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Teachers' Belief Changes in a Technology-Enhanced Pedagogical Laboratory

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Abstract: *Preservice teachers who were enrolled in a technology integration course facilitated student-centered lessons to K-12 students in a pedagogical laboratory. A quantitative instrument, Teachers' Beliefs Regarding Technology Use Survey (TBTUS), was employed to measure the impact of the pedagogical laboratory experience on preservice teachers' beliefs regarding technology integration. The impact was largely insignificant. The qualitative data suggest that changes might be incremental and TBTUS might not be sensitive to the changes that occurred after 22-hour treatment, with only six hours of real teaching experience. Moreover, unlike vicarious experiences, personal teaching experiences may be different for each candidate, so they might have learned strategies that are unrelated to the beliefs that were measured.*

Keywords: teachers' beliefs, technology integration, pedagogical laboratory, field experience, teacher learning

1. Introduction

Contemporary vision of technology integration focuses on technology as a tool to transform education. Hooper and Rieber (1995) present a model illustrating a developmental process that teachers may go through to take full advantage of the potential of technology. Teachers progress through the initial exposure to technology and basic technological skill acquisition, to occasional application of the skills learned, to integration of technology into instruction, and finally, to the change of their beliefs and practice toward student-centered, constructivist learning. Hooper and Rieber (1995) believe that this process will continue as the educational system evolves and adapts to reflect the new understanding of how people learn. Similarly, Becker (2001) describes how technology integration, as a field, has progressed from focusing on computer skills and curriculum integration to using technology as a tool for educational reform. He maintains that "The final and critical piece may yet turn out to be teachers' philosophies of learning and teaching and whether they can be brought around to be supportive of constructivist applications of computer technology" (¶3). This vision is consistent with current theory and research on human learning (Brandsford, Pellegrino, & Donovan, 1999), and it is advocated as the best practice of technology integration (Becker, 1994; Dede, 1998). Notably, this view is reflected in the National Educational Technology Standards published by International Society for Technology in Education (2000).

However, current use of technology is still limited to the use of basic computer tools to support traditional approach of teaching (Bauer & Kenton, 2005; Cuban, Kirkpatrick, & Peck, 2001; Ertmer, 2005). Researchers' vision of using technology to facilitate constructivist, student-centered learning is still a distant and daunting goal (Ertmer, 2005; Mims, Polly, Shepherd, & Inan, 2006; Sugar, 2002).

A variety of barriers exist that prevent teachers from using technology to its full potential. Ertmer (1999) categorizes the barriers to technology integration into two types: first-order and second-order barriers. First-order barriers include the lack of access to resources such as equipment, time, training, and support. Second-order barriers are typically rooted in teachers' underlying beliefs about teaching and learning. First-order barriers are easier to be recognized and removed, whereas second-order barriers may require teachers to transform their beliefs in teaching and learning. Ertmer (2005) further argues that many of the conditions for technology integration already exist, and the final barrier toward technology integration is teachers' beliefs.

In this paper, we present a mixed methods study that investigates whether and how a combination of vicarious learning experiences and a hands-on technology integration field experience in a pedagogical laboratory may affect changes in preservice teachers' beliefs. The pedagogical laboratory is a setting where preservice teachers may develop and try out innovative technology integration curriculum with the help of expert teachers (Brandsford et al., 1999). Findings from this study may inform the design of similar field experience programs and contribute to the understanding of how student-centered, innovative instructional activities may impact preservice teachers' pedagogical beliefs.

2. Review of Related Literature

2.1. Teachers' Belief Changes

Teacher education programs usually have little impact on preservice teachers' beliefs (Wideen, Mayer-Smith, & Moon, 1998), because preservice teachers have already developed a stable belief system on teaching and learning upon entering college (Pajares, 1992). They view teaching as a process in which teachers pass on knowledge for students to memorize (Brookhart & Freeman, 1992; Wideen et al., 1998), and such beliefs will guide their future teaching practices (Richardson, Anders, Tidwell, & Lloyd, 1991). Researchers argue that the failure of teacher education programs in impacting teachers' beliefs might be caused by the didactic nature of the program; even programs that preach progressive education do not teach the way they preach (Wideen et al., 1998).

