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Investigating Pre-Service Science Teachers' Technological Pedagogical Content Knowledge through License and Master's Program (LAMP)

BY

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Abstract

This research used a case study approach to investigate "in-depth" pre-service science teachers' preparation programs in the Licensure and Master's Program (LAMP) in the College of Education at the University of Toledo (UT) to integrate technology into their teaching. In this study, the study focused on technology parts TK, TPK, TCK, and TPACK preparation by finding out and knowing the gap in using technology in science. The case study would include a sequential exploratory mixed methods approach, which involves collecting qualitative and quantitative data in order to understand the technology preparation for pre-service science teachers in teaching and practicing in terms of their technology knowledge (TK), technology, and content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical and content knowledge (TPACK). This paper aims to investigate pre-service science teachers' technological pedagogical content knowledge (TPACK) through the LAMP program.

This study focused on pre-service science teachers in science and social studies studying in the two-year LAMP program at the University of Toledo. Three data collection tools were used to investigate pre-service science teachers' preparation programs in college: The Technological Pedagogical Content Knowledge Scale of Pre-Service Teachers survey, an open-ended interview, and the student's study plan. According to the TPACK survey findings, the participant did not have any TPK, TCK, and TPACK. Also, in TK, the participant knew no more than 50%. The most important finding was that participants did not believe that we should teach or use technology and preferred traditional methods. Even though he stated that he knows that technology is essential in facilitating education, he did not believe that he should integrate technology in teaching into his classrooms.

Therefore, more research on TK, TPK, TCK, and TPACK would help redesign the program that prepares pre-service science teachers to be effective teachers. The pre-service science teacher in the LAMP program in this study needs more support for TK, TPK, TCK, and TPACK in their training program to teach with technologies.

Keywords: pre-service science teachers, TPACK, license and master's program (LAMP), integrating technology

درجة معرفة معلمي العلوم قبل الخدمة للمحتوى التربوي التكنولوجي TPACK من خلال برنامج الترخيص لممارسة مهنة التدريس والماجستير (LAMP)

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الملخص

استخدم البحث نهج دراسة الحالة للتحقيق في برامج إعداد معلمي العلوم قبل الخدمة في برنامج الترخيص لممارسة مهنة التدريس والماجستير (LAMP) في كلية التربية بجامعة توليدو (UT) لدمج التكنولوجيا في التدريس. في هذا البحث تم التركيز على الجانب التكنولوجي TKو TPKو TCK و TPACKمن خلال اكتشاف ومعرفة الفجوة في استخدام التكنولوجيا في العلوم. ستشمل دراسة الحالة نهجًا استكشافيًا مختلطًا، والذي يتضمن جمع البيانات النوعية والكمية من أجل فهم الإعداد التكنولوجي لمعلمي العلوم قبل الخدمة في التدريس والممارسة من حيث المعرفة التكنولوجية(TK) والمعرفة التكنولوجية للمحتوى(TCK) ، والمعرفة التكنولوجية التربوية(TPK) ، والمعرفة التكنولوجية التربوية للمحتوى(TPACK) .

ركز البحث على معلمي العلوم قبل الخدمة في العلوم والدراسات الاجتماعية الذين يدرسون في برنامج LAMP لمدة عامين في جامعة توليدو. تم استخدام ثلاث أدوات لجمع البيانات للتحقيق في برامج إعداد معلمي العلوم قبل الخدمة في الكلية: مقياس المعرفة التكنولوجية التربوية للمحتوى (TPACK) لمعلمي ما قبل الخدمة، ومقابلة مفتوحة، والخطة الدراسية للطلاب. وفقًا لنتائج مسح TPACK، لم يكن لدى المشاركين أي من المعارف التالية: TPK و TCKوTPACK. أيضًا، في المعرفة التكنولوجية، لا يعرف المشارك أكثر من ٥٠ ٪ من المعرفة التكنولوجية. وكانت النتيجة الأكثر أهمية هي أن المشاركين لم يؤمنوا بضرورة تدريس أو استخدام التكنولوجيا وتفضيلهم الطرق التقليدية. على الرغم من علمهم أن التكنولوجيا ضرورية في تسهيل التعليم، إلا أنه لم يؤمنوا بدمج التكنولوجيا في التدريس في فصولهم الدراسية.

لذلك، فإن إجراء المزيد من الأبحاث حول TK وTPK وTCK وTPACK سيساعد في إعادة تصميم وبناء برامج إعداد معلمي العلوم قبل الخدمة ليكونوا معلمين فعالين. أيضا يحتاج معلمي العلوم قبل الخدمة في برنامج LAMP في هذه البحث إلى مزيد من الدعم للمعارف التالية: TK وTPK وTCK وTPACK في برنامجهم التدريبي للتدريس باستخدام التقنيات.

الكلمات الرئيسية والمفتاحية: معلمي العلوم قبل الخدمة، المعرفة التكنولوجية التربوية للمحتوى ، دمج التكنولوجيا.(LAMP))، برنامج الترخيص لممارسة مهنة التدريس والماجستيرTPACK(

Introduction

In light of rapid technological progress, traditional educational practices do not provide teachers with all the 21st-century skills to teach with technology. Furthermore, there is a lack of motivation for teachers to use technology in their teaching (Al Fayfi, 2013). Teachers should be educated on using technology in their teaching through educational meetings and training courses (Al Fayfi, 2013).

