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Teachers Experiences with Learning Through Making

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This is to certify that the doctoral dissertation by

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Walden University
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Abstract

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by

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MEd, Indiana Wesleyan University, 2000

BS, Indiana University, 1993

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Learning, Instruction, and Innovation

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Abstract

Experts describe maker education as activities relating to the construction of artifacts that encourage learning through teamwork, problem-solving, and innovation. Teachers in recent years have been turning to maker-centered learning strategies to develop 21st century skills along with emphasizing strong content knowledge focusing on creation and creativity. Previous maker-based learning research focused primarily on the technology and tools associated with these activities; however, little research exists on the teachers' involvement with these learning strategies. The purpose of this phenomenological study was to explore the experiences of teachers currently using maker-centered learning strategies as an instructional practice in grade 5–12 classrooms. Based on the idea of constructing knowledge through active learning, the conceptual framework for this research encompasses multiple learning theories including constructionism, constructivism, experiential learning, and cooperative learning. The research examined the motivation of teachers' using maker-centered learning strategies and the challenges and benefits they have experienced. Data were collected using semistructured interviews and written lived experience descriptions from seven teachers currently using maker-based learning in their classrooms and analyzed using InVivo coding. The participants described their experiences as facilitators in student-centered classrooms that focus on collaboration and learning through failure. Time and assessment are common challenges while increased student engagement and student social and academic growth are common benefits. Experts maintain that maker-centered learning improves 21st century skills and prepares students for success in college, careers, and lifelong learning opportunities.

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Dedication

I dedicate this doctoral study to my parents- my father, the late Richard Girton and my mother, Anne Girton Kumeh - your love and support have made me the person I am today. Thank you for believing in me even when I did not believe in myself. To my amazing husband, Bob. You always knew when I needed an extra push, a break, or a good laugh to reduce my stress. Thank you for listening to me talk through ideas even when I made absolutely no sense, for being supportive of my decision to undertake this journey, and for not letting me give up no matter how often I wanted. I love you more than you know.

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KVMS: To the staff and students- Thank you for your proofreading, your confidence, and your support while keeping me grounded. You mean the world to me!

Finally, to my favorite rock star, Ginger Lewman, my life changed that day in the Blogger's Cafe at ISTE. Thank you for always answering my questions, sharing your vast knowledge, assisting in gathering the participants for this study, and just being your fantastic self.

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Chapter 1: Introduction to the Study

Background of the Problem

The need for more science, technology, engineering, and mathematics (STEM) curriculum has become a commonly used mantra in education over the last decade. According to Reeve (2014), a need for a globally competitive workforce drives the push for STEM curriculum. STEM careers require 21st century skills such as problem-solving, collaboration, critical thinking, and communication (Hilton, 2015). According to Greenstein (2012), the time has come for schools to stop focusing on what students know and instead to focus on what students can do with that knowledge. It is becoming increasingly important to prepare students with the abilities to think critically, collect and evaluate evidence, and solve complex problems. STEM-based learning activities are commonly used to teach these skills.

Educators need to teach students skills to solve problems never seen before and that they may not see for years. Jerman et al. (2018) discuss careers in digital and virtual factories and high-tech smart system jobs, along with the areas of artificial intelligence, mechatronics, and robotics. The traditional classroom is data-driven and policies such as No Child Left Behind and Race to the Top rely heavily on standardized test data to monitor student growth and teacher performance (Lauen & Gaddis, 2016). Students take an average of 112 mandatory standardized achievement tests during their education (Hart et al., 2015). These standardized test scores influence student promotion, remediation or extension opportunities, class placement, course suggestions, and graduation. These test scores are also publicly reported and linked to teacher evaluations, school funding, teacher contract decisions, school rewards, and sanctions (Segool, Carlson, Goforth, Von Der Embse, & Barterian, 2013). According to Ackerman (2004), these direct instruction based methods have shown little impact on improving student achievement.

The increased pressure on schools to offer STEM curriculum and meet student achievement goals has led to the use of *maker education*. The term maker education refers to hands-on activities that encourage academic learning through teamwork, experimentation, and problem solving (Herold, 2016). While the label maker education is relatively new to the educational arena, according to Martinez and Stager (2013), solid educational constructs that include hands-on learning, problem-based learning, and arts-based initiatives are the foundation of this movement. Maker education has developed into a significant movement in the field of education with schools and teachers attending workshops and conferences dedicated to making and attempting to implement maker approaches in their classrooms.

In this study, I focused on maker-centered learning and the experiences of teachers who follow this mindset. Experts describe making and the maker as those activities relating to construction and fabrication using technological resources in a learner-centered environment that promotes design through collaboration and innovation (Papavlasopoulou, Giannakos, & Jaccheri, 2017). Dougherty (2016) described the maker movement as a platform for collaboration and creativity beyond what previously existed.

Maker-based learning practices encompass the do-it-yourself movement, STEM and STEAM education, increased technological resources, project-based learning, and the need to get more students interested in STEM fields. The focus of the maker mindset as it applies to educational settings is on learning through encouraging students to have a sense of inventedness to explore answers in an engaging and interactive manner. Over the last decade, maker-based learning has moved into K–12 settings to provide hands-on learning opportunities for students of all ages. Making in the classroom includes activities in science and math classes as well as courses specifically devoted to making such as the Project Lead the Way curriculum.

Project Lead the Way (PLTW) is a nonprofit organization that has developed a hands-on curriculum for use in schools to develop students' appreciation of how math and science relate to the world around them. PLTW teaches students to apply what they learn to real-world concepts and enable students to use the knowledge and skills they need to be successful in a technology-based world (Cahill, 2016). Making in the K–12 educational setting takes on many forms in multiple settings, including classrooms, school libraries, computer labs, industrial arts classrooms, and visual or fine arts classrooms.

Student-centered maker-based classrooms differ significantly from traditional classrooms. A growing number of schools are embracing the philosophy of the maker movement to create meaningful and engaging learning experiences. Recently, the addition of increased focus on creativity in STEM curriculum and technology has schools utilizing the arts in a movement referred to as STEAM (Peppler & Wohlwend, 2018). Research shows that creativity, accompanied by structure and guidance, supports deep student learning (Bevan, Petrich, & Wilkinson, 2015). These types of creativity have existed at such places as the Tinkering Studio in San Francisco and making can provide this creativity in the classroom (Bevan, Petrich, & Wilkinson, 2015). According to Halverson and Sheridan (2014), making is poised to make an impact on schools and students, but there is little research to support the use and benefits of making in schools or the teachers who use maker-centered activities in the classroom. Harlow and Hansen (2018) stated that the maker movement is on the verge of transforming education from a focus on testing and monotony to emphasizing creation and creativity.

Problem Statement

Today's teachers are expected to meet many demands, including strong content knowledge, meeting all types of students' learning needs, and developing 21st century skills. One way that teachers are doing this is by utilizing a maker-centered learning philosophy. According to Dougherty (2016), making is a mindset rather than a curriculum or set of planned activities. Chu, Quek, Bhangaonkar, Ging, and Sridharamurthy (2015) found that developing a maker mindset in children supports their ability to complete technical tasks and problem solve. In their future education and careers, students will be asked to synthesize the available information efficiently and effectively apply that knowledge to solve increasingly more complex tasks.

The amount of research that focuses on the use of maker tools and strategies with various student populations, including research on 3D printing (Wang, Zhou & Wu, 2016) the use of computer software (Sullivan, 2012), and design thinking approaches (Retna, 2016) has grown over the course of the last decade. Researchers have examined learning experiences and benefits of making with specific student populations including students in a hands-on museum environment (Brahms &

Wardrip, 2016), high school engineering students (Nichols, 2016) and early childhood students (Brahms and Wardrip, 2017). However, the research concerning educator experiences in this area is limited.

Of the studies I was able to locate during the course of completing this literature review, research included experiences of pre-service teachers who developed a one-time Maker Faire activity at a school (Madden, Beyers & O'Brien, 2016), teachers who took part in workshops exposing them to various maker tools and strategies for integrating maker-based learning (Cohen, Jones, Smith, & Calandra, 2017, Jones, Smith, & Cohen, 2017; O'Brien et al., 2016; Paganelli et al., 2016). Cohen, Huprich, Jones, and Smith (2017) and Hsu, Ching, and Baldwin (2018) conducted research examining teachers' perceptions as they participated in graduate courses using maker projects.

Researchers have also studied maker-based learning practices in areas outside the K–12 classroom such as libraries (Curry, 2017; Lugya, 2017), mobile maker labs (Craddock, 2015), higher education settings (Gaskins, Johnson, Maltbie & Kukreti, 2015), and extracurricular learning opportunities (Vossoughi, Escude, Kong, & Hooper, 2016). Other research on teacher experiences focused on related concepts such as educational games for hands-on learning (Qian & Clark, 2016) or project-based learning approaches (deChambeau & Ramlo, 2016).

While each of these studies has contributed to the understanding of the benefits to students and their perceptions of maker-based learning as well as educator attitudes toward integrating maker tools and activities into their instruction, none have included the teachers' experiences with these learning processes. The purpose of this qualitative study was to describe the experiences of K–12 teachers currently using maker-centered learning as an instructional strategy within their learning environments. In this study, I explored and why teachers use maker-based learning practices as part of the curriculum. I explored how and why teachers use making as part of their classrooms as well as the benefits and challenges for themselves and their students encountered in the use of making as part of the curriculum.

Purpose of the Study

The purpose of this qualitative study was to describe the experiences of teachers currently using maker-centered learning as an instructional strategy in their learning environments. The experiences these teachers shared provide a rich context to explore why these teachers instituted maker-based learning practices and how they implemented this change in their teaching practices. I researched the benefits and challenges teachers perceived as affecting their classroom environments. This research is particularly important as teachers are expected to provide more services and meet higher expectations in their classrooms. I interviewed current teachers of Grades 5–12 who use maker-centered learning in their classrooms in an effort to describe their experiences, as well as perceptions of the benefits and challenges, and motivation. I sought to understand why teachers chose to use maker-based learning practices as an educational pedagogy and what knowledge or practical wisdom the teachers have gained from using this type of teaching and learning.

I interviewed teachers from multiple states who are currently integrating maker-centered learning activities as a part of their instructional practices. The participating teachers were volunteers that I located using the participant list from a workshop led by an educational consultant at a nonprofit educational service center. The facilitator of this professional learning experience, who is a member of my professional learning community, agreed to provide the contact information for the participants in her workshops. Participants were teachers who have participated in a professional learning experience where they learned how to shift from a traditional classroom to a STEAM-based maker-centered classroom environment. I found the second pool of participants using recommendations from teachers in the researcher's professional learning network.

Participants shared background information using an online questionnaire. The questionnaire involved topics including the subject and level taught, the length of experience in using maker-centered learning activities, and the demographics of the area they are teaching in. The list of participants who met the decided upon criteria was then asked to participate in more in-depth interviews. The requirements for participation included a minimum of 2 years teaching in a K–12 classroom using maker-centered learning activities regularly.

Societal Impact

There are two aspects of societal change related to the study of hands-on, collaborative STEM education. Maker-based learning experiences are of particular importance for students in low-income areas and urban or very rural areas, where funds and opportunities for access to experts and mentors knowledgeable in STEM topics are limited (Barton, Tan, & Greenberg, 2017). Researchers posit that the purpose of encouraging STEM careers is for improved global economic competition (Garibay, 2015). According to Phelan, Harding, and Harper-Leatherman (2017), STEM careers correlate with higher salaries, and the disproportional number of underrepresented students engaged in STEM opportunities contributes to economic and social inequity in the United States. Underrepresented students include students of color, female-students, and students from lower income areas who may not have access to maker-based learning practices. Maker-based learning practices have been found to breakdown socioeconomic barriers, according to Barton, Tan, and Greenberg (2017). Somanath, Morrison, Hughes, Sharlin, and Sousa (2016) found that maker-based learning practices increased school engagement, improved technical literacy skills, and led to healthier personality development through collaboration, peer involvement, and self-efficacy skills. Similarly, Sheffield, Koul, Blackley, and Maynard (2017) found that girls involved in maker-based learning practices were more likely to show increased communication, perseverance, and positive attitudes regarding STEM topics.

While research leans toward the economic benefits of maker-based learning practices, Clapp et al. (2017) assert that maker-based education helps to promote students' comprehension of social issues and finding solutions that are meaningful to their community. Researchers in STEM education emphasize that maker-based learning practices aide in the development of students' understanding regarding social issues, their potential to design solutions for these problems, and other needs of a global society (Barton, Tan & Greenberg, 2017; Schell, 2016). The Next Generation Science Standards for K–12 students stress the importance of teaching students to ask questions, define problems, and design solutions for issues in their own communities and the world at large to become agents of change (Rachmawati, Prodjosantoso, & Wilujeng, 2019).

One of the main tenets of maker-based learning is the collaborative nature of making and learning. Students and makers in general work together to solve problems in social settings (Dougherty, 2016). In the same way, students can grow to work collaboratively to solve real-world problems. Those with a maker mindset work together to identify and solve social, environmental, and global problems. Garibay (2015) suggests that making social change a focal point in education and providing students the opportunities to research real-world issues may increase students' social empowerment, which encourages students to understand that they can make a difference that results in change (Clapp et al., 2017).

Research Questions

The questions that I used to guide this research were as follows:

Research Question 1 (RQ1): What are the experiences of teachers planning, creating, and using maker-centered learning as an instructional strategy in their classrooms?

Research Question 2 (RQ2): What motivates a teacher to implement a maker-centered curriculum as an instructional strategy in their classrooms?

Research Question 3 (RQ3): What do teachers understand to be the challenges and benefits that they have encountered as they use maker-centered learning?

Research Question 4 (RQ4): What types of changes have teachers seen in themselves and their students since the implementation of maker-centered learning activities?

Conceptual Framework

The constructivist theory describes the experiential nature of learning and how individuals construct what they learn. Experiential learning and the construction of knowledge are essential components of maker-based learning practices. According to Hasan Khan (2013), a constructivist learning environment is student-centered, with the teacher acting as a facilitator who must create a learning environment conducive to active learning. Active learning refers to a method of instruction in which students are purposefully involved in the learning rather than just listening to and absorbing content (Bonwell & Eisan, 2005). In the case of maker education, learning takes place as students work to solve a problem.

According to Dewey (1938), the construction of knowledge is a cognitive activity, and that while engaging students with physical activities and hands-on lessons may be essential to learning, it is often not enough. Teachers must provide activities that involve the minds and hands of students to build knowledge through a process of education and experience. Piaget (1968) stated that the teacher's role is to facilitate learning. Maker-centered learning activities provide the teacher with opportunities to engage students in building knowledge.

Constructionism states that learning occurs best when students actively work with media or objects to create and build artifacts shared with others (Papert, 1993). This theory of active learning is found throughout all aspects of the maker movement as well as other educational approaches often linked with maker education and maker-based learning practices including work on peer learning, cooperative learning, project-based learning, experiential learning, and challenge-based learning.

Research Design

The purpose of this phenomenological qualitative study was to describe the experiences of teachers currently using maker-centered learning activities as an instructional strategy within their learning environments. The phenomenological research included data collected through interviews from teachers using maker-based learning practices in their classrooms. Through the interviews, I sought to determine the participant’s successes, obstacles, and motivations in developing and using maker-centered learning practices as a part of their learning environments. According to Vagle (2014), phenomenological research is used to explore the connections and relationship between the person and the experience. In this study, I aimed to explore the relationship between teachers who choose to use maker-centered learning activities and their perceptions of this approach to student learning.

Definitions of Terms

Maker education: Maker education is an instructional approach that relies on hands-on, collaborative learning experiences focused on solving authentic, real-world problems, according to Dougherty (2016). As an offshoot of the maker movement, maker-centered learning activities emphasize students’ creativity, problem-solving, and critical thinking skills. Maker education programs take place across a variety of environments including, classrooms, university settings, camps, community programs, and libraries. For the sake of this research study, the focus will be maker-based learning practices in a K–12 classroom.

STEAM education: STEAM fields are science, technology, engineering, art, and math connected and designed to integrate STEM subjects into other disciplines to teach students to think critically and take a creative approach to problem-solving (Jolly, 2014). According to Moreau and Engeset (2016), business leaders and educators are rating creativity as a critical leadership quality that is lacking in many individuals entering the workforce. The need for creativity has led to the addition of an arts component to STEM education, resulting in STEAM education. Hunter-Doinger and Sydow (2016) state that evidence shows creativity to be equally as important as the other components in the learning process. Artistic elements to learning increase traits such as motivation, innovation, responsibility, and self-efficacy (Madden, Beyers, & O'Brien, 2013).

STEM education: Science, technology, engineering and math (STEM) make up the academic subjects typically associated with education policy and curriculum decisions in schools (Gonzalez & Kuenzi, 2012). The influence of STEM education has grown in both education and the workforce. An increase in expectations for schools to provide STEM education opportunities is a common theme in the media. According to Erdogon and Stuessy (2015), careers in STEM are estimated to grow significantly over the next decade. The typical teacher certification demands little in the way of STEM which requires teachers to engage in continuing education events and professional development opportunities, according to Nadelson et al., (2013).

Assumptions

I assumed that the teachers gave me honest and open responses during the interviews. The interview data were kept confidential to make this possible. Because the interviewees agreed to take part in the research study regarding the use of maker-centered learning activities, I also assumed that the participating teachers used making as an instructional method in their curriculum and had a positive feeling about the impact of maker-centered learning activities on students and their learning.

Limitations

The number of participants was limited to no more than ten teachers, thus not allowing for generalizations of a large population. However, teachers represented different grade levels, educational settings, years of teaching experience, and experience using maker-centered learning practices to provide different insights into learning. A second limitation involved consistency in coding. With only one researcher the data analysis could lack interrater reliability. A peer debriefer aided in the research process and provides interrater reliability. The peer debriefer has experience with qualitative research analysis and supports the credibility and trustworthiness of the research by reviewing the emerging themes and clarifying interpretations. Additionally, I tried to ask clarifying follow-up questions and consistently code all data as collected.

Significance of the Study

According to Maughan (2018), the maker movement is poised to change education radically. Unlike the regimented traditional classroom, the maker-based learning classroom encourages student-centered, interest-driven, and process-oriented curricula. Where a conventional school environment has separated subject matter into efficient categories of learning, such as reading, social studies, science, and math classes, a maker-based learning classroom advocates the fusing of these parts together in support of the understanding that in the real world, no such divisions exist. Sheridan et al. (2014) explained the value of the multidisciplinary classroom saying that maker-centered learning practices seem to break down disciplinary boundaries and facilitated process- and product-oriented practices leading to innovation. In a school with maker-based teaching and learning, students are challenged to be creators rather than consumers of their learning. Advocates of maker-centered learning practices claim that this integrated format has the capability of reframing the way students learn in the areas of STEM education. Daugherty (2013) urged institutions to rethink the purpose of school and to consider how students learn best.

Schools are focusing on preparing students for college, but manufacturing companies are seeing a shortage of skilled workers. Schools need to provide technical training and include programs that support on-the-job apprenticeships (Kavanaugh, 2017; Smith & White, 2017).   This interdisciplinary approach focuses on creativity, innovation, design thinking and inquiry which mesh with the maker education and maker-based learning movement (Schooner, Nordlof, Klasander, & Hallstrom, 2017).

A classroom that focuses on maker-centered learning activities offers a new type of learning environment that moves beyond the traditional practice of a teacher imparting knowledge at the students sitting in a cemetery style classroom setting to one of student exploration in learning. Introducing this type of education may be challenging for teachers who are more familiar with textbook-based teaching. A maker-centered classroom is not the neat and tidy, quiet learning environment that many teachers are experienced with using (Herold, 2016).

The role of the teacher in a maker classroom must change from the sage on the stage distributing information to the position of mentor, problem-solver, facilitator, activist or networker, according to Rico and Ertmer (2015). Dougherty (2016) state that educators using maker-centered learning activities see their roles as facilitators who guide the students' learning experiences.

Preservice teacher education programs and traditional teacher role models have conditioned teachers and school administrators to align classroom practice with a predetermined set of learning expectations, with very little flexibility to support a culture of innovation, according to Goh, Yusaf, and Wong (2017). This misalignment between formal teacher training experiences and the pedagogical philosophy tied to making might be a challenge with regard to implementing a maker-centered program for some teachers and school administrators (Goh, Yusaf & Wong, 2017). Maker-centered learning requires a classroom environment and teacher that can successfully manage an experiential teaching and learning style with less focus on subjects and more time spent on the experience of learning, according to Dougherty (2016).

According to Martinez and Stager (2013), the ability to cultivate classroom conditions that are supportive of creativity is critical to developing a thriving maker-centered classroom environment. The authors go on to explain that the support of innovation in these educational spaces is vital for success in classrooms using maker-based learning. Students should feel a sense of acceptance, creativity, and freedom.

The influence of maker-based learning practices can increasingly be felt in the K–12 classroom, and there is a belief that implementation of the maker movement within education can bridge the ever-growing gap between formal classroom knowledge and real-world problem-solving (Martinez & Stager, 2013). However, there is little known about the ways in which teachers have chosen to implement maker practices, what their overall perceptions of the movement are, and how their own maker experiences have impacted their teaching practices. This study fills a significant gap in the literature regarding teachers using maker-centered learning as an instructional tool within their classroom environments.

Organization of the Remainder of the Study

The remainder of this study will include an overview of maker-centered learning and the experiences of those educational professionals using it. The literature review includes a discussion of the conceptual framework of the research discussing constructivism and constructionism. The literature on the learning theories associated with maker-centered learning is examined in the analysis of the research section. I explored maker environments and the recent push for increased education in STEM/ STEAM areas in the next portion of the literature review. The collaborative nature of maker-centered learning is in the following section where I expand upon the need for STEM / STEAM learning to prepare students for future success. Finally, I summarize the findings as this section leads to the selected research methodology.

Chapter 2: Literature Review

The purpose of this phenomenological qualitative study was to describe the experiences of teachers currently using maker-centered learning practices as an instructional strategy within their learning environments. I sought to determine the participants' experiences in developing and applying maker-based learning practices, their perceptions of the benefits, challenges, and student learning outcomes associated with a maker-centered classroom, and their understanding of their roles as teachers in this type of learning environments. I sought to explore why and how teachers use maker-based learning practices and the teachers' perceptions of making as a method for increasing student learning. In this chapter, I provide an examination of the evolution of maker-centered learning, the educational theories and models associated with maker-centered learning, and finally, the benefits seen in classrooms using maker-based learning practices.

