To date, few objective measures have been used in research to gauge TVIs' AT proficiency.

I contend that self-reports are not a reliable measure of TVIs' AT proficiency. Perceptions of proficiency vary across individuals and can be influenced by subjective experience and contrast with how surrounding colleagues use technology. For instance, one of the interviewees Quinn considered herself to be very technology savvy and able to troubleshoot technology problems independently. She did not work with other TVIs or teachers who challenged her technology uses. If she had been given a Likert-scale survey to rate her own skills, it is likely she would have rated herself highly. However, over the course of her interview it became apparent that she did not carry out higher-level technology skills such as conducting an internet search to learn about newer technologies or troubleshoot problems. She also did not know how to utilize email so as to search for archived information, although she did suggest an understanding of the concept. Lastly, although Quinn listed several companies who made AT and used the word *listservs*, she did not include any modern technologies or current organizations that manage popular listservs for the TVI and AT communities. Further communication with the workshop trainer, Erin, revealed that Quinn had required extra one-on-one tutorials throughout the workshop in order to develop basic skills needed to participate in the training. While extreme and limited to one case, this example shows how unreliable self-reports of technology use can be.

Another perspective is that a highly proficient TVI might offer lower self-ratings because he or she knows how much more technology there is to learn. Of the remaining three interviewees, all were knowledgeable about modern technologies yet they realized the extent of what they did not know once they began learning about previously unknown iPad applications. Although they reported needing to learn more, the descriptions of how they used technology, the vocabulary they used, and the strategies they utilized for troubleshooting all indicated high levels of AT proficiency. In other words, capturing their habits in technology use provided more accurate measures of AT proficiency than a rating scale on a self-reported survey might have. Upon re-thinking how TVIs' AT proficiency might be more reliably measured, considerations for determining the validity of training evaluation naturally follow.

Determination of training efficacy. Often times, workshop participants are given evaluations immediately following the end of a training session. In this study, the impact of what participants learned did not become evident until the teachers returned to their students and applied the technology to each of their specific use cases. Even then, time was needed for each teacher to problem-solve and determine how best to utilize the iPad in different contexts for different student needs. For this reason, evaluation of the iPad training was impossible to carry out upon completion of the initial face-to-face workshop. Instead, this study explored the efficacy of this model of professional development in terms of the impact on TVIs' practices and integration of technology with students based on what they learned. Observation and interview data were analyzed for evidence on how teachers incorporated technology into their practice and included instances of teachers sharing stories of technology use as case studies. Without the longitudinal and qualitative follow-up to the face-to-face training, it would have been impossible

to accurately capture and begin to understand how the iPad training affected TVIs' skills and evolved into proficient use.

Theoretical Implications

The Virtual Water Cooler (VWC) references several previously existing concepts: Community of Practice (CoP), social network theory, organizational theory, and Computer Supported Collaborative Learning (CSCL). Each concept builds upon the other and collectively informs how a VWC can function for ongoing and informal professional development in an online space.

Community of Practice. Wenger's idea of a CoP is largely an operational framework that has been applied to grassroots development of workplace practices. Its descriptions include employee organization beyond formal mandates and collaboration across hierarchical structures of authority. The nature of how colleagues informally exchange knowledge and construct their own habits of practice were concepts that had not been previously applied to itinerant teachers who do not share an organizational space. This study contributes literature on CoPs to include one model of workplace organization and informal professional development for TVIs. It reports on what teachers gain from membership to a CoP and how a CoP can support the construction and maintenance of their professional practice.

Social network theory. Similarly, social network theory has also been applied to other social and professional groups online but not specifically viewed through the lens of informal interactions among a group of itinerant teachers. Prior research has noted the development and fluidity of participants' movements between central and peripheral roles within a group, and the current study extends this application to include contributions of expertise and activity level as indications of central or peripheral engagement. This study borrows data visualization methods from social network analysis to illustrate how participants moved between central and peripheral roles of expertise. By doing so, results surfaced that exemplify the *community dimension* of Wenger's CoP framework and connect the framework to practice.