Technology is changing the routines and practices in most human work areas, but education has fallen far behind (Mishra & Koehler, 2006). To keep pace with this change in science, some countries' departments of education have changed the science courses' name to "Science and Technology" and enriched teaching methods and classroom infrastructure with technology (Can, et al, 2017). Because departments education has seen technology and science as a good combination, pre-service science teachers' professional development program have added Instructional Technologies and Material Design and Computer courses as a part of their preparation. Also, some education departments have used the TPACK theory for pre-service science teachers to know how to integrate technology in teaching and found that as the class level of pre-service teachers increases, their level of TPACK increases as well (Can, et al., 2017).

One type of pre-service teacher education is Licensure and Master's Program (LAMP), which prepares pre-service teachers in their subject area, such as science, and also at the graduate level, are typically 12-24 months. The problem is unclear to what extent LAMPs prepare pre-service science teachers to integrate technology in their teaching. However, these programs in charge of training teachers need to incorporate more training on information and communication technologies (ICTs) and redesign teachers' training programs to use ICTs in teaching science (Jita, 2016). Even though pre-service science teachers may have positive attitudes and understanding regarding ICT, the teachers' training programs fail to provide appropriate ICT-training courses for teaching and learning science (Alev, 2009).

To identity the lack of preparation for integrating technology in their classrooms, educational researchers use the theory of Technological Pedagogical Content Knowledge (TPCK or TPACK). TPACK provides the educational research field "a theoretical framework for understanding the teacher knowledge required for effective technology integration"

(Jang, 2012, p.91). Also, Srisawasdi (2014) suggested that TPACK helps prepare pre-service science teachers to meet 21st-century skills and integrate technology in the classroom.

Therefore, integrating technology is an essential and essential component to have effective teaching, especially in science. In this regard, the problem is that more studies are being done in TPACK in other countries in order to know how to integrate technology in teaching in specific science subject areas, such as in Turkey (Kartal, & Afacan, 2017; Can, et al., 2017), Kuwait (Alayyar, Fisser, & Voogt, 2012), Thailand (Srisawasdi, 2014), and Indonesia (Agustin & Liliasari, 2017). On the other hand, less research is available in the U.S. and even less for science education teachers (Habowski, 2012)

Purpose of the Study

Excellent qualitative purpose statements should cover "information about the central phenomenon explored in the study, the study participants, and the research site" (Creswell, 2014, p.169). In this paper, the purpose of this case study is to discover and understand the technology preparation for pre-service science teachers at the University of Toledo Education college in LAMP. At this stage in the research, the technology preparation will be generally defined as the ability to use technology in teaching and practicing in terms of their technology knowledge (TK), technology and content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical and content knowledge (TPACK). This study is a pre-service science teacher in Science Social Studies who is studying in the two-year LAMP program at the University of Toledo.

Since there is little research on pre-service science teachers' preparation, it makes sense to investigate training programs in colleges. Also, even though some previous studies may address the same ideas that the researcher wants to address, teacher preparation programs will be different from one college to another and even from one country to another, which have different education systems based on their culture, values, and needs, such as studies by Can, et al. (2017) and Kartal and Afacan (2017).

Furthermore, some teachers' preparation programs maybe one year and others two or four years; the way that programs are designed and constructed will be different even in the same country, such as Habowski's (2012) study. Also, each study focused on a specific subject and level. For example, Habowski's (2012) study focused on secondary science certifications and "technology-rich" as a specific subject; Can, et al. (2017) and Kartal and Afacan (2017) study focused on 1st, 2nd, 3rd, and 4th-year students who are studying in Science Education Department of a Faculty of Education in Turkey. The research approach is primarily based on these two studies: Can, et al. (2017) and Kartal and Afacan (2017), as they did in Turkey.

Even though studies have been done such as Can, et al. (2017) and Kartal and Afacan (2017) in the same things that study interested in, a researcher interested in doing similar things with the American context and culture different situations and programs. To reflect integrating the science teachers' knowledge in technology, content, and pedagogical to the classroom context, it needs to detect the different dimensions of Technological Pedagogical Content Knowledge (TPACK) in their preparation programs.

TPACK has become a research focus for those who interest in teachers' professional development from many countries around the world in recent years as a process to know about effective technology for teachers to integrated knowledge (American Association of Colleges for Teacher Education [AACTE], 2008).

Therefore, the TPACK framework will help us to understand how content, pedagogy, and technology knowledge intersect to impact pre-service science teachers to integrate technology in their teaching. However, this study focuses on the technology part, which aligns with Creswell's (2013) recommendation to "focus on a single phenomenon (or concept or idea)" to be explored or understand (p. 169). Therefore, the study will answer the research question by focusing on the technology specific TPACK preparation of pre-service science teachers in their training program. This study investigated how the TPACK theory helps understand how pre-service science teachers' preparation in LAMP at UT helps them integrate technology in teaching.

Based on a previous study's findings, we expected that TPACK would help understand how to integrate technology in teaching for pre-service science teachers. This study will try to investigate the pre-service science training teachers' preparation program related to their TPACK.

The Theoretical Framework

The TPACK framework is based on Lee Shulman's construct of pedagogical content knowledge (PCK) and is modified to incorporate technology knowledge (Mishra & Koehler, 2009). According to Koehler and Mishra (2009), "The development of TPACK by teachers is critical to effective teaching with technology" (p. 60). There are three main elements of teachers' knowledge: content, pedagogy, and technology. The TPACK framework is interactions between these three elements of knowledge, represented as PCK, TCK, TPK, and TPACK. This relationship is illustrated in Figure 1.

