International Journal of Education Humanities and Social Science

ISSN: 2582-0745
Vol. 3, No. 03; 2020

SUPPORTING THE INTEGRATION OF TECHNOLOGY IN ELEMENTARY SCIENCE INSTRUCTION: A REVIEW OF LITERATURE

Elizabeth B.Morales
BS Entomology, BA Communications, Master's Curriculum and Instruction Candidate, Bilingual Elementary Teacher
Tonya Huber
PhD, Texas A&M International University, College of Education, 5201 University Boulevard, Laredo, USA

ABSTRACT
Technology has been integrated into practically every aspect of our daily lives and children are immersed in it from a very young age. Teachers are now expected to integrate technology into their instruction in order to engage students and strengthen their science and technology skills; however, as technology consistently changes, teachers often find themselves lacking the knowledge and skills to effectively execute this integration. The purpose of this literature review is to explore if explicit professional development (PD) positively affects the integration of technology in elementary science instruction. First, the author examined what was already being done to change teacher perceptions towards integrating technology in the elementary science classroom. Then, the author analyzed the literature to identify the strengths, limitations, and commonalities among the different studies. Overall, the findings revealed that explicit professional development over the span of one or more years can have a positive effect towards teachers integrating technology into their science lessons.

Key Words: Elementary science, integrating technology, professional development, STEM.

1. INTRODUCTION
Elementary science instruction forms the foundation for more complex science courses in the upper levels; without it, students struggle to compete globally. Around 38% of fourth graders, 34% of eighth graders, and 22% of twelfth graders attained a level of proficient or higher on the National Assessment for Education Progress (NAEP) science assessment in 2015 (National Science Board, 2018, p. 4). According to the NAEP, these percentages reflect a 4% increase among fourth and eighth graders between 2009 and 2015, but the scores remained stagnant among twelfth graders (National Science Board, 2018, p. 4).This alarmingly slow growth in proficiency highlights a need for innovative change in the way teachers deliver science instruction; a change that is essential for students to deepen their comprehension of science concepts and to prepare them to compete in a global market. As reported by the National Science Board (2019): "Internationally, the United States ranks in the middle of 19 advanced economies in producing high-achieving science, technology, engineering, and mathematics (STEM) students, with such education systems as Singapore, Taiwan, and South Korea outpacing the United States"(p. 7).The U.S. Department of Education (2016) has been encouraging all teacher

ISSN: 2582-0745
Vol. 3, No. 03; 2020

education programs toprepare their graduates to "effectively select, evaluate, and use appropriate technologies and resources to create experiences that advance student engagement and learning" (p. 4). An effective use of technology integrated into classroom instruction can have a significant impact on student retention but the blueprint for this integration must first begin during teacher developmental training.

The studies analyzed in this literature review highlight this point, as the authors examine both *pre-service* and *in-service* teachers as they receive professional development training to enhance their knowledge and ability to integrate technology in their elementary science instruction that in turn leads to student academic gains in the subject. The findings from the review are crucial in allowing school districts and teacher education programs to understand the benefit of explicitly training teachers to integrate technology into their K-6 science instruction. Furthermore, these studies highlight an important concept: for students to build a strong foundation towards upper level science courses, they must first be engaged through avenues of communication that they are most familiar with in modern society. Technology, as a tool, in the hands of a well-trained teacher, can be a gateway for further exploration on the part of the American student because it is a vehicle for learning that they fully grasp and are accustomed to. For the United States to improve its standings in the global educational landscape, particularly when it comes to STEM, equipping teachers with training in technology integration is, according to these studies, vital.

Definition of Terms

Nine common terms used throughout the studies were defined, as noted in Table 1, to help the reader contextualize the terminology used in the research studies and the content examined in this review.