Maker Movement

Making is defined as the use of resources to create something of interest (Chu, Quek, Bhangaonkar, Ging, & Sridharamurthy, 2015). There are several viewpoints of making as a movement. The maker movement, according to Dougherty (2013), is a social movement encouraged by people who create their own way with a sense of what they can do as well as what they are capable of learning to do. Papavlasopoulou et al. (2017) refer to the maker movement as a broad topic that builds on the idea of an individual as a maker. Dougherty describes makers as people who see new, inexpensive technologies as an invitation to play (Thomas, 2014). According to Thomas (2014), the maker movement acknowledges and rewards the principles of responsibility, resourcefulness, skill, and persistence. This acknowledgment develops a sense of empowerment for people who believe that they are capable of making.

Maker-based learning practices in schools are generally associated with the areas of science, technology, engineering, and math. Educational leaders in recent years have called on institutions to encourage student learning through maker-centered learning activities that grow the maker mindset through meaningful and engaging learning activities (Cohen et al., 2017). Although not focused explicitly on education, the maker movement advances many goals in formal education. Making has been found to improve STEM education and to promote 21st century skills such as creativity, problem-solving, collaboration, and self-expression (Kalil, 2013). In maker-based learning practices, the emphasis is on fostering this maker mindset to empower learners of all ages.

The concept of making something and exchanging the knowledge and expertise is fundamental to the maker movement and maker-based learning, according to Hatch (2013). Learning and sharing are critical components in settings in which maker-centered learning practices are used. According to Dougherty (2013), there are several requirements for bringing the maker movement to education. Schools must create a culture in the learning environment that develops a maker mindset or a growth mindset. Educators must also strive to link the practice of making to formal academic standards and concepts. Schools and preservice teacher programs must develop new measures of teaching to encourage making in the classroom and prepare teachers who utilize these goals (Maughan, 2018). Educational settings need to identify, promote, and share an extensive database of projects and kits based on the varied interests of those involved. According to Dougherty (2013), schools should host online social platforms to encourage and support collaboration among teachers, students, and the community. To promote the maker movement schools should foster programs that help students to take control of expanding the interests of others and build the group of makers. Finally, educators should work to foster confidence and creativity in all students as agents of change in their own lives, their schools, and their communities (Doughtery, 2013).

According to Dougherty (2013), the process for bringing the maker movement to school involves creating a context in which to build a maker mindset including designing and developing maker-based learning environments. Seymour Papert's work on constructionism and making began with the formation of the Fab Lab at MIT in 2001 and spread quickly as other Fab Lab branches opened at other universities (Barrett et al., 2015). Fab Labs, short for Fabrication Laboratories, offers a variety of machines and tools, including computer-aided design cutting machines, drill presses, 3D printers, and laser cutters. These open spaces are available for anyone to use if they share what they make and learn with others (Doughtery, 2016). According to Forest et al. (2014), while creativity and innovation are central to the engineering process, open-ended design programs in a university setting are uncommon. K–12 educational settings can offer this same accessibility.

According to research completed by Project Zero of Harvard School of Education, three characteristics can evolve from using maker-centered learning practices. The first theme is that of a community characterized by collaboration, an expectation to share information and ideas with others and distributed teaching and learning (Clapp et al., 2017). The second characteristic of making is a process which includes problem-solving, flexibility, experiential learning, and a driving curiosity. Finally, the environment where making takes place is an important characteristic. The environment generally consists of open and accessible places rich in tools and a variety of media, according to Clapp et al. (2017).

The process of making involves teamwork and problem-solving, which allows students to construct their own knowledge. These learning processes have been in classrooms since before the maker movement formally began. Similarly, many teachers are familiar with other common themes in maker-centered learning including collaborative learning, peer learning, experiential learning, and cooperative learning (Clapp et al., 2017). The conceptual framework for this study involves these common theories and learning strategies.

Conceptual Framework

The conceptual framework connects research to show the system of perceptions, assumptions, expectations, and theories that promote and inform research (Jabareen, 2009). The notion of constructing knowledge through active learning is the basis of the conceptual framework for this study. Dewey believed that motivation to learn occurs when students have some choice about how and what to study (Dougherty, 2016).

Many of the educational theories that experts associate with maker-centered learning practices are not new to teachers, including the theories influencing this research of constructivism and constructionism. Experts express that making involves theorists studied by all educators including Piaget, Montessori, and Paper (Maughan, 2018). According to these theories, learning takes place in an active, hands-on social manner. Each of these approaches supports one another and in their own ways impacts maker-based strategies as a learning method.

Constructivist Learning

Constructivist learning evolved from the work of childhood development scholar Jean Piaget as he synthesized the work of Dewey, Montessori, Frobel, and others with his own work. Constructivism focuses on cognitive development and a deep understanding of a topic as a learner constructs knowledge in an efficient manner (Fosnot & Perry, 1996). Piaget believed that learning occurred by tinkering, making, and engineering solutions to problems (Stager & Martinez, 2013). Piaget theorized that when teachers present students with a learning environment grounded in action, students can meet with success in all areas (Dougherty, 2016). Feedback and self-reflection reinforce new insights. According to Yoders (2014), constructivist teaching features cognitively active learners, building on their prior knowledge. Hands-on, constructivist learning is learner-centered, and learner-driven and allows students to create their knowledge as they build upon experience (Sharma, 2014).

There are several constructivist learning models available and each focus on a cyclical approach. As children work together in constructivist settings and engage in meaningful activities, learning and development occur (Li & Liam, 2013). Yoders (2014) found several essential aspects of constructivism in practice. One fundamental facet is that learning occurs when students are cognitively and actively involved. New knowledge is built upon prior experience as learning is applied and feedback provided. Finally, reflection by the learner is key to the process (Yoders, 2014).

Teaching behaviors associated with constructivism include the encouragement of student initiative, student-driven lessons, questioning techniques used to garner student understanding, and encouraging students to discuss their ideas and perceptions with one another and the teacher (Keiler, 2018). According to Martinez and Stager (2013), making is a way to approach education and the ability to solve problems through active learning, discovery, and experimentation with creativity. This meaningful experimentation is a primary connection between constructivism and maker-centered learning practices.

Constructionism

Constructionism is often confused with constructivism. Both constructivism and constructionism incorporate the concept of building knowledge. Constructionism, or the process of thinking about learning, is described as how people learn by beginning a task or creating a prototype, reflecting on the work, revising, and sharing (Martinez & Stager, 2013). Constructionists posit that learning comes from experience and the construction of understanding, often in a social setting (Martinez & Stager, 2013).

Papert used the term constructionism to propose that students be permitted to utilize a focused learning model that relies on hands-on learning. Constructionism emphasizes building an artifact, discovering issues, and comprehending them is the most effective approach to learning (Noss & Clayson, 2015). The objective of constructionism is to give students activities with the goal that they can learn by showing improvement over what they could previously, according to Khanlari (2013). Papert effectively anticipated the use of innovation, that would enable students to apply their learning to different subjects through inventiveness.

When teachers utilize Papert's constructionism to incorporate making and planning, they see the artifact as a model of student learning (Khanlari, 2013). Martinez and Stager (2013) give credit to Seymour Papert as the father of the maker movement because the process of making plays an active role in learning through experiences. Papert takes the constructivist approach further toward the action end of the learning spectrum with constructionism as learning takes place in a meaningful activity that makes learning authentic and shareable (Martinez & Stager, 2013). These experiences build on existing knowledge with exposure to new ideas. According to constructionism, the creation of shareable artifacts is essential to the ability to construct knowledge or formulate understanding. These artifacts are evidence of learning (Martinez & Stager, 2013).

The constructionist learning theory promotes student-centered discovery learning where students build connections between ideas aided by the teacher who facilitates rather than offering direct instruction (Noss & Clayson, 2015). The most effective learning, according to Noss and Clayson (2015), takes place when learners are active participants in the making of objects in authentic learning situations. With active learning, activities replace the direct instruction of information by the teacher. These activities include class discussion, role-playing, peer review, and game-based learning tasks. This active participation in collaborative learning environments is central to Papert’s theory of constructionism and maker-centered learning practices (Thompson, Lindstrom & Schmidt-Crawford, 2017). In programs using maker-based strategies, learners have control over their own learning through the building of knowledge (Papavlasopoulou et al., 2017)

A framework known as Makification bridges constructivism, constructionism, and the maker movement (Cohen, Jones, Smith, & Calendra, 2017). The principles of Makification include creation, iteration, sharing, and autonomy (Cohen et al., 2017). These principles of Makification coincide with Hatch's principles in the Maker Manifesto. The first principle of the Maker Manifesto is that physically making artifacts is fundamental to building deeper learning (Hatch, 2013). The second principle of the framework, iteration, is modifying the design process. Researchers found this acceptance of failure and the willingness to persevere in being critical to the idea of maker-based learning practices (Martin, 2015). According to Papert (1993), sharing and reflection are vital to making. The process of sharing, personally or digitally, inspires and encourages students to build on the work and ideas of others (Sullivan, 2015). Ardito, Mosley, and Scollins (2014) found that students using robotics in mathematics had an increase in academic skills and collaborative thinking and working. The final principle of Makification is autonomy, per Cohen et al. (2017). This personal connection to making results from the choice involved in making, students' personalization of projects, and the ownership arising out of creating artifacts.

Ownership results in enhanced motivation, according to Savery (2006). According to Gerstein (2016), maker-based learning practices involve student-centered tasks based on authentic problems that involve creativity and innovation. Motivation and student engagement also increases with other active learning strategies associated with maker-centered learning practices. These active learning strategies are features of constructivist and constructionist learning theories. While not educational theories, active learning strategies are also found to promote experimentation and collaboration with peers (Herold, 2016).

Active Learning and Maker-based Learning

While constructionism and constructivism are two widely touted learning theories associated with maker-centered learning practices, other instructional strategies are also related to the maker movement in education. The strategies discussed in the following section have all been termed active learning strategies, meaning that students are learning through active processes or learning by doing. Researchers found that an average of 98% of the teachers asked felt that students learn better by doing through some active task (Moye, Dugger, & Starkweather, 2016). According to Freeman et al., (2014), active learning strengthens students' abilities to develop their own answers. Active learning concentrates on the teaching function, enables students to be responsible for their own learning, involves the students with thinking and problem-solving as they process through the tasks presented. These active tasks can be associated with Vygotsky's social constructivism and his theory of peer learning and the Zone of Proximal Development.

Zone of Proximal Development.

Integral to maker-centered learning is the theory of peer learning and the work of Lev Vygotsky. Peer learning involves students interacting with one another to complete educational tasks and meet academic goals (Clapp et al., 2017). Vygotsky's social constructivist model focuses on the social interaction that increases learning. Vygotsky posits that learning moves along a continuum from a social context to the internalization of knowledge by the learner (Amineh & Asl, 2015). According to Vygotsky, students learn from and with one another, resulting in increased self-esteem, teamwork, and communication skills (Clapp et al. 2017). The cycle includes engaging in and exploring a topic during an activity, explaining and elaborating on the concept with teacher guidance, and evaluating or reflecting on the idea (Sharma, 2014). One aspect of the social constructivist learning model is that of Vygotsky's Zone of Proximal Development within which learners transcend developmental stages though processes such as scaffolding and apprenticeship (Li & Lam, 2013). Vygotsky found that students can reach educational goals otherwise outside their ability levels with assistance from others, a concept referred to as scaffolding. The range between a student's independent developmental level and the level of potential development when working with peers is considered the zone of proximal development.

Like other constructivist theories, social constructivism stresses problem or project-based learning, peer interaction, and collaboration among both learners and experts from outside the classroom (Gross & Gross, 2016). According to Amineh and Asl (2015), collaboration is an essential aspect of Vygotsky's theory of the Zone of Proximal Development and constructivist learning to aid students in the construction of knowledge. This construction of knowledge is evident in maker-based learning practices. The interdependence of learners leads to collaboration between students as they work together to construct knowledge.

Interdependent learning theories.

Collaboration and the construction of knowledge are not fundamental to only constructivist and constructionist theories. Over the past few decades, changes in education have resulted in a variety of models for this learner-driven style of education. These discovery-based learning experiences involve more inquiry, collaboration, and experiential learning situations (Reynolds, 2016). Researchers identified teamwork and cooperation as the central core in building meaning to solve complex problems (Asunda & Mativo, 2016).

Cooperative learning is an example of a student-centered instructional strategy in which students work as a team, are responsible for their own education and are also charged with assisting in the teaching of all group members (Li & Liam, 2013). During cooperative learning activities, students interact with other group members and work together to solve a problem or reach a common goal.

Collaborative learning, a central element of inquiry-based learning, builds on the view that knowledge is a social construct as students work collaboratively to solve complex problems, complete tasks, or create artifacts (Alamjed, Skinner, Peterson, & Winning, 2016). The ideas that learning is student-centered, students learn by doing through group work and peer support, and authentic activities are real-world based are the basis of collaborative activities (Hummel, 2015). These collaborative skills often need to be taught and modeled by the teacher, according to Farrell and Jacobs (2016). The use of these principles ensures cooperative efforts.

Researchers have found four elements that teachers should encourage and monitor during cooperative learning to ensure collaborative efforts. Positive interdependence recognizes that each group member has a unique contribution to make to the group and students must rely on one another to make those contributions (Desai & Kulkarni, 2016). Heterogeneous groups formed with members whose skills and experiences vary in numerous ways and these abilities and differences provide diverse abilities and perspectives to a task (Farrell & Jacobs, 2016). A third principle discussed in research is the individual accountability that each member is expected to contribute to and be a part of the work of the team. Members are expected to interact with one another through discussions, feedback, and supporting one another (Li & Lam, 2013). This element is affected using interpersonal skills, including time management, communication, and conflict resolution skills.

Research has shown several advantages to interdependent learning, including increased academic achievement and the development of skilled communication, according to Li and Lam (2013). Collaborative learning in group settings provides students with the academic and social supports needed to enhance learning (Alamjed et al., 2016). Other research has found that collaborative learning is critical to accomplishing a goal as learners are challenged to listen to differing viewpoints and defend their ideas (Asunda & Mativo, 2016). Peer motivation to master content and improved attitude toward learning were also noted in the research (Kyndt et al., 2013).

Other researchers have found more interpersonal benefits to cooperative learning, including increased benefits for students of all ability levels and ethnic groups, with increased self-esteem and self-concept while also enhancing perceptions of one another (Clapp et al., 2017). Similarly, Han, Capraro, and Capraro (2015) discussed the collaborative and interdisciplinary aspects of STEM Project-based learning and found deeper understanding, higher engagement, and increased academic success for students.

Collaboration and cooperative learning are critical aspects of a classroom involved in maker-based learning practices. These learning processes take a variety of forms. In classrooms using maker-centered learning practices, when students work in cooperative learning groups, they collaborate within their groups, but also as they talk amongst themselves and observe other groups (Martinez & Stager, 2013). Bowler and Champagne (2016) found that relationships and communication through interdependent learning practices were central to the maker movement. Students share resources, provide feedback, and share their work with one another. Martinez and Stager (2013) refer to this as a development of interpersonal connections as students collaborate and work cooperatively with one another.

Through connected learning in maker-based learning strategies, student engagement increases more than in a traditional classroom setting (Rees, Olson, Schweik, & Brewer, 2016). Interdependent learning aids students in creating their knowledge rather than relying on merely accepting facts from an expert (Sahin, Ayar, & Adiguzel, 2014). Students involved in interdependent learning gain knowledge from one another through the sharing of insights, perceptions, and experiences. This theory of experiential learning is a critical component of maker-based learning practices.

Experiential learning theory.

Experiential learning is a well-known approach to learning related to many other areas of education including self-directed learning, lifelong learning, and active learning. Experiential learning is as an educational philosophy based on what Dewey referred to as a "theory of experiences" (Kolb & Kolb, 2005). Dewey believed that curriculum designed around real-world problems motivated students to learn as they assume responsibility for how to explore the topic (Dougherty, 2016). Dewey felt that learners created new knowledge and transformed themselves as they connected new experiences to what they already know (Fenwick, 2001). By choosing what to study and how to study the topic, students are motivated to study topics that interest them (Stebner, King, & Baker, 2016).

Kolb's experiential learning theory focuses on the assertion that learning is a process. Kolb defines experiential learning as the transformation of knowledge through experience (Coker & Porter, 2015). According to Kolb and Kolb (2005), students learn from experiences through active involvement in the task and the time is taken to reflect on the experience. Kolb's experiential learning model spirals through four stages: experience, observation, the formation of new concepts, and experimentation ((McCarthy, 2016).

While Kolb's experiential learning theory is one of the most well-known, his is not the only work on the topic. Joplin's theory of experiential learning closely resembles Kolb's theory. Joplin (1981) stresses that experiential education is student-centered rather than teacher or group centered. Experiential learning is personal to the learner, focused on the process and aimed at a more holistic approach formulated around student experiences (Joplin, 1981). Similar to Kolb's four-stage circular approach, Joplin's five-step model includes focus, a challenge, feedback, support, and finishes with debriefing in that same cyclical fashion (Joplin, 1981).

While Kolb and Joplin stress a cyclical approach to experiential learning, Jarvis argued that learners move freely through the learning process. Jarvis posited that learning is a process as primary and secondary experiences transform into knowledge, skills, and beliefs (Dyke, 2017). While he agreed with Kolb that reflection is essential, Jarvis stressed that the engagement with different ideas and beliefs is critical for learning to take place (Dyke, 2017). The learner must acquire and use analytical skills to conceptualize the experience. Additionally, students must maintain the decision making and problem-solving abilities necessary to use the new ideas gained from experience.

According to Kolb, Kolb, Passarelli, and Sharma (2014), highly effective educators using experiential learning have not taken on just one role but take on multiple positions in the classroom addressing experiences, reflection, thinking, and acting. The four familiar educator roles include facilitator, subject matter expert, evaluator, and coach. Service learning, a form of experiential learning, helps students bridge real-world life experiences and classroom learning, and transform these connections into useful knowledge, according to Eyler (2009). According to Coker and Porter (2015), experiential learning opportunities should help students develop a broad range of knowledge and skills to enable a student to not only maximize their learning but also to transfer that knowledge to other settings. In order to best achieve knowledge with experiential learning, educators must also encourage and include opportunities for reflection and feedback (Eyler, 2009).

Research has found multiple benefits to the use of experiential learning. According to McCarthy (2016), experiential learning practices promote student interest in the concepts studied, increase understanding and retention of knowledge, and develop intrinsic lifelong learning. Experiential learning has also been found to develop critical thinking skills, improve communication, and encourage teamwork between students from various backgrounds, according to Coker and Porter (2015). These same benefits appear with the use of maker-based learning activities in classrooms. One learning approach that uses experiential learning practices is Project Based Learning as students work to solve driving questions.

Project Based Learning

Connected to, but not synonymous with maker-based learning practices, is the instructional approach known as Project Based Learning. Project Based Learning is an interdisciplinary teaching method in which students gain knowledge and skills by investigating and engaging in collaborative, real-world challenges over an extended period of time (Han, Capraro, & Capraro, 2015). There are many similarities between maker-based learning practices and Project Based Learning. Project Based Learning involves complex tasks and challenging problem-solving processes (Wang, Zhou, & Wu 2016). According to Clapp et al. (2017), maker-centered learning and Project Based Learning is often interest-driven and involves creating products that represent student learning. Research has shown Project-based learning methods to increase students' motivation and engagement (Ball, 2016).

Similarities of Approaches to Learning

These learning processes have several recurring themes. Constructivist approaches to learning, teaching, and education emerge in active learning pedagogies (Cattaneo, 2017). The fundamental aspects of each of the pedagogies described remain interwoven. Active learning approaches are those designed to involve students in the learning process. Each of these active learning strategies is learner-centered and encourages student reflection to be most successful. The value of these active learning strategies for students includes improved attitudes toward themselves and their peers, development of social experiences between students, and time for the teacher to perform other necessary functions.

Other similarities between these strategies involve the role of the teacher. Teachers move from being the transmitter of knowledge to more of a guide working to encourage and question students (Dougherty, 2013). Teachers using active learning strategies regularly involve students in making, communicating, sharing, working together, and reflecting on the process and their learning (Anagün, 2018; Whitton, 2018). Teachers serve to document the learning that takes place in active learning pedagogies. Active learning also allows the teacher the freedom to coach, network, listen, and advocate for student learning (Kudryashova, Gorbatova, Rybushkina, & Ivanova, 2016).

According to Freeman et al. (2012), fundamental principles of active learning include opportunities for learners to exercise creativity through multiple media, increased motivation when engaged in meaningful play, and the development of activities involving students' personal interests. This learning approach connects the classroom, community, and home while respecting each learners' strengths and abilities (Freeman et al., 2014). The connections between these principles and the explanations of maker-centered learning practices are readily apparent. Maker-based learning practices propose a model of active learning that allows learners to delve into personal interests with increased engagement and motivation (Bowler, 2014). Purposeful play, inventiveness, and tinkering are fundamental to the maker-centered learning culture, according to Whitton (2018). Basing their ideas on constructionism, educators using maker-based learning practices advocate that learners be allowed to employ a student-centered learning model allows learners to construct their knowledge of various subjects through inquiry, personal experiences and learning by doing (Halverson & Sheridan, 2014). Learning through the making of things is constructionism in action.

Review of Broader Problem

The term "maker" began with Make magazine from O'Reilly publishing in 2005, and the amount of data has grown exponentially since that time (Dougherty, 2016). However, the concept of *making* has existed for ages with the do-it-yourself attitude found in many people and groups. The topic of making outside of education is not without a full range of information. Articles related to the subject matter describe how to start making, books exist on various projects to be made, and educational publications contain articles with reasons why making is essential for student learning. There are YouTube videos and channels, like Sylvia's Super-Awesome Maker Show, DIY projects created and blogs such as Instructables, MakerBridge, and Makezine, outlining every aspect of the concept (Martinez & Stager, 2014; Mallon, 2014).

However, in all this information, minimal academic research has been conducted on the how or why of using maker-based learning practices as a part of a learning environment. Little research exists on teachers' experiences in using maker-centered teaching approaches as a part of their curriculum. This research study sought to examine the experiences of teachers using maker-centered learning practices in their classrooms.

Maker Mindset

Making is a source of innovation. The maker mindset has been described as a frame of thinking that encompasses the values of the production of artifacts and problem solving by seeking do it yourself solutions (Chu et al., 2015). Individuals with a maker mindset see themselves as having the ability to acquire the knowledge to formulate a creative solution that they can construct. Chu et al. (2015) found three characteristics of a maker mindset, including a sense of self-efficacy, increased engagement in tasks, and accomplishment of tasks based on student interest. According to Dougherty (2013), a school can create the space with all the needed tools and materials, but unless they can nurture a maker mindset, they will not be able to develop innovative thinkers and makers successfully. Maker-centered learning supports the formation of a maker mindset and encourages students' identities with a sense of capability to make things for themselves (Rodriguez, Allen, Harron, & Gadri, 2019). Teachers and adults need to benefit from making, too. Having the mindset of a maker is essential when leading young students as well as a chance to explore and make. The maker mindset and maker-based learning practices are often associated with STEM and STEAM curriculum areas.