Theory and research on teacher learning suggests various strategies to promote changes in teachers' belief. Three key components are common to these strategies: experience, reflection, and support. The first component includes providing both personal and vicarious experiences (Ertmer, 2005) in which preservice teachers either practice the use of technology to facilitate student-centered learning or to observe other teachers' technology integration experiences. In a literature review on preservice teachers' beliefs, Richardson (2003) suggests that a key barrier to preservice teachers' belief change is the lack of real world experience. Preservice teachers should be given the opportunities to practice teaching with technology in all teacher education courses and field experiences, as well as during the induction phase (Mims et al., 2006; Moursund & Bielefeldt, 1999). Vicarious experiences are also important. Preservice teachers should observe how other teachers, especially experts,

teach with technology. The observation can be in person or through electronic means such as text- or multimedia-based scenarios (Ertmer, 2005; Krueger, Boboc, & Cornish, 2003; Wang, Means, & Wedman, 2003).

The second component important to affecting changes in teachers' beliefs is reflection. Educational theorists have long recognized the importance of reflection in teacher education (Shulman, 1987). Reflection is a key process during which a teacher "looks back at the teaching and learning that has occurred, and reconstructs, reenacts, and/or recaptures the events, the emotions, and the accomplishments. It is that set of processes through which a professional learns from experiences" (Shulman, 1987, p. 19). Teacher educators have adopted various strategies to encourage and guide teacher reflection. Some common strategies include reflective journal writing (Kember et al., 1999; Loughran, 1996), portfolio (Ellsworth, 2002; Orland-Barak, 2005), and classroom discussions. Recently, electronic tools have been adopted to promote teachers' reflective practice, including e-mails, e-journals, Weblogs, bulletin/discussion boards, chatrooms, listservs, and digital video (Calandra, Dias, & Dias, 2006).

Experience and reflection alone are inadequate to facilitate the change of beliefs; various support mechanisms should be in place to provide preservice teachers with information and materials, as well as social-cultural support to facilitate reflection and belief change. First, new materials, methods, and strategies should be made available to provide the new information and knowledge that teachers need to change their way of thinking and teaching (Orrill, 2001). Second, social-cultural support is critical to shaping teachers' beliefs and practice. Social-cultural support can be provided by developing communities of teachers who share values and opinions, discuss new methods and strategies, and support each other in taking the risk of changing their practice (Ertmer, 2005). In these communities, there is collaboration and support at the group level and one-on-one support among peers and between experts and novices (Orrill, 2001). Social-cultural support is also important within teacher education programs. Moursund and Bielefeldt (1999) advocate that in these programs, faculty should model technology integration and mentor teachers should be made available to support and encourage preservice teachers as they practice teaching with technology in field experiences.

The model pedagogical laboratory has the potential to serve as an appropriate environment to facilitate preservice teachers' belief changes (Brandsford et al., 1999). In a National Academy of Sciences report, *How People Learn,* a panel of researchers (Brandsford et al., 1999) advocate the development of model pedagogical laboratories as a part of the teacher education research and development agenda. The laboratory provides preservice teachers with an opportunity to work like scientists who experiment with the latest findings in learning and instructional theories by trying them out with students recruited from local schools, observing student learning, and reflecting on the strategies. The three key components that we found important in the teacher education literature, including experience, reflection and support, are present in the pedagogical laboratory. First, experience is an essential element in the pedagogical laboratory. Preservice teachers may gain personal experiences in practicing research-based instructional strategies and acquire vicarious experiences by observing the teaching practice of their peers and expert teachers. Second, preservice teachers are encouraged to reflect on their experiences. They are guided to think of themselves as scientists, who conduct experiments and reflect on the results and

changes needed. This mentality may help them become reflective practitioners. Third, instructional materials and expert teachers are available in the pedagogical laboratory to provide support to preservice teachers. The pedagogical laboratory is "a locus of information" (Brandsford et al., 1999, p. 51) that stores materials important in teaching, including model lessons, units, and facilitation protocols. Expert teachers work with preservice teachers to support their practice teaching and belief change.

