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Are Preservice Teachers' Perceived Science Teaching Readiness Affected by Science Technology Workshop Participation?

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Abstract

This study explored the perceived readiness of K-12 pre-service teachers to integrate technology into science instructional strategies. Research found that when technology training is offered throughout preservice teacher programs, teachers are more likely to be prepared and willing to integrate technology into their classroom. Seven preservice teachers at a rural, four-year university participated in a workshop to learn how to use a variety of instructional technology tools in science courses. Pre/Post-tests measured their perceived readiness to integrate technology. Results supported research that suggests that properly trained preservice teachers are more likely to integrate technology.

Literature Review

The purpose of this study was to explore the perceived readiness of preservice teachers to integrate technology into science instructional strategies. The study asks whether pre-service teachers' participation in a technology workshop would change their perceived readiness to integrate technology in science instructional strategies. As future teachers, they must be able to apply technology in ways that will improve instruction, extend learning, and promote critical thinking skills.

The role of pre-service teacher technology preparation as a crucial component of teacher preparation programs, and the various aspects of that preparation, have been explored by several studies. Barton & Haydn (2006) conducted a study to explore "...the views of initial teacher trainees on various components of their training in the use of new technology to teach their subject." In their study, they found positive relationships between two components of the training and the participants' attitudes toward use of technology; these components were: (1) the participants' own proficiency in the use of technology, and (2) the extent of mentor support of technology use during training (Barton & Haydn, 2006).

Admiraal et al. (2017) studied two "technology-infused courses of one teacher education programme...," finding two factors that impact use of technology in their teaching: the extent of practice of techniques in the classroom, including receiving student feedback on the effectiveness of the technique, and the "modelling of teacher educators and teachers in school" (Admiraal et al., 2017). The authors reviewed the Technological Pedagogical Content Knowledge (TPACK) concept set forth by Mishra and Koehler (2006) which describes "...essential qualities of teacher knowledge required for technology integration in teaching ... the three components of "content, pedagogy and technology" (Mishra and Koehler, 2006).

In their study of existing teachers and the use of technology, Ardiç and Işleyen (2017) found that technology integration in the classroom can be improved with training. In a pilot study, Abbitt & Klett (2007) explored self-efficacy and found it to be a factor in pre-service teachers' attitudes toward use of technology. Participants were students in four courses that were required in their teacher preparation program. Each course had a differing focus toward technology use in the goals of each course - 1) overview of educational technology; 2) application of educational technology software; and two of the methods courses with an overview of teaching methods using technology at the 3) secondary level and 4) elementary level). Similarly, Li, Garza, Keicher, and Popov (2019) also found links to self-efficacy and technology usage.

As school districts are required to incorporate Common Core Standards into curricula, preservice teachers and teacher education programs must adopt the best teaching practices from InTASC (Interstate Teacher Assessment and Support Consortium) and CAEP (Council for the Accreditation of Educator Preparation) for accreditation standards. Some see the application of technology as a means to increase student learning and possibly increase standardized test scores (Martindale, Pearson, Curda, Pilcher, 2005). Use of technology includes modeling "best practices in digital learning and technology applications ...” (CR Meeting Notes, 20132), and promoting a student-centered learning environment that possibly results in higher student cognitive levels of Bloom’s taxonomy (Draude & Brace, 1999). Teachers who use technology as a teaching tool will better equip students to perform at higher levels.

A variety of studies of technology in the classroom describe benefits that include promoting active learning and confidence, increased engagement and test scores (Sanders, 2014). Particularly in the field of science instruction, computer programs (such as those utilized in the workshop in this study) have been developed that provide visualization of concepts for deeper learning (Dede, 2014). Teacher education programs teach content and pedagogy; experiences in the use and integration of technology in classrooms may be less than desired or missing altogether from some education programs. Often, this may be due to an ambiguous definition of where and how technology integration fits into the preservice teacher preparation (Spaulding & Glover, 2016). A majority of teacher education programs address teaching with technology in a single, dedicated technology course (Hargrave & Hsu, 2000). Such programs should provide preservice teachers with numerous exposures to technology experiences throughout the curricula, and increase both the quality and level (introductory, intermediate, and advanced) of content.

