Professional Development for Information Communication Technology Integration: Identifying and Supporting a Community of Practice through Design-Based Research

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Abstract

Research suggests effective classroom ICT integration occurs through needs-based, collaborative professional development (Chandra-Handa, 2001; Cuttance, 2001; Figg, 2000; Gibson, Oberg, & Pelz, 1999; Gross, 2000; Haughey, 2002). A community of practice (CoP) (Wenger, 1998; Wenger, McDermott, & Snyder, 2002) can be an effective mode of such collaborative professional development. A synthesis of the literature enabled the construction of the concept that a CoP, investigated through a design-based research methodology, can contribute to effective ICT integration research. Principles for this research approach are discussed and address the membership of a CoP and teacher/researcher ownership of research goals and design. (Keywords: community of practice, design-based research, information communication technology integration, professional development.)

INTRODUCTION

The purpose of this article is to synthesize a conceptual position that addresses a method of supporting teachers' classroom Information Communication Technology (ICT) integration. From a review of the literature of community of practice (CoP) and design-based research I argue that a CoP, investigated through a design-based research methodology, has the possibility of contributing to effective research into ICT integration. This article will also outline three related concepts as yet insufficiently researched: membership of a CoP; teacher ownership of research goals; and researcher/teacher control over the research design.

In accordance with Hennessy, Ruthven, & Brindley (2005), the term ICT encompasses a range of hardware such as computers, graphing calculators, personal digital assistants (PDAs), digital video equipment, peripherals like scanners, digital cameras, digital projectors, and science probes; as well as software (generic, subject specific, and multimedia). Over the past several years, school boards have been investing significant amounts of money into these ICTs with the goal of integrating them in classrooms (Ringstaff & Kelley, 2002). Studies have shown that classroom use of ICTs promotes student achievement and collaboration (British Educational Communications and Technology Agency [BECTA], 2005; Cox, Webb, Abbott, Blakeley, Beauchamp, & Rhodes, 2003;

Inkpen, Ho-Ching, Kuederle, Scott, & Shoemaker, 1999; Pisapia, Knutson, & Coukos, 1999; Tiessen & Ward, 1997) and improves student motivation (Betts, 2003; Passey, Rogers, Machell, McHugh, & Allaway, 2003). However, the success rate remains low; most teachers are just coping with the new demands of ICT integration and sustainability (Cuban, 2001; Tearle, 2003). Studies suggest that few teachers integrate ICTs in ways that enrich student learning (Harrison, et al., 2002; Hennessy, et al., 2005). According to Harrison, et al., these lower levels of ICT integration may be associated with a leveling off of teacher confidence in ICTs, which could be due to a need for more teacher support. Both of these studies conclude that teacher support should address pedagogies required to develop learner-centered experiences.

To enrich student learning through the integration of ICTs professional development is of the utmost importance (Ringstaff & Kelley, 2002; Solomon, 1995). These professional development initiatives should be ongoing (Haughey, 2002) and designed to address particular teachers' needs regarding how and when to use ICTs (Roberts, 1999). In a UK study conducted by the Department for Education and Skills (DfES) (2004) more than 90% of teachers reported that their primary source of training, professional advice, and support came from colleagues. Traditional models of professional development, such as one-day workshops, often remain the norm even though they are inadequate since they do not provide for ongoing collegial interaction.

A CoP (Lave & Wenger, 1991; Wenger et al., 2002) can provide such collegial, collaborative and ongoing interactions. A CoP is a "persistent, sustained social network of individuals who share and develop an overlapping knowledge base, set of beliefs, values, history, and experiences focused on a common practice and/or mutual experience" (Barab, MaKinster, & Scheckler, 2003, p. 238). CoPs provide the time and space where teachers come together to identify similar challenges, collaboratively discuss possible solutions, enact these solutions, assess their success and then revisit the challenge. Over the past several years, research addressing how ICTs can support CoPs has been reported (Barab et al., 2003; Hewitt & Scardamalia, 1998; Hung, Chee, Hedberg, & Seng, 2005; Kirschner & Lai, 2007; Scardamalia, 2003; Scardamalia & Bereiter, 1993). However, few studies have focused on how CoPs can support classroom ICT integration. A CoP may be an effective mode of professional development to support classroom ICT integration.

