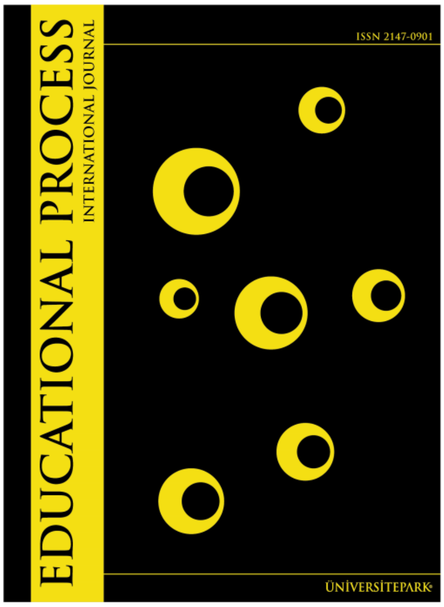

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Marian G. Rosenberg, St. Pius X Catholic High School, United States. (e-mail: eliza.avdiu@umib.net)

Yunjo An, University of North Texas, United States. (e-mail: yunjo.an@unt.edu)

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Supporting Science Teachers' Learner-Centered Technology Integration through Situated Mentoring

MARIAN G. ROSENBERG and YUNJO AN

Abstract

Learner-centered technology integration is a challenging task for many teachers. In an attempt to support science teachers' learner-centered technology integration efforts, this study developed a situated mentoring program and examined its impact on teachers' attitudes, technology integration practices, and perceived barriers. Further, the study explored ways to improve the situated mentoring program. Qualitative data were collected from pre-mentoring interviews, observations, and post-mentoring interviews. The results revealed that most participants were teacher-centered and somewhat skeptical about the value of technology for learning prior to the mentoring program. The situated mentoring program had a positive effect on the participants' attitudes toward learner-centered technology integration. However, in terms of changes in technology integration practices, the results were mixed and varied from teacher to teacher. The personalized professional development and support appeared to be one of the major strengths of the situated mentoring program. Findings from the participants' program evaluation data provide useful insights into professional development for learner-centered technology integration.

Keywords: Learner-centered instruction, student-centered learning, technology integration, learner-centered technology integration, situated learning, situated professional development, science teachers, mentoring.

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Introduction

The Next Generation Science Standards note that science students cannot fully understand scientific practices nor can they truly appreciate the nature of science without actually engaging in those practices (NGSS Lead States, 2013). Learning about science as a passive observer is inadequate. Science education can benefit from learner-centered approaches, such as project-based learning, problem-based learning, and inquiry-based learning. Project-based and problem-based learning methods have been shown to help students learn to be more open-minded in addition to improving test scores and helping them remember what they learned over a longer period (e.g., Fallik, Eylon, & Rosenfeld, 2008). In science classrooms, inquiry-based instruction has gained significant attention in recent reform programs. Regarding the effectiveness of inquiry-based learning in the science classroom, Abdi (2014) found that students who were instructed through inquiry-based learning achieved higher scores than those who were instructed through the traditional method. The National Science Education Standards set the goal of infusing more frequent, high-quality inquiry-based practices into science instruction (National Research Council, 1996), but this transformation has not yet been realized.

Technology can enhance learner-centered instruction, especially in the science classroom, and can lead to students' deeper understanding of scientific concepts (Dani & Koenig, 2008). For example, interactive simulations can promote students' understanding of abstract concepts by allowing them to quickly design, conduct, and revise their own experiments and test hypotheses (Hannafin & Land, 1997). Technology provides easy access to learning resources and tools that can be used to construct knowledge (Hannafin & Land, 1997). Technology can also facilitate students' collaborative research and discussions. Model making, interactive tutorials, personal response systems, and probeware are additional examples of technologies that can be used to support learner-centered science instruction (Dani & Koenig, 2008). However, teachers are faced with many barriers to technology integration, especially when they are trying to make pedagogical changes at the same time (Pedersen & Liu, 2003). In order to address the barriers to learner-centered technology integration, this study developed a situated mentoring program for science teachers and examined the effects of the mentoring program on the teachers' attitudes, technology integration practices, and perceived barriers.