In a study that not only explored the differences in technology integration between rural and non-rural schools, but also looked at attitudes toward technology integration, Howley, Wood & Hough (2011) found that teacher "preparation for using technology [had] been inadequate to support the engagement of students with sophisticated technology applications" (Howley, Wood & Hough, 2011). Yet, "rural teachers reported more favorable attitudes than non-rural teachers" (Howley, Wood & Hourgh, 2011). However, the authors discussed the importance of "a predictable set of supports...to help rural teachers integrate technology in ways that promote the sophisticated engagement of their students" (Howley, Wood & Hough, 2011). Such supports include upgrade of technology and professional preparation, both factors that are "predictive of technology integration measure in terms of the sohphistication of student technology use" (Howley, Wood & Hourgh, 2011). Angeli & Valendies (2008), suggest without classroom experiences and opportunities for pre-service teachers to teach with support of technology they can not gain experience or confidence in technology integration.

Technology use is increasing in today's classrooms as teachers look for a means to promote student participation and improve instruction. Such technology use includes both web-based communication tools such as iNaturalist (for sharing observations from nature with an online community), as well as desktop tools such as GoAnimate (for illustrating lessons through video creation). The variety of tools explored are described in Table 1 in the Appendix. Advances in technology provide teachers with access to numerous resources that encourage student engagement, differentiated instruction, and content variation (Ball & Levy, 2008; Chandra & Fisher, 2009). Preservice K-12 teachers may not fully comprehend the impact that technology utilization has on the structure of learning environments and its effect on learning. Some researchers indicate that the use of technology in the classroom increases learning and motivation among students (Spaulding & Glover, 2016). The authors found by providing pre-service teachers with opportunities to conduct science and technology lessons in the field with cooperating teachers and their classes that the benefits gained during the experience better prepared for future instruction in the classroom. The lack of technology availability in some schools has a negative impact on teachers' perceptions concerning its use in instruction. As the availability and affordability of technology increases, and technology becomes more indispensable, preparing preservice teachers to use it more effectively becomes paramount.

Preservice teachers' beliefs concerning their technology utilization abilities determine whether they will use technology in their courses (Abbitt & Klett, 2007; Chen, 2010). Palak and Wall (1999) determined that teachers' beliefs dictate whether they will utilize either a student or teacher-centered approach to instruction. A teacher's perception of the benefits of technology is the most important determinant for whether he or she will use it as a tool (Lamb, 2011). To reinforce this concept, Lamb (2011) recommends that teachers be provided technology training that will help develop those positive perceptions. Thus, this training should begin at the preservice level while in educator preparation programs.

Research verifies that students learn best when learning is authentic and when they are engaged in activities that they perceive to be relevant. For example, robotics in science have been utilized and found to not only better engage k-12 students in learning science but also helped improve their attitudes in math (Yu-Hui, Yang, Wang, Baek, Swanson, & Chittoori, 2019). Use of technology in the classroom supports authentic learning, equipping the teacher with "...thoughtful ways of adding value to student learning" (Kolb, 2017). Additionally, when technology is valued by pre-service teachers as an effective teaching tool in the classroom there is an improvement in teaching direct content knowledge to students. When pre-service teachers are supplied with the opportunities to use technology as a vehicle to deliver content instead of a delivery truck instruction approach, instruction is more meaningful (Shively & Yerrick, 2014).

In order to effectively use technology, pre-service teachers need to be engaged in brain-storming, observation, modeling with students, practice, and reflection (Zhou, Xu, & Martinovic, 2016). This is accomplished through pre-service teacher methodology courses merging content and technology with automatic feedback, which allows the student to use both effectively in direct instruction.

According to Serim (2001), the role of the teacher is that of facilitator, rather than instructor or manager. When teachers embrace this role, student learning can be transformative, as students utilize higher order thinking abilities, and also assume responsibility for learning. Tomel (2003) indicates that technology can support learning by determining individual learning styles and providing instruction based on the individual learner's needs. Technology, used in this context, can impact learning across all curricula (DiBella, Williams, & Glover, 2015).