To facilitate a CoP, design-based research, which is in some ways similar to practitioner-based action research (see section Design-based Research below), may be an effective overarching research methodology. Design-based research is a "systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories" (Wang & Hannafin, 2005. p. 6). Design-based research pragmatically employs qualitative or quantitative research methods that are congruent with the research questions (Collins, Joseph, & Bielaczyc, 2004; Hoadley, 2004). That is, as the data collection proceeds, the researcher adjusts and fine-tunes data collection methods

in response to emerging questions and research goals. A CoP and design-based research necessarily involve a great deal of membership input and control over the process. Research studies have been conducted with the goal of improving ICT integration through a design-based research methodology (Edelson, Gordin, & Pea, 1999; Reiser, Tabak, Sandoval, Smith, Steinmuller, & Leone, 2001; Sandoval & Bell, 2004; Sandoval & Reiser, 2004; Wang & Hannafin, 2005). However, few studies to date have involved both a CoP and design-based research for the purpose of improving classroom ICT integration. Through a synthesis of the CoP and design-based research literature I will argue that a CoP, investigated through a design-based research methodology, is an effective way to research classroom ICT integration.

This paper first provides background information on CoPs, design-based research, and the concept of ownership of the research process. Following this, important issues of CoP membership are addressed. The next section concerns design-based research control, which manifests itself in research goals and research design. The last sections address implications for practice and the need for future research.

BACKGROUND

Communities of Practice

To effect lasting educational change, teachers must come together around common interests (Hargreaves & Goodson, 2006), which must also be based in authentic teacher contexts (Chalmers & Keown, 2006b; Chandra-Handa, 2001; Cuttance, 2001; Ely, 1993; Figg, 2000; Gibson et al., 1999; Gross, 2000; Haughey, 2002). Teachers' experiences must be acknowledged and valued. In a recent study of the integration of ICTs into school subjects, Hennessy, et al. (2005) suggest that professional development should move away from a focus on integrating particular ICTs (the technology itself) toward a focus on involving teachers in the process of learning about ICT integration. They suggest that a CoP where individual teachers' needs can be authentically addressed (Hung, et al., 2005; Lave & Wenger, 1991) will fulfill this function (Hennessy, et al., 2005). A CoP has the potential to connect professional development to a number of important factors including teacher involvement in the research design and implementation, new knowledge feedback, and recognition of the teachers' everyday working context (Niesz, 2007). A number of features are important to consider for a successful CoP, including CoP membership, interpersonal connection, the researchers' role, and online support. These features are discussed below.

Community of Practice Membership. Importantly, members of a CoP must want to join the group—and even volunteer (Chalmers & Keown, 2006b; Niesz, 2007). Joining a CoP for other reasons will most likely lead to contrived collegiality (Hargreaves & Dawe, 1990), which will result in a short-lived community. After voluntary membership has been assured, the CoP will often include both experienced and inexperienced teachers. This will generate a situation whereby "novices can learn through collaboration with others and by working alongside more experienced members" (Barab et al., 2003, p. 238). Ac-

cording to Lave & Wenger (1991) the "newcomers" gain from the experiences of the "old-timers." Yet, when it comes to ICT integration, "newcomers" often have their own ICT experience to share with the "old-timers." As well, more than just a sharing of expertise is possible. When members of a CoP share their experiences and knowledge, the gain to the community may be larger than the sum of its parts. New knowledge may be synthesized that might not be created without a collaborative CoP (Scardamalia, 2003).

Interpersonal Connections. To share experiences, a high level of comfort and trust among CoP members must develop. According to Wenger (1998), a CoP is bound by both formal and informal relationships. Furthermore, both personal and professional interactions are engaged. A CoP must involve members who share meaningful interpersonal connections and interactions (Chalmers & Keown, 2006b; Kirschner & Lai, 2007; Niesz, 2007) and members must be honest and comfortable with each other if they are going to spend productive time together. When this type of group relationship is present, ownership of the enterprise can develop (Niesz, 2007).