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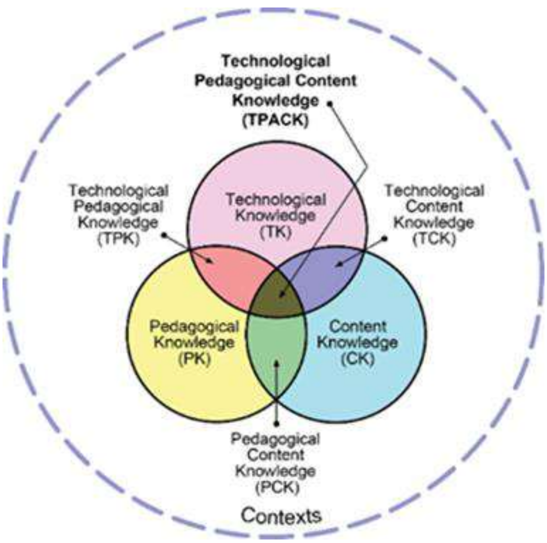

Figure 1. The TPACK framework. Adapted from "What is technological pedagogical content knowledge?". by Koehler, M. J., & Mishra, P, 2009, Contemporary Issues in Technology and Teacher Education, 9(1), p. 63. Copyright 2009 by the Society for Information Technology & Teacher Education.

- Technology knowledge (TK) refers to the knowledge and understanding of information technology or various technology that teachers can apply to their lives, teaching, and learning activity.
- Technology and content knowledge (TCK) have a deep historical relationship. Regarding how a particular technology can play an essential role in delivering content successfully and effectively.

- Technological Pedagogical Knowledge (TPK) Understands how learning processes and teaching can change when using specific technologies in certain ways.
- Technological pedagogical and content knowledge (TPACK) is an understanding of how a particular concept is formulated and presented by technology use. That created from interactions among content, pedagogy, and technology knowledge. "Underlying truly meaningful and deeply skilled teaching with technology, TPACK is different from knowledge of all three concepts individually"(p.66).

Based on the findings of previous studies (Jang, 2012; Can, et al., 2017; & AACTE, 2008), this study expects that the TPACK framework would help us to understand the teacher knowledge required for effective technology integration and the process to know about effective technology for teachers to integrate knowledge. Furthermore, the research found that increasing the time requirement in technology integration courses would increase the pre-service teachers' self-assessed TPACK and confidence (Habowski, 2012). That means that there is an effect of teacher training programs on pre-service science teachers' TPACK. Moreover, Can,et al.l (2017) found that as pre-service science teachers' class level increases, their level of technological pedagogical content knowledge increased. Also, there is an effect on their demographic variables (gender, owning computer, computer usage level, and grade level), so pre-service science teachers' experiences with technology in teaching positively impact TPACK (Kartal & Afacan, 2017).

That means pre-service science teachers' TPACK will change depending on their training program and their experience. So, the question here is what kind of courses or experiences pre-service science teachers need to have to integrate technology in their classroom. The study wants to know what knowledge is required for effective technology integration by using the TPACK theory to know that the LAMP program at UT prepares pre-service k-12 science teachers to integrate technology in teaching. To know what knowledge that pre-service k-12 science teachers need to know or practice on to integrate technology in their teaching. Pre-service science teachers need to investigate pre-service science teachers' technological pedagogical content knowledge through their training program.

According to McCrory (2008), "Teachers' knowledge of technology, science, and pedagogy comes together in knowing *where* (in the curriculum) to use technology, *what* technology to use, and *how* to teach with it." These three aspects of TPCK could be found by knowing pre-service science teachers' TK, TPK, TCK, and TPCK and their preparation in their education program related to TK, TPK, TCK, and TPCK.

Where to use Technology? The question of where to use Technology is a good question that can help students in learning and teachers in teaching to know how a particular technology can play an essential role in delivering content successfully and effectively. This idea is Technology and content knowledge (TCK).

However, it may not be suitable for others, especially in k-12 classrooms, because it depends on what Technology is available for teachers. According to McCrory (2008), in science, there are two considerations guiding decisions about technology use: Identity which parts of the science curriculum will be complex to teach and which Technology could help; Identify which topics in the science curriculum in which Technology plays an essential role in what is being taught. For example, in teaching biology, teachers might face that their students do not learn much from "dissecting real animals," some students make a mess, while others refuse to participate in dissection for their reason. A technology solution could be replacing real dissecting with virtual dissecting. As another example, using a microscope is essential to the study of biology. Here we could teach them about what could be seen with a microscope or using a simulated microscope on a computer.

What technology to use? The question of what technology to use asks what technology could available to use then decides what technology to use. McCrory (2008) argue that we could classify technology for science in three categories:

"1. Technology that is unrelated to science but is used in the service of science. Word processing, spreadsheets, or graphic software fall into this category.
2. Technology designed for teaching and learning science. Programs like Model-ItTM, Virtual Frog, CootiesTM, BIOKids, and WISE have been developed specifically for teaching K-12 science.

3. Technology is designed and used to do science. This includes instruments such as microscope, remote (web-based) telescopes, CBL probes, and scientific calculators" (p.197).

Also, McCrory (2008) mentioned that science teachers at all grade levels have a purpose of using each of these technology categories. However, using these categories in teaching will be different for each case. So, the essential knowledge that science teachers should know is their schools' resources. Also, teachers should understand them and apply them to their lives, teaching, and learning activities. This idea is Technology knowledge (TK).

