2021

Mobile Device Experiences of Science Teachers in Urban Schools

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This is to certify that the doctoral study by

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Abstract

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MA, Grand Canyon University, 2007

BS, Central Michigan University, 2004

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Walden University

November 2021

Abstract

Inconsistent use of mobile technology in the science classroom challenges teachers regarding integrating mobile technology to enhance students' learning. This study addressed teachers' challenges in integrating mobile devices to enhance student learning outcomes in urban sixth to ninth grade science classrooms. The purpose of this exploratory qualitative study was to gather the experiences and perceptions of urban sixth to ninth grade level science teachers. In line with Siemens and Downes' theory of connectivism, the research questions examined how urban sixth to ninth grade level science teachers use mobile devices in their classrooms and the benefits, and the participants' perception regarding the challenges of using it. Purposive sampling was used to collect the qualitative data through semistructured interviews of 13 urban sixth to ninth grade science teachers. Data were analyzed using axial coding and thematic analysis. Key findings of the study were that teachers used mobile devices to improve their efficiency and improve communication with students. Benefits to students included receiving immediate feedback, accomplishing tasks quicker, being more engaged in lessons, and practicing 21st century skills. Key findings of challenges included issues around connectivity, privacy, lack of building-wide policies, and difficulty teaching students to use their devices responsibly. These findings may help science teachers consider the benefits and challenges before using mobile devices for learning. Results may contribute to positive social change by providing administrators insight into how mobile devices can keep students engaged and the importance of implementing policies. Recommendations include providing training for teachers in managing students on mobile devices and implementing building-wide policies for consistency.

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Chapter 1: Introduction to the Study

Educators face the significant challenge of finding innovative ways to motivate and engage students in the classroom (Zohri & Laghzaoui, 2015). These innovative ways usually require educators to establish learner-centered teaching strategies that cultivate students' interest (Bartholomew & Reeve, 2018; Zohri & Laghzaoui, 2015). The availability of different mobile technologies provides teachers and learning institutions with creative opportunities to redesign curriculums to integrate devices and promote engagement and motivation (Bartholomew & Reeve, 2018; Zohri & Laghzaoui, 2015). The knowledge at one's disposal and the accessibility of mobile devices inspire educators and facilitate the learning environment's transformation to accommodate the interests of young students who are more receptive to activities that use technologies (Zohri & Laghzaoui, 2015). Bartholomew and Reeve (2018) indicated that many junior high schools have access to mobile technology through broadband connections and other infrastructure improvements that are expediting the shift to collaborative learning. With the availability of these technologies and their continued use, teachers' role, experience, and perceptions regarding the relevance and importance of these mobile technologies usually determine the implementation and success of these programs. For example, some schools have implemented bring your own device (BYOD) or bring your own technology (BYOT) programs, in which students use their personal laptops, smartphones, iPads, tablets, or other cellular devices for educational purposes in the school environment (McLean, 2016).

In Chapter 1, I introduce the study, including the background, the problem statement, the purpose of the study, the research questions, the conceptual framework, and a description of the study's nature. I also present the definitions of several key terms in order to clarify the crucial concepts underlying this study. Further, I address the assumptions, scope, delimitations, limitations, and significance of this qualitative research study. In the final section, I summarize the information presented in this chapter and suggest potential implications for positive social change.

Background

The enthusiasm for employing teaching and learning technologies in education programs vary according to the different levels of educator experience. According to O'Bannon et al. (2017), the use of mobile technologies beyond K-12 education is extensive. Factors such as a lack of appropriate BYOD policies at the junior high school level and teachers' lack of familiarity with the utilization of technologies in the classroom continue to prohibit meaningful changes in learning practices (O'Bannon et al., 2017). Nikolopoulou (2018) indicated a disconnect between the intended and achieved uses of BYOD and new technologies in modern classrooms.