Literature Review

Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, and Sendurur (2012) found that the greatest barriers to technology integration were teachers' beliefs and attitudes, as well as their knowledge and skill levels. Several studies indicate that negative attitudes about technology and lack of knowledge about how to integrate technology are among the major barriers faced by teachers (e.g., Anderson, Groulx, & Maninger, 2011; Ertemer, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Russel, Bebell, O'Dwyer, & O'Connor, 2003). Regarding learner-centered technology integration, research shows that most teachers have positive attitudes toward learner-centered instruction and learner-centered usage of technology (An & Reigeluth, 2011; Yilmaz, 2008), but it is worthwhile noting that teachers' pedagogical beliefs and attitudes are not always consistent with their actual practices. Palak and Walls (2009) found that even when teachers integrate technology frequently and have beliefs that are consistent with learner-centered instruction, they do not automatically begin to use technology in learner-centered ways within the classroom. Similarly, An and Reigeluth (2011) noted that learner-centered philosophy does not necessarily lead to learner-centered practice. The results of their study showed that barriers such as lack of technology, lack of time, lack of knowledge about learner-centered instruction, and assessment might prevent teachers from creating learner-centered classrooms even when they are learner-centered in their philosophy. Interestingly, most participants in their study believed that they were learner-centered teachers, but still wanted to learn more about learner-centered instruction, especially practical strategies. More research is needed in order to better understand the barriers to learner-centered technology integration.

Brown, Collins, and Duguid (1989) described a theory of situated cognition where learning takes place within an authentic context. Rather than dispensing knowledge and then expecting students to return to their place of work and use the knowledge effectively, knowledge is gained in the work environment as the student practices with a mentor, and supported by a community. Situated learning, which involves both active individual construction of knowledge and enculturation into a larger community (Cobb, 1994; Lave & Wenger, 1991), directly applies to how teachers learn to use technology with their classes. Situated professional development involving a mentor or technology coach has been shown as an effective way to help teachers learn to integrate technology (Holmes, Polhemus, & Jennings, 2005; Kopcha, 2012; Sugar, 2005). Preservice teachers are frequently assigned to a mentor teacher during student teaching programs, and this arrangement helps new teachers integrate technology where the mentor teacher is experienced with technology instruction (Bell, Maeng, & Binns, 2013; Grove, Strudler, & Odell, 2004; Ward, West, & Isaak, 2002). Veteran teachers can learn to use technology through mentoring as well and have more access to communities of practice among their colleagues. Pairing experienced, technology-using teachers with new teachers "has the potential to enhance beliefs about and increase instructional uses of technology" (Russell, O'Dwyer, Bebell, & Tao, 2007, p. 415). Matzen and Edmunds (2007) suggested that teachers who "see technology modeled using constructivist compatible, student-centered approaches" (p. 427) are likely to incorporate similar technology usage into their own teaching practices.

Many successful professional development programs also include some type of community of practice where small groups of teachers, with common goals and interests, come together on a regular basis to share knowledge in an informal way (Bell et al., 2013; Glazer & Hannafin, 2008; Guzey & Roehrig, 2009; Hughes, Kerr, & Ooms, 2005; Kopcha, 2010; Patton & Parker, 2017). Communities of practice have proved useful for changing the school culture and for spreading and maintaining technology integration efforts for the long-term. Hughes et al. (2005) found that teachers benefitted from collaboration with colleagues about technology use in their common content area and recommended establishing content-focused technology inquiry groups as part of a professional development approach to technology integration. Science teachers learning to integrate technology can benefit from opportunities to collaborate with peers and receive mentoring from other teachers in the authentic context of science teaching (Bell et al., 2013).