How to teach with technology? In this stage, McCrory (2008) argues that science teachers need to "mine their internal resources—their knowledge of science, of students, and pedagogy—to anticipate and prepare for what will likely happen when the technology is used" (p.198). For example, using virtual Frog dissection, which is available as an iPad app and as an interactive whiteboard app, what might the teacher consider before his first use? The teacher has identified a problem: learners have a hard time understanding how to dissect a frog and knowing the digestive system of the frog; the teacher has identified an available technology: his school has iPads with Frog dissection app, and he has internet, or he has an interactive whiteboard in the classroom and Frog Dissection app on it. Some things he needs to consider before starting the project include:

- Teaching students about frog dissection.
- They are giving students time to play with the system before starting with their subject matter lessons.
- Identify any errors or obstacles encountered while using the program and develop alternative plans in case of breakdown.
- Organize the classroom to do the activities by determining if the activity is individual or group, timed or open-ended, and work on the same problem or a different problem.
- Identify how they will assess what the students learned.

In short, in the process teachers go through when they build a scenario for how they teach with technology, a teacher would develop a knowledge that he could use this scenario next time he uses the same technology. This idea is Technological Pedagogical Knowledge (TPK). Also, "it is very context—and content-specific knowledge, depending on the technology available, the students, and the subject matter. This idea is

TPACK" (Mccrory, 2008, p.199).

To reflect integrating the science teachers' knowledge in technology, content, and pedagogical to the classroom context, it needs to detect the different dimensions of Technological Pedagogical Content Knowledge (TPACK) in their preparation programs. To know where (in the curriculum) to use technology, what technology to use, and how to teach with it by knowing pre-service science teachers' TK, TPK, TCK, and TPCK.

In short, TPACK theory helps to understand how pre-service science teachers' preparation program (LAMP) at UT helps them to integrate technology in teaching by finding out the TK, TPK, TCK, and TPCK preparation of pre-service science teachers.

Research Question

To achieve the purpose of this study as outlined above, the following four research questions were addressed:

1. How does the TPACK theory help us understand how pre-service science teachers of the LAMP program at UT integrate technology in teaching?
2. Where (in the curriculum) pre-service science teachers of the LAMP program at UT use technology (TCK)?
3. What technology pre-service science teachers of the LAMP program at UT use in their classes (TK)?
4. How pre-service science teachers of the LAMP program at UT teach with technology (TPK & TPACK)?

Theoretical Significance

First of all, knowing TPACK provides the educational research field "a theoretical framework for understanding the teacher knowledge required for effective technology integration" (Jang, 2012, p.91). Second, the study will provide more information about pre-service science teachers' TPACK in the U.S., especially in Ohio state, which is needed because previous research has focused on other countries, such as Turkey, Kuwait, Thailand, and Indonesia. However, less research is available in the U.S. and even less for science education teachers. Third, previous research is not clear about the specific program, whether it is a master's or undergraduate program. The study focuses on research in LAMP. So, the study's significance is a transfer of "the importance of the problem for different audiences that may profit from reading and **using** the study" (Creswell, 2014, p.296).

Practical Significance

Knowing the pre-service science teachers' TPACK can help instructional designers think about the course they design for pre-service science teachers to meet their needs to integrate technology. Knowing pre-service science teachers' TPACK can help develop a successful professional development program (PDP) because it builds on their needs. It will also help prepare pre-service science teachers to integrate technology in the classroom and meet 21st-century skills (Srisawasdi, 2014). In short, using the TPACK theory for pre-service science teachers helps us to know how to integrate technology in teaching (Can, et al., 2017).

Additionally, knowing pre-service science teachers' TPACK will help the researcher to understand pre-service science teachers' TPACK and where (in the curriculum) to use technology, what technology to use, and how to teach with it (McCrory, 2008). The findings could help determine whether or not the LAMP program at UT prepares them to integrate technology into their teaching and improve pre-service science teachers' TPACK to integrate technology.

Delimitations & Limitations

This study delimited to focus on the technology part. Therefore, the study will answer the research question by finding out the TK, TPK, TCK, and TPCK preparation of pre-service science teachers in the licensure and Masters Program (LAMP) K-12 University of Toledo. However, this study ignores three elements, which are CK, PK, and PCK. That helps "further define the research study parameters" (Creswell, 2013, p.170). Another delimitation for this study was that the researcher only focused on two collecting data: interviews and documents.

This study's findings are limited to pre-service science teachers in the licensure and Masters Program (LAMP) in K-12 at the University of Toledo in the U.S. in Ohio. So, the researcher did not have any information about subjects or places other than pre-service K-12 science teachers in the LAMP program at the University of Toledo.

Research Methods and Procedures

Qualitative Approach and Rationale

This research used a case study approach to investigate "in-depth" (Creswell, 2014, p. 290) pre-service science teachers' preparation programs in the LAMP program at UT to integrate technology into their teaching. In this study, the study focused on technology parts TK, TPK, TCK, and TPACK preparation by finding out and knowing the gap in using technology in science. According to McCrory (2008), "Teachers' knowledge of technology, science, and pedagogy comes together in knowing where (in the curriculum) to use technology, what technology to use, and how to teach with it." These three aspects of TPCK could be found by knowing pre-service science teachers' TK, TPK, TCK, and TPCK and their preparation in their education program related to TK, TPK, TCK, and TPCK.

