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Promoting Science and Technology Professional Development using an Invitational Education Approach

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Traditionally, professional development for teachers is delivered in a top down approach. Using Invitational Education as a framework, this study explored a "doing with" rather than "doing to" approach to professional development focused on integrating technology and science. Four teachers incorporated tablet-based computers into their science lessons, with a goal of using a Tablet-based Note-taking Application (TbNA) as a science notebook. Field notes from professional development meetings and an in-depth interview with one teacher were analyzed. All teachers successfully integrated technology into their science lessons and were open to further use of technology. One teacher met the goal of using the TbNA – developing specific goals and integrating it consistently into her science lessons. Importantly, she viewed her part in the professional development project as a positive experience. Our findings suggest that an Invitational Education approach might better help teachers with technology integration compared to more traditional trainings.

Keywords: Technology Integration, Science Education, Professional Development, Invitational Education

Introduction

Learning is a social process (Vygotsky, 1978) in which others' ideas influence thinking, stimulate change, and bring about new ideas. However, the teaching profession often lacks this social aspect, as teachers describe feeling isolated and alone (Lortie, 1975), separated from other adults even when they come together for Professional Development (PD). Traditionally, PD has been delivered through "top-down 'teacher training'" (Darling-Hammond & McLaughlin, 1995, para 2), in which experts offer workshops in the hope that teachers will receive the knowledge and implement it in their classrooms; however, this thinking has undergone a recent shift (Lumpe, 2007). Based in the conception of "knowledge-of-practice" (Cochran-Smith & Lytle, 1999, p. 273), it is now believed that teachers should play a critical and active role in constructing the knowledge they need through collaborative groups, in which all members function as researchers and learners together rather than receiving it from others.

Collaborative groups as a form of PD are supported in the literature on teaching and learning, through an assumption about the way in which teachers learn to teach effectively. This assumption is based in the work of Ball and Cohen (1999) and Grossman (1990), who assert that practice-

based PD supports the learning of teaching. Based on this assumption, teachers learn as part of a professional community engaged in the practices of planning, observing, and reflecting on one another's teaching. This view of PD fits within the theory of Invitational Education; implicit in the idea of allowing teachers to direct their own PD are the four basic assumptions of Invitational Education, trust, respect, optimism, and intentionality (Purkey, 1991).

An area in which teachers claim to have limited PD opportunities is the effective use of educational technology, with 78% of elementary teachers reporting independent learning in this area (Gray, Thomas, & Lewis, 2010). The need for PD on technology is high, as elementary schools have increased the amount of technology, including tablet based devices, available to them (Hill, 2012; Leonard, 2013; Miranda & Russell, 2012; Quillen, 2011), however, this investment has resulted in minimal return on use (Miranda & Russell, 2012). Miranda and Russell (2012) found that the biggest indicator of technology use was the teacher's own experience with the technology, which raises concerns about more widespread technology integration. In addition, the National Educational Technology Standards (NETS) (ISTE, 2007) call for meaningful use of technology by students, pointing to integrated use within the Profiles for Technology Literate Students, as well as ongoing professional learning for teachers. To help move beyond teachers learning about technology integration on their own, the 2017 ISTE standards for educator use of technology emphasize the need for teachers to learn together. The standards stated that educators should "continually improve their practice by learning from and with others" (p. 1).

The prevalence of educational technology and the increased calls for more effective use of technology by students has resulted in more technology-focused PD trainings for teachers. An important ongoing question for the field of education is how PD can be provided in ways that are efficient, effective, and engaging for teachers? To address this question, this study examines an Invitational Education approach to PD involving technology integration into elementary science education.

The release of A Framework for K-12 Science Education (National Research Council [NRC], 2012) and the Next Generation Science Standards (NGSS) (Achieve, 2013) brings with it the need for new knowledge, skills, and techniques as well. These documents call for a "shift from teaching science as inquiry to teaching science as a practice" (Osborne, 2014, p. 177), outlining eight practices, including, "obtaining, evaluating, and communicating information" (NRC 2012, p. 74), which includes engaging students in writing about "their work using journals to record observations, thoughts, ideas, and models" (p. 77). Science notebooks are a popular means of engaging students in this type of written communication, and as a way to improve student understanding of the science content and practices (Aschbacher & Alonzo, 2006; Baxter, Bass, & Glasser, 2000). With the development of Tablet-based Note-taking Applications (TbNA), the opportunity is available to integrate science and technology in a meaningful manner.