Purpose of the Study

Although technology has become more prevalent in today's classrooms, many teachers still find it difficult to integrate it into their curriculum, and even fewer use it effectively to support learner-centered instruction (O'Dwyer, Russell, & Bebell, 2005; Palak & Walls, 2009). In science classrooms, learner-centered methods enhanced with technology can help engage students and lead to higher levels of achievement (Odom, Marszalek, Stoddard, & Wrobel, 2011; Zucker, Tinker, Staudt, Mansfield, & Metcalf, 2008). The current study develops a situated mentoring program in an attempt to support science teachers' learner-centered technology integration. In this study, situated mentoring refers to mentoring that is situated within the context of the science teachers' classrooms. This study examines the effects of the situated mentoring program on the teachers' attitudes, technology integration practices, and perceived barriers. Further, the study explores ways to improve the mentoring program. The following research questions guided the study:

- What were the effects of the situated mentoring program on science teachers' attitudes toward learner-centered technology integration?
- How did the situated mentoring program affect science teachers' learner-centered technology integration practices?
- How did the situated mentoring program affect science teachers' perceptions of barriers to learner-centered technology integration?
- How could the situated mentoring program be improved?

Methodology

Context

The study was conducted at a large private high school located in the southeastern United States. Each classroom at the school had a ceiling-mounted LCD projector and 7-14 student desktop computers. In addition, document cameras, interactive whiteboards, and student response systems were shared among the classrooms and made available for any teacher to use. Science classrooms were complete labs containing regular student desks as well as lab desks with sinks, electricity, gas, and scientific equipment. The school had an optional "bring your own device" (BYOD) policy. The strategic technology plan of the school did not specifically mention learner-centered use of technology, but did include several objectives related to this type of usage. For example, the goals and objectives included (a) increasing teachers' use of technology to infuse higher-order thinking skills, (b) using technology to differentiate instruction, and (c) encouraging students to solve problems with technology.

Participants

Only teachers from the science department were invited to participate in the study. All 11 science teachers agreed to participate in the situated mentoring program, aimed at helping them integrate technology in learner-centered ways. Eight of the 11 participants were male, and the participants' ages ranged from approximately 25 to over 70. Specialty subject areas included physics, chemistry, biology, forensics, zoology, marine biology, and anatomy. The number of years that the participants had taught ranged from four to 33 years. Table 1 details the participants' demographic data.

Table 1. Study Participants' Demographic Information

Gender		Age		Certification Level		Total Years Teaching		Years at Current School	
Male	8	21-31	3	Uncertified	1	0-4	1	0-4	4
Female	3	32-44	3	Bachelor's	4	5-9	2	5-9	1
		45-59	4	Master's	6	10-19	4	10-19	3
		>= 60	1			>= 20	4	>= 20	3

Situated Mentoring Program

The mentoring program developed for this study incorporated several components featured in other studies or included in other professional development models. These components included:

- a comprehensive approach connecting technology, pedagogy, and content knowledge (An & Reigeluth, 2011; Guzey & Roehrig, 2009; Mishra & Koehler, 2006; Polly & Hannafin, 2010);
- setting individual goals for each teacher (Garet, Porter, & Desimone, 2001; Kopcha, 2010; Mouza, 2006; Orrill, 2001);
- situated learning in the classroom based on teachers' needs (Brown et al., 1989; Garet et al., 2001; Mouza, 2006; Plair, 2008; Sugar, 2005);
- technology training and just-in-time technical support (Glazer, Hannafin, & Song, 2005; Kopcha, 2010; Sugar, 2005);
- subject-specific, customized mentoring (An & Reigeluth, 2011; Plair, 2008);
- training on learner-centered pedagogies (An & Reigeluth, 2011; Orrill, 2001);
- collaboration and communities of practice (Bell et al., 2013; Ertmer, 2005; Garet et al., 2001; Glazer & Hannafin, 2008; Hughes et al., 2005; Kopcha, 2010; Mouza, 2006); and,
- reflection on individual activities and progress toward goals (Ehman, Bonk, & Yamagata-Lynch, 2005; Guzey & Roehrig, 2009; Kopcha, 2010; Orrill, 2001).

The mentoring program lasted for two (fall and spring) semesters. The first author, who was employed as the instructional technology coordinator at the school, acted as the mentor in the professional development effort. The mentor was already in a position of trust to assist the teachers reach their technology integration goals. In addition, she had prior experience of teaching science at the high school level. The teacher-mentor relationship was expected to be different for each teacher allowing those needing to gain confidence and overcome greater barriers to meet with the mentor more often (Sugar, 2005). Meetings were also scheduled more often for teachers working on particular projects which required additional support.