STEM / STEAM

Dougherty (2013) stated STEM began with the founding of NASA during the Eisenhower administration and Ramaley first used the term in 2001 by Ramaley. According to Hunter-Doniger and Sydow (2016), the study of STEM subjects has spiked over the last decade, and while student achievement in these areas has improved, creativity scores have declined. Beside the career skills, teamwork, critical thinking, and communication required for 21st century jobs, employers are also looking for creative problem solvers (Daugherty, 2013, Hilton, 2015, Hunter-Doniger & Sydow, 2016). This innovative component comes when the arts connect to STEM, and it becomes STEAM. Artistic learning strategies that enhance inventing, innovating, and creating include self-reflection, flexible thinking, and overcoming limitations (Hunter-Doniger & Sydow, 2016). Rees, Olson, Schweik, and Brewer (2015) found that STEAM is a natural extension of STEM that is critical to design, exploration, and collaboration.

STEM, and more recently, with the addition of an arts component, STEAM education are fundamental aspects of maker-centered learning activities in school settings by providing an outlet for people to work and learn together (Rees et al., 2015). Liao, Motter, and Patton (2016) found that STEAM aids students in making correlations between subjects using problem-solving skills, collaboration, and other 21st century skills. Gettings (2016) maintained that studio thinking relates directly to academic disciplines and maker education. The eight studio habits of mind include the idea of developing craft and tool usage, engagement and persistence, envisioning solutions and final products, expressing views, reflection, observation, exploration, and understanding the influence of others (Gettings, 2016). These same habits of mind are essential to both constructivist and design philosophies. These approaches enhance the educational experience and prepare students for the 21st century workplace (Gross & Gross, 2016).

Many Career and Technical Education (CTE) programs offer hands-on learning opportunities. The integration of STEM and CTE programs offer students active learning opportunities that enhance 21st century skills. Across K–12 educational settings, hands-on learning approaches are taking hold through maker-based learning practices.

K–12 education and hands-on learning.

Hands-on learning has been in schools since before the development of the traditional shop class in the early 20th century. The Smith-Hughes Act of 1917 influenced the development of a curriculum focused on training learners for industrial environments (Barba, 2015). This curriculum developed into industrial arts programs with a focus on skill development, craftsmanship, and safety (Loveland & Love, 2017). With the influence of technology and STEM integration, there was a push to reevaluate the curriculum. Gross and Gross (2016) posit that the skill isolation practices of education fail to meet student needs. In the real world, one encounters problems requiring the use of skills across multiple disciplines. Leaders in the field sought to include problem-solving, understanding available resources, and the integration of academics with technical training (Barba, 2017; Loveland & Love, 2017).

Technology literacy shifted the focus from developing work skills to integrating technology and engineering skills for all students (Loveland & Love, 2017). This integration of engineering led to the development of Career Technical Education (CTE) and Technology and Engineering Education (TEE) programs (Barba, 2017; Strimel, Grubs, & Wells, 2017). The enhanced focus on technology and engineering in these programs attempt to align with other areas through design thinking (Jarrett, 2016).

Maker-based learning often occurs in informal settings out of schools such as summer camps, after-school programs, and special workshops (Chu et al., 2017). One such example is maker-centered learning camps, which focus on a variety of maker-centered learning activities featuring minimal and no cost maker activities including cardboard challenges (Ramey& Uttal, 2017). Other research describes maker-centered learning practices in alternative learning schools such as NuVu Innovation School, where students complete community-based projects rather than participate in specific graded courses (Cohen, 2017). According to Papavlasopoulou et al. (2016), making allows students the opportunity to have control over their learning. The interest in making in educational settings often focuses on STEM concepts.

While efforts to bring making into schools are just beginning, that is changing quickly. Albemarle County Public Schools strive to foster the values of student autonomy, engagement, and student self-efficacy regarding their own learning through maker-centered learning practices (Sheridan et al., 2014). Similarly, Gever Tulley founded the Brightworks School and Tinkering School summer camps. Tulley posits that kids are more capable than they know and encourages the students to work together to solve real problems in learning through doing (Clapp et al., 2017). Through tinkering students and instructors experiment with various approaches and materials and learn from them until they arrive at their desired results. Figuring out solutions encourages students to collaborate to build social relationships and skills.

According to Gabrielson (2015), tinkering and hands-on learning are essential aspects in the creation of knowledge. Tinkering teaches students as they work to build artifacts through constructionist learning. These projects and activities can be developed using design-based learning strategies, often in classrooms utilizing maker-based learning practices.

Design Thinking

Design thinking is a process of problem-solving through creativity, collaboration, and a willingness to fail without giving up (Martinez & Steger, 2013). Through lessons in design thinking, students use problem-solving methods in the face of complex or challenging problems (what designers do) that necessitates a set of skills (what they know) and that embody a specific philosophy (how they approach and understand their work). Regarding what designers do, the design thinking process entails repeated, iterative transitions across often-nonlinear steps.

According to Coleman (2016), the often collaborative five-element process of design thinking activities begins with empathy for those affected and understanding the audience’s needs. In the second element, users seek to evaluate and synthesize information to define the problem one is addressing while brainstorming possibilities for potential solutions takes place in the third component. The fourth aspect involves creating a rough representation of one of the many ideas. These prototypes become refined through testing and feedback, a process that entails taking risks and using failure as a learning opportunity. Finally, designers test the idea and share end products, data collected, and solutions with end users in order to gather essential feedback (Chamberlain & Mendoza, 2017).

According to Chandrasekaran and Al-Ameri (2016), design-based learning focuses on not only the end product but also the iterative steps to reaching the solution. The design thinking process employs skills such as empathy, exploration, integrative thinking, collaboration, reflection, and risk-taking (Carroll et al., 2010). Researchers suggest that various types of design thinking instruction can facilitate skill development, providing a meaningful context (Chalkiadaki, 2018). As students work to solve these authentic activities, design thinking cultivates 21st century skills and is a means to deep learning and application of STEM content. Core subjects include those academic skills such as reading and writing. Innovation skills involve proficiencies in critical thinking, problem-solving, and communication. The career and life skill domain include those teamwork competencies such as responsibility, initiative, flexibility, and productivity. The final area comprises digital literacy skills for information and computing literacy (Chalkiadaki, 2018). In addition to promoting and fostering the use of 21st century skills, design thinking pedagogy can affect deep, meaningful learning in a variety of STEM topics. STEM education in learning incorporates the ideals of design thinking with the integration of the engineering design process (Honey & Kanter, 2013).

Design thinking aligns well with and provides an ideal framework to support constructivist learning. According to Jun, Han, and Kim (2017), design-based learning is based on the constructivist theory as it seeks to help students solve problems through hands-on activities. Constructivism is a learner-centered theory that views learning as an individual's active process of making meaning and constructing knowledge. According to Jarrett (2016) design thinking challenges students to implement solutions to real-world problems. Likewise, constructivist learning environments are learner controlled, employ meaningful contexts, and involve authentic tasks (Gross & Gross, 2016). Collaborative learning is also strongly tied to design thinking. In situations using design thinking, students work together sharing ideas and suggestions as they work to solve tasks (Coleman, 2016). The development of design thinking occurs through authentic activities, an idea central to maker-centered learning practices, according to Martinez and Stager (2013).

Classrooms, where teachers use design thinking activities, involve space and opportunities for discovering, designing, creating, improving, and exhibiting (Gross & Gross, 2016). Design thinking activities and maker-centered learning activities take place in art rooms, construction shops, science lab areas, general classrooms, computer rooms, libraries and multiple combinations of these areas where students work independently or collaboratively to create digital and physical objects (Grassick, 2016). According to Dougherty (2013), the change needed in education to encourage these activities is the same change taking place in the maker community around us.

According to May and Clapp (2017), the use of maker-centered learning practices in an educational environment emphasizes creation, sharing, and learning through digital tools and builds on the connections between student interests, digital tools, peer relationships, and academic curriculum. Sullivan (2015) stated that maker-centered learning tasks expand the project-based curriculum. Sahin et al. (2014) found that maker-based activities improve complex communication skills, including negotiation, expressing oneself effectively, and listening to and accepting others' ideas as well as increasing collaboration skills. Rees et al. (2016) found that while some maker-centered learning settings use products to reinforce standards, others focus on solving a given problem through making some product, and others allow for students to direct their learning based on individual interests.

Maker-centered learning involves a range of activities including, but not limited to cardboard construction, woodworking, electronics, programming, robotics, digital fabrication, textiles, and fiber crafts (Hsu, Baldwin, & Ching, 2017). Educators guide the process of developing a maker-centered learning environment based on student interests and needs and the academic curriculum, according to Maughan (2018). Martinez and Stager (2013) state that the essential facet of maker-centered learning practices is that students learn, invent, teach, collaborate, and share knowledge based on their needs and interests.

In K–12 education, guided maker-based learning programs support deep student learning and involvement (Bevan, Petrich, & Wilkinson, 2014). Profound student learning results as students engage in predicting, designing, testing, revising, and retesting projects. Teacher innovation in maker-centered learning practices has the capacity to transform student learning.

The Role of the Teacher in Maker-based Learning

Teacher innovation is at the center of maker-based learning. Researchers define innovation as a concept or practice or an old idea used in a new and different way within a specific social setting, according to Kohler, Boissonnade, and Giglio (2015). Unlike reforms that are typically changes imposed by the government or administrative leaders, innovation emerges bottom-up from practitioners. Teachers are uniquely positioned to act as agents of change to initiate school reforms, according to Lukacs (2015). Koroleva and Khavenson (2015) stated that the critical role of an innovator is to be the driving force behind the change process and to be innovative, teachers must be willing to take risks and accept that occasional setback that will result. While making engages students and gives students ownership of their learning, the maker movement has also tapped into a desire among many educators to return to the type of teaching that drew them into the career initially (Herold, 2016).

According to Clapp et al. (2017), teachers are anywhere and everywhere in a maker-centered classroom. The role of teachers in a maker-centered learning environment varies from direct instruction, offering how-to advice, modeling behaviors, and coach or mentor roles. Students must be the driving force in a maker-centered educational setting. According to Kurti, Kurti, and Fleming (2014), school-based maker-centered learning programs function best when using low-tech projects driven by student interest. Fredrick (2015) stated that teachers using maker-centered learning activities should focus on students with tasks that encourage collaboration and risk-taking.

However, the classroom teacher cannot be the sole leader in the classroom. Other teachers play vital roles in the maker-centered classroom.

Students as teachers.

Clapp et al. (2017) discuss several reasons for peer learning to take place in maker-centered learning, including the fact that many students know more about certain topics than the classroom teacher. Peer learning allows students to provide guidance and coaching as well as support and feedback to their classmates. Efficiency is another reason to encourage students to engage in peer learning. The classroom teacher can give direct instruction on a topic, such as the proper use of a power tool, and students can then teach others as needed. This peer-teaching frees the classroom teacher for other tasks. Finally, student empowerment is a strong outcome of peer learning (Clapp et al., 2017).

Online resources for maker-based learning.

Online resources are another type of teacher in maker-centered learning settings. Using self-directed learning allows teachers to give students more choice over when, where, what, and how they gather information and knowledge. With the continuous development of technology, students have nearly unlimited access to resources, allowing students to learn what they want to learn when they want to learn it (Song & Bonk, 2016). This increase in the kinds and amounts of available online learning resources has had a profound impact on the ideas and beliefs that surround learning. Using internet resources also allows students to examine the validity and reliability of online sources. Students can use online materials to access text information, tutorial videos, advice from experts, inspiration, and ideas. Online resources also provide students access to knowledge and advice from outside experts in areas of interest.

Outside experts and maker-based learning.

Outside experts can also act as teachers in a classroom using maker-centered learning practices. These teachers from the community offer expert advice and suggestions not garnered in any other way. Maker educators encourage students to connect with experts in the community who can answer questions, provide inspiration, and teach a variety of skills, according to Clapp et al. (2017). Visitors to a classroom using maker-centered learning practices also model what it looks like to be a maker as they share their knowledge and inspire students (Martinez & Stager, 2013).

According to Martin (2015), one of the most prominent features of maker-based learning programs is the availability of digital tools which provide nearly limitless opportunities for learning. The affordability of these new devices allows for easier access, and as students learn to use them, they can make things never before imagined. Tools and technology involve learning, and the power exists in not only the use of the device but also how it makes one think about the device (Dougherty, 2016). The purpose of new tools and the learning that accompanies them create conditions ideal for student learning and thinking. This access to resources and tools is just one benefit to students in classrooms using maker-based learning practices.

Benefits of Maker-based Learning

A classroom using maker-centered learning strategies is entirely different from the traditional classroom. While conventional classrooms feature students sitting quietly at desks all completing the same tasks, classrooms using maker-based learning practices are quite the opposite appearing chaotic as students can be seen actively participating in authentic learning activities (LopezLeiva, Roberts-Harris, & von Toll, 2016). Kolb et al. (2014) stated that classrooms are not uniform with standardized instruction but instead are made up of relationships between unique teachers with unique students influenced by a variety of contexts. The do-it-yourself learning style of a classroom using maker-centered learning practices allows students to take control of their own education.

Digital tools, a community framework, and the maker mindset are the three critical elements for understanding making in education, according to Martin (2015). Chu et al. (2017) explored the concept of making learning fun using maker-centered learning practices in the elementary classroom. These researchers found that students using maker-centered learning activities in the classroom experienced positive effects, including increased involvement, social interactions, and experimentation. The research into maker-based learning practices has found several benefits to this type of teaching and learning.

Through making and building, teachers can cultivate student learning in a multitude of ways based on long-established learning theories (Martin, 2015). A review of the literature found four themes regarding the benefits of using maker-centered learning practices in schools. According to Smith and Smith (2016), humanistic values strengthened, including an increase in learner happiness using making in education. Student engagement and an increased excitement about learning are benefits of using maker-centered learning practices. The increased engagement resulted as students were absorbed in an activity (Chu, Angello, Saenz, & Quek, 2017). According to Jacob and Buechly (2013), sustained commitment supports the expression of a positive personal identity. Clapp et al. (2017) referred to this feeling as a sense of agency as students begin to see themselves as agents of change with a willingness to take risks.

The power of the social learning context inherent in maker-centered learning practices was another benefit featured in previous research. As students share and collaborate, opportunities arose for learning and feedback, according to Lee, Kafai, Vasudevan, and Davis (2014). These opportunities came as students shared their products, ideas, and knowledge with others (Martin, 2015). Making can also empower students and shift their learning from being passive consumers of information and products to active creators and innovators involved in their own knowledge creation.

Authentic learning experiences designed to engage children in real-world experiences enable them to see beyond what happens in the classroom to understand how to apply what they are learning and doing (Bonwell & Eison, 2005). Increased self-efficacy resulted as students took charge of their learning through increased experimentation, involvement, problem-finding and problem-solving (Chu et al., 2017; Papavlasopoulou, Giannakos, & Jaccheri, 2017). Somanath et al. (2016) found that the use of design challenges in classrooms that use maker education engaged at-risk learners, encouraged students to develop and produce their own projects and apply the experiences in other educational contexts.

The use of maker-centered learning practices within schools offer powerful contexts and deliver opportunities for students to learn collaboratively as they develop new skills. According to Marshall, Smart, and Alston (2017), students who learn through inquiry-based instruction perform better academically than those who learn in a traditional classroom environment. The use of maker-centered learning practices in classroom settings has also been found to grow students' competence in many areas including technology skills, computational literacy, and critical thinking (Chounta, Manske, & Hoppe, 2017). These skills fall within the group of skills commonly referred to as 21st century skills. Other improvements develop in the areas of design, planning, and communication skills. When teachers provide opportunities in maker-centered learning**,** students encounter new skills and technologies and doors open to new career paths. maker-centered learning can help to prepare students to become lifelong learners (Martinez & Stager, 2013).

Challenges of Maker-based Learning

Maker-centered learning programs offer schools multiple benefits but also bring schools several challenges. There are a multitude of problems facing teachers as agents of change as they implement making into their classrooms. According to Lukacs (2015), innovative teachers often face a lack of support from the school administration and a lack of time for goal setting, networking with other innovators, and gathering support from stakeholders. Taking the roles of facilitator, coach, evaluator, and subject expert in a maker-centered classroom is often more difficult than traditional teaching (Kolb, Kolb, Passarelli, & Sharma, 2014).

Maker educators must concede the fact that not all students will be able to complete projects fully. Given constraints like technology and time, not everything will go as planned. Learning processes and outcomes cannot be predefined requiring teachers to continuously monitor and assess learning taking place, according to Chounta, Manske, and Hoppe (2017). Teachers using maker-centered learning strategies in the classroom must also ensure that procedures, tools, and environments extract appropriate student development at the same time they encourage student motivation and joy (Giannakos, Divitini & Iverson, 2017).

Another challenge associated with using maker-based learning strategies in the classroom is the idea of equity. Vossoughi, Hooper, and Escud (2016) discussed equity regarding expanding access to high-quality STEM learning. The historical inequalities of race, gender, socioeconomic status also exist in maker-centered learning environments (Vossoughi, Hooper, & Escud, 2016). Barton, Tan, and Greenberg (2017) found that most makers are white males and many of the activities used in making encourage participation by male students including robotics, 3D printing, and the use of various power tools.

Clapp et al. (2017) found that the expense associated with maker-based learning practices can make some tools out of reach of schools with budget concerns. Staffing and finding experts, budget constraints for higher-end technology and the cost of various consumables were challenges in running school-based maker-centered learning practices, according to Graves (2014). The sustainability of consumables used in classrooms using maker-based learning practices also poses a funding problem. Especially in more impoverished communities, there have been massive reductions in funding for arts education programs, and this is found in maker-centered learning programs, as well

(Clapp et al., 2017). Funding reductions could affect the future of maker-based learning programs.

Future of Maker-based Learning

With the benefits and challenges associated with using making in the classroom, there are still many unknowns about the future of maker-centered learning practices. Today's rapidly expanding job market requires future workers to be more adaptable, independent, and enterprising than earlier generations. There has been support among business owners for the maker movement in education as they see it as an investment for future talent and employees in the ever-changing job market (Hilton, 2015). Many proponents fear that the maker movement will degrade when used in schools because traditional education settings tend to involve more rigid schedules, demands for equal involvement, and a test-based accountability structure. (Halverson & Sheridan, 2014). While there is limited research on the concept, researchers have expressed interest in the ability of maker-centered learning practices to increase student learning outcomes and standardized test scores.

Synthesis of Findings

Maker-based learning practices, while not commonplace in public education, are based on concepts and theories familiar to many classroom teachers. Many policymakers and educators see the potential of maker-centered learning programs and assert the desirability and importance in these learning practices (Peppler & Bender, 2013). The research demonstrated multiple themes across learning environments. The facilitators in these learning environments described similar benefits and challenges. Through its alignment with constructionism, constructivism, experiential learning, and other active learning approaches, maker-based learning provide a method for increasing skill levels through collaboration and participation. This review of the literature demonstrates that the future will require students to be proficient in 21st century skills, including creativity, communication, critical thinking, and problem-solving. Research has also shown that maker-based learning practices provide these skills for students as well as an increased interest in STEM / STEAM learning (Martin, 2015).

The rise in the number of classroom and schools featuring maker-based learning practices led this researcher to ask how and why teachers have chosen to use these learning practices. The purpose of this phenomenological research study was to explore the experiences of teachers currently using maker-centered learning practices in their classrooms. In the coming chapters, I discuss the teachers' perceptions of the meaning of maker-based learning practices and their interpretations of these experiences.

Chapter 3: Methodology

The purpose of this qualitative research study was to describe the experiences of K–12 teachers currently using maker-based learning practices as an instructional tool within their learning environments. While the studies discussed previously in the literature review have contributed to the education field's understanding of teacher perceptions towards integrating maker tools and activities into their instruction, each has been limited by focusing on the environment and student experiences. This study fills a significant gap by examining the experiences of a group of teachers who have engaged in long-term maker-based learning practices.

The design for this phenomenological study consisted of collecting data through interviews about the experiences of teachers who have used maker-based learning practices and analyzing the data to reduce information to essential statements and universal themes. The teachers that I selected to participate in this research used maker-centered learning programs to provide a curriculum-based, hands-on learning environment for students in K–12 settings. I gathered information about the teachers' experiences with maker-based learning strategies through semistructured interview questions. Participants had the opportunity to share and describe situations using maker-centered learning strategies and express their perceptions of these practices including activities, benefits, challenges, and observations.

Through this phenomenological research study, I examined the teachers' experiences as they plan, create and currently use maker-centered learning practices as an active learning method. According to Vagle (2014), phenomenological research focuses on the intentionality or connectedness and relationships between people and the world around them. In the case of this research study, I studied the phenomenon of maker-based learning practices as an instructional approach and the impact of this learning approach as perceived by the teachers who use it.

In the next sections, I present the qualitative phenomenological methodology and design chosen for the study. The chapter begins with the Research Design, which includes the research questions and the research approach I used for this study. In the next section, the Role of the Researcher, I discuss my plan for data collection, data analysis, and my proposed method for bracketing to avoid bias. I discuss the process I employed to identify, contact, and secure participants for inclusion in the study in the section Target Population and Participant Selection. I divided the Methodology section into subsections including Procedures, Instruments, and Data Analysis. These sections will aid future researchers in reproducing my study. The Ethical Assurances section includes information regarding issues of credibility, transferability, reliability, confirmability, and ethical procedures. The Expected Findings section discusses the themes I expect to discover regarding teachers and their experiences with maker-based learning processes. Lastly, I provide a chapter summary.

Research Design

The fundamental aim of this study was to explore K–12 classroom teachers' experiences in using maker-based learning practices. I based the questions that guided this research on my interest in maker-based learning practices as well as a review of the available research. I investigated the following research questions:

RQ1: What are the experiences of teachers planning, creating, and using maker-centered learning as an instructional strategy in their K–12 classrooms?

RQ2: What motivates a teacher to implement a maker-centered curriculum as an instructional strategy in their classrooms?

RQ3: What do teachers understand to be the challenges and benefits that they have encountered as they use maker-centered learning?

RQ4: What types of changes have teachers seen in themselves and their students since the implementation of maker-centered learning activities?

