The Evolution of a Teacher Professional Learning Network for Digital Literacy

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Abstract: This case study describes the evolution of a teacher professional development project for digital literacy. The goal of this teacher professional development project is to support teachers' effective use of technology and professional learning in an ICT-based learning environment by creating a professional learning network (PLN). The case suggests that the situated, collaborative learning environment of this PLN provided supportive affordance to improve teachers' use of technology and professional learning. In addition, we highlight teachers' voice as an important element to sustain the effectiveness of the PLN.

Introduction

The Creating, Collaborating, and Computing in Mathematics (CCC-M) project is a School-University initiative that responds to the real concerns about improving teachers' effective use of technology and disciplinary understanding in the mathematics classroom. The goal of this teacher professional development project is to support teachers' effective use of technology and professional learning in an ICT-based learning environment[1] by creating a professional learning network (PLN). In this paper, we focus on the early iterations of this project during which the PLN was developed and updated. The purpose of this study is to document the evolving process of this PLN with a focus on the following question:

How best can we help teachers use technology to support their student learning and their own professional learning?

Conceptual Background

As discussed in the introduction, there are two main challenges we would like to address in this project: a) how can we support teachers to use technology effectively in their classroom; and b) how can we use technology to promote teacher professional development. Our work to address these challenges is inspired by the previous studies in the field.

Digital Literacy and Professional Development

There is a consensus that professional development (PD) plays an important role in improving teachers' digital literacy for teaching (Angeli & Valanides, 2009; Lawless & Pellegrino, 2007; Russell et al., 2003). However, previous research indicates that traditional technology training for teachers, mainly educational technology courses and workshops, does not adequately support teachers' high-level technology use in the classroom (Lawless & Pellegrino, 2007; Zhao, Pugh, Sheldon & Byers, 2002). A central criticism is that these training activities primarily focus on the technical skills of operating technology tools rather than integrating technology into teaching (Selinger, 2001; Zhao et al., 2002). Technology tools are often taught in a way that fails to connect with teachers' everyday practice and content-specific pedagogical purposes.

Mishra and Koehler (2006) argued that the use of technology should not be separated with its corresponding subject content and pedagogical goal. The relationship among technology, content, and pedagogy is

[1] ICT is referring to *Information and Communications Technology*.

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mutually related, each element provides constraints and affordances to the other two. Successful teaching with technology requires teachers to deliberately consider these three elements taken together in order to develop specific pedagogical plans for specific content area with appropriate technologies. Furthermore, they proposed the method of *learning technology by design* to encourage effective integration of technology in the classroom. This approach involves providing teachers with the experience to design the use of technology in solving real educational problems. Instead of lecturing, the *learning technology by design* method emphasizes situating teachers in an authentic context and allowing teachers to explore the technology through active inquiry, research and reflection. By connecting technology learning and real practice, it is assumed that teachers could develop a deep understanding of effective technology use and better apply their knowledge in the classroom.

In this project, we adopted the method of *learning technology by design* to support teachers' learning of various digital tools. In specific, the PD activities focused on assisting teachers to design the use of recommended digital tools and adapt these tools in their own classroom.

Teacher Professional Learning in an ICT-based Learning Environment

Technology, especially information and communications technology (ICT), is not only a popular topic in teacher education, but also become a powerful tool to support teacher PD (Borko, Jacobs & Koellner, 2010; Lieberman & Pointer-Mace, 2009). Various virtual learning environments help teachers to overcome the constraints of place and time. Ubiquitous online conferencing networks expand the opportunity for collaboration among teachers, enabling teachers to learn from colleagues inside or outside of their school.

Nevertheless, concerns are raised that exposure to ICT tools does not necessarily lead to productive teacher learning and practice (Brophy, 2003; Goldman, 2001). Just as teachers need to thoughtfully integrate technologies into their classrooms, good PD program needs to clarify its pedagogical purpose of ICT use for teacher PD. Goldman (2001) also argued that facilitation is a key element to yield effective teacher learning in ICT-base learning environments. Teachers need guidance and support to better benefit from using digital tools for their own professional learning. Thus, a learning principle of this project is to facilitate teacher learning with appropriate ICT tools.