2.2. Affecting Changes in Teachers' Technology Beliefs: Related Studies

Although theories and models on teacher learning and belief changes abound in the literature, little research has investigated the effectiveness of the strategies designed to affect belief changes related to technology integration. Park and Ertmer (2007) examined the impact of problem-based learning (PBL) on preservice teachers' beliefs regarding technology use and on their intended teaching practice. Park and Ertmer (2007) argued that a PBL environment may initiate changes in teachers' beliefs because this approach encourages problem solving, critical thinking, and decision-making. They conducted a quasi-experimental study using pre- and post-surveys and lesson plans to investigate the change of beliefs and potential teaching practice in an eight-week course (16 hours in total, 2 hours per week). Participants in the PBL condition group watched two digital video clips of interviews with school administrators who described their intention to hire new teachers capable of integrating technology into their classrooms. Preservice teachers' overall task in the semester was to work in groups of two or three to create a fictional teacher candidate and develop a job application for the new positions. Throughout the course, they watched video cases of exemplary technology integration in K-12 classrooms, discussed problems related technology integration, identified the strengths and weaknesses of various problem solutions, created a Web-based portfolio using artifacts such as digital curriculum vitae, technology integration lesson plans, and teaching philosophy, and presented the portfolio to the interview panel. Preservice teachers in the control group reviewed and evaluated various multimedia programs used in the K-12 curriculum, created two lesson plans involving the use of technology, and completed one digital video development project.

Park and Ertmer (2007) used Teachers' Beliefs Regarding Technology Use Survey (TBTUS), a 54-item, 7-point instrument to measure preservice teachers' beliefs before and after the PBL experience. This instrument was based on a model created by Miller and her colleagues (2003), who believed that changes in three aspects of teachers' beliefs are necessary for meaningful technology integration: pedagogical orientation, teachers' self-efficacy beliefs, and beliefs about the perceived value of computers in teaching and learning. TBTUS is a reliable instrument built on items used to measure these three factors in previous research (Bai & Ertmer, 2008; Ertmer et al., 2003).

In their study, Park and Ertmer (2007) found that teachers' beliefs regarding technology use did not significantly change after the 16-hour vicarious PBL experience. However, they significantly shifted their intended teaching practices from teacher-directed to student-centered learning. Park and Ertmer (2007) speculated that preservice teachers' 16-hour vicarious PBL experience of technology use might be too short to make a difference on their beliefs. Park and Ertmer (2007) cited Richardson (2003) to state that belief change in an academic course is difficult, especially when there is no significant and structured involvement in a field experience. They also suggested that the

instrument used to measure beliefs may not be sensitive to the changes reflected in preservice teachers' intended teaching practices.

Another related study focuses on the impact of a field experience program on preservice teachers' beliefs. This study was conducted in a pedagogical laboratory, which incorporated the three components important to affecting belief changes: experience, reflection, and support (Ma, Williams, Prejean, Lai, & Ford, 2008). The field experience program included three phases: teacher candidate preparation, laboratory experience, and reflection. The first phase was teacher candidate preparation. The primary goal of this phase was to provide preservice teachers with content, pedagogical, and technological knowledge needed to facilitate technology-enhanced activities. Preservice teachers viewed video case studies of student-centered learning classrooms and experienced how an expert teacher delivered a technology-integration model lesson. The second phase was laboratory experience. It aimed to offer personal experience to facilitate technology-enhanced, student-centered learning. Preservice teachers took turns to facilitate activities, observed their peer's facilitation practice, and collected video footage of their peers. They kept a reflective journal in phases two and three. The third phase was articulation and reflection. It was intended for preservice teachers to reflect on their facilitation experience and at the same time to practice their technological skills in creating digital videos. After each facilitation experience, preservice teachers met and discussed their experiences. Once the laboratory experiences were completed, they created a reflective video with a peer.