I considered several qualitative research designs for this study. I initially explored a case study because according to Yin (2014) a case study provides an in-depth description of a phenomenon within its real-life context. A case study would be a good choice if I were investigating an individual teacher or a single complex issue with specific boundaries. An ethnographic study would be better suited if I were to immerse myself in a culture over an extended period in order to investigate the changes and characteristics based on the descriptions by Creswell and Poth (2013). Grounded theory provides an explanation or theory based on the data (Merriam & Tisdell, 2016). Because the experiences and perceptions of the teachers using maker-based learning practices are central to understanding the phenomenon, I consider the phenomenological research method to be the most applicable approach to answer the research questions.

According to Vagle (2014), phenomenology involves studying individuals' lived experiences. Experts describe phenomenology as the study of how people relate concepts and understand events through their senses (Merriam & Tisdell, 2016). Phenomenology is both a school of philosophy as well as a type of qualitative research in which researchers focus on the experience itself and how those occurrences are transformed into consciousness (Merriam & Tisdell, 2016). According to Giorgi (2012), phenomenology focuses on the activities of the consciousness and the experiences that present themselves in a person's consciousness. The phenomenological methodology is utilized to reduce personal experiences of an event, thus arriving at a description that is the essence of the phenomenon (Vagle, 2014). For these reasons, I chose the phenomenological approach for this study in order to focus on the lived experiences of the teachers using maker-based learning practices.

Phenomenology research falls primarily into two categories: interpretive or descriptive. Interpretive phenomenology is used to explore in detail the meanings participants give to events in their personal and social world. A person's perceptions rather than the experiences or events are the focus of interpretive phenomenology (Vagle, 2014). Descriptive phenomenology is based on the study of personal experiences and requires a description of those experiences (Padilla-Diaz, 2015). A researcher using descriptive phenomenological methodology attempts to identify the essential structure of the phenomena. According to Merriam and Tisdell (2016), descriptive phenomenology is complex and requires a researcher to depict the basic structure or essence of an experience. Researchers using descriptive phenomenology utilize bracketing to prevent the interjection of personal bias when gathering information from participants.

In this study, I used a descriptive phenomenological research methodology to understand the experiences and perceptions of teachers using maker-centered learning practices as a learning approach. The research design consisted of collecting experiences of teachers who have used maker-centered learning strategies and analyzing this data to reduce information to significant statements and search for common themes. I selected this design to collect the reflections and experiences of teachers as they traversed the process of designing and creating their maker-based learning programs. In my role as a researcher, I analyzed the data to explain the phenomenon.

Role of the Researcher

My role as a researcher was to interview and collect data from teachers about their experiences in using maker-centered learning strategies in their K–12 educational settings. Ensuring reliability and subjectivity, while avoiding threats to validity and bias, is critical to qualitative research designs. Because I was the only researcher who collected, analyzed, and interpreted the data, there was potential for researcher bias. I took several steps to reduce that bias, including contacting teachers with whom I had no prior relationships. Before any interviews took place, I obtained Institutional Review Board (IRB) approval to conduct the research. The ethics protocol for this project was reviewed by the Walden University Center for Research Quality and Institutional Review Board for Ethical Standards in Research, which provided clearance to carry out the research. Walden University's approval number for this study is 07-10-18-0407607, and it expires on July 9, 2019. This approval information was provided to each participant along with an explanation of the research purpose in order to obtain their consent for an online interview. The recording and careful transcription of interviews provided descriptive validity as well as my descriptions of the environment where the discussions took place. To minimize interpretive bias, I bracketed my thoughts and opinions throughout the analysis process.

According to Vagle (2014), bracketing involves acknowledging one's own interpretations of the topic and putting that knowledge aside. This reduction allows the researcher to be more open to the phenomenon without enabling preconceived notions to influence the results. Descriptive research involves three steps beginning with the researcher reading the whole description to understand the data. The researcher then rereads the description and marks meaningful units, areas where there is a transition in meaning. In the third step, the researcher transforms the data marking what the participant said explicitly of the phenomenon. According to Giorgi (2012), this step is critical for completing a full and rich description. The more detailed sections are then revisited and used to clarify and interpret the essence of the data collected during the research.

According to Giorgi (2012), the researcher must give focus and attention to the information presented, based on the happenings. The goal of describing the experience is to understand and not to interpret it (Giorgi, 2012). The researcher using the descriptive phenomenological method must begin with the correct attitude, according to Giorgi (2012). This attitude of reduction requires an individual to bracket past experiences concerning an event to better understand why the event occurred. Based on this attitude, I attempted to refrain from allowing my own opinions and experiences from influencing the flow of the interview or the ideas the participants might express.

At the core of this methodology is the attitude of the researcher; the correct approach allows for a phenomenological reduction to take place (Giorgi, 2012). The proper perspective requires the study's researcher to ignore or temporarily delete all past knowledge concerning the phenomena thereby avoiding bias. Vagle (2014) suggested that researchers write a subjectivity statement before conducting interviews which describe assumptions, beliefs, and researcher background experiences with the phenomenon. These subjectivity statements can be revisited periodically to focus on personal opinions and perspectives. I kept a journal of the steps I took for data collection and analysis, as well as my opinions and thoughts throughout the process as Vagle (2014), suggested.

The focus of phenomenological interviews is the description of the phenomenon with precise details with the participant's final approval (Padilla-Diaz, 2015). I shared the final transcripts via email with each participant to allow them to add or expand on any information or ideas that they shared in order to ensure their final approval. Six of the seven participants replied to the transcript to acknowledge its receipt and accuracy. As I worked with participants and throughout the process, I endeavored to remind the teachers that all statements and documents would remain confidential to allow them to be open with what they shared. The participants are teachers who use maker-based learning practices and therefore, have an interest in maker-centered learning. Upon completion of this study, I emailed a summary of the research findings to each participant as well as the leader of the professional development workshop from whom I obtained the list of prospective participants.

Target Population and Participant Selection

The participants for this study were teachers who use maker-centered learning strategies as an instructional method. For this study, random selection was not practical because it was essential that participants were teachers currently using maker-based learning practices. For that reason, purposeful sampling was used to find participants who teach using maker-based learning strategies as a part of their curriculum in a K–12 setting. Purposeful sampling, characterized by the inclusion of specific criteria, ensured that participants share everyday experiences regarding the phenomenon, according to Padialla-Diaz (2015). I utilized purposeful sampling to ensure that participants meet the specific requirements.

To gain participants, I contacted teachers who had teaching experience utilizing maker-based learning practices. The teachers also participated in maker-based professional learning workshops. Two renowned consultants from a nonprofit educational service center in the Midwestern United States conduct professional development workshops on maker-based learning practices several times each year across the country. The workshop is structured to be an intense and immersive professional learning where teachers learn how to shift from more traditional teaching to a STEM classroom as they create and use maker-based learning strategies. The mission of the professional development is the belief that teachers teach how they are taught and if schools want teachers to teach from a foundation of *learning by doing*, then the professional learning should be conducted in that same way. The professional development workshop is intentionally designed to replicate the highs and lows teachers might encounter with students over a year long program. The trainers guide, model, and directly instruct the participants, based on their individual and unique needs. These two consultants are members of my professional learning network and agreed to share the contact information of participants in their workshops. According to Rubin and Rubin (2012), people are more open to talking with researchers if they feel some personal connection. The shared professional network connections allow me to gain access to knowledgeable interviewees with whom I already have a mutual connection.

Prior to contacting any participants, I sought IRB permission to conduct the research. Once I obtained IRB approval, I secured the written use agreement from the educational service center that provides the professional development workshop participant list. One of the consultants sent a Google Form to past participants in the workshop asking for volunteers to share contact information if they were willing to be contacted for this research. The form yielded 17 possible research participants. I contacted the teachers from the workshop participant list via email to determine if they are willing to participate in the research study. Three teachers from this list consented to participate and were sent an email with a link to the secure questionnaire hosted on surveymonkey.com where they were asked several questions to determine if they fulfill the criteria for inclusion in this study. In order to find enough participants, I also posted a request for participants on the professional learning network sites LinkedIn and Facebook Educators. The other four participants volunteered from these posts. I emailed the same consent form and subsequent questionnaire to these participants. Questionnaires can be used to collect qualitative data; however without the level of detail to thoroughly understand the participants' perspectives. The benefit of having the participants complete a questionnaire was that it could be used to determine the teachers who meet the required criteria.

The questionnaire in this study provided background information on the participants' teaching experience, in what grade levels and subject areas the teachers use maker-centered learning, a small amount of data about the schools where the teachers work, geographic information, and enrollment data about the school where the participants teach. The questionnaire involved questions that included information such as what types of activities and strategies take place and how frequently teachers use maker-based learning practices. Additionally, I was able to ensure the participants met the requirements for inclusion in the research study before collecting any data. I based participant selections on the results of the questionnaire. The information from the questionnaire also helped guide my interview questions to fit each participant. There is a copy of the questionnaire located in Appendix A. An interview using open-ended questions followed the completion of the questionnaire.

Specific criterion was used to determine if these participants met the requirements for this research study. The following criteria were employed to identify the participants for this qualitative phenomenological research study:

1. Teachers currently using maker-centered learning practices a minimum of once per month.

2. I confirmed that the teachers' share common characteristics which led to defining the maker-centered learning programs, a maker mindset as a teaching and learning practice including:

- End users are students in Grades K–12
- Involves authentic, hands-on projects
- Involves lessons that promote critical thinking and collaboration
- Experiences that engage students across multiple social and academic standards

According to Creswell and Poth (2013), a studied group should consist of 3 to 15 members who can articulate their experiences. Vagle (2014) suggested that smaller sample sizes are typically used in qualitative research to allow the researcher to focus on collecting rich descriptions. Smith, Flowers, and Larkin (2009) suggest a small sample of three for beginning researchers to interpret each participant's explanations of the phenomenon. For this research study, I chose to begin with a minimum of six participants increasing to a maximum of eight participants to reach the depth and rich description required for phenomenological research as well as a thorough examination in my study. The number of participants for this study was seven.

An initial group of six to eight teachers provided for teachers at different grade levels to share their experiences. Based on my professional network connections, I anticipated several responses from teachers who use maker-centered learning practices and who would be willing to participate in the research. The professional development workshop coordinators shared contact information, and I used email to connect with these teachers using maker-based learning practices in their schools. There were fewer workshop participants who agreed to interviews than I had hoped. One reason there were fewer participants might be that it was over the summer break from the public schools and teachers were not available. This lack of participants led me to post the invitation in my professional learning community.

Methodology

I divided this section of the chapter into three subsections including Procedures, Instruments, and Data Analysis. The Procedures subsection contains a discussion of the methods I planned to use to conduct the research. The Instruments subsection is where I explain the two types of data sources I planned to utilize in this study. Finally, I discuss my plan for coding the data I collect in the Data Analysis subsection.

Procedures

This research study is a phenomenological study that sought to examine teachers' experiences using maker-centered learning strategies in their learning environments. I sought to explore the research question, "What are the experiences of teachers planning, creating, and using maker-centered learning strategies as a part of a K–12 learning environment?" In this research, I examined teachers' perceptions of the benefits and challenges of using maker-centered learning strategies and what motivated them to implement a maker-based curriculum into their classrooms. Therefore, the data sources for this study included open-ended interviews and written descriptions regarding the use of maker-based learning strategies in the classroom.

The participating teachers were interviewed to gather data for this research study. The projected sample size for this research was no less than six but no more than eight teachers currently using maker-centered learning practices as a part of a K–12 learning environment. Detailed information was collected from each informant using open-ended interviews. Because travel for face to face meetings was impractical due to time and financial constraints, I used a virtual forum to conduct interviews. Once I secured the participants, I explained the purpose and scope of the study and obtained written consent to conduct the interviews. Upon receiving the participants' written permission, I emailed each participant separately and set up a time to hold virtual meetings. These virtual interviews were conducted using an online application Zoom and were expected to last approximately 60 minutes. One benefit of this online meeting program was the ability to record the conversations for transcription using a service such as VoiceBase or Happy Scribe.

I collected additional data through written descriptions provided by teachers participating in the study via email. Teachers were asked to complete a written description narrative which describes an example of maker-based learning practices in their classrooms. The range of opportunities for teachers to share their experiences with maker-based learning gave the researcher a more complete picture of the teachers' perceptions, struggles, and successes with the research topic.

Instruments

Recorded interviews were the primary source of data collection. The interview process included open-ended questions to gain a better understanding of the participants' experiences with using maker-centered learning strategies and their perceptions of maker-based learning strategies. Researcher created items were designed specifically for this study to allow participants to share their impressions and describe their experiences in their own words. In order to gather details, I structured my interviews based on three types of linked questions. Based on guidelines suggested by Rubin and Rubin (2012), I used main questions to answer my research questions, followed by probes to encourage the participants to share more details and give examples of their experiences using maker-based learning strategies. Then I used follow-up questions to develop the participants' descriptions of their perceptions and experiences to gather more detail (Rubin & Rubin, 2012). I placed a copy of the interview questions and the protocol in Appendix B.

The second form of data I collected was a lived experience description from each participating teacher. According to Vagle (2014), a lived experience description is an oral or written account of a phenomenon. Using the protocol from Appendix C, I asked the teachers to write about an event in their classroom that described their perceptions and ideas of maker-based learning strategies. Descriptions of lived experiences foster attention to details that might otherwise seem unimportant allowing the researcher to examine the meaning and develop a conceptual understanding of the phenomenon. (VanManen, 2017). Kafle (2011) posited that phenomenon is best understood through the exploration of stories that people share about their experiences.

While researcher created, the questions in this interview were reviewed to ensure that the experiences can best be shared and explained. An expert in maker-centered learning examined the questions for this discussion. The subject area expert leads professional development workshops for teachers currently or planning to use maker-centered learning programs within their schools. The expert was asked to evaluate the questions for clarity and to determine if the items would encourage participants to share their experiences.

To prepare for the interviews used in this study, I conducted two pilot interviews with colleagues. These two teachers are familiar with maker-centered learning strategies but did not participate in the research study. These two meetings helped to determine if the questions would apply to teachers using maker-centered learning strategies and provided necessary practice for conducting an interview, transcribing, and coding the transcripts. Pilot tests also allow the researcher to determine and inform participants of expected time commitments for data collection (Rimando et al., 2015). Upon completing the pilot interviews, I asked the teachers to also comment on the clarity of the questions and to determine if other items were needed. According to Turner (2010), pilot tests allow researchers to determine if there are flaws, areas lacking transparency, or other weaknesses within the interview and enabled the researcher to revise areas of concern before I conducted the interviews with the interviewees.

Data Analysis

The researcher collected two forms of data. First, I gathered data using open-ended interviews to collect information on the experiences of the teachers and their use of maker-centered learning practices. I conducted open-ended interviews using questions to explore teachers' experiences, how they see the teacher and students' roles in the use of maker-centered learning strategies and how maker-based learning connects with their curriculum goals. The data collected also included lived experience examples by the individual teachers about their own teaching and learning environment. The interview transcripts and written lived experience descriptions provided were reviewed and classified to determine common events, and data analysis will include a thematic review of the data to understand patterns in the teachers' interviews and narrative content.

I anticipated the initial interviews to take place over an estimated two-week period. After the initial interviews, I asked follow-up clarifying questions to teachers as necessary after I completed the first round of data analysis and gained a basic understanding of the information shared. All interviews were conducted virtually using Zoom and were expected to take approximately one hour to complete. During the interviews, I took notes of preliminary ideas for future reference.

For the interviews, I used virtual software that allowed me to record my participants' interviews. The recordings of the interviews were able to be transcribed using an online software program such as oTranscribe or Happy Scribe. These online services convert an audio file into a text document saving me valuable time and possible errors in manual transcription. Upon completing the transcripts, I manually checked to ensure the accuracy of those transcripts. Based on the work of Saldena (2015), I made preliminary jottings of ideas or areas for analytic consideration. After reviewing the transcripts, I examined the pre-coding notes for preliminary codes I had already identified as well as note any new codes or themes that arose. I then asked follow-up questions as needed. For the lived experience descriptions the teachers shared with me, I used this same process. I analyzed these descriptions for patterns and prevailing themes. With both sources of data, I analyzed, I hoped to identify patterns of repetitive actions or comments described by the participants. Using these patterns, I confirmed the descriptions and trends of maker-based learning practices and the teachers' perceived routines, roles, and relationships in their classrooms (Saldaña, 2015).

According to Saldaña (2015), documents must be analyzed carefully and critically because they portray the perceptions of the teacher who created them. The written lived experience descriptions helped me to describe the experiences of the teachers as they plan, create, and use maker-based learning practices in their classrooms. As I examined the narratives shared by the teachers, I planned to look for evidence of 21st century skills as they are used in classrooms during the maker-based learning practices. The teachers' answers to the interview questions also helped to build this description as well as explaining a teachers' motivation to implement a maker-based learning curriculum. Challenges and benefits of maker-based learning practices and changes teachers have experienced were also identified as I examined the data.

I completed an ongoing data analysis throughout the study. According to Vagle (2014), phenomenological research data analysis should follow a whole-part-whole process. A researcher begins with reading the whole text to become familiar with all the data. Researchers then proceed with line by line reading taking note of experts that contain initial meanings (Vagle, 2014). I planned to use InVivo Coding to analyze the data. According to Saldaña (2015), InVivo coding uses the participants' words to discover the depths of their experiences. As I read through the interview transcripts and written lived experience descriptions, I made notes of words and phrases that explain the teachers' experiences. At this point, I contacted the participants with any follow-up questions to clarify the initial themes. I applied descriptive coding to the data sources as

I analyzed them to summarize the essential topics into phrases which would become the codes. A second and even third line by line reading involved careful note taking and marking of potential themes (Vagle, 2014).

All the interview transcripts and analysis notes took place online, and the resulting files saved separately. I printed out each transcript to manually apply the second round of codes and sort the data into codes and themes as I progressed in order to understand the teachers' experiences better. Using colored highlighters and sticky notes helped organize the data that resulted from these interviews. I was able to select text using terms identified on the paper transcripts and sort the commonalities as well as a note where I can combine like terms or ideas. The codes and themes were color-coded based on the question or main essence of the section. This color-coding system helped me find the specific experiences shared by teachers using maker-centered learning strategies as a part of a K–12 learning environment.

I developed the data into a textual description of the experiences of the teachers using maker-centered learning strategies, a structural narrative of what the teachers experienced and an overall essence of their perceptions of using maker-centered learning practices as a part of the learning environment. These experiences were sorted and described based on the themes that appeared in the data. Following the completion of this study and the approval of this dissertation, I will share a summary of the results with each of the participants.

Ethical Assurances

A researcher must rigorously conduct and record all data in the study to ensure credibility and reliability (Merriam & Tisdell, 2016). In addition to the ethical assurances in this section, I planned to remain in contact with my research committee members regarding the data collection and analysis procedures and process. I discussed my work and the data collection and analysis process with my committee chair on a weekly basis. This section addresses how I ensured the validity, reliability, and transferability of the research study. The ethical procedures of participants and the security of data conclude this section.

Credibility refers to the truth and trustworthiness of the data in a study (Merriam & Tisdell, 2016). One method for achieving credibility is through the use of triangulation. Triangulation refers to the use of data gathered from multiple sources and a variety of respondents to help overcome the bias that might result (Merriam & Tisdell, 2016). I utilized triangulation by using interviews and written lived experience descriptions as data sources. The use of six to eight teachers from different schools and grade levels also aided in the triangulation of data. The use of iterative questions further increased credibility. Iterative questioning includes questions that are designed to allow for overlap and follow-up with further probing questions in order to give respondents multiple opportunities to thoroughly describe their experiences and impressions. As suggested by Yin (2014) this gradual process begins with smaller questions and builds until I have addressed my research questions.

Credibility can also be strengthened using peer debriefing. According to Spall (1998), peer debriefing offers several benefits to qualitative research. Peer debriefing takes place when a colleague examines the congruency of the findings and tentative themes (Merriam & Tisdell, 2016). Use of a peer debriefer supports the credibility of data as a researcher and a knowledgeable peer conduct extensive discussions about the data and preliminary analysis (Spall, 1998). Peer debriefing contributes to the research by authenticating the interpretations to be believable and valid (Spall, 1998). For my peer debriefer, I used a colleague who is familiar with my research topic and qualitative data analysis. Because she did not see participant information, this debriefer was not required to sign a confidentiality agreement. Finally, the use of member checks can enhance credibility. According to Thomas (2017), member checks refer to the sharing of transcripts with participants for comment, clarification, or correction. I sought feedback from the participants by emailing each participant a copy of their interview transcripts for their review to determine if they wanted to make corrections or add clarification.

Reliability, or rigor, of qualitative research, refers to the concept that if another researcher were to analyze the data from the study, they would gather similar results (Creswell and Poth, 2013). In a qualitative study, dependability is more challenging to ascertain because the purpose is to describe a specific phenomenon, which in this phenomenological research study, is the experiences of teachers using maker-based learning practices. Reliability is based on consistency and carefully applying research practices, according to Cypress (2017). I included a clear description of the methods used for collecting data to increase the visibility of the research practices and analysis.

This open account of the research allows those readers to consider the steps I used in determining the consistency and rigor in my study.

Confirmability and objectivity during qualitative research refer to the quality of the data collection and analysis by the researcher. (Patton & Bogdan, 2002). To increase objectivity in this study, I strived to prevent personal opinions from affecting the analysis or interpretation of the data. This objectivity can be achieved by using multiple sources of data to provide opportunities for confirmability of the data. The multiple sources of data in this study included interviews and written lived experience descriptions. Bracketing also enhances objectivity. Phenomenological reduction demands that a researcher bracket prior knowledge and opinions about the phenomenon being studied (Giorgi, 2012). Bracketing involves putting aside the non-essential knowledge and trying to limit its influence on the data. Based on the suggestion of Vagle (2014) I used a reflection journal in order to help me to focus on my role as a researcher, my assumptions and opinions about maker-based learning practices, and my background as a teacher as they impact this research study. I used these subjectivity statements before, during, and after each interview to help me focus on my assumptions and more easily bracket this prior knowledge not to cloud my objectivity.

Before any interviews taking place, I obtained IRB approval through the Research Center at Walden University. All participants received a detailed consent form which covered any concerns a participant may have had. The risk of physical or psychological harm was estimated to be not applicable as it posed no threat to the teacher. Through the informed consent document, the researcher assured participants that cooperation in the study was entirely voluntary and if they chose, they had the right to refuse to answer any question or to leave the study at any time. Participants were made aware that any information given would remain strictly confidential. Because I do not work with any of these teachers or have any direct personal contact with them outside this study, there was no conflict of interest in the completion of this research study.