Professional Learning Network and Design-based Research

In the CCC-M project, we attempted to support effective teacher PD by creating a PLN. PLN or professional learning communities (PLCs) is an innovative PD model which is generally viewed as "a group of people sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning-oriented, growth-promoting way" (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006, p.223). We thought this model was suited for the CCC-M project since its underlying principles were in line with the ideas we adopted to improve teachers' effective use of technology and disciplinary understanding in an ICT-based learning environment.

Specifically, we highlighted several features of this PLN. First, it engaged teachers in a learner-centered, authentic learning environment. Teachers explored technology tools and mathematics teaching in the context of their own classrooms. They were empowered as active learners to construct their own knowledge for practice and to provide suggestions to improve PD activities. Second, it aimed at fostering teacher collaboration through sharing practice and reflective inquiry. Teachers were asked to plan, share, interrogate, and reflect on their teaching practice with their colleagues in a respective manner. Third, it provided long-term, ongoing supports for teachers' continuing PD. Participating teachers had regular PD activities during the school years, including face-to-face PD meetings and online learning activities. These PD activities were facilitated by a leadership team which consisted of internal school experts and external university-based educational researchers.

Moreover, we applied the approach of design-based research (Brown, 1992; Collins, 1992) to design and validate the effectiveness of the PLN. Following this approach, we started with identifying the real challenge and analyzing targeted context. The second step was to develop learning theories for this PLN. We then designed PD activities using these learning principles and implemented the activities in the real context. During the implementation process, we evaluated teacher learning as an evidence for potential improvement. If teacher learning did not achieve anticipated outcomes, revised PD activities would be developed and implemented. These processes as a result formed a cyclical system of research iterations (see Figure 1). This paper, in particular, focuses the first two interactions of the project.

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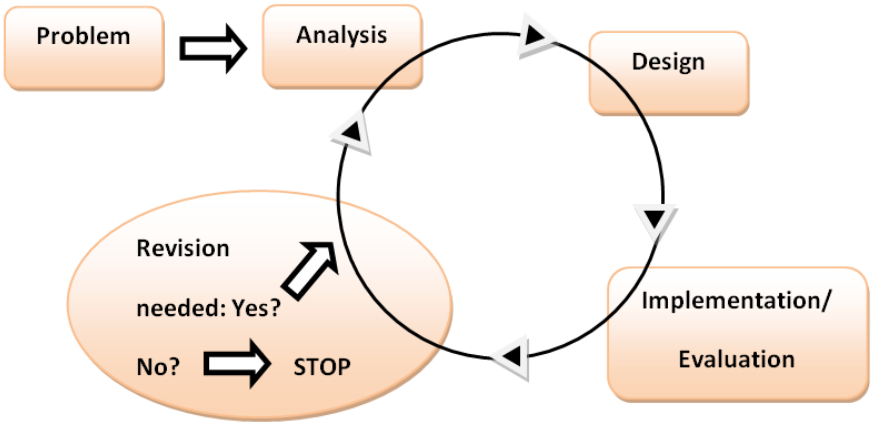

Figure 1. Iterations of systematic cycles (adapted from Plomp, 2013 in Nong, Breuleux & Heo, 2005, p.1237).

Context and Case Analysis

Context and Participants

The CCC-M project (see Heo & Breuleux, 2015; Nong, Breuleux, & Heo, 2015) is a partnership project between university researchers and an English school board in the Montreal area. Before the first cycle started, a leadership team was formed to plan the project. This leadership team consisted of university-based educational researchers (i.e., the principal investigator, a research associate, and a research assistant), three consultants of the school board (i.e., one techno-pedagogy consultant and two math consultants from the elementary and secondary levels), and one senior administrator from the school board. The school board consultants then recruited thirteen mathematics teachers who voluntarily enrolled in the project, including seven Grade 6 elementary teachers and six secondary math teachers. Their teaching experience ranged from 2 to 19 years.

The duration of the first cycle (Year 1) was from August, 2013 to May, 2014. The second cycle (Year 2) lasted from September, 2014 to April, 2014.

Case Analysis

We employed the method of descriptive case study (Yin, 2009) to describe the evolving process of how this PLN supported teachers' disciplinary understanding and effective use of technology in the mathematics classroom.