Researchers' Role as CoP Member. Researchers also need to feel a sense of ownership. While still acknowledging the significance of teachers' contexts and experiences, researchers have an important role in providing another valuable perspective (Niesz, 2007). Researchers can and should offer theoretically-based ideas to the CoP. Yet, experts often hold back their input for fear of overstepping their authority, which would be detrimental to the CoP (Wubbles, 2007). Many important questions, observations, and guidance can be provided by the intellectual support of outsiders like researchers. Outsider participation must not be undervalued. However, categories of "members" should not be isolated as, or even termed as "insiders" and "outsiders." In the ideal CoP there is a blurring of members' roles (Kirschner & Lai, 2007; Triggs & John, 2004). A reciprocal understanding of teachers' and researchers' perspectives can lead to a synthesis of solutions to teacher challenges and research questions.

Online support for CoPs. Recently, both teachers and researchers have had an opportunity for support through online communications. When local CoPs are supported with online communication, teachers can remain in their own schools and, at the same time, be able to share their experiences with others in different locales (Laferrière, Lamon, & Chan, 2006). This provides for *distributed cognition.* According to Laferriere, et al (2006), "The notion of distributed cognition suggests that when diverse teachers with different expertise come together, they can draw upon each other's expertise and create new insights into teaching and learning" (p. 78). With online support, there is an increase in the number of "newcomers" and "old-timers", which enriches the communities. The process of creating new insights through online group interaction is a form of knowledge building (Scardamalia, 2003) which provides another context for sharing.

Design-based Research

The most appropriate methodology for a study about CoPs may be design-based research. Design-based research is a relatively new research methodology that has been identified as:

research, based strongly on prior research and theory and carried out in educational settings, [which] seeks to trace the evolution of learning in complex, messy classrooms and schools, test and build theories of teaching and learning, and produce instructional tools that survive the challenges of everyday practice. (Shavelson, Phillips, Towne, & Feuer, 2003, p. 25)

In some ways design-based research is similar to practitioner-based action research as both involve the identification of authentic challenges, the development of plans to solve these problems, followed by implementation. For both, this is done in an iterative fashion that integrally involves participants. However, design-based research is different in that the researcher comes to the location with a theoretically-based research question and research design. In action research, it is the practitioners who discover the challenge and then the researcher comes in to help with the research process (Wang & Hannafin, 2005). A second difference relates to the goals of research. One of the primary goals of design-based research is the search for new educational theories (Davis & Krajcik, 2005, Wang & Hannafin, 2005). Action research does not explicitly search for these new theories.

In design-based research, the participants' feedback is particularly valued. Unpredicted feedback and observations may come to the fore; the design-based research participants—together with the researcher—may then initiate a new intervention to better fit the new data (Sandoval & Bell, 2004). By collecting and analyzing data on the learning that takes place throughout the CoP process and comparing this to the processes that were engaged, indications of success and improvement to the model may be found (Wubbles, 2007).

Traditionally, teachers as practitioners have often been viewed as users of researcher-generated theories (Triggs & John, 2004); this has created a gap between these two realms of education. Effective professional development can involve a complex interplay between these realms (Chalmers & Keown, 2006b) which could result in teachers using ICTs to narrow the gap between researchers' work and teachers' practice (Bereiter, 2002), as well as create usable knowledge in the real world (Lagemann, 2002). Research reports indicate that design-based research may help bridge this gap by simultaneously providing local solutions to teachers' practice as well as creating usable knowledge for the generation of new educational theories (Anderson, 2005; Barab et al., 2003; Jitendra, 2005; Tabak, 2004).

CoPs often engage in iterative design processes where initial plans are formulated and conducted, data is collected and analyzed, and then decisions are made regarding the next steps. The research goals and designs can change in this process. Design-based research fits very well with a CoP as both are designed to respond to the ever-changing reality of messy educational settings. As the data collection proceeds, the researcher, in collaboration with the teachers, may redesign data collection and draw upon other research methods. For instance, if quantitative methods are required, or if qualitative methods are needed, then

they will be used as the data will contribute to the research question and the goals of the CoP (Collins et al., 2004; Hoadley, 2004).