The researcher gave each person's online questionnaire form responses, interview, and written lived experience descriptions a unique identification code to maintain participant confidentiality. This system was used to label all transcripts, notes, and data analysis for that participant. To maintain discretion, I have stored all questionnaire data, interview transcripts, participant information, and data analysis as Microsoft Word documents in password-protected files on a removable storage device. I will save any hard copies of the interview transcript, notes or other data for the duration of this research study only and then all hard copies will be destroyed. To ensure confidentiality, I have not used the participants' actual names, locations, or any additional identifying information such as their school districts in this document. All digital files will be retained for six years following the completion and approval of this dissertation before being destroyed.

Expected Findings

Based on the literature review, I expected to see familiar themes throughout the interviews. As maker-centered learning strategies are a recent innovation in education, I hoped to find that many of the teachers I spoke with view themselves as innovators and as agents of change within their schools. Innovations in education are most commonly requests from the administration or outside the system to prompt change that are accepted and adopted by teachers to meet their own visions (Koroleva & Khavenson, 2015). Ferrari, Cachia, and Punie (2009) define innovative teaching models as those methods which foster students' creative potential and stimulate learning through authentic activities. I also expected that teachers would state that they observe changes in student engagement and collaboration outside the maker-based learning environment.

I expected to see several universal concepts run through the interviews as well including tools, equipment, projects, high levels of student involvement and collaboration (Forest et al., 2014; Martinez & Stager, 2013). In the literature review, many of the maker-centered learning strategies shared common themes with student collaboration but also common challenges and benefits to using maker-centered learning strategies. Some of the common problems that appeared in the literature review included budget constraints and the difficulty in finding qualified experts (Fourie & Meyer, 2015; Slatter & Howard, 2013). Some of the benefits mentioned in the literature review included increased student engagement and collaboration (Hatch, 2013). These same challenges and benefits would likely also occur in educational settings.

Summary

In Chapter 3, I presented the research methodology regarding the study of teachers experiences with maker-based learning practices. The main research question for this study is: What are the experiences of teachers planning, creating, and using maker-centered learning as an instructional strategy in their K–12 classrooms? The data sources for this research are semistructured interviews and written Lived Experience Descriptions shared by participants.

The chapter covers my role as the researcher and the methods I planned to use for participant selection. I also included the methods for data collections and my plan for data analysis. Next, I discussed the ethical assurances including credibility, reliability, transferability, and confirmability. I also shared the steps used to ensure participants' confidentiality and information security. Finally, I covered the results I expect to find upon completion of the study. As I present the findings of my research in Chapter 4, I will provide an organized and thorough analysis of the participant's experiences and perceptions of their experiences using maker-based learning practices.

Chapter 4: Results

Introduction

The purpose of this qualitative study was to describe the experiences of teachers currently using maker-centered learning as an instructional strategy in their 5–12 classrooms. The experiences these teachers share provide a rich context to explore why these teachers instituted maker-based learning practices and how they implemented this change in their teaching practices. In this study, I sought to research the benefits and challenges teachers perceived as affecting their classroom environments. This research is particularly important as teachers are expected to provide more services and meet higher expectations in their classrooms. Schools and teachers specifically are being asked to prepare students for 21st century skills such as collaboration, communication, digital literacy, problem-solving, and critical thinking (Hilton, 2015). Additionally, school districts and states use standardized testing to determine student educational placements, teacher effectiveness, and even school funding (Hart et al., 2015; Segool et al., 2013). Teachers are turning to hands-on, active learning through maker-based learning strategies to meet these demands.

In this chapter, I will first explain the research background and setting for the study. Next, I describe the participants in this research study and their learning environments. Subsequently, I describe the methods I used to collect and analyze the data that I gathered during the interview process as it pertains to the research methodology described in previous chapters. A discussion of the implementation of credibility, transferability, and confirmability make up the next section. Finally, I share the results of the data analysis as it applies to the research questions.

Pilot Interview

I was able to complete two pilot interviews to prepare for the data collection of this research study. The first participant was a middle school math teacher with whom I work closely. The interview was conducted after school hours in her classroom and lasted about 40 minutes. During this interview, we had several discussions about a few of the terms I was using, such as constructionism, constructivism, maker-based learning, and making, as they were not apparent to a person not studying this topic in such an in-depth manner. I was able to refine some of the terms I used in my research questions or add clarifications to the questions that made the ideas clearer to the interviewee. The recording equipment worked effectively, and the in-depth interview produced data as expected. After the interview, I felt that I received positive and constructive feedback that helped me recognize the strengths and weaknesses of the interview. This process bolstered my confidence and helped to prepare me for the actual interviews and data collection process.

I conducted the second pilot study using the virtual meeting software, Zoom. With the clarifications to the interview questions, I was able to gather more information about the second teacher’s use of maker-based learning strategies in her classroom. I have a long history of friendship and collegiality with this interviewee, and during our discussion, I found it difficult to refrain from adding my own comments and opinions and determined that it was critical for me to be very diligent about this as I conducted the actual interviews. The virtual software made recording and adding times to the transcripts much easier. Again, this interview was determined to be a success.

Research Background

I conducted this phenomenological study to examine the experiences of teachers who use maker-based learning strategies in K–12 classrooms. I selected participants based on their answers to a survey detailing their teaching methods and experience that is expounded upon in the next section. I based the questions that guided this research on my interest in maker-based learning practices as well as a review of the available research. In this vein, I investigated the following research questions:

> RQ1: What are the experiences of teachers planning, creating, and using maker-centered learning as an instructional strategy in their K–12 classrooms?
>
> RQ2: What motivates a teacher to implement a maker-centered curriculum as an instructional strategy in their classrooms?
>
> RQ3: What do teachers understand to be the challenges and benefits that they have encountered as they use maker-centered learning?
>
> RQ4: What types of changes have teachers seen in themselves and their students since the implementation of maker-centered learning activities?

A phenomenological study allows researchers to understand the lived experiences of the individual by describing what was experienced (Creswell and Poth, 2013). According to Vagle (2014), phenomenologists set out to describe how individuals move through relationships and events related to an experience. Based on the information I collected from the teachers, I described the teachers' experiences as they use maker-based learning strategies in their classrooms in Grades 5–12.

Setting

I contacted each of the participants through a mutual social media and online professional learning community connection. According to Gelinas et al. (2017), participants are more likely to take an interest in research with online contacts with whom they feel some connections. Four of the seven participants had taken part in a hands-on STEAM-Maker professional development program conducted by an educational service center in the Midwest. The other three participants teach at a school using project-based learning or maker-based learning programs. I sent each teacher who agreed to participate in this research study a survey to determine if they met the criteria.

The survey covered the subject area and grade level taught and the number of years of teaching experience. I asked the teachers to select the activities used in their classrooms such as hands-on, active learning, collaborative learning, project-based learning tasks, engineering design-based tasks, and inquiry-based learning tasks. Additionally, I asked the teachers how often these maker-centered learning strategies are used as a part of their curriculum. A complete copy of the survey is in Appendix A. Based on the survey results, teachers who use over half of the 12 given strategies at least once every two weeks were invited to participate in the research study.

After I contacted each participant via email, I conducted virtual interviews at the participants' convenience. Five of the seven participants chose to conduct their virtual interviews at their school setting in the summer before school had started for the year or after their school contract teaching hours while the other two participants were in a venue other than their school. Two of the seven teachers taught in schools where their school districts mandated PBL.

Demographics

To maintain participant confidentiality, I assigned each participant a code using the capital letter P and a number (P1–P7). In Chapters 4 and 5, I refer to each participant using that identification code. This section details the participants' profiles and describes the data collection and analysis processes. Seven participants agreed to take part in this research study. Figure 1 shows a visual breakdown of the participants.

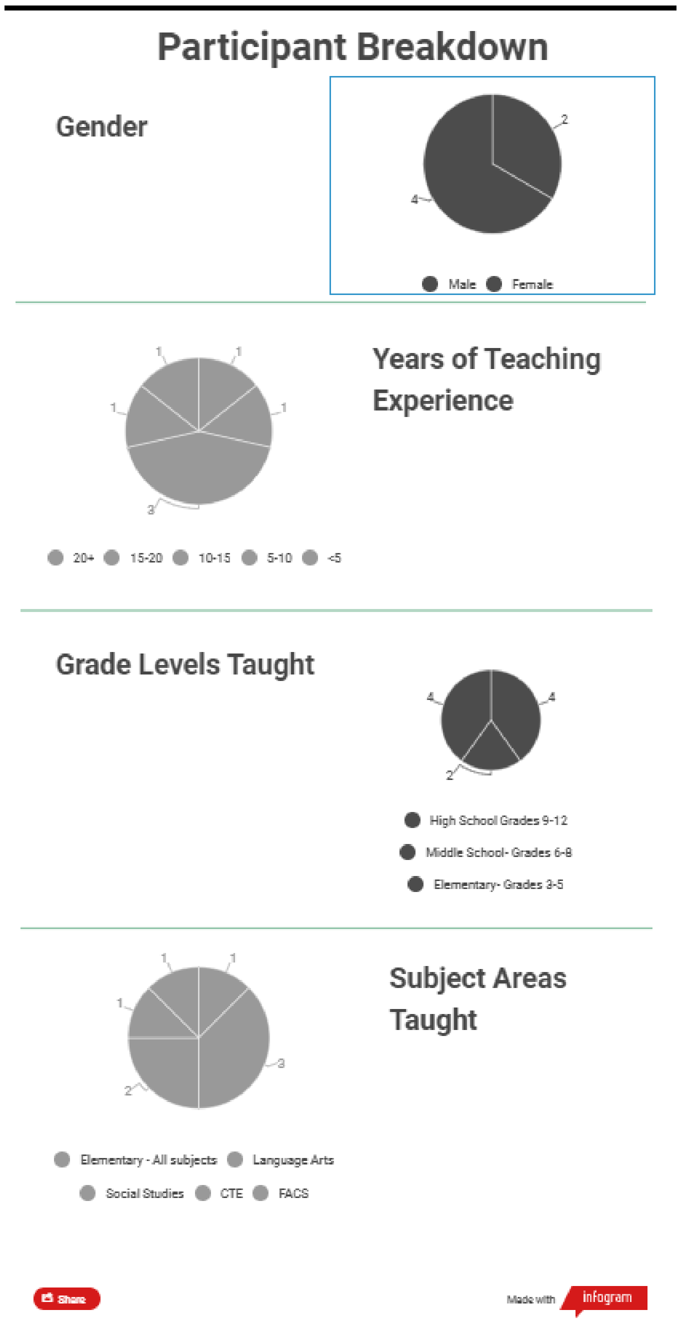

Figure 1: Participants Breakdown

Of the participants, five were women while two were men. The participants teach in a variety of grade levels with four teaching high school including Grades 9–12, two teaching at the middle school level in 6th-grade classrooms, and one elementary level teacher currently working in 5th grade. The participants have teaching experience that ranged the spectrum of an entry-level teacher with just two years of experience to a teacher with over 20 years of experience who was nearing retirement. At the time of the study, all participants were working in full-time teaching jobs in classrooms ranging in grades from 5–12. Participants shared the types of maker-based learning strategies they used in their classrooms. Figure 2 shows those responses.

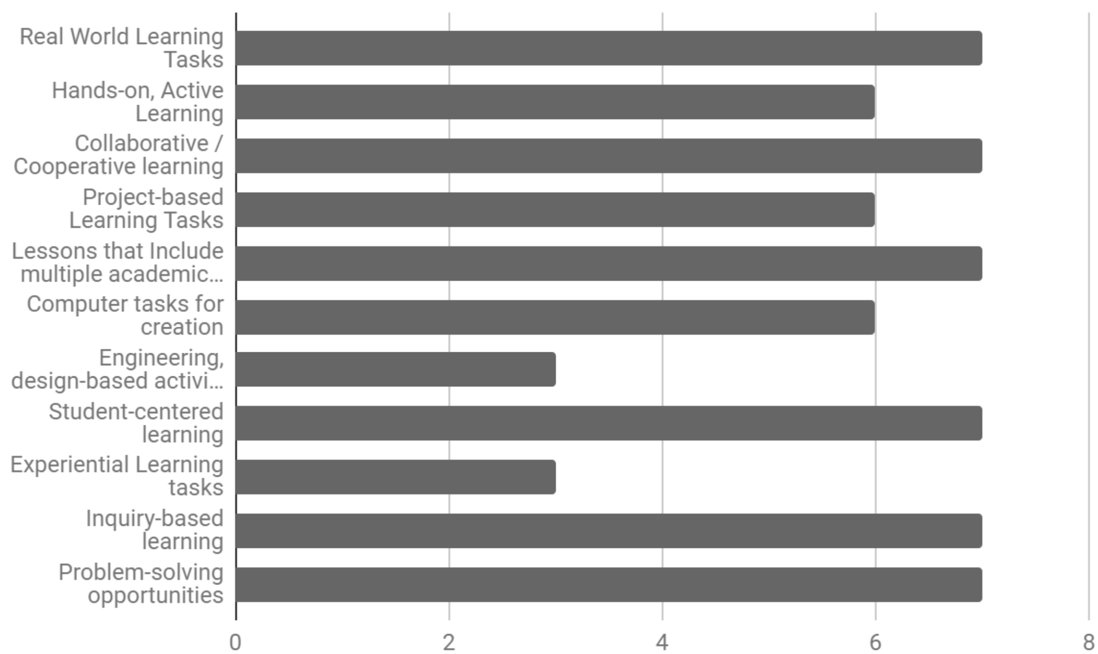

Figure 2: Maker-based Learning strategies

Together with the types of activities the teachers used, the survey contained questions on how frequently the teachers use maker-based learning strategies in their classrooms. Six of the seven teachers use maker-centered learning in their classrooms at least once per week. Figure 3 shows how often the participating teachers use maker-based learning strategies.

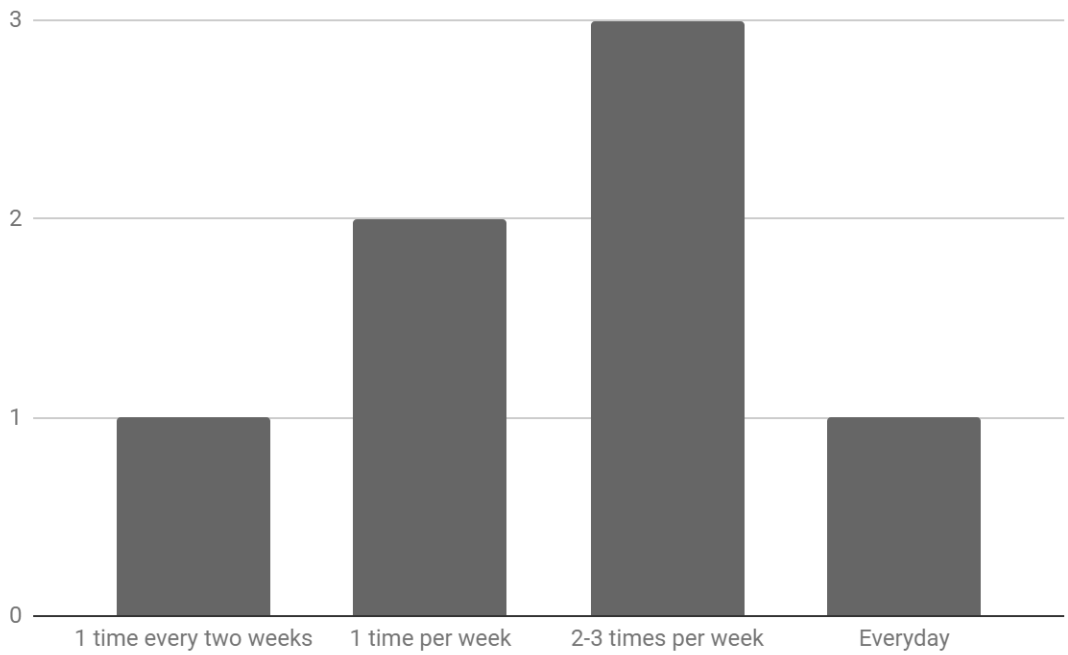

Figure 3: Frequency of Use

Participant 1

Participant 1 taught for 15 years at the elementary level before returning to school to earn a high school English / Language Arts education degree. She taught high school English for a few years and then added an endorsement in Family and Consumer Sciences (FACS). At the time of this study, she was teaching multiple sections of high school English and two sections of a FACS class. Participant 1 used maker-based learning strategies in her elementary classroom and has continued to use these practices in her high school classroom.

Participant 2

Participant 2 brings a wide variety of experiences to the sample of participants. Due to fluctuating enrollment, her 10 years of teaching have included self-contained classrooms at a variety of grade levels as well as single subject classrooms in Grades 3, 4, and 5 and then as reading teacher for Grades 4 and 5. Participant 2 has used maker-based learning strategies in all her classrooms. This year she will teach in a 5th-grade classroom in a small, rural school in the Great Plains.

Participant 3

This female middle school, Language Arts teacher has been teaching upper elementary and middle school for 20 years. She teaches 6th grade for a large school district on the East Coast. She believes her instruction became focused on technology and online resources when she earned her master's degree in instructional technology several years ago.

Participant 4

One of two male participants, Participant 4 is a high school Career and Technical Education (CTE) teacher in his 5th year of teaching. He initially began teaching in an upper elementary classroom and then moved to a large, urban school district in the Midwest to teach in an industrial arts program.

Participant 5

Participant 5 is a female middle school social studies teacher in her third year of teaching. She student taught in a classroom using inquiry-based learning and enjoyed that experience. Participant 5 teaches 6th grade at a small, rural school in a Midwest state.

Participant 6

The other male participant transitioned to teaching and works in a high school social studies classroom in the Midwest. He has taught a variety of courses in the social studies department to juniors and seniors for ten years.

Participant 7

This high school language teacher has nine years' experience. She currently teaches high school language arts including such courses as freshman reading, a college dual credit English course, English to juniors and seniors, speech, and expository writing. Participant 7 teaches for a small school district in the Midwest.

I based the data analysis on the virtual interviews that were conducted using semistructured questions to gather information about the teachers' experiences with maker-based learning strategies. Appendix B contains a list of these interview questions. Two of the four questions were the research questions while the other two questions gathered information regarding the research questions. Participants had the opportunity to share and describe situations using maker-centered learning strategies and express their perceptions of these practices including activities, benefits, challenges, and observations. The experiences of each participant influenced the amount of detail and in the responses. Based on the research questions, the interview questions included the themes of the strengths and benefits experienced by the teachers, the teachers' perceived evolution in the use of maker-based learning strategies and their perceived roles in the maker-based learning process in their schools.

Data Collection

I used purposive sampling to obtain seven volunteers to interview. I located participants through my professional learning network teachers. A professional development speaker from an educational service center sent a Google form to her contact list from a maker-based learning program asking teachers to participate in this research study. I found additional participants through contacts in my professional learning community on the website LinkedIn. Using the direct message application in LinkedIn, I sent a message to three professionals whom I knew was familiar with maker-based learning. These professionals were contacts that I had made through attendance at professional conferences such as Indiana Connected Educators (ICE) and the International Society for Technology in Education (ISTE) conference. I explained that I was completing research on maker-based learning and asked them to put me into contact with teachers who were currently using these strategies and possibly fit the criteria I was using for participants.

I sent each teacher with whom I was put into contact an email. In the email, I introduced myself and explained how I had obtained their contact information. I then went on to explain my research topic and the criteria for participants. I asked each person if they would be willing to let me send them the information and consent form to participate in my research study. I sent 32 such emails until I found seven teachers who agreed to participate. All the teachers whom I sent the consent form agreed to take part in the research, and all seven fit the criteria based on the survey.

Once I had a participant, I sent them an email to schedule their virtual interview at their convenience. Because it was during the summer break, the teachers and I had flexible schedules that allowed us to speak during the day. Virtual interviews were conducted online using the software program Zoom which allowed me to record the interviews. Before and after conducting the interviews, I recorded my views and ideas in a reflective journal. The use of a reflective journal allowed me to bracket my thoughts before, during, and after the interviews and data analysis.

Bracketing, according to Vagle (2014), involves researchers acknowledging their own opinions and interpretations of the topic. Researchers using descriptive phenomenology utilize bracketing to prevent the interjection of personal bias when gathering information from participants. Reflection and bracketing allow the researcher the opportunity to suspend judgment and focus on the essence of the experience by looking at it from different perspectives (Merriam & Tisdell, 2016). The records kept in my reflective journal before and after each interview helped to limit researcher bias. This bracketing was also completed during the data analysis process.

Each interview lasted approximately thirty minutes. I did not rush any of the participants, and I made every effort not to lead any of the answers or insert my own opinions into the interviews. Questions were phrased not to suggest an answer. Questions that lead an interviewee include phrases such as, “Don’t you think…” or “That must have been…” I listened to the answers the participants gave verbally and tried to be aware of their body language to be sure they were comfortable and relaxed as we talked.

I based the order of the questions from the flow of the interview process. I also asked follow-up questions for clarification or to elicit more detail about an answer. I asked participants to tell me more about topics such as how they felt about reactions from others to encourage them to share more. I also asked hypothetical questions, such as, "If this were an ideal situation, what would you see happening?"

Data Analysis

The overarching research question for this study is: What are the experiences of teachers planning, creating, and using maker-centered learning as an instructional strategy in their classrooms? In order to examine this question, I began each interview with a question about how the participants began using maker-centered learning strategies. The ensuing discussions led to the second research question, what motivates a teacher to implement a maker-centered curriculum as an instructional strategy in their classrooms? I next asked the participants about the challenges they have encountered with using maker-centered learning. This question along with the subsequent question, asking about the benefits of using maker-based learning, comprise the third research question. As the teachers described, how, when, and why they use maker-centered learning strategies and how those practices developed, their responses led to a description of the changes they have seen in themselves as they implemented these strategies and answered the fourth research question. Furthermore, the teachers' written lived experience descriptions illustrated an experience using maker-based learning strategies and their classrooms. Taken as a whole, the answers to these interview questions and the written narratives lead to a rich description of the teachers' experiences in using maker-centered learning strategies.

Before transcribing the audio recordings of interview responses, I listened to each recording at least two times. The transcription process of each interview took two to three hours. I began the process for each transcription using the voice to text feature of Microsoft Word. I then replayed each audio file while editing the voice to a text document. Upon completion, the transcripts were printed to make it easier for me to read and code them. I read each transcript thoroughly to begin the process of developing preliminary codes, derived from repeated material collected in the responses.

According to Saldena (2016), In Vivo coding refers to using words or phrase used by the participants. To more easily identify the codes, I began highlighting terms, sentences and entire sections related to general ideas using the words of the teachers. For each highlighted area, I made notes in the margins that used. I then went back over each transcription and wrote a keyword or term in the margin that used words or phrases from the participants. This initial coding was extensive. I proceeded to read each interview transcript line by line adding additional codes and more detail to the existing codes. As I completed the reading, I worked to ensure that I coded each interview question in some way. For the reading and coding of the written lived experience description provided by each teacher, I used these same procedures.