Organizational theory. In the context of the current study, the methodological approach and analyses align with organizational theory in two ways. First, it is a study of how TVIs can take advantage of new tools to organize themselves in a novel space and build their practice. The solution of using a Yahoo Group to connect allowed these participants to adapt to challenges of a dispersed practice and overcome the limitations imposed by physical separation. Second, it is also a discovery of how TVIs can use new strategies to update their toolkits as technology and student demands change over time. In this way, the results lend theoretical grounding to the *practice dimension* of Wenger's CoP framework and illustrate an updated model of how TVIs can develop an organizational space that supports much needed ongoing professional development. A modern concept of how TVIs can organize their practice was needed to address weaknesses that were previously identified and provide solutions for this profession to remain relevant (Barley & Kunda, 2001).

Computer Supported Collaborative Learning. Although the basic premise of this study was to replicate Little's work on locating teachers' learning in informal interactions, differences between online versus face-to-face learning necessitated the inclusion of literature from CSCL. The inherent nature of computer-mediated communications questions several assumptions that are a given in face-to-face interactions. Nuanced expressions might be misinterpreted, body language is absent, and rapport must be developed with more intention. The success of formal online learning programs depends on the combined interaction of

socioemotional and cognitive processes (Kreijns, Kirschner, & Jochems, 2003).In this case, the online portion of the iPad workshop was informal and actually voluntary and supplemental to the face-to-face training. However, both socioemotional and cognitive processes remained critical in order for this informal computer supported environment to serve as a forum for collaborative learning and professional development.

Overall, the new connections forged between these existing areas of theory necessitated the development of a new conceptual framework that could merge prior themes with updated applications for practice.

The Virtual Water Cooler. Wenger's CoP is an operational framework that is perhaps undertheorized at the intersection of CSCL and informal learning. The initial attempt to characterize the Yahoo Group as a CoP diverted from previous studies due to distinct differences in interaction and informal (rather than formal) learning in a computer supported environment. Therefore, replication of Little's work in locating teachers' learning in a physical space was limited and required re-consideration in the virtual space. This study develops the concept of a VWC in order to first define a virtual space that can effectively host similar instances of informal interactions and learning as those found in a face-to-face CoP. Upon defining a Yahoo Group as a CoP, further examination of the VWC sought to situate teachers' learning in the socioemotional and cognitive processes that developed online. Ultimately, outcomes of this so-called intervention were measured in terms of changes in teachers' practices similar to how results of other teacher-focused CoPs have been reported (Palincsar, Magnusson, Marano, Ford, & Brown, 1998; Stein & Coburn, 2008). By situating teachers' learning in a virtual space, the VWC leverages a delivery system for ongoing professional development that itinerant TVIs currently lack.

Although this particular VWC existed as a Yahoo group, other VWCs might manifest as an online interactive blog, a Facebook Group, or Twitter community. The VWC has potential to leverage affordances of technology to engage new environments and opportunities for learning that might be otherwise underutilized to support teachers with a dispersed practice. Rather than using technology to translate formal face-to-face instruction to a virtual classroom (such as in CSCL models), the VWC embeds informal teacher interactions in a virtual community. The vibrancy of such a community has unlimited potential in connecting together more teachers and expertise than would be possible in a physical school space.

Limitations of the Study

In this particular case, a face-to-face training preceded the formation of an online CoP. It is possible that the participants gained enough familiarity with each other during this initial training to circumvent the common challenge of building socioemotional connections online. Initial impressions that developed in-person could have aided the development of new relationships and provided a reference for social context cues that are often lost in computer mediated communities (Kreijns et al., 2003). Without this initial face-to-face contact, would this CoP have been as effective? It remains unknown how much impact these initial impressions contributed to the development of a VWC.

Another distinction of this Yahoo Group was the presence of a moderator. From her role as one of two workshop trainers, Erin was already regarded as an expert among the group of participants, and she engaged the group from a position of leadership. Her online posts modeled the types of information that could be exchanged informally and likely set an example of what to share and how interactions could be carried out. The interactions were informal, but Erin's role

as a facilitator likely contributed to the success of developing a VWC space. Although it is unknown how influential her function was, previous research suggests that the presence of a moderator is indeed critical for sustaining an online community for informal learning (Gray, 2004).

This study included twenty participants, but observation data were only collected from the teachers who were active participants in the Yahoo Group. Because subscription to the Yahoo Group was automatic, it is unknown what role this CoP played for habitual spectators who never posted at all. This limitation to identity, affinity, and potential collaboration is similar to the case of teachers who might eavesdrop on conversations in a school space yet never actively engage in those informal interactions. As might be the case with teachers in a school, it is also unknown if any of the participants from this group engaged in technology-related interactions with other peers outside of the Yahoo Group. This unknown is possible but not highly probable though, given the isolation cited in many of the TVIs' practices. None of the four interviewees referenced any other sources for informal learning that contributed to their professional development.