A recent meta-analysis, which addressed 10 years of studies that used a design-based research methodology for investigating ICT enhanced learning environments, reported strong support for design-based research as a good methodological fit for ICT integration research (Wang & Hannafin, 2005). From this study, a set of nine design principles for design-based research into ICT integration were developed: (1) Support design with research from the outset; (2) Set practical goals for theory development and develop an initial plan; (3) Conduct research in representative real-world settings; (4) Collaborate closely with participants; (5) Implement research methods systematically and purposefully; (6) Analyze data immediately, continuously, and retrospectively; (7) Refine designs continually; (8) Document contextual influences with design principles and (9) Validate the generalizability of the design. For the purposes of this article, principles one, two, and four were found to be particularly valuable and are addressed in the section titled "Design-Based Research and Control in a Community of Practice."

Who Owns the Research?

If principle four (close collaboration) from the Wang & Hannafin (2005) study is accommodated then the result could be a narrowing of the gap between research and practice. Often bridging the research-practice gap is one of the functions of educational research. To do this, the roles of researcher and practitioner in a CoP should be also be bridged. That is, researcher and teacher roles should be equally valued and both should contribute equally to the research process. The next two sections address research goals and research designs as important considerations affecting a sense of ownership over the research process in a CoP.

Research Goals. Research goals are objectives to be reached through the research process. Long-term goals are usually the reason for doing the research. Some teachers may understand and embrace long-term goals and see them as important to their work. For example, a long-term goal for a senior high school science teacher might be to improve students' achievement in chemistry. These long-term goals can involve short-term goals and by stating and reaching short-term goals, long-term goals may be realized. For example, this high school science teacher may attempt to reach the long-term goal by first setting a goal addressing students' interests and learning styles. The process of stating these long and short-term goals, planning to reach them, collecting data, assessing them, and revisiting them encompasses a typical research design for a CoP.

To commit to long-term goals, teachers must be willing to engage in change (Fullan & Hargreaves, 1991). They also need to be granted a strong sense of ownership over the process and products of the research (Hennessy et al., 2005; Richardson, 1992; Zolner, 1996). Triggs & John (2004) state teachers need "a strong sense of engagement where the 'teacher actors' felt they had a sense of control, ownership and agency, and where they felt able, even eager, to take

risks" (p. 431). Therefore, a researcher should not go into a school and unilaterally impose changes. If a CoP is a way forward, then the maintenance of such a community requires participants to be integrally involved in deciding upon many facets of the community, including possible changes to their practice (Hennessy et al., 2005). In fact, it has been found that when CoP goals are focused on teachers' immediate classroom practice, the CoP has a much better chance of sustaining itself (Niesz, 2007; Vivienne & Marie, 2005). Triggs & John (2004) propose that researchers and practitioners should be part of the knowledge generation and utilization process. Barab et al. (2003) also stress the importance of teacher-owned, long-term research goals. However, Barab recognizes the potential for tension between researchers and participants if these long-term goals do not align. He suggests that if there is no alignment between the researcher's and teachers' goals then the sustainability of the CoP will be compromised. Furthermore, not only should long-term goals be owned by the teachers, they should also generate short-term goals (Orrill, 2001). The Orrill study focused on a long-term goal of teachers becoming learner-centered through the integration of a particular ICT (computer-based workplace simulations). Through her research, she found that it was necessary for teachers to generate the short-term goals to gain a sense of ownership.