Kay et al. (2017) have identified BYOD among urban students as a major distraction, which creates gaps between learners' achievements by relying on technology and the use of traditional learning processes. Mobile technologies facilitate the acquisition of the modern learning skills that students need to be successful, but there are notable challenges in the implementation of educational technologies in junior high schools (Nikolopoulou, 2018). Learners' appropriate use of the available technologies to

improve their reading, writing, comprehension skills, and information access skills is critical (Nikolopoulou & Gialamas, 2017). Kay et al. (2017) indicated that students in junior high schools could decide the appropriate technologies to use for their learning processes with minimal guidance based on the limitations and strengths of different technologies.

Bartholomew and Reeve (2018) explored the adoption of technologies in junior high schools. These researchers asserted that most high school learners consider the use of BYOD to replace traditional learning practices, rather than complementing and supporting existing practices. Over 75% of junior high school students own a mobile device with access to the internet (Nikolopoulou, 2018). The use of devices such as Kindles, cell phones, laptops, and tablets may support learning and instruction (Gillies, 2016). Gillies identified the lack of proper BYOD policies as the primary challenge facing educators who wish to incorporate technology in the classroom, resulting in uncertainty of teachers' perceptions and attitudes regarding the whole proposition to use technologies to enhance teaching and learning. Based on the inadequacies described above, such as the lack of appropriate BYOD policies, the lack of familiarity with technologies, the disconnect between intended and achieved uses, and the uncertainty of perceptions and attitudes of teachers, I identified a need to explore the challenges urban teachers face to enhance student learning in terms of the use of BYOD.

Problem Statement

The problem that I addressed through this research study was the challenges teachers face in integrating BYOD to enhance student learning outcomes in urban sixth to

ninth grade level science classrooms. Electronic devices are incorporated into the teaching strategy in various educational settings. Under BYOD programs, students are encouraged to use their own technology, such as mobile phones, when completing their work (Schuck et al., 2017). According to Crompton et al. (2016), while many technological advances have been made since the onset of the 21st century, mobile learning research in urban science classrooms is relatively scarce. The majority of studies published in peer-reviewed journals have pertained to elementary schools. Sung et al. (2016) called for further research in different educational settings, with an emphasis on age groups and subjects taught. Other authors have identified the need for additional research to establish the most optimal instructional strategies and practices for enhancing student achievement in science classrooms where BYOD is adopted (Crompton et al., 2016; Sung et al., 2016).

Crompton et al. (2016) and Sung et al. (2016) included teachers' positive and negative experiences with BYOD to provide a picture of teachers' experiences. Williams and Larwin (2016) suggested that factors such as teachers' attitudes and experiences toward the use of technology in the classroom help identify the activities that can benefit from BYOD to enhance student academic achievement. More recently, Crompton et al. (2016) and Schuck et al. (2017) stressed that poor student achievement of learning outcomes stem from traditional teaching practices and lack of reliance on technological alternatives that engage students. The findings of Crompton et al. (2016), Parsons and Adhikari (2016), and Santos et al. (2018) indicated that, with defined expectations, academic achievement such as student motivation, collaboration, and improved digital

skills of students and teachers could be achieved through the utilization of mobile devices in classrooms. Few scholars have investigated urban sixth to ninth grade teachers' experiences and practices with BYOD in the science classroom. Previous authors found that teachers' ability to incorporate mobile devices in their instruction appropriately is the key determinant of student achievement and performance (McLean, 2016; Nikolopoulou & Gialamas, 2017). As such, the problem that I addressed through this study was the challenges faced by teachers in integrating BYOD to enhance student learning outcomes in urban sixth to ninth grade level science classrooms. Addressing this gap in practice was critical to providing evidence of how teachers employ technology in the classroom to enhance student engagement, support academic achievement, and identify opportunities for change in educational reform.

Purpose of the Study

The purpose of this basic qualitative study was to gather the experiences and perceptions of urban sixth to ninth grade level teachers regarding the benefits and challenges associated with BYOD in enhancing student learning outcomes in the science classroom. I developed the guiding research questions of this study based on this purpose.

Research Questions

The following were the research questions that guided the study:

RQ1: How do urban sixth to ninth grade level science teachers use BYOD in their classroom, and what are the benefits?

RQ2: What are the challenges associated with using BYOD by teachers in urban sixth to ninth grade level school science classrooms, and how can these challenges be overcome?