The study included various sources of data from the project database. There are five types of data: a) documents including the agendas of leadership meetings and PD face-to-face meetings, and the end-of-year reports that summarized previous PD activities; b) the field notes of PD face-to-face meetings and leadership meetings; c) artifacts from face-to-face meetings; d) transcripts of leadership meeting and teacher interviews at the end of Year 1; and e) the log files of teachers' online posts (e.g., textual posts, video posts, and website links).

Thematic analysis was used as the primary methodology in data analysis, because it enabled us to systematically analyze a wide variety of information using a top-down approach (Boyatzis, 1998). Corresponding to the two-year cycle of the project, two major themes were generated. The first theme was defined as Cycle 1 which describes how the initial PD activities were designed, implemented, and evaluated in the first cycle. The second theme was defined as Cycle 2 which elaborated the revision of PD activities in the second cycle according to the evaluation of previous cycle.

The Case: Two-year Cycles

Cycle 1 (Year 1)

Right after Year 1 started, the leadership team identified an objective of *developing the use of digital tools for teachers and students* based on the predetermined challenges from the school board. This objective included two sub-objectives:

1. Introducing potential digital tools that teachers could integrate into their classroom to help student learning;
2. Identifying digital tools for teacher learning.

Sub-objective 1. In Year 1, the leadership team introduced two technology tools (ideas) to teachers: flipped classroom using Educreations and math tools on the interactive white board (IWB). Teachers were also encouraged to share any digital tools that they thought useful in their classroom.

Flipped classroom is a popular instructional idea which uses video as an instructional tool (Bergmann & Sams, 2012). The basic idea of the flipped classroom is that teachers move their in-class lectures ahead of the class, typically by preparing some short video lessons for students to watch before the class. By doing so, teachers could spend more time during the class to engage students in problem solving activities. In addition, it gives more opportunities for teachers to interact with students and provide instruction when needed. The idea of introducing the flipped classroom was to encourage teachers to offer more instruction based on student learning rather than lecturing. The leadership team further recommended Educreations[2] as a tool for teachers to create instructional videos. Another potential tool we developed was IWB, especially the various math tools on the IWB. The leadership team chose this tool because more and more classrooms in the school board had equipped with IWBs and most teachers in the project had already used IWBs in their teaching. The CCC-M PD activities could offer great opportunities for teachers to explore the different uses of IWB math tools.

After the digital tools were identified, the leadership team developed a PD activity model to guide teachers' learning of the tools based on the method of *learning technology by design* (see Figure 2). As mentioned in the previous section, the general idea was allowing teachers to explore the use of tools in the context of their own classroom. For example, the leadership team introduced IWB math tools at the third face-to-face PD meeting. Following an intensive sharing and discussion on the math concepts that students struggled with, the technology consultant from the design team demonstrated the use of different IWB math tools. She then required teachers to work in groups, using IWB math tools to create a mini lesson for one of the struggling concepts. Meanwhile, the other PD facilitators from the leadership team provided technical support needed for teachers. After planning section, one or two of the teachers in each group were responsible for carrying it out. The rest of teachers asked questions and gave feedback once the lesson was taught. At the end of the meeting, the leadership team encouraged teachers to implement the tools in their classroom and share their experience as well as thoughts online. At the fourth face-to-face PD meeting, teachers reflected on their uses of IWB tools and discussed the improvement of tool use.

[2] Educreations is a tablet app that enables its users to create video tutorials. The app turns the tablet screen into a recordable whiteboard that allows users to draw on the board and add text, photos, and animated images. Users could also record their voice while editing the board.