Research Design. As noted above, a research design involves stating goals, planning to reach them, collecting and analyzing data, and revisiting the goals for the next iteration. In a recent publication addressing how CoPs may aid in ICT integration, Triggs & John (2004) ask an important question: "In what ways might practitioners become more involved in the design, process, and findings of research?" (p. 428). These researchers suggest a relationship between researchers and teachers where "voice, agency and stance are equitably distributed" (p. 428). That is, teachers must have a strong voice in how the research is conducted. While the researcher may be the initiator of a research project and a CoP, as is the case with design-based research, the teachers must then be empowered to take ownership. This ownership should not only involve research goals but also some control over the research design. Triggs & John (2004) initiated a CoP, which functioned to support teachers in their efforts to integrate ICTs. They found it necessary to elevate the importance of this control of the research design by creating subject design teams. These teams were comprised of both teachers and researchers, and evolved to the point where the boundaries between their traditional roles were blurred. The research goals and research designs of the teams were equally contributed to by all members. The roles continued to blur as teachers began to take on more responsibilities as researchers and the researchers co-taught with teachers. However, this collaborative relationship between the researcher and teachers was not always uncontested. Teachers and researchers both needed to take a step back to revisit their role within the project. As Barab et al. (2003) said, tensions between the roles of researchers and teachers need to be acknowledged and negotiated. Tabak also recognized this possible tension between researcher and participants over the control of the research design process by considering *exogenous* designs (dominated by the researcher) and *endogenous* designs (dominated by teachers) (Tabak, 2004). Like

Barab, Tabak insists that these tensions must be recognized, acknowledged, and negotiated if a CoP is to reach goals and be sustained.

OWNERSHIP AND COP MEMBERSHIP

Before the researcher-teacher relationship can be initiated, the choice of CoP membership must be made. For a CoP and a design-based research methodology, the choice of teacher participants is crucial. Research has contributed to outlining a process for making choices regarding the membership of a CoP. First, size does matter. That is, teachers in smaller, local CoPs are effective in reaching their goals (Hung et al., 2005; MacDonald, 2006a). As well, the participants should share similar subjects (Hennessy et al., 2005). But, how small should these communities be? Can similar subjects be a strong enough tie to bind these teachers together into a successful CoP?

According to a Canadian study of professional development for ICT integration, "Activities should address the needs of target groups and model the behaviors that they advocate in the way they're planned, delivered, and evaluated" (Roberts, 1999, p. 26). Where ICT support programs are designed specifically with the needs of schools and teachers in mind, schools use of ICT is greatly improved (Ronnkvist, Dexter, & Anderson, 2000). But which teachers' needs should be kept in mind? The challenge now lies in identifying the group members, the parameters of the group, and the common research goals. The following sections outline principles for identifying the membership of CoP. These principles concern the size of the community and the need for community members to coalesce around common interests.

Size of the Community. As noted above, size does matter. CoP groups numbering from seven to 13 (Chalmers & Keown, 2006a) or 12 to 14 (Triggs & John, 2004), rather than larger groups, are most effective in developing interpersonal relationships. Even when CoPs involve whole schools, teachers are often subdivided into smaller teams of like-minded or subject-based teachers (DuFour, 2004). Smaller groups may be more able to address their own particular needs (Hung et al., 2005; MacDonald, 2006a). A smaller core group of people will also help ensure that individual voices are heard. This smaller group of subject-based teachers can provide a valuable local community against the backdrop of the broader school and district (Hodkinson & Hodkinson, 2004). That is, these small groups of teachers may interact with each other and also interact with other local communities of teachers from other schools or school districts, which may help build new knowledge (Scardamalia, 2003). However, the development of an effective CoP is complex and does not necessarily automatically begin to work just by the sharing of information with smaller groups of like-minded teachers (Hennessy et al., 2005). Other factors, like a sense of ownership, come into play.

Common Ground. To develop a sense of ownership participants must feel that they belong to a special group (Lave & Wenger, 1991). CoPs, although perhaps not named as such, are often vibrant working groups already in place in a school (Hennessy & Deaney, 2004; Hodkinson & Hodkinson, 2004). Who are the members of these groups? Hennessy, et al (2005) suggest that CoPs should

have an "emphasis on developing and sharing pedagogic expertise concerning ICT use in subject [discipline] teaching and learning and re-evaluating objectives, curricula, and assessment" (p. 187). According to another investigation of the ideal make-up of a CoP, the culture of particular school disciplines have a significant influence on learning within the community. That is, particular groups of teachers with a similar subject focus should be brought together to coalesce around their interests and goals. However, as noted earlier, participation should ideally be voluntary. Yet in K–12 education, circumstances do not always permit this.