In this current study, the case studies would include a sequential exploratory mixed methods approach, which involves collecting qualitative and quantitative data. The researcher's issue is that prior research in colleges explored pre-service science teachers' preparation quantitatively. Here, the researcher wants to investigate pre-service science teachers' preparation programs in college using qualitative exploratory mixed methods.

However, the qualitative data will be gathered first then followed by quantitative data. That means the main thing here will be the qualitative data. Also, in this design, the "results from the qualitative data analysis are used to help determine the focus and type of data collection in the quantitative phase" (McMillan, 2012, p.324). This research design works well, especially when the number of participants is slight, such as in the Fall semester of 2017-2018, when there are 11 Pre-service science teachers in the first and second semesters who are studying in the one or two-year LAMP program at UT. The researcher will use triangulation data in this study, which means that the researcher will be collecting data from multiple sources that include interviews, a survey, and document (a plan of study) analysis (Creswell, 2014, p.259).

Role of the Researcher

First of all, the researcher believes lecturers at universities should take responsibility to train students and inspire them to be good teachers by preparing them to be independent and internalizing their learning, which is the researcher interest and her job in her country as a lecturer of education technology for pre-service science teachers in an education program. Also, the researcher is interested in science teachers because the researcher has a bachelor's degree in biology.

Therefore, the researcher tries to prepare pre-service science teachers to be effective future teachers who can communicate well by being more knowledgeable in technology than their students, known as the generation of technology. Thus, the researcher is interested in knowing about the LAMP program that UT offers and how to prepare them to integrate technology, which will help the researcher in the future.

Selection of Site and Participants

The research site could be "limited to one metropolitan city or one small geographic area" (Creswell, 2014, p. 170). In this study, the site is the UT LAMP, particularly pre-service science teachers for middle school (Science Math, Science Language Arts, and Science Social Studies), whether in the two-year program or the one-year program. There are 11 pre-service science teachers for middle school who have one of the two selected areas being a science concentration (Science Math, Science Language Arts, and Science Social Studies), two of them in the two-year program in the second semester, and 9 of them in the one-year program in the first semester.

This study was conducted in the fall semester of the 2017-2018 academic year, and second-semester pre-service science teachers studying in the two years' UT LAMP participated in the study.

The study was conducted with one pre-service science teacher for middle school in Science Social Studies. The two-year LAMP pre-service science teacher took 36 hours of course credits; each course has three credits. These courses are EDP 5110 Basic Educational Psychology, SPED 5000 Issues in Special Education, CI 6120 Social Studies Methods, CI 6220 Social Studies Practicum, TSOC 5300 Philosophy and Education, RESM 5210 Testing and Grading, CI 6160 Social Studies Advanced Methods, CI 6260 Social Studies Student Teaching and Internship, CI 6410 Content Area Reading, CI 6950 Student Teaching and Internship, and CI 6890 Theory & Research in Teaching Content.

Data Collection Procedures

The data collection procedures "include setting the boundaries for the study, collecting information through unstructured or semi-structured observations and interviews, documents, and visual materials, as well as establishing the protocol for recording information" (Creswell, 2014, p.239). In this study, three data collection tools are used to investigate pre-service science teachers' preparation programs in college using qualitative exploratory mixed methods. There is a 40-minute meeting to gather information from the participant. At the beginning of the meeting, the pre-service science teacher started to check items from a survey called "Technological Pedagogical Content Knowledge Scale of Pre-Service Teachers" for ten minutes to get a general idea of their knowledge about what TPACK means in order to help them understand the questions in the interview. Then, the researcher started to interview for 30 minutes. In short, there are three data collection tools as following.

The first data collection tool that the researcher used in the interview. In the open-ended interviewing for this study, the researcher examines an issue related to pre-service science teachers' preparation programs in college. The researcher will conduct face-to-face interviews with pre-service science teachers individually and record the interview to study this. To determine how they have personally experienced their preparation program in college, which is the LAMP program at UT. Also, "these interviews involve unstructured and generally open-ended questions that are few in number and intended to elicit views and opinions from the participants" (Creswell, 2014, p.240). These open-ended interviewing questions will be related to pre-service science teachers' technology knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK).

The second data collection tool that the researcher use is "Technological Pedagogical Content Knowledge Scale of Pre-Service Teachers" survey that the researcher adopted from Sahin (2011). This data consisted of 7 subscales. In this study, the researcher will focus on four of them: TK, TPK, TCK, and TPACK. These subscales have several items, such as 15 items for TK, four items for TPK, four items for TCK, and five items for TPACK. This survey regards pre-service science teachers' preparation program in their technology knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK).

The third data collection tool that the researcher uses is a document, a planning study of the student and the curriculum they have taken during their program. However, for this study's purpose, the researcher only focused on two of these methods collecting data: interview and document.

Data Recording Procedures

According to Creswell (2014), in the procedures for recording data, researchers "plan to develop and use a protocol for recording observations in a qualitative study" also "plan to develop and use an interview protocol for asking questions and recording answers during a qualitative interview" (p.244). In this study, the researcher conducted a 30-minute interview that focused on gathering information about their knowledge about technology and how the LAMP program at UT prepares them to integrate technology into their teaching. The researcher audio-recorded the interviews using the iPhone Voice Memos application. Additionally, the researcher collected a plan of study from the participant, which is the curriculum they have taken during their program to enhance the information gathered from them about their knowledge and whether the LAMP program at UT prepared them to integrate technology into their teaching.