In a study of the pedagogical laboratory, researchers analyzed preservice teachers' reflective journals and interviews (Ma, Lai, Williams, Prejean, & Ford, 2008). The qualitative data indicated that the pedagogical laboratory experience was extremely valuable to preservice teachers. It gave them a new understanding of and inspiration for teaching. Preservice teachers realized how difficult, but also how exciting and rewarding teaching can be. The field experience challenged their beliefs of teaching and technology integration. For example, the demand for diverse types of knowledge and skills needed to facilitate student-centered, technology-enhanced lessons was overwhelming for some preservice teachers. Some of them were frustrated in the student-centered environment where they did not feel having complete control. They also encountered other problems related to student-centered learning and technology integration such as technical issues, meeting diverse needs of learners, as well as handling group dynamics and power struggle. In the meantime, preservice teachers began to appreciate the different strategies used in student-centered classrooms as compared to those in traditional classrooms. They started to allow students to choose their tasks and began to feel comfortable about learning from students. Most of them explicitly stated that they would incorporate student-centered learning activities into their future classrooms, although they were aware that it might take much more than one field experience or one semester for them to change their beliefs and to acquire the knowledge and skills necessary for facilitating student-centered learning.

3. Research Purpose and Questions

The current study continues the investigation of teachers' belief changes in the context of the pedagogical laboratory. Park and Ertmer (2007) speculated that preservice teachers' 16-hour vicarious PBL experience of technology use might be too short to make a difference on their beliefs. Time might be a factor, but the quality of experience might make a difference too. Will

a combination of vicarious experiences and personal technology integration experiences in the pedagogical laboratory have a greater impact on preservice teachers' beliefs than vicarious PBL experience alone? Previous qualitative data (Ma, Lai et al., 2008) suggested that field experience in a pedagogical laboratory might change preservice teachers' beliefs, so in this study we intended to determine the quantitative evidence for the change. We also collected qualitative data to help explain the quantitative results.

This study had both theoretical and practical purposes. The theoretical purpose was to add to our knowledge of what factors may lead to changes in teachers' beliefs. The practical purpose of the study was to determine the effectiveness of the pedagogical laboratory program so as to inform the design of this and similar programs. Two research questions were addressed:

1. Does the pedagogical laboratory experience affect changes in preservice teachers' beliefs regarding technology use?
2. Why and how does the pedagogical laboratory experience affect changes in preservice teachers' beliefs regarding technology use?

4. Methods

Mixed methods served as the methodology for the study (Johnson & Onwuegbuzie, 2004). We used quantitative techniques to examine whether the student-centered activities in the pedagogical laboratory significantly enabled changes in preservice teachers' beliefs. We employed a one-group pretest and posttest design using pre- and post-surveys given to preservice teachers to detect any significant changes of beliefs before and after the field experience. We supplemented the quantitative findings with qualitative reflection and interview data to explore various factors that might explain the quantitative data. Both qualitative and quantitative data were complementary in helping us search for congruent findings.

4.1. Participants

Twenty-four preservice teachers from two intact sections of a technology integration course, *Technology in the Classroom,* participated in the study at a Southern research/ teaching university. One instructor taught both sections of the course. Among the subjects, two were males and 22 were females. Ten majored in early childhood education. Three majored in middle school education. Eleven majored in secondary education with concentration in English, music, and arts education. The majority of the pre-service teacher participants are traditional college students who are about 18-22 years old. Most of them have little teaching experience.

4.2. Pedagogical Laboratory Experience Procedures

The pedagogical laboratory experience took place in the middle of the semester. It included three phases: preservice teacher preparation, laboratory experience, and reflective journal writing. It took preservice teachers a total of 22 hours over four weeks to complete. Preservice teacher preparation lasted three and a half weeks, with a total of approximately 14 hours. Laboratory experience took place on two consecutive Saturdays and lasted a total of six hours. Reflective journal writing took about two hours.

Preservice teacher preparation consisted of three main components. First, the university instructor modeled the teaching of a robotics lesson to middle school mathematics education majors and a digital storytelling lesson to early childhood education and secondary English, music, or arts education majors. The model

lesson was intended to provide the content and technological knowledge needed for preservice teachers to facilitate the lessons themselves. They also served as practical examples of how the lessons should be facilitated. The second component of preservice teacher preparation focused on providing vicarious experiences and pedagogical knowledge needed to affect preservice teachers' beliefs. Video case studies of project-based learning and cognitive apprenticeship were presented, and preservice teachers were encouraged to compare these student-centered learning environments with traditional classrooms to identify the rationale for and characteristics of student-centered learning. A list of facilitation strategies, compiled from theory and research related to student-centered learning (Hmelo-Silver & Barrows, 2006; Jonassen, 1999; Mevarech & Kramarski, 2003) were presented to preservice teachers. The list includes not only general strategies such as questioning, modeling and providing motivational prompts, but also specific strategies to encourage reflection and guide group collaboration. Preservice teachers were required to watch video case studies from INTIME (2001) Website and identify what strategies teachers used to facilitate the technology-enhanced lessons. The third component involved collaborative lesson planning. As a team, preservice teachers planned a series of robotics or digital storytelling activities for the children. Sample lessons were provided to guide lesson planning. Preservice teachers were required to consider the following in the planning phase: state and national standards, the children's' grade levels, lesson procedures, and possible facilitation strategies.