Conceptual Framework

The framework that informed this study was the concept of connectivism put forth by Siemens (2005) and Downes (2005, 2008a, 2008b). According to Siemens (2005), behaviorism, cognitivism, and constructivism are the three broad learning theories most often used in creating instructional environments; however, these were developed in an era when learning was not impacted by technology. Since then, these foundational principles have been altered, as the body of available knowledge and the means of accessing it have grown exponentially (Siemens, 2005). Siemens further explained that because connectivism is underpinned by the assumptions of chaos, network, complexity, and self-organization theories, its crucial premise is that it is not possible to experience everything; instead, it is through connecting with others that one gains the most valuable experience and knowledge.

According to Siemens (2005), in the process of learning, networks are constructed and traversed. While the learning theories of behaviorism, cognitivism, and constructivism postulate that learning occurs only within a person, connectivism emphasizes knowledge is stored and manipulated by technology, suggesting that learning arises within the technological environment (Siemens, 2005). Consequently, connectivism was an appropriate lens through which to explore the use of technology to enhance learning, as this process is assumed to take place within social networks

comprising teachers, students, and the outside environment. As mobile devices also facilitate the recognition and interpretation of patterns, this increases student engagement and performance (Downes, 2010a). Over time, the learners become better communicators, further improving their learning ability (Downes, 2010b).

Nature of the Study

I conducted a basic qualitative study by performing semistructured interviews with science teachers in urban sixth to ninth grade level school settings. According to Maxwell et al. (2009), a basic qualitative study is an examination of a phenomenon through the description of participant perceptions, opinions, and lived experiences. The interview questions asked were regarding science teachers' attitudes and experiences using BYOD, such as mobile devices, in their science classes. The qualitative methodology includes naturalistic analysis, in which researchers inductively analyze real-world environments to create vivid narrative explanations based on experiences and interpretations (Rubin & Rubin, 2012). In basic qualitative studies, participants' attitudes, experiences, values, and thoughts are investigated based on their real-life experiences (Percy et al., 2015). Specifically, basic qualitative research works well with other interpretive constructs, such as connectivism, as it is not constrained by a methodological rule (Kennedy, 2016). Thus, when investigating and exploring the phenomenon of teachers' experiences of using BYOD such as mobile devices, it was appropriate to use a standardized or basic qualitative analysis (Kennedy, 2016).

Definitions

The following terms are both defined and cited to provide a clear and comprehensive perspective for the forthcoming reading of this qualitative study.

Bring your own device(s): BYOD is a term used when a school permits students to bring their own devices to use for educational purposes in the school environment; alternatively, it may be referred to as bring your own technology (BYOT; McLean, 2016).

Educational technology: This is a field of study which explores the analysis, design, creation, implementation, and evaluation of the educational environment and materials to improve education and learning (Kurt, 2015).

Junior high school: Junior high schools usually include the sixth, seventh, eighth, and sometimes ninth grades (Merriam-Webster, 2020a).

Learning outcomes: This term refers to the integrated complexes of knowledge, abilities, and attitudes (Battersby, 1999) that are specific, observable, and measurable and can help describe an individual's learning (University of South Carolina, 2020).

Urban area: An urban area relates characteristics of a developed city with a high population and infrastructure (Merriam-Webster, 2020b; National Geographic Society, 2021).

Assumptions

According to Rubin and Rubin (2012), an understanding of a study's assumptions enables the selection of the strategies and methods that the researcher uses. The first assumption was that interviewees would provide honest answers without the fear that

their personally identifiable information would be revealed. The second assumption was that students were allowed to use and bring their mobile device(s) to school in some compacity. I made various assumptions throughout the research process to ensure that the potential shortcomings and limitations would not prevent the project's completion. I assumed that the participants allowed the use of mobile technologies in their learning environment. I also assumed that the participants selected for this study had adequate knowledge of their institutions' advances regarding the BYOD policies, strategies, initiatives, and challenges. Importantly, I assumed that the participants would provide accurate and complete accounts, experiences, perceptions, opinions, and recommendations regarding BYOD implementation in the learning process and the development of instructional designs.