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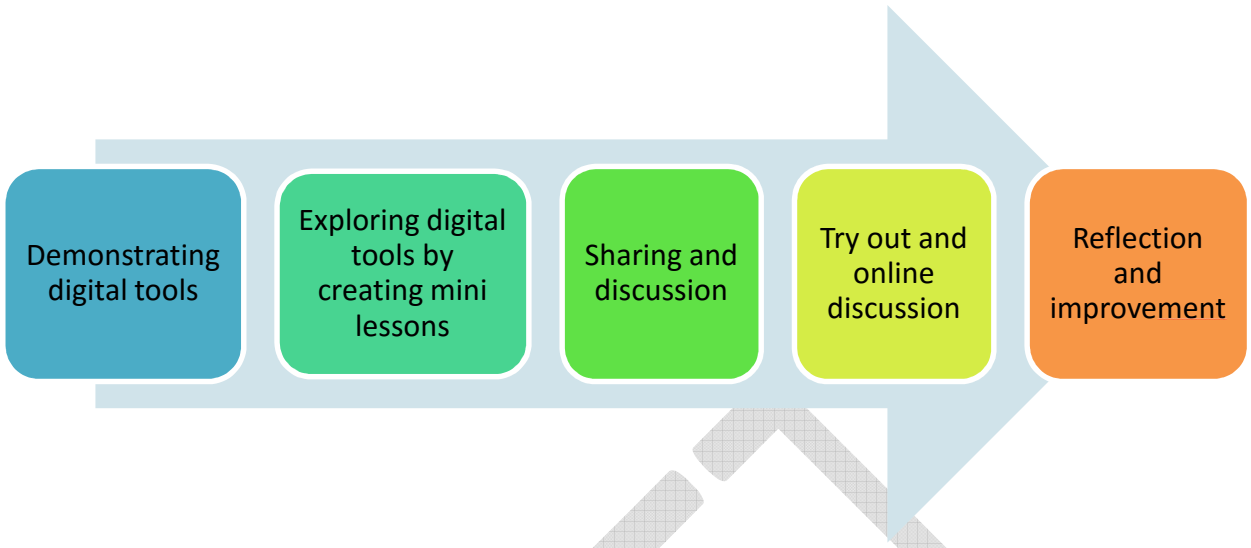

Figure 2. PD activity model to introduce digital tools.

Sub-objective 2. Due to the busy schedule of teachers, the leadership team decided to create an online learning group on Edmodo for teacher ongoing learning between face-to-face PD meetings. Edmodo (https://www.edmodo.com/) is a widely used online learning network for K-12 teachers, it enables its users to interact and collaborate with others by sharing information, experiences, and thoughts[3]. Teachers were asked to post weekly on the Edmodo. The posts could be about sharing their experience in the classroom (with or without technology), sharing learning and teaching materials, and responding to others' posts. Members from the leadership team also joined the online learning activities to facilitate and support teacher learning.

Overall, the participating teachers took an active stance to learn new digital tools and use these tools to support their teaching practice. They were able to think and reflect on the use of digital tools together with the real situation in their classroom. For example, one teacher reflected on the different experiences he had when using Edmodo with his students.

> *I have set up each group (class) with an Edmodo.com page. My grade 8 (students) love it. They use it as a community where they can help each other and get clarifications for classes other than my own because they followed each other for most subjects. Oppositely, my grade 9 (students) never check, and if they do they won't admit it in class. I see a big difference in how the tool is perceived between groups.*

In addition, the collaborative learning environment in this PLN fostered a culture of mutual support between teachers to improve their professional learning. Teachers shared their experiences in the classroom as well as teaching and learning information, provided suggestions to other's problem, and adopted new teaching strategies and the use of digital tools from others. For instance, one teacher changed her use of Educreations video from an instructional tool to an assessment tool. She asked her students to explain their understanding of math concepts through making short Educreations videos. This idea was quickly adapted as an effective assessment strategy by several other teachers in the PLN.

Despite the achievement of teacher learning, several problems emerged in Year 1. First, there were not enough teacher discussions in term of specific math content and student learning. Even though teachers were able discussed the use of digital tools in the context of their classroom, there was a lack of in-depth reasoning on why and in what way the tools could improve student learning of specific math areas. Teachers' discussions more focused on teaching rather than student learning of mathematics. Second, online PD activities were less productive compared to face-to-face PD activities. Most online posts stagnated at superficial level. The general pattern of class experience

[3] Teachers could also create online learning groups on Edmodo for their students and use it as an out-of-class learning platform.

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sharing was: "what I have done in the classroom" plus "whether students liked it or not". Teachers' interaction in terms of promoting others' thinking and learning was limited.

From the interviews with teachers, we found that some teachers needed to develop a habit to use the online learning platform for their learning. Because of their busy schedule, teachers also asked for regular reminders to access to Edmodo. Furthermore, several teachers suggested having more structured online PD activities.