In order to explore the idea of integrating technology and science, we invited teachers to participate in ongoing, collaborative PD. This PD was developed around the idea that the researchers would conduct research through a "doing with" rather than a "doing to" approach (Purkey & Novak, 2008, p. 9). This led to the question, How does professional development, where teachers are invited to

participate in learning and research around their practices, influence teachers' technology incorporation in science?

Literature Review

The potential of technology to support educational endeavors has been discussed for over 30 years. For example, Mojkowski (1989) positioned technology as a powerful productivity tool that can support real world learning, that, one day, might transform schooling all together. Over time, as the potential value of technology for teaching and learning, various PD initiatives were envisioned for teachers. These trainings emphasized integrating technology into education and often targeted different grade levels and relied on various training paradigms.

Research on the effectiveness of these PD efforts revealed some common barriers and challenges to successful implementation. Some of the barriers included a disconnect to actual classroom practice, a lack of sociocultural awareness, a lack of focus on scalability and sustainability, and a lack of definition of what constitutes effective technology integration PD (Kopcha, 2012; Smolin & Lawless, 2011; Tondeur, Forkosh-Baruch, Prestridge, Albion, & Edirisinghe, 2016). Among these barriers, one consistent issue has been the use of traditional PD that is designed and developed based on top down decisions without teacher input (Barnett, 2003). In response to this issue, researchers have proposed the need to examine new approaches to PD (Carpenter & Krutka, 2015, Rodesiler, 2017; Wyatt & Ager, 2017). One new approach to PD, that is the focus of this particular study, is known as the Invitational Education approach.

Invitational Education

The theory of Invitational Education argues that learning is enhanced when learners are positively encouraged or 'invited' into the educational experience (Haigh, 2011). Invitational Education started as a theory of practice designed to create a total school environment that intentionally summons people in schools to realize their relatively boundless potential (Purkey & Novak, 1984; Purkey, 1990; Purkey & Stanley, 1991). Purkey (1999) explains that Invitational Education is centered on four main assumptions:

1. Respect: Everyone in the school is able, valuable, and responsible and is to be treated accordingly.
2. Trust: Education is a cooperative, collaborative activity where process is as important as product.
3. Optimism: People possess relatively untapped potential in all areas of worthwhile human endeavor.
4. Intentionality: Safe schools are best realized by creating and maintaining inviting places, policies, processes, and programs and by people who are intentionally inviting with themselves and others, personally and professionally (pp. 2-3).

As a framework for school transformation and school climate changes, studies have shown that Invitational Education can help create and maintain safe and successful schools, promoting an optimal learning environment for all (Fretz, 2015; Stanley, Juhnke, & Purkey, 2011; Steyn, 2006; Vega, Moore, & Miranda, 2015). The theory of Invitational Education has been considered a promising approach to implementing successful PD (Steyn, 2005). For example, Steyn (2006)

examined nine "inviting" schools in two different states. The results revealed that the Invitational Education approach led to the effective implementation of PD. Similarly, Mitchell (2016) emphasized that successful PD requires the major strands of Invitation Education (trust, respect, optimism, and intentionality), since PD is a formal process designed to promote personal and professional growth.

This work was interested in using an Invitational Education approach to PD to focus on integrating technology and science. For background purposes, the following section explores relevant literature on science notebooks.

Science Notebook

Science notebooks have become fixtures in many science classrooms, as a place to record data during an investigation and for students to synthesize their thinking (Fulton & Campbell, 2014). More specifically, using a science notebook, students document and reflect on scientific discovery, which includes recording inquiry-based observations and activities, conducting investigations and experiments, collecting data, and summarizing investigating (Campbell & Fulton, 2003, Cox, 2012, Fulton, 2017). Importantly, science notebooks become an effective assessment tool for teachers, which allow teachers to track students thinking process and understanding of science concepts (Aschbacher & Alonzo, 2006; Ruiz-Primo, Li, Ayala, & Shavelson, 2004). For that reason, the use of notebooks as a part of science instruction has been encouraged in many school districts (Aschbacher & Alonzo, 2006).