During the laboratory experience, every two preservice teachers were paired to facilitate a student-centered lesson to a group of one or two children for two three-hour field experience sessions. These children were recruited by word of mouth. They were either children or friends of the university employees or students, or they have participated in the technology programs offered by this research team in previous semesters. Preservice teachers took turns to lead the group and to conduct peer observation. They recorded their partner's use of facilitation strategies on a Facilitation Strategies Note Taking Guide.

Preservice teachers wrote a reflective journal after each three-hour field experience session. They were required to think of a critical incident that happened during their field experience to anchor their reflection. A critical incident can be identified by thinking of an "aha" or "oops" moment that preservice teachers experienced during the field experience. It is typically a significant moment that may raise some questions or challenge one's beliefs. Previous research shows that structured writing guidance, such as the critical incident technique (Flannagan, 1954), has led to higher levels of reflection among preservice teachers (Griffin, 2003; Hamlin, 2004).

4.3. Data Sources

There were four data sources in this study: (1) Teachers' Beliefs Regarding Technology Use Survey (TBTUS) (Park & Ertmer, 2007), (2) teacher perceptions survey, (3) reflective journal entries, and (4) follow-up interviews with selected preservice teachers.

TBTUS (Park & Ertmer, 2007) was given to preservice teachers both before and after the pedagogical laboratory experience. TBTUS included 35 items that measured teachers' beliefs about student-centered learning, seven items that measured teachers' self-efficacy for technology integration, and 12 items that measured teachers' perceived value for computers in teaching and learning. The 35 items measuring teachers' beliefs about student-centered learning fell into three sub-scales:

(1) Learner-centered beliefs about learners, learning, and teaching (LB-LLT) (14 items), (2) non learner-centered beliefs about learners (NLB-L) (nine items), and (3) non learner-centered beliefs about learning and teaching (NLB-LT) (12 items).

Teacher Perceptions Survey (TPS) was a 15-item survey given to preservice teacher participants at the end of the pedagogical laboratory experience. This survey was developed by our research team. These items asked preservice teachers about their perceptions of the pedagogical laboratory experience, including how much they and their students liked and learned from the field experience, how challenging the experience was, and how much they felt prepared for the field experience.

Preservice teachers were required to submit a reflective journal after each three-hour field experience session. Questions and prompts were provided to guide the writing of the reflective journals.

We conducted follow-up interviews with selected preservice teachers to understand their experiences in the pedagogical laboratory and perceptions of their learning. A purposeful sampling technique helped us identify six interviewees who had different perceptions revealed in TPS. Four interviewees somewhat agreed or strongly agreed that the field experience changed their previous beliefs about teaching and learning, and the other two strongly disagreed. The interviews were recorded and transcribed.

4.4. Data Analysis

In order to answer research question one, "Does the pedagogical laboratory experience affect changes in preservice teachers' beliefs regarding technology use?", several two tailed paired t-test were calculated by comparing the pretest and posttest scores on various beliefs measured by TBTUS. TPS was analyzed by recording preservice teachers' responses in an Excel spreadsheet and calculating basic statistics such as means and percentages. TPS was designed mainly for the practical purpose of obtaining preservice teachers' feedback so as to improve the program in the future. Not all the survey items were directly relevant to this study. Therefore, TPS served as supplementary data to TBTUS.

To answer research question two, "Why and how does the pedagogical laboratory experience impact preservice teachers' beliefs regarding technology use?", Miles and Huberman's (1994) data analysis procedures were followed to analyze the qualitative data. In the data reduction step, we coded the transcripts and journals into conceptual chunks and grouped the chunks into categories. In the data display step, we ran queries to make sense of the relationship among the categories. And lastly, we wrote conclusions to explain the quantitative results.