Many researchers find that preservice teachers believe they are unprepared to integrate technology into their teaching strategies (Han, Eom, & Shin, 2013). Some scholars indicate that university educator preparation programs are not teaching preservice teachers how to incorporate technology into their teaching regimen, but rather, place an emphasis on mastery of basic computer skills (Lee, Shin, Yoo, & Lee, 2000; Llorens, Salanova, & Grau, 2002; Russell, Bebell, O'Dwyer, & O'Connor, 2003). Howley et al.

(2011), in their study of rural and urban K-12 teachers' use of technology, found that technology use increased positive attitudes in rural teachers. The authors looked at the confidence of teachers to "influence whether or not they decide to use technologically mediated approaches" (Howley et al.). Some preservice teachers either do not perceive the importance of technology as it relates to their discipline, or they have other problems that limit its integration into their teaching (Pamuk, 2012). As a result, they may not be motivated to learn how to integrate technology into their teaching strategies, and lacking knowledge, have difficulty properly utilizing it when the need arises (Cullen & Greene, 2011).

Based on the above research, this study was designed to specifically determine the perceived readiness of pre-service teachers to integrate technology into science courses. Specifically, it focused on a single science education workshop designed to teach preservice teachers various assistive technologies in the area of science education. Participants were introduced to a multitude of science education technologies that could potentionally assist them in teaching any future science students.

Methods

Participants

The study was conducted at a rural, four-year university. Participation was restricted to only those 7 preservice teachers participating in the science education workshop, but there were no restrictions on whether formally admitted into the department's teacher education program or not.

The seven respondents consisted of freshman (1), sophomores (1), juniors (1), seniors (3), and graduate level students (1). Of these 5 were male and 2 were female.

Context

The study attempted to determine if preservice K-12 teachers' participation in a science technology workshop changed their perceived readiness to integrate technology in science instructional strategies. The null hypothesis of this study was that there would be no significant statistical difference between each respondent's pre- and post- survey responses. Conversely, the alternative hypothesis for this study was that significant statistical differences would exist between each respondent's pre- and post- surveys.

The workshop content was delivered in two segments. During the first segment, participants used web-based tools (appendix) to explore applications appropriate to any discipline. The second segments provided participants opportunities to conduct science-based activities using analytical equipment. Although the applications were science-based, they could be modified for use in different disciplines. The workshop concluded by having participants respond again to the same anonymous survey, to determine if perceptions had changed.

Data Collection

Researchers developed instructional unit applications utilizing Vernier LabQuest 2, Texas Instruments Nspire CX-CAS, Go Animate, Emaze, Nearpod, Kahoot, as well as other web-based applications (appendix). This study utilized a survey instrument that was adapted from the Technological Pedagogical Content Knowledge (TPACK) survey. The internal consistency (alpha) ratings of TPACK vary from .75 to .92 (Schmidt et al, 2010). The survey consisted of the following areas: technology knowledge, pedagogical knowledge, pedagogical content knowledge, and technological content knowledge. The survey consisted of 44 items asking workshop participants to identify their perceptions of technology-enhanced, learning-centered instruction. The survey employed a 5-point Likert scale with the following responses: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, or 5 = strongly agree.

The Wilcoxon Rank Sum test was used to analyze the pre/post-workshop survey data.

Results

All seven participants took both the pre and post-survey. A Shapiro-Wilk test yielded a probability value of $p = 0.000$ for each question, indicating that the data distribute in a normal probability manner.

Probability (*p*) values greater than 0.050 indicate normal distribution of data. Each of the 35 Technological Pedagogical Content Knowledge (TPACK) questions was assigned a Likert scale value of 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree or 5 = strongly agree. Clasen and Dormody (1994) indicate that Likert scale data is not normally distributed. A Wilcoxon Rank Sum statistical test was conducted to determine significant differences between the participant's pre/post-workshop surveys. Table 1 shows individual Wilcoxon Rank Sum results for pre/post-survey questions with *p*-values less than 0.050. *P*-values less than 0.050 indicate significant differences between participants' pre/post-workshop survey responses.