ISSN: 2582-0745
Vol. 3, No. 03; 2020

Table 1. Terms and Definitions Related to Technology Integration in Science Lessons

Term	Definition	Reference
content knowledge	"refers to the subject area understandings"(pp. 649 - 650) or what you know about a subject	Pringle et al.(2015)
educative curriculum	"curriculum that promotes teacher learning by first placing the teacher in the role of the learner with curriculum they will subsequently use in their own classrooms" (p. 432)	Longhurst et al.(2016)
in-service	"certified, matriculated teachers who are in an official teacher capacity in P-12" (p. 8)	U.S. Department of Education (2016)
pedagogical knowledge	"refers to the processes and methods of teaching and learning"(p. 649)	Pringleet al.(2015)
pre-service	teachers who "are matriculating through traditional teacher preparation program and teaching regularly in classrooms under the direction of a mentor teacher but are not yet in an official teacher capacity in P-12"(p. 8)	U.S. Department of Education (2016)
professional development	structured professional learning that results in changes in teacher practices and improvements in student learning outcomes	Darling-Hammond et al. (2017)
technological knowledge	"refers to knowledge about technologies for use in teaching and learning" (p. 649)	Pringle et al. (2015)
technological pedagogical content knowledge (TPCK, later TPACK)	framework that "provides an understanding of the knowledge required by teachers for effective technology integration" (p. 745)	Rehmat & Bailey (2014)
technology integration	"the appropriate selection and use of technology within a science lesson or unit to facilitate or enhance student learning of the content"(p. 745)	Rehmat & Bailey (2014)

2. METHODOLOGY

A literature review was conducted using two databases: WorldCat and ERIC EBSCO. Galvan and Galvan (2017) mentioned that WorldCat search results are considered "to be more trustworthy and comprehensive" (p. 20) by most scholars whom they consulted. WorldCat "searches a virtual database consisting of the catalogues of about 72,000 libraries in 170 countries and territories" (Galvan & Galvan, 2017, p. 20). A total of three searches were conducted using WorldCat. The following parameters were set for all WorldCat searches: *peer-reviewed article*, *TAMIU Killam Library*, and *2014 – 2019*. The first search rendered five results using the search terms *integrating technology* and *core curriculum*found on Table 2. This search

ISSN: 2582-0745
Vol. 3, No. 03; 2020

did not lead to any relevant sources,sothe search terms were adjusted. The search term *elementary* replaced *core curriculum* as the focus for this review was the integration of technology at the elementary level. This search rendered 107 sources. Galvan and Galvan (2017) recommend "examining an article entry" and its list of "Subject Keywords" to direct a researcher towards related topics and other sources(p. 32). In doing this, the focus of this review was narrowed, and another search was performed using the search terms *integrating technology*, *elementary*, and *science*. This new search yielded 82 sources of which six were relevant. Another search was conducted using ERIC EBSCO to seek additional relevant studies. This database was selected due to its association with educational research. The parameters were set as *peer-reviewed* and *full text*with a date spanning from January 2014 – November 2019. Identical search terms and criteria were applied in determining the relevancy of the results which will be discussed in further detail in this review. Seven sources were found of which only two met the criteria—those two sources had already been identified in the WorldCat search.

The six sources were selected based on meeting at least three out of the four following criteria: (a) title included *technology integration* or *integrating technology*, (b) study included elementary, (c) sample groups were from the United States, and (d) focus was on the impact of explicit professional development on teachers. A pattern was found in reviewing the studies and one of the articles was omitted due to its lack of addressing science. The focus of this literature review was narrowed to the impact that professional development has on the integration of technology in the elementary science classroom.

Table 2. Audit Trail of Database Searches

Database	Dates Reviewed	Search Terms	Sources Located	Relevant Sources
WorldCat	2014 January – 2019 October	"integrating technology" AND "core curriculum"	5	0
WorldCat	2014 January – 2019 October	"integrating technology" AND "elementary"	107	5
WorldCat	2014 January – 2019 October	"integrating technology" AND "elementary" AND "science"	82	6
ERIC EBSCO	2014 January – 2019 November	"integrating technology" AND "elementary" AND "science"	7	2

Analysis

Table 3 contains(a) participant demographics, (b)summaries of the methodology, and (c) findings for each study. The criteria used to distinguish the studies are as follows: (a) authors and publication year, (b) participants, and (c) detailed methodology. These criteriaproved to be useful in organizing the important information from each study and allows for a quick comparison at a glance.

ISSN: 2582-0745
Vol. 3, No. 03; 2020

Table 4 is organized by (a) purpose, (b) strengths, (c) limitations, and (d) direct quotes for each of the relevant studies that were reviewed. These criteria were selected to give the reader a quick overview of the studies and help determine the validity of the research.
The relevant findings in this review can be found on Table 5. This table was organized by (a) authors and (b) findings to provide the reader with a quick overview of the findings for each study and be able to determine any commonalities or patterns among the results.Analyzing the content of each of the articles to identify the aspects to be tabled was a major part of the analysis.