Data Analysis Procedures

According to Creswell (2012), there are six steps usually used in analyzing qualitative data, which are;

> engaging in an initial exploration of the data through the process of coding it; using the codes to develop a more general picture of the data descriptions and themes; representing the findings through narratives and visuals; making an interpretation of the meaning of the results by reflecting personally on the impact of the findings and on the literature that might inform the findings; and finally, conducting strategies to validate the accuracy of the findings (p.237).

These steps also illustrate how the researcher prepares and organizes the data for analysis, and it is not always taken in sequence.

In this research, the data analysis procedures started with recorded the interview, then completely transcribed by using an online software at www.trint.com; then, the researcher modified it to ensure the information's accuracy in order to analyze. Then the transcript and the survey were classified into four parts, each of them focused on one kind of knowledge on which the researcher built the interview: TK, TPK, TCK, and TPACK. The researcher also sought to identify and describe each pattern and theme from the participant's perspective (s), then tried to understand and explain these three broad patterns and themes to know what knowledge they have, where they learned that, and how they learned that. Finally, the researcher revealed descriptions and common themes that participants described their LAMP program experiences (Creswell, 2014).

Strategies for Validating Findings

According to Creswell (2014), "qualitative validity means that the researcher checks for the accuracy of the findings by employing certain procedures" (p.251). In this study, the strategies to ensure the validity findings include the following:

1. Triangulation**-** That means that the researcher will be collecting data from multiple sources that include interviews, survey, and document (a plan of study) analysis (Creswell, 2014, p.259);
2. Member checking—The researcher meeting does this with each participant two weeks after the initial interview. The individual meeting includes a review of the results and information that has been reorganized with each participant to correct any errors or misinterpretation (Creswell, 2014, p.259);
3. Peer examination—The researcher here shared the results with faculty members and a graduate assistant in the LAMP program and the Education Technology Department to examine and improve the findings (Creswell, 2014, p.259).

Research Ethics

According to Creswell (2014), "the code of ethics is the ethical rules and principles drafted by professional associations that govern scholarly research in the disciplines" (p.290). In this study, the researcher's strategy to conduct ethical research ensures participants' privacy, including using a pseudonym for the participants on the report, audio recordings, and hiding participants' identity (Creswell, 2014, p.138). Before and after collecting the data from the participants by interview, all participants must read and sign an informed consent form found in Appendix A. The informed consent explains the scope and the purpose of the study, the possible benefits and the risks of the participants, confidentiality, and participation contact information.

Findings

The interview participant was a pre-service science teacher studying in the second semester in the two-year LAMP program at the University of Toledo from the fall semester of 2017-2018 academic year. Choosing one student from the LAMP Program is because there is only one pre-service science teacher in Science/Social Studies in the two-year LAMP and is the most experienced in the LAMP program compared to those who are in their first semester. That provided an opportunity to limit the scope of the potential student experiences. The analysis of the interview started with recorded interviews that were transcribed entirely verbatim. Then the transcript was classified into four parts; each of them focused on one kind of knowledge on which the researcher built the interview, which was TK, TPK, TCK, TPACK. Here, the researcher sought to identify and describe each pattern and theme from the participant's perspective, then tried to understand and explain these patterns and themes to know what knowledge they have, where they learned that, and how they learned that. Finally, the researcher revealed descriptions and common themes that participants described from their LAMP program experiences. These three questions, which are *what* knowledge they have, *where* they learned that, and how they learned that, are the three broad themes for the researcher's analysis.

Note that a pseudonym is used for the participant’s name. The open-ended interviewing and “Technological Pedagogical Content Knowledge Scale of Pre-Service Teachers” survey that I adopted from Sahin (2011) display their technological pedagogical and content knowledge (TPACK) to integrate technology into their teaching.

Sam’s TCK; Where in The Curriculum to Use Technology?

According to the TPACK survey, Sam did not have any knowledge in the four TCK items: using area-specific computer applications, using technologies helping to reach course objectives easily in my lesson plan, preparing a lesson plan requiring the use of instructional technologies, and developing class activities and projects involving the use of instructional technologies.

The central theme here is that the participant does not have specific technology courses in the LAMP program to know where to use technology in his classes. Sam described that he learned about *where* in science to use technology in his classes “Basically from learning and from watching either through the orientation that we had here, also just in the classroom." Also, he added that he did not have experience using technology throughout his life. For example, he described that:

> when I went through school through education when I was in middle school or high school I mean we might have an overhead projector but the use of smart boards a lot of use of computers just wasn't there. I mean most of the course was a lecture it was all lecture coursework and there wasn't a lot of technology growing up. I remember when the school first had a computer and that was when I was in sixth grade. So the first time I saw a computer in a classroom was in sixth grade. Also, there was a few computers in the entire school but that was until sixth grade. Even when I was in high school, they were still teaching typing on electric typewriters. Also, I would give you an idea of the first computer I had in high school. Desktop computer with a black and white screen. It wasn't even a color screen. You're still spending fifteen hundred dollars. By today's standards, it would be about the for one of I mean your Chromebook has more power than what I think.

The lack of knowing where in the curriculum to use technology in the classroom is because there is no course provided in LAMP for pre-service science teachers, reflected in his study plan. Can et al. (2017) argue that pre-service science teachers' professional development program should add Instructional Technologies and Material Design and Computer courses, as a part of their preparation seen technology and science as a good combination after researching science education. To identify which parts of the science curriculum will be hard to teach and which technology could help, identify which topics in the science curriculum in which technology plays an essential role in what is being taught (McCrory, 2008).

Sam's TK; What Technology to Use in Your Classes?