In order to sort these codes, I wrote each research question at the top of a four-column chart. I next recorded the codes written in the margins under each question to which the code was related. If the code was repeated in more than one question or by more than one participant, I made a tally mark after the code. The number of tally marks with each code indicated the number of times it appeared in the transcripts. While the participants have a wide range of experiences and teach in a variety of settings, grade levels, and subject areas, there were primarily similar responses. I sorted and combined these initial codes based on the research questions and created Figure 4.

<table>
<tr><th>RQ1: Teachers' experiences</th><th>RQ2: Motivation for implementing maker-centered learning</th><th>RQ3: Challenges and Benefits</th><th>RQ4: Changes in teachers and students</th></tr>
<tr><td>Failure

Control

Curriculum

Process

Sharing

Administration

Enjoyment

Individualized</td><td rowspan="2">Making

Change

Student need

Innovation
Problem-solving

Interdisciplinary learning

Authentic learning

Different

Student passion

Relevance</td><td>Challenges:
Time

Student challenges

Parents

Assessment

Control</td><td rowspan="2">Evolution

Student-choice

Mindset

Balance

Collaboration

Influences

Process

Relevance</td></tr>
<tr><td>Teacher's Role:
Modeling

Facilitator:

Instigator

Protection

Community

Safety</td><td>Benefits:
Applying skills

Motivation

Engagement

Creativity

Empowerment

Student success</td></tr>
</table>

Classroom: Organization Areas Flex seating		Collaboration Flexible Curriculum Redoing work Planning Process	

Figure 4: Categorization of codes

The codes that appeared most frequently in the data included: administration, failure, student-led/student-centered, hands-on, collaboration, facilitator, time, assessment, mindset, engagement, success, and relevance. After becoming more familiar with the data and the codes I had written in the margins of the transcripts, the lived experience descriptions, and on the chart, I was able to categorize these codes by research questions. The first round of categorizing the highlighted areas produced the initial themes.

As I began charting the codes that I wrote in the margins, I began to realize that each term fit under multiple research questions and there was an overlap developing between research questions. I also noticed that areas marked with the words “Teacher’s Role” covered multiple topics and therefore I broke this down into greater detail. The same process was needed with the term “Classroom” as this term included not only the physical space but also the organization and resources in the room.

As I examined the codes sorted by the research question, I searched for patterns and commonalities. Based on the codes in the table and the commonalities I found, I was able to determine overarching themes for the data. While each participants' experiences have been different, I was able to connect these commonalities to show the themes the descriptions shared. Impressions from these patterns also fit with concepts from the literature review. For example, the literature review included information on the maker mindset and this concept appeared in the data based on the codes "mindset" and "making." Similarly, the learning theories of collaboration and hands-on learning were mentioned by the participants using these same terms.

In the next step of the analysis process, I condensed statements within the coded data to formulate the major themes that emerged from the teacher participants' responses to the interview questions. In this step, I examined each statement to determine whether a statement should become a theme. The statement could become a theme if the text provided valuable insight into teachers' experiences using maker-centered learning strategies in their classroom? Moreover, I determined if the statement was a common idea among the participants that warranted its inclusion as a theme. Once I read through the codes in each research question column, if the statement met each of these examinations, I created a theme.

After completing a list of codes by theme, I began reflecting on the overall meaning of the data. I sorted and resorted the codes looking for commonalities. Relationships among the codes and categories became apparent and were combined as themes emerged. Three themes were developed based on these commonalities. As I further examined these themes and the relationships among them, the more significant and common themes remained. Themes associated with the more significant themes became subthemes. These themes and the following subthemes were developed based on the research questions. A final review of these codes allowed me the ability to sort themes into main themes and subthemes.

During the interviews, participants were asked several questions to describe their experiences using maker-centered learning strategies. The lived experience descriptions also provided an opportunity for teachers to describe their experiences. Each data collection item was examined to explore the four research questions. Figure 5 shows the research questions and the themes that resulted from this examination. The three main themes are; Learning Environment, Focus, and Experiences.

Research Questions	Subthemes
What are the experiences of teachers planning, creating, and using maker-centered learning as an instructional strategy in their K–12 classrooms?	• Classroom Setup • Collaboration
What motivates a teacher to implement a maker-centered curriculum as an instructional strategy in their classrooms?	• Learning Environment • Student-centered learning • Administration
What do teachers understand to be the challenges and benefits that they have encountered as they use maker-centered learning?	Benefits • Engagement • Skills Challenges • Time • Assessment • Pushback
What types of changes have teachers seen in themselves and their students since the implementation of maker-centered learning activities?	• Teacher's Role • Mindset • Failure

Figure 5: Connections Between Research Questions and Themes

When asked what motivated the participants to implement a maker-centered curriculum as an instructional strategy, the teachers discussed the concept of student-centered learning, their teaching philosophies, and support from their school administration. The teachers described the benefits of increased engagement and student skills. The teachers also described challenges they face including a lack of time, the struggle of assessing learning, and pushback from others. These themes encompass the third research question regarding what the teacher understand to be the challenges and benefits of using maker-centered learning strategies.

Finally, I asked the teachers about the fourth research question, regarding the changes they have seen in themselves and their students since implementing maker-based learning strategies. The themes that emerged included their roles as teacher, their mindset, and the idea of failure as an opportunity for learning. When taken as a whole, the interview questions describe the experiences of teachers planning, creating and using maker-centered learning strategies in their 5–12 classrooms. The remaining subthemes of the teachers' classrooms set up, and the collaboration rounds out the clarification of this research.

The themes and subthemes resulting from the research question exploration were regrouped into the three main themes of Learning Environment, Focus, and Experiences. These three significant themes were constructed of the subthemes explained in the themes and results section. A description of each important theme and their subthemes will be described in the themes and results section using verbatim text from the participant interviews.

Evidence of Trustworthiness

Credibility refers to the truth and trustworthiness of the data in a study (Merriam & Tisdell, 2016). Triangulation, data gathered from a variety of sources and respondents, included the use of multiple interviews and written lived experience descriptions as data sources. The use of seven teachers from different schools and grade levels aided in the triangulation of data. Iterative questioning gave respondents a variety of opportunities to thoroughly describe their experiences and impressions. This process was accomplished through primary and follow up questions.

Credibility was also strengthened using peer debriefing as I often spoke with a colleague familiar with my research study. We discussed the interpretations and consistencies that I was finding in the interviews. The peer debriefer and I talked once or twice a week for approximately 15 or 20 minutes each time over the course of about six weeks while I was conducting interviews. Each meeting generally consisted of me explaining what I was working on or what commonalities I saw in the interviews. The peer debriefer offered suggestions or ideas such as how to possibly get more participants and asked for clarification regarding themes.

The use of member checks enhanced credibility. According to Thomas (2017), member checks refer to the sharing of transcripts with participants for comment, clarification, or correction. I emailed each participant a copy of their interview transcripts for their review to determine if they want to make corrections or add clarification. One high school English teacher replied with a question regarding how I planned to use quotes from the interviews. Another participant replied with some additional thoughts she had after our interview that she wanted to add. The remaining five participants replied that the transcript was correct and that they were pleased with the contents.

Reliability, or dependability, of qualitative research, refers to the concept that if another researcher were to analyze the data from the study, they would gather similar results (Creswell & Poth, 2013). In this chapter, I included a clear description of the methods I used for gathering data to increase the visibility of the research practices and analysis. This open account of the research allows those readers who make comparisons to consider the steps I used in determining the consistency and rigor in my study.

Confirmability and objectivity during qualitative research refer to the quality of the data collection and analysis by the researcher. (Patton & Bogdan, 2002). To increase objectivity in this study, I strived to prevent personal opinions from affecting the analysis or interpretation of the data. Furthermore, using multiple sources of data provides opportunities for confirmability. According to Merriam and Tisdell (2016), triangulation using multiple sources of data increases credibility. The multiple sources of data included interviews and written lived experience descriptions. The written lived experience description offers the first-person documentation of experience. The participants in this study were asked to write a short description of a maker-based learning activity that they completed in their classroom along with a brief description of their classroom set up. The written lived description protocol can be found in Appendix C.

The use of bracketing also enhanced objectivity. Phenomenological reduction demands that a researcher bracket prior knowledge and opinions about the phenomenon being studied (Giorgi, 2012). I used a reflection journal in order to help me to focus on my role as a researcher, my assumptions and opinions about maker-based learning practices, and my background as a teacher as they impact this research study. I also used this notebook to record the work I conducted on this research study to have a clear record of my efforts. As I began analyzing the data, I used the journal to make notes about universal themes that surfaced and to record notes on how this data corresponded to the literature for use in Chapter 5. In addition to allowing me to bracket my thoughts about maker-centered learning, the journal acted as an audit trail enhancing dependability.

The teachers and their descriptions provided a unique perspective as they shared their experiences. Reviewing the data, the researcher noticed three consistent topics discussed by the participants and discussed in the next section. I reported these findings' themes reflecting the significant topics shared across the seven teacher interviews. As findings, I discussed the themes individually using support from the interviews. In the interpretations section of this chapter discusses the themes as a systematic whole as related to maker-based learning practices.

According to Merriam and Tisdell (2016), transferability examines the extent to which one set of research findings can be generalized. To address transferability, rich descriptions about the setting, the participants, and research findings must be provided. The resemblance between participants answers and overlapping interview data allows other researchers to determine if the findings of this study will apply to similar research studies (Morse, 2015). Additionally, the written lived experience descriptions confirm the setting and experiences of the teachers as they use maker-centered learning strategies. The data collection of this study clearly describes each participant and the setting in which they use maker-centered learning strategies.

Themes and Results

As mentioned, in the previous section, I examined the codes that were sorted by each research question to summarize the data collected. The purpose of qualitative phenomenological data analysis is to understand the participants' experiences and allow the data to answer these research questions. In this case, the research questions that guided this study were:

> RQ1: What are the experiences of teachers planning, creating, and using maker-centered learning as an instructional strategy in their K–12 classrooms?
>
> RQ2: What motivates a teacher to implement a maker-centered curriculum as an instructional strategy in their classrooms?
>
> RQ3: What do teachers understand to be the challenges and benefits that they have encountered as they use maker-centered learning?
>
> RQ4: What types of changes have teachers seen in themselves and their students since the implementation of maker-centered learning activities?

By putting similar pieces of data together into themes, the researcher creates an organizational framework. Coding the data collected assisted in determining themes vital to understanding the participants' experiences. Taken together, understanding the teachers' motivation, the challenges and benefits they have observed in the use of maker-centered learning strategies and the changes teachers have seen in themselves and their students throughout the use of maker-centered learning strategies, make up the experiences of participants' as they use maker-centered learning strategies in their 5–12 classrooms. Figure 6 provides a visual representation of the three major themes as well as the subthemes derived from these themes.

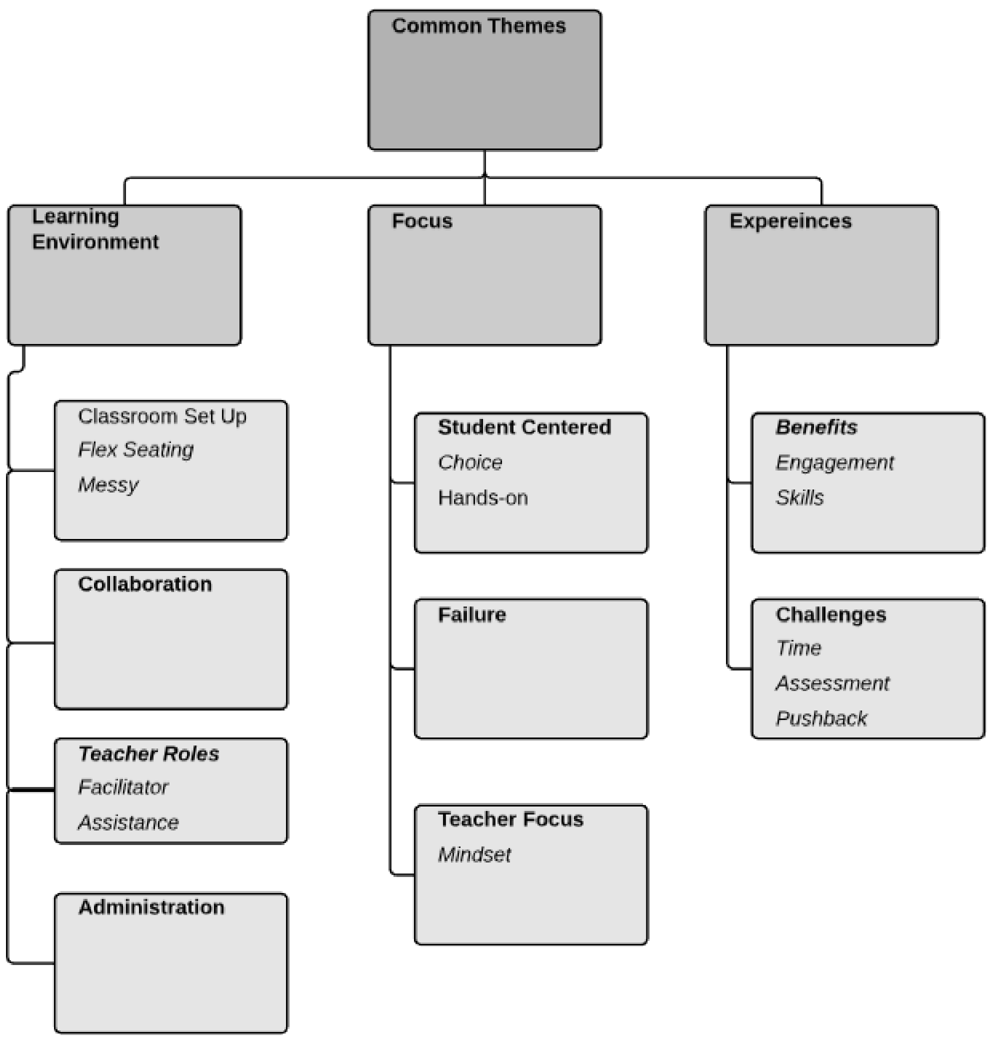

Figure 6: Common Themes

Theme One: Learning Environment

Every interview participant mentioned the learning environment. The learning environment aspects included how the classroom was set-up, the materials provided, and how the students and adults used the space to meet learning needs best. Providing students with space and seating arrangements to work together was one common theme between all teachers. This theme applies to the first research question regarding the experiences of teachers using maker-centered learning strategies.

Classroom set-up.

Three teachers also described resource areas in their classrooms with the materials that students may need to use. Many teachers used flex seating to allow students in a location that encouraged collaboration and space to work. P1 described her classroom in this manner:

> My classroom was set up with round tables for all students. This set up allowed for collaboration and teamwork to happen easily and more often. It encouraged students to ask for help from one another. This also allowed students to have ample space when we did work on projects as I allowed them to work at tables, on the floor, and you know...

Round tables and desks in groups allow students to work together more efficiently and encouraged the freedom to create (P2).

Messy and chaotic environments.

A maker-based classroom setup was often described by these participants as messy and chaotic, which a few teachers admitted was difficult for them. P1 started her use of maker-based learning with an area for students to tinker. “I just kind of put a whole bunch of things in one corner of my room and when they had time to tinker, they tinkered,” she stated. P1 also described how her room was “really messy” because when she started using maker-based learning, she did not have an organization style. “When they had a huge project, where do you store it? Where do you put it? That took a lot of work to try to figure out how to make that work.” P2 commented that “They are learning because it is hard when you sit back, and your room looks like chaos, sometimes and it’s loud and crazy and there's popsicle sticks everywhere.” When asked about the organization of teaching five classes and having the students make projects, P5 replied, “Sometimes it can be a mess, but the kids are talking and learning, and that makes all the mess worth it!”

Collaboration.

The classroom set up with group seating allows for increased collaboration, according to P5. P3 noticed that in her room, students who didn't like to work together were working together because they shared a vision of what they were doing. P2 found that the collaboration involved with maker-based learning allowed “peers to see things in classmates they wouldn’t normally see.” This collaboration was seen throughout P1’s building as she commented, “the more collaborative we became as a building, the more collaborative the kids became.”

P6 described the benefits of collaboration between teachers and students in this way:

> …with the interdisciplinary, students can see how everything connects and how everything works, with the longer block of time, because you've got the two courses, you can really dig into a project and really go at it. I think, I think that something like that would be huge because you're both gonna come at it from different aspects, perspectives, both teachers and they're going to come out with different experiences and different connections. And you're going to be able to really like build those connections, and it would be really organic.

Teacher as providing assistance.

Another common discussion under the theme of the learning environment was the role of the teachers in their maker-based learning environments. The participants saw this as a change from a traditional classroom which relates to the fourth research question concerning the changes teachers have seen in themselves throughout their experience with maker-based learning strategies. The most common description of their role was that of a facilitator.

P3 stated:

> I facilitate- so what you need and how can I get that to you? And that includes sometimes permissions from administrators and parents to allow the child to take a study to the next level. The kids do most of the work, you know. I'm asking questions. I'm walking around. I'm taking pictures and, in the end, when I do the grading, I grade them on their presentations when they present to the class. My job is to know to protect

> my students and to give them the wings they need and to you know, wade through the brush and cut away some of the stuff in the way so they can make things happen.

P2 also discussed the various ways that she facilitates her students' learning as she said:

> I'm going to run the hot glue gun or hammer, I'm going to maybe help a little bit with research, but just really be it encouraging to the kids and positive. Some of them need extra encouragement to get things done and stay on task, those kinds of things. Really just walking around the room and asking the kids questions, you know.

The theme of asking students questions to guide and understand their learning was also frequently mentioned. P2 stated that she moves around the room encouraging students and providing "extra encouragement to get things done and stay on task." She also stated that she asks her students, "What are you working on? Where are you at?" Similarly, as P6 asks about his students' goals, he asks, "What steps are you going to take to get there?" P3 and P2 said, P4 and P5 also commented on how they walk around the classroom working to understand the students' thought processes and to help students think more clearly about what they are learning. For example, P5 stated that she moves from group to group asking open-ended questions to encourage deeper thinking like, "Why is that important?" or "What is another way to look at whatever we are talking about?" P5 went on to say that many of her students have not learned to communicate effectively which requires her to mediate the group work to some degree.

Role of administration.

The role of the administration was the third learning environment theme. The role of the administration applies to the second research question that pertains to the motivation of these teachers as they implement maker-centered learning strategies. While all the teachers agreed that the administration played a critical role in their use of maker-based learning strategies, how their administrations responded to their learning environments were not the same.

When asked about the support of her administration, P2 responded:

> Our principal is very supportive. He’s 100% on board. He sees that value and that benefit, and it's absolutely amazing to have that support from our admin. I mean I know so many other people out there who struggle of that and so it's, it's just absolutely wonderful to have a principal who sees the value in those things for kids.

P3 has had her administration question her maker-based learning strategies over the years. However, she feels that once her principals observe the outcomes, they are often supportive. She stated:

> I get accused of being naive and having too much trust, and I make my principals very nervous but every year my test scores are high, and they’re the highest in the building. So, you know when I get a guy like my last principal who says, “Now [Name], I don't know.” I just say “Trust me. See what happens, and if it fails, we’ll talk. If it doesn't fail, pat me on the back and trust me.”

Support and trust from principals and other administrators are not available for all teachers using maker-based learning strategies. P6 and P7 work in a school district where the corporation mandated the use of maker-based and project-based learning. Despite the mandate, these participants do not feel that their administration understands maker-based learning strategies or PBL. They shared their experiences with an unenlightened administration in these comments.

> P6: You have to be in a building where admin is willing to walk that walk with you. Because if they if they haven't been in it and they haven't taught it, and they haven't lived it. They haven't been in with you to say like, 'Why is this working the way it does?' Then in it is really tough.

The participants' comments demonstrate the importance of the learning environment in their use of maker-based learning strategies. The second theme that I discovered was the idea of the focus in a classroom that implemented maker-based learning strategies.

Theme Two: Focus

The second significant theme that appeared in the data analysis was focus including the subthemes of student-centered learning, failure as a source of learning, and the student and teacher mindset. The second and fourth research questions chronicle motivation and changes over time and are addressed in this theme. During their interviews, each teacher discussed the ideas they feel are at the central focus of their classroom. These themes include a student-centered classroom where learning-by-doing is critical and the idea that failure is an essential aspect of the learning process. The mindset of the students and the teacher in a classroom using maker-based learning strategies is the final subtheme regarding focus. P2 described the focus of her classroom as providing hands-on, real-world learning with our kids while addressing the standards, yet teach the things they need to know.

Student-centered - choice.

As stated, each teacher discussed the student-centered aspect of his or her classroom. P1 expressed this student-centered aspect as letting the students "kind of steer the bus," and that the staff stressed that "anytime that we wanted to have an end goal in mind, we just really didn't care how they got there or what they used to get there." Other teachers echoed this sentiment that students have the freedom to reach the end goal in a way that best works for them including P3. She gives her students the "opportunity to do something to show me what they learned and to take the learning to the next level in that case." P7 expressed the student-centered aspect of his classroom saying, "I really just try to emphasize the process of students deciding what they need to know, where they're interested in, everything being student-led."

This freedom of learning and the student-centered aspect includes allowing students to learn in their own way. P5 described that as, "giving them the tools and then giving them a situation or information that they then have to form themselves." P4, meanwhile, stated that he tries to focus on student interests as he ties those interests across his entire curriculum. Let's find something that's relevant to you. I can cover every bit of the curriculum with whatever it is you want to do. (P4)

P2 includes allowing students the choice of where to work as part of her student-centered classroom. She articulated this choice in the following manner, "Students had to find the space that worked best for them, which sometimes they needed guidance, but they often found that when they were wise in their choice, they became more productive in whatever we were working on." These freedoms were also often expressed in the way learning in these classrooms is more hands-on.

Student-centric – hands-on.

P1 expressed this subtheme of kids learning by doing as she described how she has evolved as a teacher who uses maker-based learning strategies. She said that in her classroom:

> The product no longer mattered, the things that the kids did, the actual final product- none of them looked the same - was the process that they went through and the ability to individually choose how they were going to get there.

P4 connected this hands-on learning process to the way he learns as he is a spatial learner and a physical learner. "Get them outside the realm of what they see on a daily basis and what we call school you know, give them a different opportunity to find something that they're passionate about," encourages P2.

Failure as part of learning.