Early mentoring meetings focused on discussing the teacher's curriculum for the year, their teaching style, and any technology integration they already had planned or project implementation ideas they may have had. The mentor used this time to make the teachers aware of what technology resources could be made available to them. Together, each teacher and the mentor set goals for integrating technology in learner-centered ways. If a teacher had no pre-existing ideas for meeting his or her goals or if the teacher's ideas were not aligned with learner-centered instruction, the mentor suggested projects and activities. Since the overall goal was to help the teachers use technology in learner-centered ways, the teachers were encouraged to include projects or activities that (a) were personally challenging and meaningful for each student, (b) helped students develop real-world skills such as communication, collaboration, creativity, and critical thinking, (c) encouraged reflection on learning and the development of self- and peer-assessment skills, and (d) provided choices for students (An, 2012).

Once goals were agreed upon, the mentor worked to secure the technology needed, made sure it was installed and working smoothly, helped the teacher learn how to use it effectively, and provided troubleshooting for any problems that arose. In addition, the mentor facilitated the teachers' use of technology by interfacing with the school's Information Technology (IT) department, media center staff, eTextbook publishers' technical support, and the developers or technical support representatives for various hardware and software products available at the school.

The mentor conducted a variety of activities aimed at helping the teachers reach their technology implementation goals. Most of the teacher instruction was learner-centered in that it was centered on the needs and abilities of the individual teachers. The teacher and mentor decided what each teacher wanted to accomplish and how to meet their individually established goals. The mentor supported and encouraged the teachers, provided feedback and guided them to reflect upon their classroom experiences. Much of the teacher training took place in the authentic context of the teachers' own classrooms, and often while the teacher was engaged in facilitating student learning.

Data Collection

Qualitative data were collected from pre-mentoring interviews, observations, and post-mentoring interviews.

Pre-mentoring interviews. Before the mentoring program began, one-on-one semi-structured interviews were conducted with each participant. The pre-mentoring interview questions focused on the teachers' beliefs about learner-centered instruction, and their perceived barriers to integrating technology in learner-centered ways. Participants chose whether to be interviewed in their classroom, the science office, or the instructional technologist's office. Interviews lasted for 10-45 minutes, depending on the length of the teachers' responses. All of the interviews were audio-recorded, and then subsequently transcribed by the first author. Notes were also taken during the interviews as a means of data backup.

Observations. Participants' teaching practices were observed during the mentoring program. While some classroom observations were informal, a formal observation of each teacher for an entire class period (approximately 45 minutes) took place on at least two occasions, once near the beginning and once at the end of the mentoring period. As for the formal observations, the mentor prearranged a time with the teacher rather than arriving unannounced. Data were recorded using the semi-structured observation instrument (see Appendix A).

Post-mentoring interviews. At the end of the mentoring program, a second interview was conducted with each participant. The questions asked at the post-mentoring interview concerned the teachers' practices with regard to integrating technology in learner-centered ways at the conclusion of the mentoring program, their perceptions of the effectiveness of this integration, changes in their attitudes, and their thoughts about the mentoring program. The post-mentoring interviews were also recorded and then subsequently transcribed.

Data Analysis

Qualitative data from interviews and observations were carefully examined, coded, and constantly compared through thematic analysis (Lincoln & Guba, 1985; Miles, Huberman, & Saldaña, 2014).

- Research Question 1 (Changes in attitudes toward learner-centered technology integration): After initial coding, data from pre- and post-mentoring interviews were compared in order to examine changes in the participants' attitudes toward learner-centered technology integration.

- Research Question 2 (Changes in technology integration practices): Observational data were carefully examined, coded, and compared in order to examine the changes in participants' technology integration practices.
- Research Question 3 (Perceived barriers to learner-centered technology integration): Data from pre- and post-mentoring interviews were coded and compared in order to examine the participants' perceptions of barriers to learner-centered technology integration.
- Research Question 4 (Evaluation of the mentoring program): Participants' answers to the post-mentoring interview questions were carefully examined and coded in order to assess the participants' thoughts about the mentoring program.