Studies of science notebooks have found them to be effective tools for supporting and assessing children's learning of science in preschool and elementary classrooms (Brenneman & Louro, 2008, Zangori & Forbes, 2014). Other studies have continued to investigate and demonstrate the implementation of science notebooks for pre-service teacher training, as well as in-service teacher PD (Allen, Matthews, Parsons, 2013; Lewis, Dema, & Harshbarger, 2014; Morrison & McDuffie, 2009; Schmidt & Fulton, 2014).

Methods

This study was qualitative in nature, as it is interpretive, experiential, situational, and personalistic (Stake, 2010). The data presented here come from a study focused on the use of the TbNA within science. Specifically, we examined the ways in which teachers integrated technology into their existing science instruction while participating in a collaborative PD driven by their interest in science and writing and their role in a research-based charter school, grades K-5.

The participants included educators from a charter school and experts from a large Pacific-based university. The educators included three elementary teachers (Grade K-1, 2-3, and 4-5), ranging in experience from 2 to 39 years and the elementary school department chair, with 32 years of experience. The experts consisted of an individual with expertise in elementary science education and one with expertise in elementary educational technology. Participants partook in four PD sessions that were two hours long each (8 hours total), over six months of time. The two experts served as participant observers (Creswell, 2007) as they were members of the collaborative group, but also observed and interviewed the participants.

The PD sessions were held after school at a time and location convenient to the teachers (Steyn, 2005). The focus of the four sessions is described in Table 1.

Table 1

Focus of PD Sessions

Session	Focus
1	Introduction to the TbNA application – time to explore its various tools and capabilities
2	Notebooks – deepening students' communication and documentation of science understandings within the notebook
3	Teacher sharing – use of technology and questions
4	Teacher sharing – use of technology; successes and challenges integrating technology into science lessons

Invitational Education Approach for Professional Development

The theory of Invitational Education serves as a lens with which to examine how an invitation to participate in PD and research may have influenced teachers' integration of technology and science. Our goal for this project, was to provide learning opportunities and to conduct research with the teachers, aligning with the Invitational Education purpose to provide a "more exciting, satisfying, and enriching experience for everyone involved" (Purkey, 1991, p. 1). We believe that when teachers are provided the opportunity to work collaboratively on a common goal of interest, that they have the ability to change not only their own understandings but student learning as well. Invitational Education has at its core, four basic dimensions (Purkey, 1991, p. 4), two of which pertain directly to professional learning:

- Being Professionally Inviting with Oneself – an individual seeks out opportunities to grow and learn in a professional sense.
- Being Professionally Inviting with Others – an individual promotes learning among others by setting high aspirations and attending to aspects, such as programs, places, and processes.

Along with these two dimensions, we considered the four propositions of Invitational Education – trust, respect, optimism, and intentionality (Purkey, 1991) – as essential components to the PD sessions. For teachers to integrate new information into their existing practice, we believe that they must feel that these propositions are in place. Trust is an integral part of collaborative PD, as members of the group are interdependent and rely on one another in order to move forward. Along these same lines, respect, or the idea that everyone involved in the project is valuable and has something to add, is essential. In addition, the idea that all are working toward a positive outcome, optimism, is important. Finally, the intentionality of the project, or the idea of creating a purposeful goal for the PD that will be of benefit to all involved is also vital.

Data Sources

Data sources included field notes from the PD sessions and an in-depth interview with one of the teachers. The field notes were analyzed to identify how the teachers integrated the technology. The interview was recorded, transcribed, and content analyzed (Berg, 2001) to isolate common themes that might help the researchers determine the possible influence the PD format had on the teacher's integration of technology and science, specifically the TbNA application.