According to the TPACK survey, the participant knows 7 of 15 TK items, which are using a word-processor program (ex., MS Word), using an electronic spreadsheet program (ex., MS Excel), communicating through Internet tools (ex., e-mail, MSN Messenger), using a presentation program (ex., MS PowerPoint), saving data into a digital medium (ex., Flash Card, CD, DVD), using the printer, using the projector, using the scanner, and using digital camera as illustrated in Table 1.

However, the participant does not know 8 items, which are solving a technical problem with the computer, knowing about basic computer hardware (ex., CD-ROM, mother-board, RAM) and their functions, knowing about basic computer software (ex., Windows, Media Player) and their functions, following recent computer technologies, using an electronic spreadsheet program (ex., MS Excel), using a picture editing program (ex., Paint), using area-specific software, and using the projector.

The other central theme is that the participant does not know much technology that he could use in his classroom. Even the technology that he knows, he knows the basics Sam described that:

> LAMP program. Basically it was just a lot of introductions of the different you know using a smart board using how to use that I call it the projector. And. So therefore when I went to my mentor teacher. And they have all these things in the classroom now they have the projector they have the smart board.

Table 1

Part of TPACK Survey for Sahin (2011) shown the Technological Knowledge (TK)

Subscale	Items (I have knowledge in …)	Check
Technology Knowledge (TK)	Solving a technical problem with the computer	
	Knowing about basic computer hardware (ex., CD-Rom, mother-board, RAM) and their functions	
	Knowing about basic computer software (ex., Windows, Media Player) and their functions	
	Following recent computer technologies	
	Using a word-processor program (ex., MS Word)	√
	Using an electronic spreadsheet program (ex., MS Excel)	
	Communicating through Internet tools (ex., e-mail, MSN Messenger)	√
	Using a picture editing program (ex., Paint)	
	Using a presentation program (ex., MS Powerpoint)	√
	Saving data into a digital medium (ex., Flash Card, CD, DVD)	√
	Using area-specific software	
	Using printer	√
	Using projector	
	Using scanner	√
	Using digital camera	√

Also, he added that he identified these technologies that are available to him and how to use them through self-education. Sam described that:

> You know I just started playing with it and utilizing it and learning how to do it. My mentor teacher she does something with a smart board I probably do a little bit more as far as using it. So in the program even in orientation and in the beginning I remember. Seeing it being used in. You know basically. Self-doing because it's available.

Sam described that he believes that the LAMP program should not teach these technologies because he thinks that there is an expectation that all pre- services should know about technology before they enter to LAMP program. So, he felt that he left behind and he needs to work by himself to learn that. Sam described that:

> I think there is almost like an expectation because most of you have to understand. In my entire cohort I'm the o rent generations. So therefore, your typical LAMP students is you know once a 20 in their mid 20s. They've used this stuff they'd probably have in their classroom. Whereas to me it's completely brand new. So, I'm learning it but it's not like I'm. Totally computer literate at all. So, they've either used it or they had in their classrooms prior to. coming in. But by the time. You know of us you know when I first graduated college, I graduated 96 and then I went for my first master's which was like in 2000. And just when I got my master's degree but that wasn't in organizational management it was not an education. It had nothing to do so I wouldn't have been exposed. To that it was a completely different field. So, this is so me entering the education field. In 2016/2017. You know there's probably you know a lot of expectations of these things being used because a lot of people probably even undergrad. So yeah, even though. There might be others in my age group if they've already got a C that's already gone through some sort of Education Program.

The lack of knowing what technology to use in his classroom because there is not course provided in LAMP for pre-service science teachers, as shown in his plane of study. Jita (2016) argues that teachers' training programs need to incorporate more training on information and communication technologies (ICTs) and redesign teachers' training programs to use ICTs in teaching science. In order to know what technology to use technology in their classes. McCrory (2008) argues that the essential knowledge that science teachers should know is their schools' technological resources. Also, teachers should understand them and apply them to their lives, teaching, and learning activities.

Sam's TPK & TPACK; How to Teach with Technology?

According to the TPACK survey, Sam did not have any knowledge in the four TPK items: choosing technologies appropriate for my teaching/learning approaches and strategies, using computer applications supporting student learning, being able to select technologies useful for my teaching career, and evaluating the appropriateness of new technology for teaching and learning. Also, he did not know the five TPACK items: integrating appropriate instructional methods and technologies into my content area, selecting contemporary strategies and technologies helping to teach my content effective, teaching successfully by combining my content, pedagogy, and technology knowledge, taking a leadership role among my colleagues in the integration of content, pedagogy, and technology knowledge, and teaching a subject with different instructional strategies and computer applications.

The other central theme here is that the participant did not learn how to use technology in his classroom. Sam described that he learned to use technology by asking his instructors the question, learned by himself, observed. Or watched. Sam described that:

> I just observe. I watched like as I said I've had a couple of lab instructors like Dr. Sanchez for example he showed a couple of things on how to do it because I asked a question like hey, I've never used a smart board. What can you tell me? You know I would just bring it up and ask questions and then they would show me a couple thoughts.

Also, he added that the LAMP program did not teach how he could use a particular technology in his classroom. However, he could ask his instructors who teach him in the LAMP program questions if they know this technology. Sam described that:

> LAMP program didn't teach these things for example today you will learn this technology and how you use it with teaching or how this help you. So, if you ask a question about specific technology and the lecture have this knowledge about this

> technology, they will give you the answer. There wasn't how you use smart board in the class or how to use an over-projector it was just I mean there is some part. It's just I mean. It was just one of those things like Was there anything specifically taught. No.