Triangulation of the data from multiple sources helped to minimize the effects of observer bias. This triangulation procedure allowed themes to be established through convergence of the data, thus adding to the study's validity (Cresswell, 2014, p. 201). Member checking was also employed during the interviews so as to assure the accuracy of the qualitative findings (Fraenkel & Wallen, 2008).

Results

Research Question 1. Changes in Attitudes toward Learner-Centered Technology Integration

The pre-mentoring interview data indicated that more than half of the participants were inexperienced with learner-centered instruction prior to being part of the mentoring program. Although several participants mentioned the importance of the role of the teacher as a facilitator, others described their primary role as being that of information provider. In fact, seven participants made at least one comment that seemed to equate teaching with lecturing, or implied that teachers had the requisite knowledge and their role was to convey it to the students via lecturing or explanation. Sample quotes include the following:

> You've still got to teach, especially at the AP level… You've got to get up there, and you've got to show them how to do some of the harder stuff… I've obviously got to teach the basics.
>
> Most important aspect – well, of course teaching the material, communicating it to them in a way they comprehend.
>
> Next chapter is photosynthesis. That'll be mostly me because they'll be so confused. And, it's really just going to be survival for my benefit cause if I don't explain it and explain it and explain it, then the day before the test it'll be like it was this morning where there were 20 kids lined up.

Also, the participants were somewhat skeptical about the value of technology for learning. Prior to the mentoring program, five of the 11 participants specifically mentioned having heard of research showing that students learn better when they write things out by hand instead of using a keyboard. There was also a sentiment of "I didn't learn with technology and I did fine." Parker said, "I tend not to encourage it. Because, like I said, this is more a product of how I learned it… I found pen and paper to be the most effective way for me to learn chemistry." Jordan expressed a concern about technology engaging students, but not helping them learn. A few participants mentioned concerns about students' "extraneous use" of technology and fear that technology will replace going outside and hands-on activities and will harm students' abilities to communicate.

After participating in the mentoring program, the participants became more familiar with learner-centered teaching methods and had more positive attitudes about integrating these methods into their science classrooms.

> Before this year I definitely was – my thought process was – that the kids had to learn, we taught, they learned, they took the test. And now it's more of, you know, just lead them to the water. Let them drink and come up with it themselves. Give them some structure but not overly structured, and they'll get the job done
>
> I mean I think it's absolutely the way to go… it's just figuring out how to get them to teach themselves and teach each other in a better and more effective way.

During the post-mentoring interviews, fewer participants described the teacher as the dispenser of knowledge, focusing instead on the facilitator role of the teacher in a learner-centered classroom. Eight teachers mentioned the importance of the facilitator role of the teacher. Jamie spoke about how group work benefits students who get the opportunity to teach their classmates and about the teacher's role in "getting them comfortable with the idea of how to figure things out on their own." Kelly talked about students being the "main actors" in a learner-centered classroom.

The post-mentoring interview data also showed that the participants were more positive about using technology in the science classroom and believed that it was beneficial to the students' science learning, especially when the technology was used in learner-centered ways. Most participants spoke positively about their experiences with learner-centered technology integration during the mentoring program. For example, Cameron spoke about how the use of Excel enhanced students' graphing activities in her class giving "more immediate results." She mentioned that, "it was definitely better than hand graphing." Jordan, who expressed a strong opposition to using technology in his classes during the pre-mentoring interviews, talked about the positive feedback from the students about a project involving groups of students researching and creating Google Slides presentations. He was pleased with the quality of their projects and seemed optimistic about trying to do more in the following year. Sam addressed the ability of the students to achieve content mastery through technology-enhanced, learner-centered instruction.

> They were able to learn the material themselves and then present it in an organized fashion that related at least to specific topics that I wanted them to cover and then on their own they chose what they were most interested in about that particular topic or organism.