Each teacher discussed the importance of failure as a part of learning which is the third theme identified. P1 expressed that as she began using maker-based learning strategies, "My initial push was for them to just try new things. So, I felt like up anytime we could do something hands on just to make something, even if it failed." P1 stated that this fear of failure is common with students. P3 also discussed how students fear trying new things to avoid failure when she said:

> I think our kids are conditioned to sit still and do what you're told, and I think the challenge to be willing, to be willing to just try something that they've never tried before. I've had more conversations with kids about how it's ok to fail. And it won't be the end of the world, and I promise their parents won't beat them. Because the F won't go on the report card because it's not that kind of a fail. (P3)

When asked about how she has evolved in her use of maker-based learning strategies, P2 discussed control and failure with her students. This teacher described her involvement and how she handles failure as a way of learning in her classroom as:

> I've learned to not get involved as much, I guess, helping the kids. It's OK to let them fail, and that was hard for me. I'm very much a control freak in certain aspects, and so I want it to look good for them, and I don't want them to fail, but they learn so much when they fail. And I tell my kids I said, "The only mistake you ever make is when you stop. You know if you make a mistake and you keep going, you learn from it. So, the only time you fail is if you quit trying." So, we talk a lot about that my room. How it's OK if something doesn't work or didn't turn out exactly like you thought because you learn something from it. And what would you do differently next time? So, you know, I think just letting go of all

> control and knowing it's OK for them to fail and make mistakes. Not have everything be perfect and all that because that's life. Nothing is perfect. Nothing turns out right the first time. (P2)

P4 discussed how he handles failure in his classroom as a learning opportunity if it can occur safely. He allows students to fail to provide the circumstances for a discussion. P4 described this in the following manner:

> Sometimes they'll ask, "Can I use this apparatus to do this particular job?" And sometimes the answer is no; it's just not the right tool for the job. Sometimes I know it won't, but I know we can fail safely, so I let them fail. And we'll find out why you can't use this machine for this particular task. (P4)

Teacher mindset.

Under the theme of focus, the subthemes were linked to the idea of the teacher and student mindset. Many of the participants stressed that moving to a maker-based learning classroom required a change of mindset both for themselves and their students. P1 stated, "My goal was just to add more time in my class to shift my mindset of those kids, and when they're tinkering and when they're playing, it is learning. So shifting my mindset that way." P3 described the need for teachers to shift their mindset in order to improve their teaching as she stated:

> And the other teachers in my building, they're afraid to do that. They are afraid to lose control over what they think are test scores because that's a driving force now and part of our evaluation every year is that our students

> improve in reading. I wish I had adopted this attitude sooner as I think it would have made me a better teacher. (P3)

This shift of mindset in teachers and students results in classrooms that do not fit into the traditional definition of teaching and classrooms. P3 described the need for that shift in this manner:

> The kids need it. I listen to teachers in my building say things like, "Well I learned that way, and it worked just fine." OK, for you. But how boring is that? And are you one of those people whose goal is just to get A's? Or are you actually trying to learn stuff? There is a difference. (P3)

All seven participants see themselves as agents of change in the process of shifting the mindset of their colleagues and students. P3 sees herself as "sort of a rogue" as she is the only teacher in her building using maker-based learning strategies. P2 has found that in her building, more teachers are using maker-based learning. She explained it this way:

> A lot of our staff who have been around a long time, they're saying 'This is what we used to do. This is what learning used to look like.' You know, that they had the freedom and the open-ended units and those types of things.

P2 understands the concerns of teachers with using maker-based learning and described a need for balance between traditional classroom instruction and maker-based learning strategies. She described this need for balance in the following way:

> And so, in my classroom, I really tried to balance you know the time that they're just sitting and listening to me, and the time they’re researching, learning on their own, I think there's a place for both in every classroom.

The focus of a classroom using maker-based learning strategies includes a wide range of commonly discussed points. Student-centered learning that is hands-on and based on student choice is the central theme in these teachers’ classrooms. The shift to this maker-based focus included a shift in mindset for the teachers and the students. In the third theme, the teachers describe their experiences using maker-centered learning strategies.

Theme Three: Experiences

Each participant was asked to discuss the benefits and challenges they had faced while using maker-based learning strategies in the classroom. These questions directly answered the third research question. Engagement, student empowerment, and improved academics were a few of the common benefits mentioned by the teachers interviewed for this study. Likewise, many of the participants mentioned time, assessment, and combatting pushback as common challenges that are faced as they use maker-centered learning strategies.

Benefits

These teachers were very confident in their discussion of the benefits using maker-based learning practices in their classrooms. The most commonly described benefits of maker-based learning strategies include intrinsic motivation and student engagement.

Intrinsic motivation.

P2 described the need for intrinsic motivation in classrooms this way:

> I think that's one of the biggest things is self-motivated learners. It's tough. I think now more than ever it's good to get kids to be intrinsically motivated about learning and allowing them to have the power and creativity and have that choice and voice in what they're doing and how they're learning. That's definitely the direction that I see things going and to get them to find that intrinsic motivation.

Many of the teachers appreciate the way students are engaged and taking ownership of their learning in a maker-based classroom. Several of the teachers described teacher-directed instruction as "sit and get." P6 described the benefit of student-led learning in this manner:

> I think that for one thing, kids really has to think critically and which I think is great. I think they have to be creative. They have to actually take some ownership over the learning. They can't passively sit back and say, "Teach me what I need to know."

P3 discussed that her students are so engaged in classroom activities that they do not realize that they are learning a vast number of skills. She stated:

> The best compliment I've ever had from students is that they learn more about _ (static) _ from me than any other teacher. I don't need them to learn English. It's who we are. It's what we do, and they do learn English. They just don't know that they are doing it. They don't know

> that they're learning to be better writers and communicators. It's just a part of what we do. (P3)

Student engagement.

The increase in student engagement also enables students to take charge of their learning. P3 stated, "Every year I'm kind of flabbergasted by the way the kids own it and make it their own." P5 described how increased student engagement led to other classroom changes when he said:

> A lot of the kids that I end up with in my class are either the ones that can't do traditional school, or this is their halfway house on the way to expulsion. They don't know what to do with these kids. And in a lot of them, they have poor social skills. They have poor academic skills but, in my environment, they can thrive, and that's, you know, they can find some success. It builds their self-esteem up, and they realize that - Hey I can learn how to weld …. The ones who are coming here from 4.0 GPA-land who are coming here just to learn to use the tools. They struggle because they can't think with their hands. In here if I take away their calculator and say you know, what's half of an eighth and they can't do it. They can't. It's interesting in that it's fun to watch the underachievers teaching the brainiacs. Hey- this is how you work this machine and again, that builds their self-esteem. Everybody wins if I can start the dynamic in the classroom right at the beginning. We all succeed.

P2 echoed these benefits to students and the way they see themselves and others in her interview with this description:

> Allowing the opportunity for some peers to see things in classmates they wouldn't normally see. I've seen that several times and you know, a kid can have a lot of great things going on in their head but don't always know how to express themselves but then you give them an opportunity to do what they want, and how to get to a learning outcome and they'll just impress everybody in room, so that's probably. Definitely, one of the greatest things that I have come across is peers seeing others in a different light.

P3 described that the students are not the only learners in her classroom as she described how she learns along with them. Her description of the learning activity associated with a hobo convention was:

> Ah well, I learn stuff every year because the kids bring things into it that I hadn't thought about and hadn't considered like a hobo convention. It never occurred to me to go through the whole primary process, and quite frankly I'm not a social studies teacher. I don't know that much about the whole process but [student name] did, and he came in with the research he won everything together, and he organized it, and I sat back, you know. And he said, 'Do I have to run for office?' I said "No you are the organizer. That's you. You have an A right now but just keep doing what you're doing because you just took over my class and I get to watch and

> learn" and so that's a big benefit. I think I think it's a big plus to watch kids blossom, you know. I certainly smile more when I let go of control, and I sleep better now and sometimes, you know.

The increase in student engagement brings about improvements in students learning and academic abilities. P1 described these improvements in the following manner:

> The kids really do like it when they get into it, they really do. Any time like they don't have time to sit and think and rethink something and redo things and so the more I could add that in a safe environment, such as like a maker space where using Legos to do it, then I see it when they're doing their writing. They're way more likely now at the end of the year then they were, way more. Like to relook at something in their writing and fix it and change it.
>
> Where at the beginning of the year it was like one and done. So really cultivating that, hey, it's never done. You could always look at things and see how you could make them better. The more I brought into that some of that stuff I don't want to say easy but threw more fun activities, more hands-on activities; then I was seeing the benefit like when it came to their schoolwork, like the writing.

Technology.

The participants also mentioned improvements in technical skills as a benefit to using maker-based learning strategies. P5 appreciates the opportunities for students to use different resources and different aspects of technology in the activities. Both P4 and P5 stated that the use of technology encourages creativity and the ability to "think outside the box." Similarly, P3 appreciates the way the use of technology encourages student self-advocacy skills as they learn to solve problems with their iPads independently and with less reliance on the teacher to fix issues.

Challenges

While there were many benefits discussed by the participants, the use of maker-based learning strategies in the classroom is not without a few challenges. Time, assessments, and pushback were the most commonly mentioned challenges to maker-based learning strategies.

Time.

When asked, five of the seven teachers stated that time was a challenge. "Time. It seems like there's never enough," according to P3 and P5. P1 also lamented the lack of time when she stated:

> It was amazing how little time high schoolers have to tinker and play and try new things. I found it hard in the English classroom just because of the amount of writing and reading I had to do, just time-wise. It was hard to find time to bring in time for kids to tinker.

As a high school teacher, P7 also expressed the lack of time in terms of classes for which she needs to prepare and the scheduling difficulties of bringing in outside experts due to their schools' block scheduling policy.

Assessment.

The time needed to meet deadlines for assessments was also mentioned by P3 when she stated, “In our report cards, we have to have grades. You have to meet deadlines with that, and I find that that's a big challenge.” P2 also described the struggles of assessing student work in her interview. She stated:

> How do I give a grade for something when we know all kids are different, and they all do things differently? Focusing on process, not products. What did they get out of it, through all of it, and not just what was their final outcome? Because a kid can come to you and have a whole lot of nothing to show, but they learned a lot through what they did. So, um, I think a little bit it's scary for some of our kids who are really good at pleasing the teacher and sit down and give me a checklist and I'm gonna do A,B, and C and I'm going to get an A., And then you say, “This I want you to do and I not going to tell you how to do it. You gotta figure it out. That's totally mind-blowing for them. And so, getting them over those hurdles to see it's OK, you know, and kind of talk them through it, so.

Students struggle with the changes in these classrooms as they are unfamiliar with this type of learning. P4 describes his students’ struggles in this manner:

> You know, in the traditional industrial arts machine shops, you know, the way it's always been since the days of black and white textbooks. The teacher says, “Here’s the print for the project. Let

> me show you how to use the tools. Now you build the project."
> The way I try to design it - I'm going to show you how to use the tools. Now, what do you want to make? That's what the struggle is - They don't know what they don't know. I can show them a blacksmithing video, that's all they want to do. If I show them a video on making jewelry, that's all they want to do. They can' think outside the box. They've been so trained to follow the rubric that they can't think for themselves anymore and it's hard. So, I have to get to know them and find out what turns them on.

P3 agreed with this statement as she described her students' biggest challenges. "Sometimes the biggest challenge is the kids who are conditioned to fail. They've always failed, and they always feel like what they do isn't good enough," she states. P2 related these challenges with students' struggles to self-advocate as she said:

> And I find that kids have a really hard time voicing needs sometimes. It drives me nuts when a kid comes up to me and says my pencil broke. OK, well what are you gonna do about it? I mean there are kids where I'm like OK, and they stare at the like, Well, what are you gonna do about it? Like, I am not going to do anything about it. You're like that's simple. So, doing some of these projects and getting them to really voice needs.

Pushback.

Changing student and teacher mindsets bring challenges as they push back against these unfamiliar practices. When asked about when she began using maker-centered learning strategies in her school, P1 stated:

> A couple of the things did not go well, and so there is some pushback. There's pushback by the kids; there's pushback by other adults. Kids truly want to sit down, take in the information that they need to pass the test, and go. So, to really get them to really change their mindset on what learning is it is, is a big challenge.

As the school where P6 and P7 teach began to institute maker-based learning strategies throughout the school, there were conflicting opinions. P6 described the situation this way:

> Well, when it became time for year two, those rest of the building people weren't on board because they have pedagogical differences, to begin with- that's why they didn't pick them. So, there was a lot of push back. There's a lot of people that didn't really want to do it. I think the first group that came through loved it. The first group of 8 or 9 teachers, like we're really on board. The next group, "Well, that's not what I do." Which, I mean, I totally get, so they're kind of forced into it.

Similarly, P3 stated that other teachers in her school do not share her passion for maker-based learning. She states that "They feel as if I am not working as hard as they are because A) I'm not stressing over it and B) I've given it to the kids." Each of the seven teachers interviewed expressed that this pushback and the challenges were worth the effort. As P2 stated,

> I think now more than ever it's good get kids to be intrinsically motivated about learning and allowing them to have the power and creativity and have that choice and voice in what they're doing and how they're learning. That's definitely the direction that I see things going.

Summary

In this chapter, I described the way I collected and analyzed the data. I described the participants in the research study both in a diagram and in the text. The research questions, the written lived experience descriptions, and the connection between these data sources and the themes were explained with an illustration and verbally. After graphically explaining the themes and subthemes revealed in the data analysis, I used text from the interviews and narratives to demonstrate these similarities.

Despite their differences in years of teaching experience, grade levels and subject areas taught and types of schools, these seven participants shared many of the same experiences, benefits, and challenges when asked about their use of maker-based learning strategies. These teachers shared commonalities in their learning environments that included the collaboration encouraged through their classroom set up and their roles of facilitators with their students. Although they have different experiences, all the participants agreed that support from the administration is critical to the use of maker-based learning strategies.

The participants discussed the student-centered focus of their classroom including hands-on activities and student choice. Changing the mindset of all involved was another common theme. Failure as a part of learning was discussed by every teacher as a key to maker-based learning strategies, as well. This change of mindset and acceptance of failure was a common challenge met by the teachers interviewed as was the issue of assessment. While the teachers faced several challenges, the benefits of using these learning strategies overcame the challenges. The benefits included improved student achievement, increased engagement, and enhanced student confidence.

The words of P4 summarize the experiences of these teachers and their use of maker-based learning strategies:

> You stand back and just watch them think. Watch the learning process. And for some, it's really fast, and for some, it's just it's just painfully slow. But if you don't interrupt it. If you just let them blossom on their own. You know, it's fantastic what can happen.

In Chapter 5, I continue the examination of these findings and connect the results of the data analysis with the literature review. Also, in Chapter 5, I make recommendations for further action and study as I also my reflections on the research study. Finally, I discuss possible social implications of the study before drawing the general conclusions on the experiences of these teachers using maker-based learning strategies.

Chapter 5

Introduction

The purpose of this qualitative study was to describe the experiences of teachers currently using maker-centered learning as an instructional strategy in their grade 5–12 learning environments. Such experiences provide a rich context to explore how and why these teachers instituted maker-based learning practices. The central research questions that guided this research study were:

RQ1: What are the experiences of teachers planning, creating, and using maker-centered learning as an instructional strategy in their classrooms?

RQ2: What motivates a teacher to implement a maker-centered curriculum as an instructional strategy in their classrooms?

RQ3: What do teachers understand to be the challenges and benefits that they have encountered as they use maker-centered learning?

RQ4: What types of changes have teachers seen in themselves and their students since the implementation of maker-centered learning activities?

In this phenomenological research study, I focused on the lived experiences of teachers currently using maker-based learning strategies in their classrooms. As described in Chapter 1, schools are implementing more maker-based learning programs in K–12 education for increased STEM/STEAM instruction. Maker-based learning incorporates educational pedagogies such as constructivism, project-based learning, design thinking, and inquiry-based learning allowing students to take an active role in creating their learning by encouraging students to have a sense of inventedness and explore answers engagingly and interactively (Hsu, Ching & Baldwin, 2018).

In Chapter 2 I examined the previous research completed on the aspects of maker-based learning strategies and demonstrated a gap in said research. The scope of this research study is significant because previous research focused on academic and social benefits and challenges for students in maker-based classrooms. Previous researchers have also focused on the tools and activities used in maker-based classrooms. I was unable to find examples of previous research that examined the experiences of the teachers in these classrooms. In Chapter 3 I discussed the methodology and data collection procedures for this research study. I conducted virtual interviews with seven teachers currently using maker-based learning strategies in their 5–12 grade classrooms, as well as an analysis of written descriptions of the teachers' experiences.

The primary themes that I found in my data analysis were learning environment, the focus on student-centered learning, risk-taking, and a growth mindset, and the teachers' experiences. The subthemes in the learning environment include similarities in the way teachers have their classrooms set up and the student to student and teacher to teacher collaboration. Another aspect of the learning environment was the role of the teacher, as well as the importance of administrative support.

The second theme revolved around the idea of focus, including a focus on student-centered learning, which encompasses student choice and the hands-on aspect of activities. Each participant also mention the idea of learning from failure and the importance of risk-taking. Teacher focus and mindset was the final subtheme that appeared in all the interviews.

Each of the teachers participating in this study shared comparable experiences including similar benefits and challenges in using maker-based teaching and learning strategies in Grade 5–12 classrooms. I compare these themes to the literature of other research studies and the implications for future research in this chapter.

I work to bring a summation between the previously conducted research, the findings in this research study, and the implications for future research studies in this chapter. The next section of this chapter is an interpretation of the research findings and seeks to compare the data from this research to that of previous studies. The following section covers the limitations of this study followed by recommendations for future research studies. In the implications section, I discuss the positive social implications of maker-centered learning and the research regarding these learning strategies as well as the implications related to the methodologies discussed in the conceptual framework. Moreover, I give my recommendations for the educational practice of using maker-centered learning in a 5–12 grade classroom. I summarize this chapter and the entire research study in the final section.

Interpretation of Findings

I have broken down the review of the literature into segments including the conceptual framework involving active learning approaches including constructivism, constructionism, and experiential learning. Previous researcher studied the technology and tools used in classrooms focused on maker-based learning and other learning spaces such as libraries and museums. The review of previous research covered the role of the teacher as well as the benefits and challenges the participants have faced using maker-based learning strategies and the evolution of 21st century skills. The topics of the tools and technologies appeared in previous research. However, the teachers in this study did not discuss these concepts regarding their role or the perceived benefits of maker-based learning. As expressed in Chapter 4, the data analysis revealed the same themes. Figure 7 shows a comparison between the previous research and the current data.

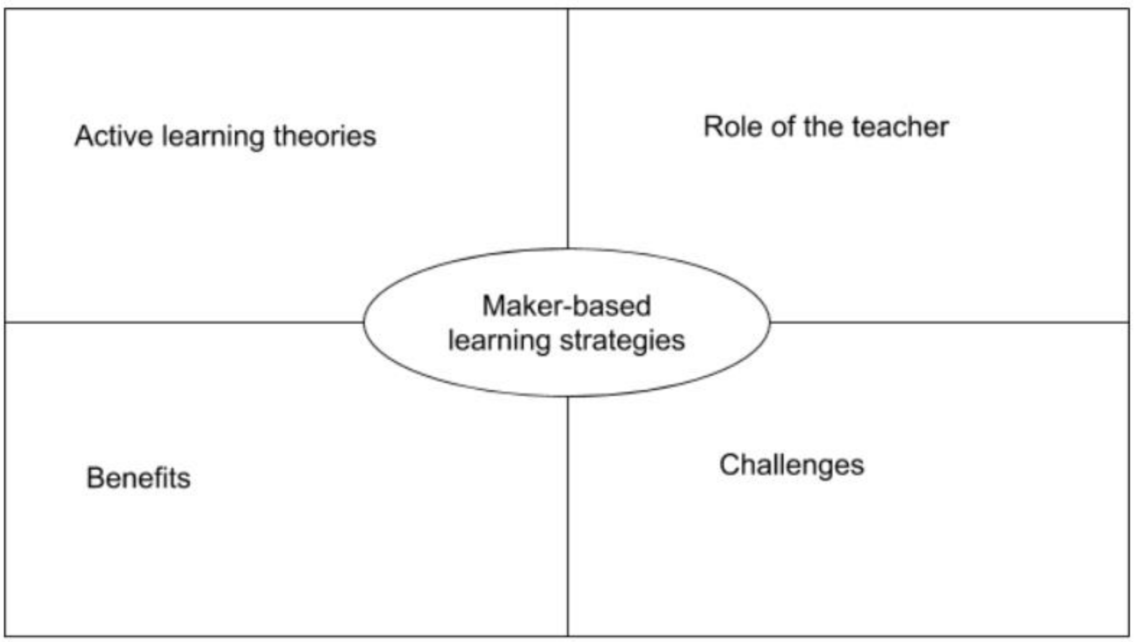

Figure 7: Interpretation of Findings

Active Learning Theories

The first recurring theme is that of the learning environment and those learning theories used in classrooms using maker-based learning strategies.   The learning environment is a significant component of each teacher's experiences with maker-based learning. The classroom is one portion of this concept.

Classroom.

According to Roberts (2016), in the traditional classroom, two-thirds of the classroom talk comes from a teacher asking questions while the students seek to provide a “correct” answer rather than collaborating with one another. Conversely, classrooms, where teachers use maker-based learning strategies, focus on more experiential, active-learning strategies based on constructivist theory. According to Blakely and McFadyen (2015), active participation and real-time connections increased transferable skills including questioning, divergent thinking, collaboration, and self-directed learning. P6 stated that he has always connected with active learning, the theory of constructivism, and the idea that “students have to construct their own knowledge.”

Allowing students to construct their own knowledge can be very different from the traditional classroom. Gordy, Zhang, Sullivan, and Lee (2018) found that active learning environments were set up to allow students and faculty flexible seating arrangements, space, and devices for collaboration, and the ability for the professor to move more freely about the room. The teachers in this study described their classrooms in much the same way: with tables to accommodate group work, an area with available resources, and space for the teacher to meet with groups or individuals as needed. P1 described these resources as “a whole bunch of things in one corner of my room, and when we had a project, they could choose from the materials I have.” P2 described her classroom as being far from perfect. “You sit back, and your room looks like chaos, sometimes, and it’s loud and crazy, and there’s popsicle sticks everywhere, but it’s okay because they are learning.” Martinez and Stager (2013) found that classrooms using maker-based learning strategies to be stocked with materials to allow students with ideas as they work to solve challenges.

In previous research, I found information on the technology, programs, and tools used by teachers in maker-centered learning environments. The teachers interviewed in this study mentioned computer skills as a part of their curriculum but did not specifically discuss tools or programs used. Each teacher interviewed described a classroom that was set up to encourage collaboration and discussion among students. P1 and P2 both use “flex-seating” that allows students to choose a seat that works best for them and allowed them to be more productive. The other participants use tables and small group areas that allow students to sit in a “community for more collaboration,” as stated by P3. According to Clapp et al. (2017), this sense of community encourages the sharing of knowledge through distributed teaching and learning.