Lastly, although online observation data only included one code count under *change in own teaching practice*, interview data showed drastically different results. It is likely that online interactions focused more on exchanging information or asking for help rather than expressing self-reflections. In contrast, interview questions specifically asked the participants to reflect on their teaching and how the Yahoo Group supported their professional development. Although observation data was limited in its ability to inform of any possible changes in teaching practice, analyses of interview data elicited better understanding of the mechanisms underlying how this VWC changed teachers' practices.

Recommendations for Practice

Overall, teachers require additional supports to update their knowledge of technology and flex their understanding of it to meet changing student needs and content demands. Time as well as funding is often limited to meet immediate training needs. Those who experience professional isolation are especially dependent on alternate means to access resources and necessary social learning communities outside of their physical communities. This section aims to bridge TVIs' needs with five recommendations for practice to benefit from the affordances of a VWC.

1. **Consider prerequisite skills for online engagement.** In order to access a VWC, TVIs need a basic understanding of available tools for connecting online and how to use them. These options might include a listserv, blog, or other social media group. If a VWC is a critical missing element of a TVI's practice and development of AT proficiency, it is strongly recommended that during teacher preparation programs TVIs develop skills for online engagement, so as to adequately prepare them for the ongoing professional development they will need.
2. **Re-purpose existing skills for professional development.** Lei (2009) proposed that the teaching profession now includes more "digital natives" than ever before, and suggested that pre-service teachers regardless need specific training to re-purpose existing technology skills for professional use. This demographic includes pre-service teachers who perhaps came of age in a social-media-rich environment or seasoned teachers who have pre-conceived habits of engaging online for personal activities. In the current study, a follow-up email was sent to the interviewees that asked, "Do you use social media in your personal life? If so, what do you use (example: Facebook,

Twitter, blogs, Meetup Groups) and how often do you check your social media stuff (how many times per day/week/month)?" Their responses are reported in Table 11 and ultimately show that overall, the TVIs interviewed in this study maintain active and consistent engagement with online social media in their personal lives. One participant even noted that she was more apt to check her personal Facebook activity on breaks during the school day rather than on days off. None of the interviewees used social media for professional purposes despite being aware of the existence of online professional groups and using social media for personal reasons. This finding was both surprising and encouraging in showing how some TVIs have the prerequisite skills to engage online yet do not do so for professional development.

Table 11
Participants' Use Of Social Media In Personal Life

TVI	Personal use of social media	Frequency of use
Donald	Facebook	Several times daily
	Twitter	Several times daily
Quinn	Facebook	Daily
	Pinterest	Daily
	Ravelry	Daily
Paula	Facebook	Daily
	Twitter	Weekly
	blogs	Weekly
	Meetup Groups	Weekly
Dani	Facebook	4 times, weekly
	Twitter	3 times, weekly
	Instagram	2 times, weekly
	Blogs	4 times, monthly
	YouTube	Daily

3. **Re-purpose existing social media as a VWC.** As confirmed by previous studies on TVIs' challenges in using technology, time and money were insurmountable hurdles in attending conferences and workshops. Essentially, TVIs in this study considered professional development to be formalized events that required resources they could not sacrifice. The purpose of replicating Little's work in locating teachers' learning in informal interactions is to contribute evidence that ongoing professional development can be informal and obtained via such interactions. Several of the participants in this study recognized the value of belonging to the Yahoo Group and expressed enthusiasm for having colleagues to connect to and exchange information with. When Erin asked if the participants would like to link to other Yahoo Groups that followed other iPad trainings, she received very enthusiastic responses. Several participants noted that with more people in a group, there could be richer access to information, resources, and ideas. These responses support previous and current recommendations that social media should serve as a host for casual and professional learning (Ching & Hursh, 2014; Dabbagh & Kitsantas, 2012; Smith & Lambert, 2014). Utilized

appropriately, online forums can serve as a form of informal and ongoing professional development and provide a venue for reflective practice.