The identification of a CoP could start broadly. Ideally, it could begin with teachers from a similar grade level. Within this grade level, teachers with a similar subject focus could be identified. Also, within this subject-focused group, particular attention could be devoted to differentiating professional development activities based on teachers' particular ICT needs. While this focusing procedure may provide an initial mechanism to identify a potential community of practitioners, many other practical concerns need to be addressed. For instance, the number of years of teaching experience will vary and these variations often play a role in attitudes toward ICTs, which in turn may affect ICT integration (Carlsen, Broe, Drewsen, & Spenceley, 2000; MacDonald, 2006b; O'Haire, 2003; Sigalés & Mominó, 2004). Also, the identified community may have other more pressing initiatives. In elementary schools, the identification of an individual subject focus may prove difficult, since teachers typically teach several subjects. For these teachers, a CoP may come together around similar educational initiatives (Hodkinson & Hodkinson, 2004) or around grade levels. However, no matter what the composition of the CoP, it should not be artificial. That is, the membership must be generated from teachers with similar interests and goals (Hodkinson & Hodkinson, 2004; Wenger, 1998; Wenger et al., 2002).

DESIGN-BASED RESEARCH AND CONTROL IN A COMMUNITY OF PRACTICE

A CoP can be the place where teachers' needs are heard. The question now is: What methodology is the best fit for investigating a CoP? In keeping with CoP principles, the methodology must focus on the needs of the participants. Design-based research may be an appropriate fit as it also focuses on the ever-changing needs of participants. In the following sections, principles for employing design-based research within a CoP and for addressing the researcher/participant relationship are discussed. These include a sense of ownership over the research goals and the negotiation of control over the research design.

Research Goals. For design-based research to be successful, the goals of the researcher and teachers must be congruent (Barab et al., 2003). As already noted (see Design-based Research section) Wang and Hannafin (2005) developed nine principles for conducting research into ICT integration. Three of these principles address research goals: support design with research from the outset; set practical goals for theory development and development of an initial plan; and collaborate closely with participants. The first two principles are concerned

with the researchers working in the realm of the research literature and setting goals for the development of theory. While these principles are important, they do not necessarily involve the participants. For ICT integration, teachers' needs vary (Haughey, 2002; MacDonald, 2006b; Roberts, 1999). Research on professional development suggests that ICT integration will only improve if teachers play key roles and thus take ownership of the ICT integration process (Laferrière et al., 2006). In their third principle, Wang and Hannafin (2005) address "close collaboration with participants" (p. 17). However, this principle may not give due credence to teachers' needs and goals. Teachers should work collaboratively with others who have similar goals (Roth, 1998; Scardamalia & Bereiter, 1993). Teachers' collaborative work with researchers should not be different. To support sustained participation, more of a bottom-up approach must be in place to ascertain potential participants' needs and goals before research is begun. Wang and Hannafin suggest collaboration after the researcher sets goals. To begin with someone else's plan, without providing ownership to participants over the research process, will be less likely lead to success for the participants and researchers. An alignment between the goals of researchers and practitioners needs to be found. If there is no alignment then the research should not proceed. I suggest an additional principle for conducting design-based research: both researchers and teachers should explicitly articulate their own goals and collaboratively assess their possible alignment before proceeding with the research.

Research Design. Once researchers' and participants' goals are aligned, another possible polarization may develop; that is, a tension over the ownership of the continually developing research design—exogenous and endogenous Tabak (2004)—could emerge. According to Tabak (2004), teachers want to have control over possible changes in their daily work. They also want any research endeavor to have an impact on their classroom practice (Barab et al., 2003). Addressing this real and universal desire will result in more successful research in the local context, as well as the possible development of new theory for other contexts.

Wang and Hannafin's (2005) meta-analysis of design-based ICT integration research did identify a principle addressing this desire for control over the research design process. However, design-based researchers must find ways to identify and acknowledge teachers' research goal and research design desires. I suggest that teachers be given opportunities to contribute to collaborative decisions regarding the ongoing, dynamic, research design. For example, imagine that a research goal for a CoP was to improve student achievement on a summative quantitative common assessment through the use of science data loggers (like motion sensors or pH sensors) in senior high science classes. Also imagine a research design that involved training the teachers to use the technology, followed by in-class use of these instruments, followed then by the summative quantitative common assessment. Also imagine the results of this summative assessment were no different than the previous years'—when the technology was not used. Based on the data collected by the quantitative instrument a member of the CoP may conclude that using the technology was not worth the effort.