Learning theories.

Students in learning environments where the focus is on meaningful situations show higher academic gains as the interaction leads to increased reflection, more complex problem solving, and improved critical thinking, collaboration, and communication skills (Chang et al., 2015). Roberts (2016) stated that collaboration brings about reciprocal learning when all contributions are valued, and students accept differences from students of all ability levels. This collaboration and support were evidenced in P3’s interview as he discussed the students helping one another. The topic of collaboration among students arose as teachers described their roles as facilitators. In the role of facilitator, teachers more commonly provide support to students managing their own learning as the teacher encourages student self-efficacy and creates an atmosphere conducive to student self-expression (Keiler, 2018).

The focus of the teachers interviewed for this study included developing 21st century skills. One significant change in mindset is the acceptance of failure as part of the learning process. To move from a traditional classroom to a maker-based learning environment requires a change in mindset by the teachers, the students, and the administration. Maker-based learning strategies relate to 21st century skills such as innovation, creativity, and risk-taking (Maltese, Simpson & Anderson, 2018). Martinez and Stager (2013) have found that creativity and collaboration are essential elements of 21st century education. Spires, Lee, Turner and Johnson (2008) state that meeting 21st century needs requires schools to transform education based on the acceptance that students have more opportunities to learn in different ways.

Student-centered.

Thiele, Mai, and Post (2014) concluded that education is more about access to information rather than just the presentation of information. P2 referred to this direct instruction as the process where students “sit and get” to gain information. The teachers interviewed for this study all described the use of a more student-centered approach. As found by Wu, Pease, and Maker (2015), participants value student voice to increase student engagement in learning by guiding the learning. According to Schlechty (2011), by directing student learning rather than controlling the knowledge acquisition, teachers find students with increased engagement, heightened attentiveness, increased students’ persistence, and higher student commitment to the learning as students find meaning and value in the lessons. P1 referred to this process as allowing the students to "steer the bus" as they are offered the choice in how to demonstrate their learning. The teachers' responsibility is to give students' choice to allow them to own the learning and to empower the students to prepare themselves for anything (Spencer and Juliani, 2017). Similarly, P3 described how her students have the "opportunity to do something to show me what they learned and to take the learning to the next level." Structured choice, according to Zucker (2018), can take the form of independent reading choice, student choice on demonstrating their learning, involvement in daily decision making, and tailoring instruction to meet individual student needs.

Teacher's role.

Teachers most frequently describe their role in the learning environment as that of a facilitator. Lee (2015) found that learning experiences where teachers transmit knowledge to a student are no longer sufficient to prepare students for future success. Learners now have easier access to knowledge and information that is continuously changing. The role of the teacher as facilitator involves supporting students and helping to keep them working toward their goals (Lee, 2015). Researchers found that teachers using maker-based learning strategies stressed the importance of student motivation, scaffolding learning, instilling principles, and developing character traits (Habok & Nagy, 2016; Kokotsaki, Menzies, & Wiggins, 2016). P3 described her role as that of "instigator" as she questions students to help them think more clearly about what they are working on and also to "clear the path so they can make things happen." Goodyear and Dudley (2015) found that student-centered learning approaches encompass guiding students to manage their own learning, teaching collaboration skills, self-efficacy, resiliency, and decision-making skills. According to Flores (2018), this is done through checking-in with students to provide feedback and advice. Teachers do this by looking for evidence of understanding, encouraging divergent thinking, and promoting collaboration and creativity. As P6 described in his interview, the teacher must also connect learners with community experts for additional information.

Administrative support.

According to Lukacs (2015), in educational change, the role of the teacher is developing to that of a trendsetter as they begin to initiate changes in schools. The teachers in this study each see themselves as agents of change. As teachers facilitate this change in learning strategies in their classrooms, the support of administration is an important aspect. Castro Silva, Amante, and Morgado (2017) found that effective school leadership presents a positive school climate. Additionally, a favorable school climate is more likely to have collaborative relationships among teachers, more diverse teaching strategies, and increased staff participation in initiatives. In this research study, the teachers with administration support had more favorable outcomes with maker-centered learning strategies that those who did not feel supported by the administration. As an example, P2 has the full support of her principal and commented that it boosted her confidence in what she was working on in her classroom.

On the other hand, P6 discussed the frustration of having administrators who do not fully support the teaching strategies as he stated, "…you have to be in a building where admin is willing to walk that walk with you." Demirtas, Ozer, Demirbilek, and

Bali (2017) found a high correlation between principal support and commitment to the organization. This commitment results in a higher quality of teaching and the school's efficiency. The support given by the administration also promotes collaboration and innovation among teachers (Castro Silva, Amante, & Morgado, 2017). This innovation requires a change in mindset by all involved. The change in mindset is part of the focus of a teacher using maker-centered learning strategies.

Teacher Focus – Maker Mindset

Changing a classroom to be more student-centered requires a shift in mindset for teachers and students. Experts refer to this attitude as a maker mindset (Martin, 2015). The four elements of the maker mindset, according to Martin (2015), include playfulness, a growth mindset, the celebration of failure as a learning process, and collaboration. According to Rodriguez, Allen, Harron, and Gadri (2019), individuals with a growth mindset enjoy learning and believe that they can complete even difficult challenges through hard work and perseverance. The teachers interviewed for this study discussed this as an acceptance of failure as a part of the learning process. P4 stated, "Failure is part of learning. It is expected." Likewise, P1 found that her students struggled with having to "build their frustration level when things didn't work and being ok with that failure."

According to Hochanadel and Finamore (2015), when teachers encourage students to persevere, a growth mindset develops, broadening grit and the capability to achieve long-term goals. This persistence allows students to problem solve and learn from their mistakes. Lottero-Perdue and Parry (2017) found that the evaluation of failure leads to a growth mindset where failure presents as feedback rather than a negative consequence. Much like the teachers using maker-based learning strategies, Maltese, Simpson, and Anderson (2018) found that failure is part of the learning process and is something from which to learn. "Kids truly want to sit down, take in the information they need to pass the test, and go," stated P1. Researchers Blakey and McFadyen (2015) found similar results with students seeking answers from the teacher rather than developing their own sense of curiosity. The participants in this study conveyed their experience that failure, through maker-based learning strategies, allows students to learn valuable 21st century skills. P3 stated that students can learn to be challenged to be willing to try something they have never tried before and that it is possible to learn from failures. This participant went on to explain how through the failure, the students learn to communicate their ideas and become more resilient as they work through challenges.

The participants in this study each shared their experiences as they discussed their motivation for using maker-based learning strategies. These motivations included a desire for student-led learning from P2, P5, and P7 as well as encouraging students to learn by doing as explained by P1 and P4. The desire to engage students in meaningful activities motivated P2 and P6. The teachers shared this motivation along with the benefits and challenges of using maker-based learning strategies they have encountered along their journey.

Benefits of Maker-Based Learning Strategies

P4 was motivated to use maker-based learning strategies as he worked with students who were hands-on learners such as himself. These participants consider themselves innovators and agents of change to make education fit the needs of their students. As P3 expressed, "Teachers who think we can still function with pencil and paper and books written by somebody back in 1912, they don't get it. They don't get who our kids are and where they are going." While not using the term "21st century skills", the teachers each discussed the core skills of critical thinking, creativity, communication, and collaboration. Engaging students in active learning to expand their 21st century skills to prepare for this future is one of the primary benefits cited by the participants.

Engagement

According to Thiele et al. (2014), education has evolved to become active engagement in learning with greater access to information. Researchers have found that increased student engagement results in a higher degree of motivation, achievement, confidence, and to improve creativity as students took ownership of their work (Blakey & McFadyen, 2015; Wu, Pease & Maker, 2015). P6 stated that he sees his students taking ownership over the learning resulting in more critical thinking and creativity. Similarly, P2 expressed that maker-based learning strategies empowered and engaged her students to be self-motivated learners. Kayler, Owens, and Meadows (2013) found that in maker-centered learning classrooms, students were able to support one another, brainstorm solutions, and provide support to one another as they worked on new challenges.

Skills

With this support from the learning community, students begin to develop more confidence in their capacity to recognize problems and work to solve them, according to

Flores (2018). As students become more confident, P1 found that her high school English students were more likely to relook at something in their writing, fix it, and change their drafts. The other high school English teacher, P7, found that the increased confidence her students gained with presenting their findings carried over into other courses and their future work in college. In addition, students who feel supported and are encouraged to voice their needs benefit from active interactions between themselves and teachers and demonstrate an increased contribution to their learning. P2 finds that through maker-based learning strategies, she encourages students to more clearly voice their needs to be able to get them the help and the correct kind of help. P5 also sees this self-advocacy as her students improve their questioning skills, a skill she feels is critical in social studies and when seeking assistance.

Seeking assistance can often occur with the use of technology. P3's students quickly learn to problem solve solutions to technology issues on their own. Some researchers claim that this is due to students' increased use of technology which makes them digital natives (Dietrich & Balli, 2014). Researchers Thiele et al. (2014) found students to be selectively tech-savvy using tools for social interaction or entertainment rather than content mastery or knowledge acquisition. Participants in this same study admitted that while technical skills can be a benefit, digital distractions are also a challenge for learners. The participants in this study did not discuss the use of specific tools, items of technology or programs used as other studies have done previously (Clapp et al. 2016).

Challenges of Implementing Maker-Based Learning

While the teachers in this research study shared benefits in implementing maker-based learning strategies in their classrooms, they have also experienced challenges that provided motivation to move through the process of implementation. Along with technology, a study of problem-based learning, Ertmer, et al. (2009) found the most common challenges to be classroom management, time and assessment procedures. These same challenges were the two most commonly mentioned by the teachers interviewed for this study.

Time

Every teacher interviewed discussed the challenge associated with time. As P3 stated when asked about the challenges, “Time- there’s never enough of it.” The high school and middle school teachers interviewed all discussed the time associated with the short class meeting times and the challenge of completing a task. P7 discussed the amount of planning time needed to established maker-based learning projects and that planning for multiple classes made this nearly impossible. P6 also described how his school’s block scheduling made the logistics of meeting with community experts difficult. As an elementary teacher, P2 appreciated being able to adjust her schedule as needed to accommodate maker-based tasks. P1 echoed this sentiment as she stated that using maker-based learning strategies was easier when she taught at the elementary level. Rico and Ertmer (2015) found that planning for open-ended learning lessons can take significantly longer than lessons in a traditional classroom as teachers must prepare for multiple possibilities rather than merely directing the learning activities.

Assessment

Many teachers also discussed the struggle of assessment associated with maker-based learning. One aspect of assessment that was a challenge was the students' reactions to not having clear-cut expectations. P2 stated the process was "scary for kids who are really good at pleasing the teacher" while P3 explained that students are "too conditioned to doing what you expect." Researchers have suggested that grading on the thought process and risk-taking rather than the final product can benefit teachers (Smith & Henrikson, 2016). Flores (2018) suggests measuring success in these areas through non-academic sources such as journal entries, sharing with others, or surveys. Offering students, a list of criteria based on the content but allowing student choice in materials and knowledge demonstration empowers students to take risks, according to Smith and Henrikson (2016).

P4 described one challenge he faces is to step back and avoid the desire to "let me do that for you." P2 also described her challenges of wanting the students to be successful and for their projects "to look good." Giving up control can be difficult for many teachers. Rico and Ertmer (2015) stated that when teachers give up control to their students, they may also feel as if they are relinquishing authority in their classrooms. P3 stated that this inability to give up control might be the fear that keeps other teachers from using maker-based learning strategies.

While many of the topics included in the literature review occured in my interviews, one aspect of the previous research was missing from the discussions with the participants. The teachers I interviewed omitted the concept of budget needs and financial inequity. The review of the literature showed several studies describing the tools and materials used in maker-based learning strategies (Jarrett, 2016; Loveland & Love, 2017). The teachers I interviewed spoke of the maker mindset and did not mention the tools that they used in their teaching. While many states are undergoing budget cuts and teacher shortages, the participants in this study focused more on the mindset and social and learning implications in their classrooms as opposed to the tools and materials.

Limitations of the Study

When conducting research, there are always limitations, and this is true for this study as well. The seven participants in this research study taught in Grades 5–12 at the time of their interviews, and while three participants had experience with maker-based learning in lower grades, the results might not be applicable to teachers of younger elementary students. Had time allowed, adding one or two participants from younger grade levels could have been beneficial in seeing if the same experiences were applicable. Additionally, teachers who are early implementers of innovative teaching strategies are not typical of the general teaching population. Therefore, the results cannot necessarily be generalized for the larger population.

An additional limitation is my personal interest and use of maker-based learning strategies. This interest and experience with maker-based learning could create a bias that places limitations on my analysis despite my best efforts to be aware of my own ideas and opinions. The aim of using the reflective journal was to keep the analysis of the data as transparent as possible as suggested by Ortlipp (2008).

Recommendations

This study offers several other topics for future research opportunities. A more in-depth study of what teachers do in order to use maker-based learning strategies in their classroom, where they garner ideas, and how others impact their use of innovative strategies would add to the body of literature the evolution of making in schools. Future research studies might also include a study of the training available for teachers interested in using maker-based learning strategies in their classrooms. This training might also provide an additional network of support that the teachers in this study and previous studies have described as needed. Additionally, researching the approach of learning from failure is possible. One might ask how environments and methods evolve as teachers learn about maker-centered learning as they succeed, fail, and adapt their classrooms to these teaching and learning strategies.

Furthermore, research could be conducted to explore the assessment practices of teachers using maker-based learning strategies in their classrooms. This research regarding assessment as a part of maker education could involve examining methods of assessment, formative and summative assessments, as well as the questioning techniques teachers use as a form of assessment. One might also examine the effects of using maker-centered learning on standardized test scores and overall student achievement data.

Based on the review of previous research and the data collected in this study, there is a strong need for support systems for teachers instituting innovative teaching and learning strategies and finding ways to support others to implement change. Some of these teachers participate in professional learning networks using social media such as LinkedIn, Twitter, and Facebook in order to interact and connect with like-minded peers. One recommendation for educational systems is to provide the needed training for administration professionals in providing this much-needed support. Such training might include professional development as well as just spending time in classrooms where maker-centered learning strategies are utilized. This same program could also be used to prove pre-service teacher candidates and other teachers' guidance on utilizing maker-centered learning strategies effectively.

Implications

Positive Social Change

The findings in this study can contribute to a positive social impact by offering a way to prepare students for college and future careers. Maker-centered learning has been found to improve students' 21st century skills including creativity, problem-solving, and collaboration (Kalil, 2013). Researchers have also found that these skills are critical in preparing students for future success in college and career (Hilton, 2015; Hunter-Doniger & Sydow, 2016). The marker-based skills benefit students not only in education but instill perseverance and skills that are beneficial for a lifetime of learning opportunities (Hilton, 2015).

Additionally, the teachers in this study see an opportunity for using the maker-based learning strategies in their classrooms as a community outreach opportunity. One might ask if these strategies are used to involve the community in any of these areas or others? P6 and P7 connect their students with outside experts in the community while P4 hopes to expand his program from his classroom to adult education programs. These learning opportunities encourage learners to see beyond the classroom and into their communities (Bonwell & Eison, 2005).

Conclusion

The purpose of this phenomenological study was to describe the experiences of teachers currently using maker-centered learning as an instructional strategy in their learning environments. Maker-centered learning strategies for this study included activities that involve authentic, hands-on projects in lessons that promote critical thinking and collaboration across multiple social and academic standards. A review of the literature found research completed on students and their learning as well as the tools and programs used in maker-based learning programs. This review of the literature also revealed a lack of research on the experiences of the teachers in their classrooms. The participants in this qualitative study were seven teachers experienced in using maker-centered learning strategies.

The conceptual framework for this study included active and collaborative learning strategies including constructivism, constructionism, and experiential learning theories. Open-ended interviews were conducted to address the research questions regarding the experiences of teachers using maker-based learning strategies in their grade 5–12 classrooms. Written lived experience descriptions along with interview data provided rich descriptions of these teachers and their experiences.

The data analysis of this study revealed three themes. The first theme, learning environment, included how the classroom was set-up, what materials the teachers provided, and how the students and adults used the space to meet learning needs best. The second common theme that appeared in the data analysis was focus including student-centered learning, failure as a source of learning, and the student and teacher mindset. Finally, the teachers spoke of their experiences in using maker-centered learning strategies. Each participant discussed the benefits and challenges they had faced while using maker-based learning strategies in the classroom. Engagement, student empowerment, and improved academics were a few of the common benefits. Likewise, many of the participants mentioned time, assessment, and combatting pushback as common challenges that are faced.

There were several commonalities between my data analysis and literature review including the importance of student-centered learning and the need for teacher support from the administration. The benefits of increased student learning and improved 21st century skills also appeared in the data analysis and review of the literature. While the challenges facing teachers of time and assessment were also similar, the teachers in this study did not mention specific tools used or funding as a challenge they faced.

As the need to prepare students for careers and problems that have not yet developed grows, the importance of innovative teaching practices like maker-based learning also increases. Furthermore, this type of active, student-centered, collaborative learning is one way to help prepare students for our ever-changing society. While in no way comprehensive, this study suggests the great importance of supporting the teachers using these innovative practices in their classrooms to encourage student growth. Although these practices and the teachers using them still need further study, this work provides one perspective on the experiences of those involved in using maker-centered learning strategies.

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Appendix A: Questionnaire

Maker-centered learning Questionnaire

All information collected in this survey is for background information only and will be kept strictly confidential.

1. How many years have you been teaching? Choose one
    - 0–5
    - 5–10
    - 10–15
    - 15–20
    - Over 20

2. What grade levels have you taught? (select all that apply)
    - PreK – K
    - Grades 1 – 3
    - Grades 4– 5
    - Grades 6 – 8
    - Grades 9 – 12
    - Higher Education

3. What subject area(s) do you primarily teach?
    - Elementary Education (all subject areas)
    - English / Language Arts
    - Math
    - Social Studies
    - Science
    - Arts (Music, visual arts, etc)
    - Technology
    - Other (please specify)

4. What is the geographical area in which you teach? (Select all that apply)
    - Rural
    - Suburban
    - Urban
    - Public
    - Private
    - Charter

5. Approximately what is the student enrollment in your school district?
    - 0 – 500
    - 500 – 1000
    - 1000 – 1500
    - 1500 – 2000
    - Over 2000

6. Which of the following maker-based learning activities do you use in your classroom? (Check all that apply)
    - Real world learning
    - Hands-on, active learning
    - Cooperative / collaborative learning
    - Project-based learning tasks
    - Lessons that include multiple academic standards
    - Computer tasks for creation
    - Engineering design-based tasks
    - Experiential learning tasks
    - Student-centered learning tasks
    - Inquiry-based learning tasks
    - Problem-solving opportunities
    - Other- Please specify

7. How often do you use maker-centered learning strategies as a part of your curriculum?
    - Once every 2 – 3 weeks
    - 1 – 2 times per week
    - 3 – 4 times per week
    - Every day
    - Multiple subject areas/lessons per day

Appendix B: Interview Guide

Introduction

The researcher will review the following with participants before each interview:

- Purpose of the interview (teacher's experiences using maker-centered learning strategies)
- Process (interviewer will ask several questions; overview of questions)
- Assurances (privacy, confidentiality)
- Recording (for accuracy)
- Check that participant is comfortable and ask if there are any questions before we begin

Opening question- Please tell me about your teaching experience

Interview Questions

1. When you decided to start using maker-centered learning strategies, what was your vision?
    - How do you see yourself as an innovator or agent of change in your school or district?
    - How do you see the maker-centered learning strategies as a part of your classroom or learning environment?
    - Where do you feel that you are in accomplishing this vision or has your perception changed since you started?
    - How has your use maker-centered learning strategies evolved?

- What are your goals or hopes for the future of the maker-centered learning strategies in your school?

2. How do the maker-centered learning programs and strategies fit into the curriculum?
    - What have been your challenges with making the two work together?
    - What types of benefits have you seen?
    - What have you seen regarding skills outside the general curriculum from maker-centered learning strategies? (Collaboration, social change, etc)
    - How do you see that your teaching style fits with a maker-centered learning curriculum?
3. How would you describe the role(s) you play in the maker-centered learning practices in your classroom?
4. Please describe an experience that took place in your classroom that you feel best represents maker-based learning.

Closing

Final question:

Is there anything else that you would like to share with me or that you think I should know about your experiences with maker-centered learning?

Prior to concluding the session, the researcher will review with each participant in the following areas:

- The researcher will transcribe the interview and send to the participant (double check email)

- The participant can review and add anything that needs to be included
- Assurances of confidentiality
- Participant to be given a copy of the dissertation once completed
- Publication plans and participant notification procedures if this occurs
- Researcher contact information to the participant

Appendix C: Written Lived Experience Prompt

Now I would like you to write an informal journal entry of sorts describing in detail your experiences using maker-based learning practices in your classroom. Do not worry about length. Explain what it is like for you to use maker-based learning practices and focus on experiences you had in the classroom. I am seeking to gather comprehensive descriptions of your experiences. My objective is to understand the essence of teachers' experiences with maker-based learning as you know it based on your participation. Some things you might share include specific situations, events, or activities that related to your experience or that have impacted you during your use of maker-based learning practices. You might also discuss your thoughts, feelings, and perceptions about your experience while using maker-based learning.

If it helps you, you might consider using the following questions as a guide while you write. Do not feel the need to address all of them directly; use them to guide your writing. Moreover, again, I would like you to draw on and refer to your personal experiences using maker-based learning.

- What have been your experiences planning, creating, and using maker-centered learning as an instructional strategy in your classroom?
- What motivated you to implement a maker-centered curriculum as an instructional strategy in your classrooms?
- What do you understand to be the challenges and benefits that you have encountered as you use maker-centered learning?

- What types of changes have you seen in yourself and your students since the implementation of maker-centered learning activities?

Do not worry about fancy or colorful language—write as though this was a personal journal or as though you were telling someone your story. Please write in paragraph form. Do not rush through it, but you do not need to agonize over it either. Just write down what comes to mind as you look back on your experiences. There is no "wrong" way to write this. I am looking for your thoughts and ideas.

It would be easiest to send your writing to me in digital format. You can add it as an attachment or write it directly in an email. Please email it to me at [email address] when you feel as though you are finished. I would appreciate if you could complete this and submit it to me by ______________________, but that is flexible. If you need more time, please just let me know.

Thank you so much for your time, energy, and effort on this!