4. **Prepare for on-demand professional development.** Given the fast pace of technology innovations, the differentiated learning needs of students with visual impairments, and the flexibility needed to apply technology in different contexts, TVIs are expected to command a vast amount of knowledge and expertise. Many of the participants cited a lack of time to "keep up" with the newest technology applications and were worried about their ability to learn every new software or device. Recall that another unique challenge of TVIs' work with technology is that student caseloads often dictate TVIs' current skills. That is, if a TVI does not have a student who uses screen reader technology, they are likely going to prioritize their time finding solutions for low vision rather than nonvisual access. Because many teachers have focused expertise based on their teaching experience, access to a professional network can help teachers avail of specific expertise in a less familiar area. When this type of network is available, teachers can more easily obtain the information they need at the time it is needed. In other words, TVIs require on demand professional development when they do not have the time or money to immediately acquire the formal training they need. A CoP can be strategically used for this purpose and enables members to locate the information and access the expertise they need when it is needed. Successful use of a CoP for this purpose depends on one critical factor: Teachers need to command the vocabulary and possess the wherewithal to search for and locate the information they need. This requirement assumes that teachers have enough knowledge of the available technology options, the applications they can be used for, and how to engage with CoPs for various purposes. For these reasons, it might be just as beneficial for pre-service TVIs to gain a broader, if superficial, exposure of all current technology options rather than attempt to gain a deep understanding of each and every possible device. When these TVIs finally have a student who requires a certain type of technology, the TVIs can then utilize the appropriate language and skills to seek specific resources and further training on demand.
5. **Facilitate access to information.** As mentioned in previous recommendations, TVIs require strategies to access resources and information to sustain their own practice. Such access needs to be easy and fit into a teacher's existing workflow. This particular study focused on a VWC using a Yahoo Group and leveraged a virtual space that most teachers already used: email. Although participants were not specifically asked how often they check email, it is assumed most teachers and professionals check email consistently. The forced subscription system also ensured delivery of Yahoo Group messages directly to teachers' inboxes. In this way, the TVIs did not have to make any extraneous effort to connect with this particular VWC. Other types of VWCs might include: Facebook groups, Twitter, professional listservs, and blogs. Each of these social media have subscription options for easy delivery and fit into a teacher's existing workflow.

Concluding Reflections

This study was carried out under the auspices of a "what works" approach. It is a reaction against all the shortcomings that have been reported in TVIs' use of technology and aims to build

evidence for effective solutions that can better support TVIs given current needs in the field. In order to make the case for this updated model of professional development, this study also delves into methods for carrying out research in using technology to teach technology, how to sustain a profession through a virtual community, and how to approach observation data collection and analyses in the virtual space.

Findings from this study suggest that solutions are possible and within reach. Many TVIs already have the skills to engage in online communities but perhaps just need to re-frame how to utilize these skills to build and engage in CoPs. TVIs, and in particular itinerant TVIs, recognize the value of connecting to a vibrant professional network, because it is often a missing element in their practice. Perhaps similar to how students with visual impairments require direct instruction in areas where understanding does not develop incidentally, TVIs simply need targeted instruction on how to engage in CoPs and understand the importance of doing so. Teacher preparation programs can easily embed habits for engagement throughout course curricula. Technology developers can be charged with providing and facilitating forums for CoPs to support implementation of their products in the classroom.

Professional utilization of social media can facilitate direct access to a larger learning community and expertise than physical school communities. In fact, the concept of face-to-face professional development can take on new meaning when unbounded by physical distances. Formal technology instruction can also be very daunting and inaccessible, but casual conversations among trusted peers are not. This study situates the development of technology proficiency in a virtual community context so that TVIs can finally have a means to overcome professional isolation. As early as pre-service, TVIs can now be led to drink from a VWC, satiate their natural inclination to learn in a social setting, and collectively jigsaw their expertise to support the profession as a whole.

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Appendix A: Interview Questions

1. What are some of the greatest challenges in using technology in your teaching practice?
2. Was there information you gained from the Yahoo Group that you did not receive during the face-to-face training?
3. Has being a part of the Yahoo Group changed how you think about or use technology with students? If so, how?
4. Tell me about the sense of community or networking you typically have in your daily teaching practice.
    a. What would the ideal community look like to you?
5. Do you feel that participation in this Yahoo Group provided you with further professional development outside of the face-to-face trainings?
6. How do you typically stay current or problem solve technology challenges that come up?
7. How many other TVIs are in your district/county? How many do you regularly connect with?
8. Any other feelings about the Yahoo Group or this type of model for connecting with other TVIs?