Table 3.Methodology

Authors and Publication Year	Participants	Detailed Methodology
Campbell et al. (2015)	27 intervention teacher participants 1,143 students from intervention teacher participants 30 control teacher participants 1,153 students from control teacher participants Science teachers and students were sixth – eighth grade level New York Group 14.3%Caucasian(White) 29.9% African American 39.3% Hispanic 14.9% Asian 15.4% English language learners Utah Group "majority [W]hite population, with a Hispanic population with the highest minority prevalence" (p. 564)	This study collected data comparing teachers at the beginning and end of a one-year period totaling 120 hours of explicit professional development on new literacy skills and information and communication technologies (ICT) (p. 564). 27 intervention teachers participated in: 80 hours of professional development during the summer 16 hours of monthly meetings during the academic year 24 hours of professional development during the winter A student achievement comparison was also conducted between students taught by a teacher participating in the PD and those from a delayed-treatment group from comparable schools whose teachers did not participate in the PD (p. 565).
Hu &Garimella (2017)	30 certified elementary school teachers 30 Caucasian females	Participating teachers completed 100 hours of professional development training in a span of a year. The training consisted of:

	4 Kindergarten 10 First 6 Second 5 Third 1 Fourth 50% age range: 31-50 50% age range: younger than 31 or greater than 50	Three6-hour sessions offered in January, February, and March 2016 Two1-week workshops pertaining to science content, pedagogy, and technology Quantitative data sources: pre- and post-learner attitudinal survey Qualitative data sources: Copies of 5E lesson plans, presentations, and journals Two classroom observations per teacher
Longhurst et al.(2016)	Professional development teacher participants Cohort 1:13 Cohort 2:10 The following completed student-learning measures at the beginning (pre) and at the end (post) of the school year State end of level assessment data was collected from the following to measure student achievement: students taught by Cohort 1:907 Cohort 2:1,188 Cohort 3:1,019 non-participating teachers' control group of students Cohort 0:2,317	Over a two-year period, teachers participated in a total of 240 hours of professional development consisting of: Two80-hour summer workshops Two 24-hour winter sessions Eight 2-hour monthly meetings during each academic year Teacher learning measures were completed before the PD, after year-one of PD, and then again after year-two of PD. Observations were also completed for 17 of the 23 participating teachers before PD and subsequently after each year of PD.
Pringle et al. (2015)	525 lesson plans were submitted for review by teachers participating in a year-long technology integration initiative. Those submitted were: 306 pre-lessons 219 post-lessons	Lesson plans were used as proxies for teacher practice as they provide insight into longer *chunks* of planned instruction, teachers' decisions about sequence, and relationships between activities and topics, and their assessment strategies (p. 650). The insights into these aspects of instruction are key as they cannot always

ISSN: 2582-0745
Vol. 3, No. 03; 2020

		be observed in a single class period. The framework for this study was based of the technological pedagogical content knowledge (TPACK). “TPACK was selected because it organizes the types of knowledge needed in order to integrate technology in K-12 teaching and learning based on technology, pedagogy, and content knowledge” (p. 649).
Rehmat & Bailey (2014)	“Participants in this study were preservice teachers in an elementary science methods course at a large university in the Southwestern US during the Spring 2012 semester” (p. 748). There were 15 student participants in the course that consisted of: 3 males 12 females 7 Caucasian 4 Hispanic/Latino 3 African-American 1 Asian Age Range: 21-35	Participants completed an open-ended pre- and post-PreserviceTeachers Technology Integration Survey (PTTIS). “The open-ended survey was designed to elicit the preservice teachers’ definitions of technology and their perceptions regarding the integration of technology in the elementary science classroom” (p. 749). “The PTTIS contained nine questions about technology integration, as well as two demographic questions (gender andrace/ethnicity); at the posttest, two additional questions relating specifically to the impact of the course were included” (p. 749). Participants completed a weekly reflection after a lesson was explicitly modeled for them in class using the 5E model, some of which included technology integration.