Additionally, Sam did not believe that the LAMP program needs to teach how to use technology in his classroom because he thought we could learn how to use it by learning certain functions. After all, he thought it is not hard to learn how to use technologies in the classroom or teaching. Sam described that:

> I don't think LAMP program really need to be a class to teach it. I mean a smart board isn't really anything different than things I've used in the past. I means I used to computers, so it isn't anything different. A smart board is basically just a dry erase board that. It is like you know you know you learn certain functions and, I'm sure.

It was clear that Sam was unknowledgeable in the functions of the technology, such as when he mentioned that "A smart board is basically just a dry erase board." Also, he added that students who teach them in classrooms know how to use technology more than him. Sam described that: "as I said, other kids that are there in the classroom in which I'm doing my student teaching, they probably have more knowledge than I do with it"

The other significant theme here that the participant did not learn how to use technology in his classroom because his "mentor teachers does not use it all that much" and he prefers the traditional way in teaching that means not using technology; Sam described that:

> I'm someone who prefers having using a board. So what I'm doing is teaching I prefer you know writing things on a board that's from my generation basically of. Lecture and coding and using a board and showing ldest person by like seven or eight years. So, there are two diffe
> it.

He mentions that he likes to use technology in teaching in the classroom. However, he could not use technology because he did not know all the functions that could help him use technology or use it in classrooms. Sam described that:

> It's like well this is cool because I can just circle it, tap it, erase everything and then move on to the next part. So do I incorporate

> it. I do it just because the tools are there. Do I know it forwards backwards sideways? Absolutely not. There's probably a thousand functions I know very little on how to use it right now.

Also, he added that even he or his monitor teachers were sometimes using a smart board in the classroom did not mean that they used all technology capabilities in teaching, or they were knowledgeable in all the functions of the technology. Sam described that:

> As far as I can sense of knowledge maybe some people use it for a little bit but they probably only use their phone for 1 percent of its capability just like the smart board I'm probably only using 2 percent of its full capabilities.

He lacks knowing what technology to use in his classroom because there is no course provided in LAMP for pre-service science teachers, as illustrated in his study plan. Also, he did not believe that the LAMP program should teach these technologies. However, teachers' training programs need to include introductory computer and technology courses to reduce teachers' anxiety and increase their competency and confidence in using technology in teaching (Anderson & Maninger, 2007). McCrory (2008) argues that science teachers need to "mine their own internal resources—their knowledge of science, of students, and of pedagogy—to anticipate and prepare for what will likely happen when the technology is used" (p.198). Habowski (2012) argues that he found "an increase in self-assessed TPACK, and a feeling of increased confidence as reported by the interns during the first-semester internship" (p. 30) of their professional development school (PDS) program concerning technology integration among pre-service science teachers.

In summary, one of the biggest shocks was that the participant did not have any knowledge in TPK, TCK, and TPACK, according to the TPACK survey (Sahin, 2011). Also, in technological knowledge (TK), the participant knew no more than 50 percent. Furthermore, the most important themes that he knew were the importance of self-initiated learning and that technologies are essential for him and teachers themselves. However, he did not believe that we should teach or use technology in some parts, and he preferred the traditional methods. That confused the researcher how he could think that technology is essential in facilitating education, but he did not believe that he should integrate technology into his classrooms.

Conclusions

This case has a substantial lack of knowledge in TK, TPK, TCK, and TPACK. However, he is a model case for science teachers. Therefore, it is essential to have multiple perspectives since not all share his perspective for not using technology. The researcher believes that personal preference and an intrinsic belief system influence his perspectives on the role of technology and whether it should be taught or not. However, some likely other participants may have different belief systems on this role depending on their background and experiences.

Additionally, other participants may have the opposite experience. For example, the researcher had a computer since the first one came out because their parents and the researcher felt that it would be necessary for the future. Because of this, the researcher has always felt that technology can be used to augment education. Also, educators should consider how people like Sam perceive technology and how his perspective and attitude toward technology relate to 21st-century skills. There is a mismatch between his perspective and modern skills, including technology and its use to facilitate several situations, such as teaching, communication, and other such uses. Moreover, students now grow up using technology even more than previous generations, so perspectives like Sam's will only become more out-of-date.

Therefore, it is even more important to know what teachers believe in the role of technology. This participant, for example, does not believe in its use in classrooms. That led the researcher to consider specific questions, such as how that plays within his classroom for students and how his attitude toward technology influences his students' attitudes.

Moving forward, this is a research area that the researcher is interested in and would like to continue to do this to know what teachers believe in technology's role. While this must be discussed as part of a serious investigation of the issue, it is uncertain which form will take. There are also teachers in the LAMP program who agree with Sam and yet continue in the program. They are identified as potential effective teachers in science, but the researcher has severe reservations about that effectiveness where technology is concerned.

Finally, it is unknown how many students like Sam are in programs like LAMP. If their numbers are large enough, that may pose problems in the future. That is not the example that we as a society want to hold up as teachers in front of a classroom where they model best practices. The researcher believes that teachers like that would not be able to prepare students for 21st-century skills. Therefore, designing programs that prepare pre-service science teachers to be effective teachers should think about this problem. Also, they should realize that it is an issue that requires further study. The researcher thinks that is probably the most important finding that has been seen as an educator. Technology will only continue to progress as time goes on; misguided attitudes cannot leave behind children's generations.

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