However, if a teacher suggested that there were other unmeasured gains through using the technology then the research goal may need to be discussed and possibly amended. For instance, teachers may suggest that students' attitudes in science improved. The goal may be refined to measure the effectiveness of ICT integration, instead of just performance on one summative assessment. If this refined goal is agreed to by the CoP membership then another quantitative or qualitative data source may be needed. Furthermore, teachers may even suggest that the quantitative gains may not be realized until the following year since students and teachers would now have had previous experiences with these instruments and their integration. If a CoP were to attend to this possibility then the research design could be amended. It would then reflect the tracking of students and their subsequent performance. Additionally, cross-grade level participation in the CoP may even be suggested as a research design modification. Whatever the ICT initiative, the researcher must be willing to amend the design, even though further ethical approval and other considerations must be addressed. The researcher must relinquish some control and ownership over the research design to the participants. However, by listening and attending to the possible changes in research goals and research design, tensions may surface. These possible tensions need to be acknowledged and accommodated through negotiation. If this is not done then a lack of teacher and/or researcher ownership will develop and hinder the effectiveness of the CoP. Providing teachers with some control of research goals and designs may also reduce the chances of a possible dependency on the researcher. Teachers with control can build collaboration capacities, which may result in sustaining the CoP in the absence of the researcher.

IMPLICATIONS FOR PROFESSIONAL DEVELOPMENT

As a needs-based, collaborative and responsive professional development structure, a CoP investigated through a design-based research methodology can result in an effective and even synergistic combination for helping teachers and researchers identify effective classroom ICT integration practices. Design-based research is specifically designed to respond to iterative research and a CoP works best when data is iteratively fed back to the membership. CoPs, together with design-based research, have been used before, but the important step of giving due weight to teachers has not been fully addressed. The possible membership of a CoP must begin with the identification of the already existing community—perhaps beginning with a common subject or other learning focus or initiative. Once the community has been identified, researchers' and teachers' research goals must be communicated and collaboratively deemed close enough to be in alignment. Also, throughout the research, the possible tensions between who makes decisions regarding changes in the research goals and research design must be negotiated between the researchers and teachers. CoPs, and teachers within these communities, probably already have the solutions to many educational problems (Bereiter, 2005). By adhering to the three principles—effectively identifying these communities, aligning researcher and teacher goals, and negotiating ever changing research goals and designs—classroom ICT

integration can be implemented in ways that encourage teacher self-reflection and satisfaction and enrich student learning. Without teacher control and self-reflection, successful educational practices will not likely be identified.

FUTURE RESEARCH

While the investigation of CoPs through design-based research appears promising, it has yet to be fully tested. Research into how CoPs affect classroom practice (Niesz, 2007), and in particular ICT integration, now needs to be engaged. By doing this research a number of possible questions could be addressed: Does the combination of CoPs investigated through a design-based research methodology identify successful ICT integration processes? If so, what are these processes? Will this combination result in new educational theories regarding how teachers may successfully integrate ICTs or theories regarding how people may successfully collaborative? If so, what are these theories? Does this combination actually provide for increased levels of teacher control and teacher reflection? If so, does this increased control result in CoPs successfully reaching their goals? Given the recent increased value of *in situ* experiences and the value of teacher knowledge in CoPs, what now is the role of the researcher? What is the role of other "outsider" influences? How much input should be provided by the researcher and other "outsiders?" How does the possible change in researcher and teacher roles affect researcher and teacher identities? Are researchers becoming facilitators and intellectual supporters rather than generators of new knowledge?

The educational research landscape may be changing. To view this landscape from the traditional researchers' peak is now being seen as too distant to fully understand the subtle surfaces of the teaching and learning terrain. A CoP, together with design-based research, may provide a way down from the peak.

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