Table 4. Purpose, Strengths, and Limitations of the Relevant Studies

Authors and Publication Year	Purpose, Strengths, and Limitations	Direct Quotes
Campbell et al. (2015)	**Purpose:** The authors examine the"impact of a professional development project focused on enhancing teacher and student learning by using information and communication technologies (ICTs) for engaging students in reformed-based instruction" (p. 562). **Strengths:** The authors compared instructional practices observed prior to teacher participant's participation in the project to determine the similarities among the intervention and control participant groups (p. 660). **Limitations:** Convenience sampling was used as a result of difficulties faced in recruiting participants.	"…this research was important because of the needed focus on how teacher's pedagogy and development change as a result of engagement in technology-enhanced science teacher PD" (p. 577). "…this research provided important evidence, demonstrating that the PD model examined shows promise in supporting teachers' learning and practice" (p. 577). "With respect to students, this research demonstrates the promise of the PD model examined specifically and reformed-based and technology-integrated instruction more broadly, for all students in the populationexamined" (p. 577). "this research demonstrated the initial promise for how low socioeconomic student populations and the non-White populations seem to be benefiting most from their teacher's participation in the PD model examined" (p. 577).
Hu &Garimella (2017)	**Purpose:** The authors examined a group of elementary school teachers' perceived preparedness and comfort with teaching science, and their subsequent implementation with K-4 students to determine the impact of participating in a professional development training on science and technology (p.159). **Strengths:** Data from the study included: • Quantitative	"The National Science Teachers' Association (Keeley, 2009; Pratt,2007) suggests that assuming "children can 'catch up' on science when they reach middle school and high school" is a faulty notion in that science learning is a cumulative progression" (p. 160). "…it seems that teachers are changing to use more student-centered, active learning and experimenting strategies with technologies, which were pedagogy modeled in the PD, to help them teach the science content in their

	- pre- and post-learner attitudinal surveys • Qualitative - copies of 5E lesson plans, presentations, journals, and class observation notes **Limitations:** The authors used a "quasi-experimental" design for their project pre- and post-test (p. 164).	elementary classrooms" (p. 170). "The participants have learned to use technologies as a vehicle for best practices (Banilower, Cohen, Pasley, & Weiss, 2010) in science instruction, and they have updated their Technological, Pedagogical, and Content knowledge (TPACK) (Guzey&Roehrig, 2009)" (p. 170).
Longhurst et al. (2016)	**Purpose:** The authors conducted this research to examine the impact on teacher practice and student learning after engaging in technology-supported reformed science teaching focusedPD (p. 432). **Strengths:** This was a multi-year study that allowed for data collection and comparison of results after one year of PD and subsequent years. **Limitations:** Six classroom observations were not completed due to teachers joining the project after the school year ended (p. 433).	"Participating teachers engaged, first as learners and then as teachers, in each of four curriculum modules developed using Slater, Slater, and Shaner's (2008) faded scaffolding inquiry approach" (p. 432).
Pringle et al. (2015)	**Purpose:** The authors examined the impact of a year-long technology integration initiative geared towards applying technological, pedagogical, and content practices in science lessons. **Strengths:** Their research uncovered a need for a commonly expressed framework to serve as a guide for stakeholders	"TPACK was selected because it organizes the types of knowledge needed in order to integrate technology in K-12 teaching and learning based on technology, pedagogy, and content knowledge" (p. 649). "Examining lesson plans can provide insight into teachers' approaches to science teaching and learning" (p. 650).

ISSN: 2582-0745
Vol. 3, No. 03; 2020

	(p. 660). **Limitations:** "A number of misalignments occurred between the goals of the technology integration initiative and teachers' intended practices as documented in their lesson plans" (p. 660). "The policy interpretation became a major weakness in the technology integration initiative, as it did not have a commonly expressed framework guiding the activities of the stakeholders involved such as policymakers, district personnel, and teachers" (p. 660).	"Furthermore, lesson plans allow for evaluation of longer 'chunks' of planned instruction, allowing insight into the teachers' decisions about sequence of and relationships between activities and topics as well as their assessment strategies, neither of which are commonly evident when observing a single class period'' (p. 650).
Rehmat & Bailey (2014)	**Purpose:** The authors realized this study to understand preservice teachers' conceptions of technology integration and if they could bechanged through explicit instruction. **Strengths:** The study was phenomenological but employed the use of students' pre-/post-surveys, reflections on model lessons, and lesson plans to derive their data and strengthen the validity of the study. **Limitations:** This was a preliminary study that included a small sample size due to class enrollment.	"The TPACK framework for science helps us define technology integration for the purposes of this study: the appropriate selection and use of technology within a science lesson or unit to facilitate or enhance student learning of the content" (p. 745). "Technology integration requires a more sophisticated understanding of technology use than what is described in previous studies" (p. 745).