5. Findings

Question 1: Does the pedagogical laboratory experience affect changes in preservice teachers' beliefs regarding technology use?

Statistical analysis indicated no significant difference on the following beliefs from the pretest to the posttest: learner-centered beliefs about learners, learning, and teaching (LB-LLT), non-learner-centered beliefs about learning and teaching (NLB-LT), self-efficacy beliefs about technology integration (SEB), and beliefs about perceived value (PV) of computers for instructional purposes (Table 1 on the next page). That is, pedagogical laboratory had no statistically significant impact on these beliefs among preservice teachers.

Table 1. T-test of preservice teachers' beliefs

Beliefs	$MEAN_{pre}$	$MEAN_{post}$	t	p
LB-LLT	5.62	5.75	-1.255	.222
NLB-LT	4.40	4.56	-2.455	.022
NLB-L	5.37	5.50	-1.2	.242
SEB	4.44	4.56	-1.6	.113
PV	5.6	5.8	-2.02	.055

Note. N=24. LB-LLT: learner-centered beliefs about learners, learning, and teaching; NLB-LT: Non-learner-centered beliefs about learning and teaching; NLB-L: Non-learner-centered beliefs about learners; SEB: self-efficacy beliefs about technology integration; PV: beliefs about perceived value of computers for instructional purposes.

There was a significant difference on the non-learner-centered beliefs about learners (NLB-L) from the pretest to posttest. That is, pedagogical laboratory had a statistically significant impact on preservice teachers' non-learner-centered beliefs about learners. However, to our disappointment, the impact occurred in the opposite direction as we hoped. Instead of assuming more student-centered beliefs about learners, the field experience strengthened preservice teachers' non-learner-centered beliefs about learners. Preservice teachers became more inclined to agree with statements such as "It's just too late to help some students."

Question 2: Why and how does the pedagogical laboratory experience affect changes in preservice teachers' beliefs regarding technology use?

Although the pedagogical laboratory experience had no statistically significant impact on most of the categories of beliefs measured by TBTUS, an analysis of TPS, preservice teachers' reflective journals, and follow-up interviews tell a more interesting story. In TPS, one third of the preservice teachers claimed that the field experience actually changed their previous beliefs about teaching and learning. They believed that pedagogical laboratory field experience was a valuable learning experience. On a scale of one to seven with one being strongly disagree and seven being strongly agree, the average rating of the following two statements, "I learned a lot from the field experience on the two Saturdays" and "The children in our group learned a lot from the Saturday program," were 5.46 and 5.75 respectively. Out of the 24 preservice teachers, 92% somewhat agreed, strongly agreed, or completely agreed that they learned a lot from the experience. About 88% somewhat agreed, strongly agreed, or completely agreed that the children in their group learned a lot from the experience.

Preservice teachers discussed their belief changes in the reflective journals and follow-up interviews. Quite a few of them commented on the value of technology in engaging students. They were amazed at how focused and engaged the students were while working on the project. One of the preservice teachers wrote,

> When we began working with the robots in class I did not enjoy it and thought the students would not be thrilled either. I was completely wrong and my opinion changed after the field experiences. I realized that the robotics training is a great way for teachers to integrate technology into their lessons. It is also a fun way for students to learn.

However, the experience also made preservice teachers realize the challenges involved in technology integration. Five preservice teachers described technical problems encountered in the field experience. A couple of them discussed how their fear of technology prevented them from successfully

facilitating the field experience. They took complete control of robotics programming because they thought if they did not feel comfortable with the technology, how could second graders accomplish the tasks? Various challenges involved in facilitating the lessons might explain why about one third of the preservice teachers did not want to have more experiences like this and they would not recommend it to their peer students. They did not believe that they were adequately prepared for the field experience.

One third of the preservice teachers reflected on various issues related to student-centered learning. A couple of them talked about feeling incompetent because their middle school gifted students were very bright and they did not have answers to students' questions. Then, they realized that teachers do not have answers all the time and sometimes they may need to brainstorm with the students. One of them wrote,

> This incident showed me that I will not always have the answers. I will have to use different strategies to get to that right answer. This incident made me feel very small and unable to instruct the students and lead them to success. That's when I stopped and realized that not every teacher has all the right answers. Brainstorming is very important in the curriculum of students, and this incident facilitated that.