Results

All four of the teachers integrated technology into their science lessons in some manner, but only one used the TbNA (see Table 2). Despite the fact that the other three teachers did not use the TbNA, they were excited to share the ways in which they did integrate technology into their science lessons. Importantly, all of them found a way in which they were comfortable integrating technology to document student learning using the iPad, even though they did not use the TbNA. As summarized in the Table 2, one teacher in working at the K-1 grade level, explained that she focused on using technology for her teaching practice rather than students' use of it. This teacher also described how helpful it was to be able to take pictures of what students created during class. Another teacher working at the 2-3 grade level reported integrating technology into her teaching, noting that her students actually used the technology to document their science observations using words, video, and photos.

During the last meeting, the teachers commented that they were looking forward to using the TbNA in the future. While using technology as a tool to enhance student learning was new to each of them, they were open to the idea of experiencing professional growth in this area, and felt comfortable pushing themselves as far as they could even though they did not necessarily meet the end goal of using the TbNA.

Table 2

Teachers' Use of Technology Based on Meeting Field Notes

Grade Level	Use of Technology	Individual Responsible for Technology
K-1	Photos of student created models of insects	Teacher
2-3	Documentary using words, video, and photos of study of birds	Students
4-5	TbNA use during moon and weather units	Students
Dept. Chair	Photos of work in mathematics; used photo as a prompt for writing	Students

Interview with a Teacher

Based on use of the TbNA, an interview was conducted with the grade 4-5 teacher. Three themes emerged, including her goals for implementing the TbNA, how she integrated the technology into her existing science lessons, and how she viewed being part of the collaborative project.

Within this study, the teacher felt comfortable setting her own goals for use of the TbNA. Just as they would in a typical paper notebook, she wanted her students "to record their observations, draw pictures, report data, draw inferences, [and] summarize information" within the TbNA. She also explained how the paper notebook goes home each year to be saved or discarded by the student, leaving "nothing that really follows the student." In comparison, she saw the TbNA as a "warehouse" and "long term storage place" explaining her vision of it becoming a "filing system of student's work since … kindergarten" in order to show the progression of their learning over time. In this way, she was developing her own broader vision for the notebook.

In addition, she talked about how she had implemented the notebook within her classroom on a daily basis, finding ways "to incorporate [the TbNA] into lessons [she] had already planned." There were times when the digital nature of the notebook seemed to be less productive, such as creating a concept map, and she decided to switch to paper and pencil and then have her students take a photograph of their work to include it in the TbNA. She viewed the technology as a positive, saying she looked for ways "[the TbNA] could accommodate, even improve what we did in the classroom already."

Finally, she shared her ideas of what it was like to be part of the collaborative study, stating that she was "excited to test it out." Most importantly, she appreciated the trust and respect we had in her to do this work, stating

> I felt like I had a good amount of time just to play with it, be comfortable with it myself, and integrate how I felt it would be most useful in my classroom, and so that was really helpful… I didn't feel scared [and] I didn't feel like it was being pushed upon me to implement it.

She summed up her ideas by stating that she found the TbNA easy to integrate and believed that students had a great deal of buy in while using the technology in science. Her feelings align with the ideas of Invitational Education, in that she (a) saw using the TbNA with her students as a purposeful goal and (b) recognized that she could provide valuable insight on using the TbNA in this way and felt comfortable sharing her insights, which resulted in a positive outcome.

Conclusion and Implications

Within this study all teachers were able to integrate technology in some manner and felt comfortable doing so, demonstrating success with the Invitational Education approach. Traditionally, technology-based PD has been delivered using a top-down approach, where experts provide training with little knowledge about the needs of the teachers. This format lacks respect of the teachers' knowledge and experience with technology and their own classrooms. Encouragingly, the Invitational Education approach used in this study produced results that are contrast common findings related to PD about technology (Keengwe & Onchwari, 2009; Plair, 2008). These finding include that technology PD can be overwhelming, leading to a lack of implementation and integration. Based on this, we propose the Invitational Education approach, rather than a top-down approach, may be essential for successful PD on the integration of technology. It should be, however, recognized that the findings of this study is based on small number of participations in PD, and further research is needed to generalize the findings.

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