ISSN: 2582-0745
Vol. 3, No. 03; 2020

Table 5. Findings in the Relevant Studies

Authors and Publication Year	Findings
Campbell et al. (2015)	Participants made significant improvements in their overall instruction when comparing pre- and post-classroom observations. "After 1 year of PD, significant positive differences were also found when comparing the intervention group after PD to the delayed-treatment control group prior to PD" (p. 574). Overall, significant positive changes were observed for each targeted standard with the curriculum modules used to anchor the professional development for intervention teacher's students compared to the control groups' students (p. 576). "And, perhaps even more compelling, are the findings suggesting that non-White students and low socioeconomic students were found contributing more to the significant positive differences identified" (p. 576).
Hu &Garimella (2017)	24 participants completed the post-survey "twenty-one (87.5%) out of 24 participants reported that they have used the new AR Science standards from the training with students" (p. 168). Students using instructional technology increased from 48% in the pre-survey to 75% in the post-survey(p. 168). Only 23 out of the 30 participants submitted their technology integration lesson plans through a Google Form. The lessons impacted a total of 403 students and covered various science topics(p. 169). Overall, the professional development positively impacted the participants' preparedness and comfort in integrating technology into their science lessons(p.170).
Longhurstet al. (2016)	The data suggest, "that both teachers and their students benefited from multi-year PD that incorporates educative forms of learning focused on integrating new literacies and technology to support scientific understanding" (p. 440). Improvements were noted after one year of professional development, but the greatest benefit came from multi-year professional development(p. 440).
Pringle et al. (2015)	Some gaps between the goals of the state's initiative and the actual implementation by teachers were found (p. 660). Teachers mostly used the internet browser and computers in their lessons, but an increase in digital microscopes, tablets, and handheld devices from pre- to post-

	lesson plan submissions was noted and attributed to new equipment and tools being purchased with initiative money (p. 660). Although the results showed an increase in the overall "sophistication of technologies used," the one-year training was not deemed enough to impact their teaching practices in regard to content and pedagogy (p. 657, 660).
Rehmat & Bailey (2014)	Participants' definition of technology changed throughout the study. The pre-survey revealed their perception of technology tools for use in science were limited to cell phones, calculators, and computers (p. 750). "The post-survey revealed a dramatic yet positive change in students' definitions of technology, including, for example, iPads, simulations, web games, a SMART Board, cameras, and videos" (p. 750). Preservice teachers' perception of technology influences their intent to integrate it and use it as part of their lessons(p. 750). Participants were able to improve their definition and application of technology in the science classroom after receiving modeling and explicit instruction (p. 753).

3. DISCUSSION AND FINDINGS

All five studies reviewed had 30 or less participants in their sample groups with only Campbell et al. (2015) and Longhurst et al. (2016) adding teacher control groups and students as part of their studies (see Table 3).Of the five studies, three were quantitative, one was qualitative, and one included both qualitative and quantitative data. All studies included some form of pre- and post-data which varied between observations, attitudinal surveys, structured questionnaires, lesson plans, and state criterion referenced tests. Each study had its own set of strengths and limitations, but they all had a common thread: to determine if explicit PD results in positive outcomes (see Table 4).

Explicit and relevant(PD) can potentially be a powerful method for encouraging teacher learning and improving classroom practice. The results from the studies in this literature review agree with the Garetet al. (2001) results: (a) sustained and intensive PD is more likely to have an impact as opposed to shorter PD's and (b) PD that is coherent, focuses on academic content, and lends itself to active learning will yield greater results in enhancing teachers' knowledge and skills (p. 935).

The studies analyzed in this review researched the effects of PD training for one or more years except for Rehmat and Bailey (2014) which lasted only a semester. Despite this shortened PD training period, the study impacted participants' definitions and perceptions of technology integration in the science classroom. The authors of the other four studies demonstrated that explicit PD over the course of one or more years showed promise in supporting teachers' learning and practice (Campbell et al., 2015; Hu &Garimella, 2017; Longhurst et al., 2016;

Pringle et al., 2015; see Table 5). However, Longhurst et al. (2016) noted a decrease in use of technology by year-two teachers, but this decreased value was higher than its baseline (p. 436).