Another issue that preservice teachers reflected on was the importance of guidance and scaffolding. Three preservice teachers realized that even bright children need guidance in student-centered environments. They came to understand that they need to "look for students' troubled areas" and "give continuous feedback during work time so that students know how they are doing."

Control was major issue that many preservice teachers encountered. For example, having preservice teachers work in pairs in this student-centered learning environment exposed them to different beliefs of teaching. A couple of preservice teachers discussed how their partners would not give control to students and they had to come up with strategies to negotiate with them.

> We let them have the camera, and the little girl let one of her fingers get in the way of the shot, and because of that my partner decided to take control of the camera. She said we didn't have enough time to make mistakes basically. I was completely taken aback. I told my partner to let the students use the camera, because I knew they would learn from their mistakes. I did go about telling her the wrong way; I should have asked to see her in the hall and then explained my decision. But, I did not think over my response properly, I just acted out of aggravation, instead of professionalism. As a result of my actions, my partner became angry with me for telling her in front of the students, but the students were able to use the camera properly after a few tries.

Another preservice teacher had to negotiate with her own instinct to take control. She had to keep reminding herself so that she would let the students control the project.

> I often thought that I had made a mistake in contributing too much to the students' project and, essentially, trying to take control of a situation that did not belong to me. I should evaluate my ideas and whether or not they will help the student learn or simply satisfy my own idea of what an assignment (especially an art one) should become.

> I will pay more attention to how often I offer unnecessary suggestions in the future, as I do not want to be a teacher who expects students to think exactly like her.

Preservice teachers not only negotiated with their own beliefs about control, they had to work with children who may not be comfortable taking control. For example, one preservice teacher struggled in the field experience because the children in her group wanted direct instruction and they did not want to take control. This led her to think that student-centered instruction might not be effective for some children. She said, "I have never thought of that, they would be kind of apprehensive of working on their own. It seemed that they wanted very teacher-guided, direct instruction."

Preservice teachers learned much more from the pedagogical laboratory experience than those measured by TBTUS. The field experience was one of their first teaching experiences, so as new teachers, they encountered various problems and learned a lot from the experience. One of the main topics that the preservice teachers reflected on was the discrepancy between teaching and planning. Almost all of them described some situations in the field experience in which the lesson did not run as expected, so they had to improvise to address the problems. They realized that there would always be unexpected situations in the classroom, so they would need to be more prepared and have backup plans in the future. Statements like the following were typical in their reflective journals:

> I learned that no matter how much you try to plan and organize yourself, something will not work as planned. It is important to have a backup plan or to be flexible and try to come to a consensus of the best course of action.

They realized that keeping a positive and confident attitude was very important in dealing with the unexpected in the classroom. For example, a preservice teacher wrote,

> I think that my partner and I acted in a very professional way. We did not freak out because everything was turning out wrong, but rather we stayed calm and found things to keep the child busy while trying to get the programs to work. I learned that in every situation I should stay calm and find the best way out.

Preservice teachers reflected on the classroom management issues that they dealt with in the field experience, including managing time and groups as well as maintaining student focus. Half of the 24 preservice teacher participants commented on the importance of time management. For example, several groups spent an extensive amount of time for the first half of the lesson, so they ran out of time toward the end. Another two groups encountered technical difficulties which delayed their projects. Another group had to rearrange the task order, because the children in their group left early, which caused technical difficulties and prevented the team from completing the project on time. One other group completed the first session sooner than expected, so the preservice teachers had to improvise and come up with meaningful activities to fill in the time. Managing the group was another classroom management issue that preservice teachers discussed in the reflective journals and interviews. One group had to generate strategies to handle a student who tended to dominate the group project. Another group of preservice teachers were amazed that they did not have to deal with this problem, because an out-spoken child in their team graciously gave opportunities to another child who wanted

to participate but who was too shy to express his opinions. Maintaining students' focus on task was not an issue for most groups because of the engaging nature of the student-centered activities. However, there were still times when some children were bored because it was not their turn to use their computer. Our preservice teachers realized that they had to have backup activities or strategies to engage those students.