Cycle 2 (Year 2)

According the result in Year 1, the leadership team revised the objective of PD activities for Year 2. The main goal in Year 2 was to engage teachers in in-depth sharing, reflection and inquiry of mathematics teaching and learning. More importantly, the leadership team tried to redirect teachers' attention from teaching to students' mathematics thinking and learning.

The idea of Math Talk was introduced as a central topic of PD activities in Year 2. Math Talk refers to students' capacity to articulate and justify their mathematical ideas as well as the ideas of others (Math talk, 2015). By revealing students' mathematic thinking through math talk, teachers could have a better understanding of student learning and develop specific strategies to promote students' mathematics learning. Consequently, the aim of PD activities in Year 2 was to help teachers prompt students' math talks and learn from students' math talks.

The leadership team developed a new model of PD activities to support teachers' learning of Math Talk. This model used short videos from teachers' classroom to foster productive teacher discussion in Math Talk. Videos were used because of it unique ability to capture the lessons in-the-moment. Teachers could watch, stop, and replay the videos, which allowed teachers to focus on and analyze specific features of the lessons in the classroom. Videos also served as a shared, concrete experience for teachers in the PLN to discuss teaching and learning in the context real classrooms. In specific, the leadership team first selected short video excerpts from teachers' lessons pertaining to Math Talk (e.g., communication between teacher and students, students' discussion in groups). In the next step, the leadership team developed guided questions to facilitate teacher discussion. The leadership team then presented the selected video clips to teachers at face-to-face meetings and engaged teachers in the activity of sharing, inquiry, and reflection. Teachers were asked to share their ideas about the videos, ask questions, reflect on mathematics teaching and learning in the clips, and develop alternative strategies to improve the lessons. After face-to-face meeting, teachers were encouraged to post their reflection and thought on Edmodo as well as their experience of implementing the ideas learned in their classroom. In addition, the leadership team posted additional video clips to Vialogues[4], creating online video-based PD activities for teacher discussion and learning.

To further engage teacher discussion, the leadership team invited several teachers as lead teachers to co-plan and support the video-based PD activities. A group of lead teachers who agreed to allow video capture in their classrooms took a responsibility to prepare the videos for teacher discussion. Together with the leadership team, these teachers identified lesson topics to be filmed and selected video excerpt from the lessons. A second group of lead teachers took a role to scaffold teacher learning and reflection. They were responsible to prepare reflective questions to stimulate teacher discussion for face-to-face PD activities by watching the selected video clips ahead. They also took a lead to ask reflective question and promote discussion for online PD activities on Edmodo and Vialogues.

Gradually, the focus of teacher discussion moved from delivering the lesson to students' mathematics learning. Teachers were able to reflect on how to prompt students' math talks, analyzing student thinking and learning, and discussing different strategies to address students' problems in mathematics learning.

In Year 2, we did not devote a lot of time to exploring technology integration in the classroom. However, we expect that the video-based PD activities in Year 2 could set a foundation for the activity of technology integration in the next cycle. That is, we hope by directing teachers' focus on students' mathematics thinking and learning, teachers could better think about how to use digital tools according to student learning of specific math content.

[4] Vialogues (https://vialogues.com/) is an online platform for video-based online discussion.

Conclusion and Implication

From the two-year cycles, we identify some lesson learned. First, the situated, collaborative learning environment of this PLN provided supportive affordance to improve teachers' use of technology and professional learning. Second, teachers' voice is an important element to sustain the effectiveness of the PLN. In this project, we included teachers' voice by asking teachers' ideas to improve the PLN and inviting some teachers into the leadership team. The participating teachers offered a valuable insight into challenges they had, topics in term of mathematics teaching they were interested in, and ways they envisioned as productive PD. Consequently, this information helped us better support teachers' PD depending on their needs. Third, the design of PLNs is not perfect in the first place, but requires ongoing, systematic validation along with the evolvement of teacher learning.

In sum, this project contributes to a better understanding of teacher PLNs for digital literacy in a K-12 context. It provides an example of developing and validating a PLN to support teachers' effective use of technology and professional learning in an ICT-based learning environment, and may encourage varied ways of PLN development for digital literacy in other K-12 contexts. In addition, the PD activities mentioned above can be applied in other context. For example, teacher educators could use videos from real classrooms as a tool to foster productive discussion and learning for pre-service teachers.

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