Discussion

As shown above, there were only two survey questions that were significantly different. One of those questions addresses preservice teacher's technology knowledge. A significant difference was discovered when participants considered the "I can learn technology easily" statement. The researchers, having observed the participants complete the workshop activities, were cognizant of the participants' initial trepidation in using analytical equipment (Vernier LabQuest units and TI Nspire units) to perform science activities. As preservice teachers performed more activities, they became more comfortable using analytical equipment. By the end of the workshop, all participants indicated that they enjoyed using the equipment and could see how they would be able to add its use into their content areas.

The other question showing a significant difference was, "I am familiar with common student understandings and misconceptions." The authors conclude this possibly due to participants' being subjected to workshop scenarios that challenged their ability to correctly assess students' answers to both closed- and open-ended science problems. Some participants were surprised to discover that in science, correct answers can sometimes be arrived at by different methods. Several were intrigued to discover that sometimes what seems to be dissimilar answers are in fact, similar.

The researchers have concluded a possible explanation for the few significant differences in participants' pre/post responses. It is possible that at the university where the study was conducted, 4 of participants indicated that 51% or more of their teacher education professors had provided an effective model of combining content, technologies and teaching approaches in their teaching. Of particular note is the fact that 4 of respondents indicated that 76% or more of their professors outside of teacher education had provided an effective model of combining content, technologies and teaching approaches in their teaching. Based on this, faculty at this institution at the time of the study were actively integrating technology into their instructional practices. Consequently, they were preparing preservice teachers to become teachers who readily integrate technology into their teaching regimen. Technology training for preservice K-12 teachers is often limited or relegated to one specific course. The results of this study support the findings of Chen (2010) that suggested that following technology training in courses, students were more likely to integrate technology into their lessons.

There were several limitations to this study. The primary limitation was the size of the sample population. Unfortunately, there were only 7 students that took part in the workshop. It is possible that a larger sample of participants may have produced slightly different outcomes. Student participants indicated an interest in learning how to integrate technology into their teaching content areas. However, all participants in the study indicated that they enjoyed learning new Web 2.0 tools and applications of Vernier and TI Nspire units. Second, there were no special education major participants in the study. This is a consideration since special education majors work with students in K-12 settings and should have a wide range of experience with technology to meet the needs of individuals learners. IDEA mandates that every student with an Individualized Education Program (IEP) should be considered for assistive technology (AT) IDEA (2004). Finding from a national study of special education teacher preparation programs found that pre-service teachers are not prepared to use technology or AT with special education students due to training being inadequately addressed (Judge & Simms, 2009). It is recommended by the authors of the study that pre-service special education majors and general education majors have training in both technology and assistive technology. The authors of the study suggest that it be replicated in different urban-centric locales using larger sample sizes and at different points during preservice teachers' progress through their programs.

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Appendix

Table 1
Wilcoxon Rank Sum Test for Pre- and Post- Survey

Variable	P
I can learn technology easily	0.04
I am familiar with common student understanding and misconceptions	0.04

$p < 0.05$

Table 2
Description of Workshop Tools

Name	Description
BrainScape	Study tool that uses a scientific approach to help users retain more information. http://www.brainscape.com/
Desmos	Online graphing calculator. http://www.desmos.com/
Electrical ToolKit	Tool that recalculates circuit values.
Elements 4D App	Interactive blocks that help students learn the Periodic Table.
iCell	Provides 3D views inside plant and animal cells.
iNaturalist	Records observations from nature and shares them with the iNaturalist online community.
Loss of Night	Maps light pollution and star visibility.
Science360	Science and engineering images and videos.
Seismometer 6th	Turns iPhone or iPad devices into a seismometer that detects and visualizes any vibrations and moves of the device.
Solve the Outbreak	Allows students to study epidemiology outside the classroom.
Spacecraft3D App	Augmented reality (AR) application that facilitates interaction with a variety of spacecraft that are used to explore our solar system, study Earth, and observe the universe.
The Brain AR App	Augmented reality app that lets students explore the layers of the head from skin, muscle and skull down to the inner areas of the brain.
Virtual Cell Animation	Biology animations, still images, narratives, and content quizzes.
TI Nspire	TI-Nspire CX CAS handheld is the latest in learning technology from TI, creating a dynamic dimension for students to visualize concepts and take an engaging, interactive role in their learning.