I assumed that adherence to the participants' ethical consideration and rights—including assurance of confidentiality and provision of all information regarding the study—was adequate to establish a positive, cordial relationship that would facilitate the completion of the study. Further, I assumed that the selection of participants in the urban sixth to ninth grade level school settings would provide adequate data. Junior high schools represent the stage where most learners have been provided mobile phones, laptops, and internet access for the first time. Thus, I assumed that by completing the study using participants at the sixth through ninth grade level, the outcomes and findings would be suitable for both lower and higher grades, as well as applicable to other disciplines besides science and technical subjects.

Scope and Delimitations

The delimitations of a study define the scope and boundaries of the inquiry (Tracy, 2019). The scope of this study was confined to the perspectives, perceptions, and experiences of urban science teachers in the sixth through ninth grades concerning the use of mobile devices strategies such as BYOD. While this research problem was justifiable due to the increasing use of mobile technologies among sixth through ninth grades learners, other potential issues such as the effects of new technologies in learning and challenges in implementing BYOD policies were also candidates for inquiry. I sought to delimit the research to the current and continuing issues of modern learning in high schools whose outcomes impact the entire K-12 educational system. The study was also delimited concerning the choice of research questions and objectives.

The study problem was researchable through different objectives and questions. I focused on the perspectives of science teachers regarding the benefits of the BYOD in improving students' achievement, assisting the development of instructional plans, lesson planning, and student motivation and learning. The selection of the theory of connectivism to underpin the review of past literature and identify the gap in practice was another delimitation. Importantly, the research sample selection was another delimitation that defines the scope and boundaries of the study. I only included the accounts of science teachers and did not seek the perceptions and experiences of other educators, administrators, and students who could enrich the study. The focus on a specific group of participants assisted me in completing the analysis of the findings.

Limitations

This study's findings focused only on urban science teachers at the sixth through ninth grade levels regarding their perceptions of the benefits and challenges of BYOD in the learning environment. I acknowledge that this study's outcomes, results, and recommendations are only beneficial to other urban junior high schools and grades proximal to the sixth through ninth grade levels. Other grades in the K-12 education system (e.g., elementary schools) and advanced educational levels (e.g., colleges and universities) may not benefit from these findings. Other limitations of this study included the selection and recruitment of participants. The inclusion of science teachers as the only sources of primary data may not have provided a comprehensive assessment of the subject, considering that students, parents, other educators, and administrators could also have provided informative reflections regarding the use of mobile technologies in urban classrooms.

The absence of such important stakeholders in the BYOD policies and strategies could have affected the completeness and credibility of this study's findings. Further, studies on technologies present other limitations from the perspective that mobile technologies are dynamic; thus, an extended timeframe is required in order for researchers to identify connections and patterns to build reliable findings and conclusions. Studies on mobile technologies and applications may become outdated in a few years, which means that the subject matter must be periodically revisited in order for the findings to remain useful for future learners, teachers, and schools. Establishing the study boundaries and potential beneficiaries helped me to eliminate most of these

limitations by focusing on the identified population and ensuring that the tutors, students, and urban high schools at the sixth through ninth grade school level receive value from the outcomes of the study. Also, the targeted population was strictly limited to practitioners who are teachers at the sixth through ninth grade school level in an urban setting. The targeted population was not limited based on gender or age, but by the mobile devices used.

Significance

The findings of this study contribute to the identified gap in practice, which was an exploration of the experiences and perceptions of urban sixth to ninth grade level teachers regarding the benefits and challenges associated with BYOD in enhancing student learning outcomes in the science classroom. The findings also provide insight into the teachers' attitudes and experiences regarding BYOD. Ample research evidence suggesting the benefits of technology and mobile devices has prompted a shift in perspective, whereby BYOD is increasingly seen as critical to enhancing student learning and achievement (O'Bannon et al., 2017). The findings of the current study filled the gap in practice in educational technology by exploring and explaining sixth through ninth grade school level urban science teachers' experiences using BYOD in their urban classes concerning BYOD approaches and best practices (Crompton et al., 2016; Sung et al., 2016). The findings of this study can be applied to address social change through developing strategies to improve teachers' performance in urban schools (Nikolopoulou & Gialamas, 2017). The implications of this study include the possible benefit towards society through an improved method for educators to reach students and address student

learning and achievement. The findings of this study will ideally contribute to social change by improving the understanding of how educators can address student engagement and learning through BYOD techniques.