Another main topic in the reflective journals and interviews was related to understanding learners. Preservice teachers began to appreciate the importance of understanding learners so that they may tailor the lessons to match the interests and prior knowledge of learners, or they may approach students in a different way. The field experience was a hurtful but eye opening experience for a couple of preservice teachers who thought they did a great job in helping a reserved child in their group open up and get involved in the project. At the end of the field experience, to their surprise and embarrassment, they heard the child crying to her mother complaining that her teachers forced her to do the project. It turned out that the child was crying to distract her mother so that she did not have to show her project to her mother. Incidents like this provided preservice teachers with more understanding of children. One of the preservice teachers wrote,

> This incident is very significant to my learning and teaching because it is so easy to assume that every child is having a great time, when in reality, there may be a child who is secretly not having such a great time, but is putting on a face to act as if he/she was.

6. Discussions and Conclusions

Similar to the study conducted by Park and Ertmer (2007), we found that the pedagogical laboratory experience had no statistically significant impact on most of the beliefs measured by TBTUS. The only beliefs in TBTUS that were significantly changed were the non-learner-centered beliefs about learners (NLB-L). Instead of assuming more student-centered beliefs about learners, the field experience strengthened preservice teachers' non-learner-centered beliefs about learners. This might be explained by preservice teachers' lack of practical teaching experience. For most of them, the field experience was one of their first teaching experiences. The issues they encountered in the field experience were overwhelming to some of them. Although student-centered learning was taught in the teacher education program, the difficulties involved in implementing student-centered learning in the field experience might have discouraged some preservice teachers from adopting this approach. Without personal experience, prior to the field experience, preservice teachers might have claimed to possess student-centered learning beliefs as they were taught by professors, but some of them might have resorted to the traditional approaches to teaching during the field experience, because they were not trained in practice on how to address various issues in student-centered learning and they were overwhelmed by the experience. Future research is needed to explore the strategies required to facilitate belief changes in the direction that are desirable.

In a previous qualitative study, preservice teachers stated that the pedagogical laboratory experience was extremely valuable and they began to appreciate student-centered learning (Ma, Lai et al., 2008). In this study, we adopted a quantitative instrument to measure the impact. However, the impact was largely insignificant. The qualitative data suggests that changes might be incremental and TBTUS might not be sensitive to changes that occurred after 22-hour treatment, with only six hours of real teaching

experience. Qualitative analysis of candidates' reflective journals and interviews indicated that the pedagogical laboratory experience did have some impact on preservice teachers' learning and beliefs. One third of the preservice teachers discussed issues related to student-centered learning. However, the impact that the field experience program had on preservice teachers might not be those measured by TBTUS. For example, as new teachers, they learned that teaching did not always run as planned, so backup activities were needed. They also learned to address various classroom management issues related to student-centered learning in the field experience. Moreover, unlike vicarious experiences that present the same issues to all preservice teachers, personal teaching experiences may be different for each preservice teacher, so they might have learned different strategies that are not directly related to the beliefs that were measured. Another factor that may explain the insignificant findings is that technological skills as well as best practices of technology integration and student-centered learning have been taught to these preservice teachers via video- and text-based case studies and lesson planning activities in this course prior to the field experience. These activities might have had some impact on teachers' beliefs before the pretest. In future research, we may include these activities as part of the treatment and develop instruments that measure the incremental changes in preservice teachers' learning and beliefs.

The field experience program might be too challenging for some preservice teachers. Although the program was limited to the facilitation of technology-enhanced, student-centered activities, preservice teachers found it much more demanding because they not only had to deal with issues related to technology integration, they also had to tackle many classroom management issues that they have not learned to address in the real world. Because of their lack of previous teaching experience, the field experience was particularly demanding. More field experience programs like this should be offered to accompany all methods courses. This field experience might not have been so overwhelming if preservice teachers had already gained some experience in managing and working with children prior to taking the technology integration course. In addition, technology integration should be embedded in all methods courses and related field experiences as suggested by some other researchers (Mims et al., 2006; Moursund & Bielefeldt, 1999). Longitudinal study of teachers' belief changes across various methods courses in multiple semesters or several years might produce more interesting findings.

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