4. IMPLICATIONS AND CONCLUSION

Although these studies provided some insight into the effectiveness of explicit professional development in integrating technology into science instruction, more research needs to be done and followed up on. In order for teachers to make the essential shift in their perceptions of integrating technology into their instructional practice, they need to experience technology integration with their science learning in educative ways that go beyond a step-by-step lesson plan (Campbell et al., 2015; Hsu, 2016; Longhurst et al., 2016; Garet et al., 2001). Additionally, professional development activities addressing technology integration should focus on training teachers how to go beyond students' rudimentary use of technology and move on to using technology to create and produce artifacts that support higher-level learning.

Teacher preparation programs and school districts should consider this explicit, firsthand experience approach to PD to assist in closing gaps among student populations. Campbell et al. (2015) noted that their research led to promising results in students benefitting from their teachers taking part in the PD, with "low socioeconomic student populations and the non-White populations"(p.577) benefitting most. Closing the gaps among all students will contribute towards the U.S. Department of Education and the National Science Board's goals of building a strong foundation at the elementary level so studentscan succeed in upper level science courses and keep the United States globally competitive.Furthermore, teachers' comfort level with integrating technology in their instruction would be improvedmaking them more likely to apply it in their own instruction as they continue to educate 21st century scholars. The field of education is ever changing, and teachers must adapt in order to reach their students with relevant and rigorous learning experiences.

REFERENCES

Campbell, T., Longhurst, M. L., Wang, S., Hsu-Yin, H., &Coster, D.C. (2015). Technologies and reformed-based science instruction: The examination of a professional development model focused on supporting science teaching and learning with technologies.*Journal of Science Education and Technology*,*24*(5), 562-579. https://doi.org/10.1007/s10956-015-9548-6

Darling-Hammond, L., Hyler, M. E., &Gardner, M. (2017). *Effective teacher professional development*.Learning Policy Institute.https://learningpolicyinstitute.org/sites/default/files/product-files/Effective_Teacher_Professional_Development_REPORT.pdf

Galvan, J. L., & Galvan, M. C. (2017).*Writing literature reviews: A guide for students of the social and behavioral sciences* (7th ed.). Routledge, Taylor & Francis Group.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers.*American Educational Research Journal*,*38*(4), 915-945. https://doi.org/10.3102/00028312038004915

Hsu, P. (2016). Examining current beliefs, practices and barriers about technology integration: A case study.*TechTrends*, *60*(1), 30-40.https://doi.org/10.1007/s11528-015-0014-3

Hu, H.,&Garimella, U. (2017). Excellence in elementary school science (EESS): Teachers' perceptions & technology integration from a professional development.*Journal of Computers in Mathematics and Science Teaching*,*36*(2), 159-172. https://www.learntechlib.org/p/178273/

Longhurst, M. L.,Coster, D., Duffy, A. M., Wolf, P. G., Lee, H., & Campbell, T. (2016). Multi-year professional development grounded in educative curriculum focused on integrating technology with reformed science teaching principles.*School Science and Mathematics*,*116*(8), 430-441. https://doi.org/10.1111/ssm.12197

National Science Board. (2018).*Science and engineering indicators 2018*. National Science Foundation (NSB-2018-1).https://nsf.gov/statistics/2018/nsb20181/assets/481/elementary-and-secondary-mathematics-and-science-education.pdf

National Science Board. (2019).*Science and engineering indicators 2020*. National Science Foundation (NSB-2019-6). https://ncses.nsf.gov/pubs/nsb20196/executive-summary

Pringle, R.M., Dawson, K., &Ritzhaupt, A. D. (2015). Integrating science and technology: Using technological pedagogical content knowledge as a framework to study the practices of science teachers.*Journal of Science Education and Technology*,*24*(5), 648-662.https://doi.org/10.1007/s10956-015-9553-9

Rehmat, A.P., & Bailey, J. M. (2014). Technology integration in a science classroom: Preservice teachers' perceptions.*Journal of Science Education and Technology*,*23*(6), 744-755.https://doi.org/10.1007/s10956-014-9507-7

U.S. Department of Education. (2016).*Advancing educational technology in teacher preparation: Policy brief*. Office of Educational Technology and Teacher Preparation Brief.https://tech.ed.gov/teacherprep/