Research Question 2. Changes in Technology Integration Practices

In terms of changes in technology integration practices, the results were mixed and varied from teacher to teacher. For example, Taylor and Jamie were already using technology extensively in learner-centered ways and therefore didn't feel the need to make any major changes in their practice. Both wanted to do even more but felt that time was a barrier. On the other hand, other participants admitted that their classes were mostly teacher-centered even when they did use technology. They described showing PowerPoint presentations or writing notes on the board as a typical class activity. Even those using an interactive whiteboard, interactive website, video clip, online animation, or document camera were often only using it for a teacher presentation.

After participating in the mentoring program, however, most participants used technology in learner-centered ways. Some specific examples of learner-centered technology integration included:

- students creating Google Sites (including digital images from mobile devices) for Acid-Base lab project in groups;
- exploring interactive PhET simulations in groups;
- groups of two students researching on the web and in subscription databases, and then creating Google Slides with an embedded Google Form for a quiz;
- virtual knee dissection in groups of two;
- interactive protein synthesis activity;
- groups of two students presenting on an LCD projector using Google Slides that they created about interesting cases in forensics history; and
- students studying climate change by examining animations on NASA's website.

Nine of the participants were observed or mentioned facilitating their students' communication or collaboration with technology, while 10 included technology projects or lessons involving student choice or decision making. Seven of the participants' classes were observed using technology for research, six were presenting information to their classmates using technology, and six were undertaking activities related to authentic, real-world issues or transferrable skills. Several of the teachers expressed a desire to continue their progress and to implement more technology-enhanced, learner-centered lessons in the future.

Two of the participants, Blair and Jean, did not appear to change their practices as much as other participants. Blair seemed reluctant to try new techniques even after planning them. While Jean used technology more often and made a major transformation to becoming essentially paperless in the classroom, the classroom observation did not provide any evidence that she had become more learner-centered. She appeared to need additional modeling of what it means to facilitate a learner-centered classroom.

Research Question 3. Perceived Barriers to Learner-Centered Technology Integration

Time was the barrier most often reported in the pre-mentoring interviews. Seven of the participants mentioned the problem of not having enough time during class, while nine talked about the lack of time needed to learn about, plan and prepare learner-centered, technology-enhanced activities. For example, Cameron said that the greatest barrier was "not having the time or making the time to redesign lessons to make them more learner-centered… time is the biggest barrier." Sandy alluded to science teachers already spending more time preparing for class than some other content areas saying, "Time. Time. Time. In science so much time is spent ordering materials, setting up labs, and moving from room to room." Lack of teacher training and students who were immature or inexperienced with learner-centered methods were other barriers that often came up in the pre-mentoring interviews.

In the post-mentoring interviews, the participants still mentioned several different barriers to learner-centered technology integration. Again, nine of the 11 participants mentioned not having enough time to learn, practice, and plan. While they appreciated the mentor's assistance with learning new skills, they still needed more time to become confident in their use of technology in learner-centered ways, especially in light of new technology being introduced so often. Kelly said, “Time. That’s my only problem. Not having enough time to master the skills myself and make me feel comfortable.” And Blair said, “I’m still feeling like I’m in catch-up mode trying to learn all these different... I just want to catch up with what’s out there already.” Some other barriers mentioned included not having enough time in class, needing to learn more about how to integrate technology in learner-centered ways, and technical difficulties.

Research Question 4. Evaluation of the Mentoring Program

In the post-mentoring interviews, the participants were asked about their perceived strengths and weaknesses of the mentoring program, as well as for suggestions on its improvement. They were also asked about individual components of the mentoring program in order to find out which ones they believed were helpful to them as they worked toward integrating technology in learner-centered ways. Overall, the participants were very positive about the mentoring program, and had appeared to make progress in their learner-centered technology integration.

Goal setting. Ten of the 11 participants found setting a technology integration goal with the mentor at the onset of the program to be helpful in their effort to integrate technology in learner-centered ways. For example, one participant mentioned that, “Whether you end up achieving those goals, you always take steps towards them.”

Collaborative planning and reflection. Ten of 11 participants reported that collaborating on a learner-centered lesson plan and reflecting on how a lesson went was perceived as helpful to them. Several of the teachers referred to their mentor helping them come up with technology-enhanced, learner-centered lesson ideas. For example, one participant said, “The mentor helped me come up with ideas for student-centered learning: brainstorming both content instruction ideas and integration of technology.”

Not all of the participants worked in groups with other teachers during the mentoring program, but those who did found the collaboration to be helpful. Parker, who collaborated on a learner-centered technology project with Cameron, Blair and their mentor, made the following comment.

> I think it helped a lot having good colleagues… who helped me out with planning things along the way. It’s nice to have somebody… to share the objective with as opposed to taking it all on by yourself. If you have somebody to bounce ideas off of – run it up the ladder and go back and forth, it’s easier than just doing it all yourself.

Learning how technology can be used for learner-centered instruction. Learning how technology can be used for learner-centered instruction was found helpful by eight of the participants. Jamie mentioned that the video clips of learner-centered science lessons the mentor showed were very helpful, and Blair felt that examples were the most helpful aspect. Five of the teachers talked about how the program gave them the ability to use technology in learner-centered ways, saying that the mentoring “allowed me to do other things with the kids that I probably wouldn’t have otherwise done.”

Situational support in the classroom. Interview results showed that the participants benefited from the mentor’s situational support in their classrooms, including both pedagogical support and technological support, when implementing their technology-enhanced, learner-centered lessons. All of the participants reported that the mentor’s support in the classroom was helpful. For example, Sam commented that having the mentor help with facilitating student learning in the classroom "was great because you help them with problems and allowed them to see what the possibilities of Prezis were." Sandy remembered some initial problems with the mobile app for the digital textbook and spoke of benefiting from having the support in the classroom saying, "Just even starting off with getting the kids to get the app… to work. That was very helpful to me."

Personalized professional development. Five of the participants mentioned that personalized professional development and support targeted to their needs was one of the program's strengths, and expressed a desire to continue their mentoring relationship. Three of the teachers discussed the need for more differentiated and leveled professional development, especially in light of the widely varying technology skill levels among teachers at the school.

Subject-specific mentoring. Four of the participants spoke of the advantage of having a mentor with both a science teaching and an instructional technology background. Reese said,

> It's extremely helpful to have somebody who understands what we do in a science classroom – what requirements we have in terms of labs… and then be able to add on to that the technology component and help us find ways to get the content across, but also be able to utilize it in lab-type situations.

Suggestions for improving the mentoring program. Very few weaknesses were mentioned by the participants. Two of the participants spoke of their lack of time to practice new methods as a weakness, while another believed that the mentor's lack of time could become a weakness in the future if more teachers became involved in the program.

When asked to suggest ways to improve the mentoring program, Parker recommended finding pairs or small groups of teachers who can work together in a community of practice. Reese suggested that the mentor pick one specific subject area, such as chemistry, within a department and focus only on that small group of teachers for a period of about three weeks or for one teaching unit. She explained that this would prevent the mentor from having to go in many directions at once and trying to help teachers with many different things. Instead, the mentor would be able to focus on how to integrate learner-centered technology into that particular unit and be exclusively available for everyone teaching that class. Kelly suggested having teachers focus on one new thing per semester, and to try to master it rather than teaching them about a lot of new technologies. Blair and Cameron both suggested providing more examples of learner-centered technology integration early on.

Discussion

Overall, the situated mentoring program had a positive effect on the participants' attitudes toward learner-centered technology integration. Most notably, they began to believe that technology doesn't simply engage students, but actually helps them to learn science. The results showed that the participants' attitudes toward learner-centered technology integration changed as a result of their positive experience with it. This finding is consistent with previous research (Ertmer & Ottenbreit-Leftwich, 2010). Most participants were found to be teacher-centered and skeptical about the value of using technology for learning prior to the mentoring program, but they began to believe that technology was beneficial in student learning, especially when used in learner-centered ways once they experienced positive results in their own classrooms with their own students. Without good tech support and someone to encourage them, brainstorm ideas with them, and be there to help if things go wrong, teachers are often reluctant to take the risks involved with learner-centered integrating technology. They may fear that time will be wasted, that they will lose control of the class, or that their inexperience with technology will diminish them in the eyes of their students. The situated mentoring program helped the participants overcome these fears, and to take on the risks which allowed them to see the positive effects on student learning as well as engagement.

Although most of the participants made progress toward their technology integration goals, there were still some participant teachers for whom the mentoring was insufficient to facilitate real changes in their technology integration practices. Overall, the greatest perceived barrier to learner-centered technology integration was lack of time, reported both before and after the situated mentoring. Lack of time has also been reported as a major barrier in previous research studies (An & Reigeluth, 2011; Francom, 2016; Pritchett, Pritchett, & Wohleb, 2013). While it is difficult to increase the amount of teachers' time to learn, plan, and practice, effective professional development such as situated mentoring can help over time. Mentoring alone may have helped decrease the time-related barrier because the mentor was able to facilitate teachers' access to technology, streamline troubleshooting and tech support, and provide personalized training tailored to a teacher's curriculum and teaching style. However, greater benefit could be obtained in the long term if the teachers eventually transition from mentoring to form a community of practice dedicated to integrating technology within their content area. A community of practice can lessen the amount of time individual teachers need to integrate technology if the teachers are sharing the workload of planning lessons, by helping each other develop technology skills, observing and giving each other feedback, and in reflecting together (Bell et al., 2013; Ertmer, 2005; Kopcha, 2010). The partnership which developed between Cameron and Parker was particularly beneficial in their successful technology integration efforts, and which left both of them interested in seeking collaboration on similar projects in the future. Partnerships like this can lead to the development of a content area community of practice, similar to those which have been shown to be effective for professional development of in-service teachers (Ertmer, 2005; Hughes et al., 2005).

Teachers appear to want and need more differentiated, leveled, or personalized professional development, especially when widely varying technology skill levels exist among teachers. The results of this study also showed that some teachers require extensive technological training and support, whilst others need much less in terms of technology support. As An and Reigeluth (2011) suggested, professional development for learner-centered technology integration should take into account individual teachers' needs and provide customized training and support in order to be successful. The situated mentoring program in this study addressed individual participants' needs and allowed them to progress at their own rates toward their own goals. The personalized professional development and support appeared to be one of the major strengths of the situated mentoring program.

The results of this study showed that teachers benefited from subject-specific mentoring. This finding is consistent with previous research suggesting that technology integration professional development should provide teachers with subject-specific technology integration ideas (e.g., Brush & Saye, 2009; Hanover Research, 2014). The participants found it very helpful to have a mentor with both a science teaching background in addition to technology integration expertise. The shared reference point with the science teachers made it easier for the mentor to understand the learning objectives and to suggest appropriate technology integration strategies. The fact that the mentor had also taught science at the high school level afforded her increased credibility with the teachers as well. The teachers knew the mentor was therefore not simply a technology expert coming into their classroom with no real understanding of their curriculum and the unique characteristics of the high school science classroom. While subject-specific mentoring is beneficial, it is not always possible to find a mentor with the relevant TPACK knowledge and experience for all teachers. Mentoring even a single individual is a time-consuming activity for a teacher with a full class workload, and most schools cannot afford to hire a full-time technology integration mentor for each content area.

One possible alternative is to groom technology integration mentors by picking one technologically-savvy member of a department and providing them with additional training as well as a lighter teaching load or a duty period off (or some other type of time and/or monetary compensation). This person can then mentor a small number of teachers in their same content area each year. This makes the mentoring program more sustainable after the full-time mentor has moved on to work with other groups.

Limitations and Future Research

The results of this study are based on data collected at a high school in the United States. Therefore, the results cannot be generalized to all high school science teachers. In addition, the same mentoring program might not be so easily implemented elsewhere because it was personalized for the teachers involved, and was also very dependent upon the school environment and the mentor. However, the findings of this study provide useful insights into professional development for learner-centered technology integration.

Future research could examine the effects of the situated mentoring program in many different contexts, including different countries, different content areas, and different grade levels. It would be interesting to explore creative ways to provide personalized and just-in-time support in schools with less resources. Future research could also examine the changes in teachers' technology integration practices over an extended period of time in order to see if the teachers' practices continue to move toward more learner-centered ways. It would be also interesting to explore effective ways to facilitate the development of teacher communities for learner-centered technology integration.

Notes

Corresponding author: YUNJO AN

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