Summary

In this basic qualitative study, I explored the experiences and perceptions of urban sixth to ninth grade level teachers regarding the benefits and challenges associated with BYOD in enhancing student learning outcomes in the science classroom. The rationale behind the development of this study and background information related to the current use of BYOD such as mobile devices in K-12 education. In this chapter, I introduced the concept of connectivism, which served as the primary foundation for this study's framework. I also provided insight into the basic qualitative nature of this study, key terms that required definitions, as well as the study's assumptions, scope, limitations, delimitations, and potential significance. In Chapter 2, I discuss the theory of connectivism in greater detail and present a review of related literature. In the literature review, I critique research studies of four relevant themes and apply connectivism to mobile learning, teachers' experiences with mobile device integration, the use of mobile devices to facilitate student learning, and the use of mobile devices to support student engagement and academic achievement.

Chapter 2: Literature Review

In this chapter, I review the findings of relevant literature in order to frame the exploration of urban junior high science teachers' experiences with using mobile technology to improve science instruction in urban junior high school science lessons in the Southwest United States. The problem that I addressed through this study was the challenges teachers face in integrating BYOD to enhance student learning outcomes in urban sixth to ninth grade level science classrooms. In this literature review, I discuss relevant topics regarding perceptions and experiences with BYOD programs and the relevancy, benefits, and challenges of mobile phone inclusion in the classroom. Research findings that facilitate the integration of technology into teachers' classrooms and aid in fostering a 21st century learning experience are also reviewed. The search strategy, theoretical framework, and a summary and conclusion are also presented in this chapter.

Literature Search Strategy

The literature reviewed for this study was retrieved from the Walden University online library databases, including Science Direct, IEEE Xplore Digital Library, ProQuest, ERIC, SAGE Journals, also Google Scholar to cross-reference and locate relevant articles. The key words used to locate relevant material included the following: *connectivism*, *mobile devices, BYOD, classrooms, attitudes, urban, inner-city, junior high, middle school(s), K-12 education, technology in classrooms, primary schools, secondary schools, mobile phones, smartphones in science, smartphones in classrooms, iPads in school, touchscreen, student engagement, student perceptions,* and *teacher perceptions*. I used Boolean operators such as *AND* to narrow down a search, *OR* to help

expand a search, and *NOT* to narrow or exclude some of the results. The investigation involved the following three exclusion criteria to ensure the use of the most pertinent articles: (a) sources that lacked an abstract, (b) sources that were older than 2014; and (c) sources published in languages other than English.

An exploration of the primary databases yielded numerous articles. Sources related to BYOD, mobile devices, and urban teaching and learning environments were prioritized. Research findings related to BYOD that did not focus on urban schools were also incorporated due to a lack of urban school research, but they provided context to the understanding of technology inclusion. Additionally, 102 studies related to the definition of BYOD, mobile devices, urban teaching, and learning environments were reviewed, analyzed, and synthesized to elicit themes. For the literature review, I thematically grouped and classified the articles by topics of significant constructs: (a) 23 applying connectivism to mobile learning, (b) 30 teacher experiences with integration of mobile devices, (c) 31 mobile devices for learning, and (d) 18 using mobile devices to support student engagement and academic achievement.

Conceptual Framework

Connectivism was the framework that guided this study. In a series of publications, Siemens (2005, 2006a, 2006b) presented the theory of connectivism learning. The theory was subsequently developed further by Downes (2005, 2008a, 2008b, 2010a, 2010b). Siemens (2005) introduced eight fundamental principles that guide connectivism learning:

- Learning and knowledge rest in diverse opinions.

- Learning is a process of connecting specialized nodes or information sources.
- Learning may reside in nonhuman appliances.
- The capacity to know more is more critical than what is currently known.
- Nurturing and maintaining connections are needed to facilitate continual learning.
- Ability to see connections between fields, ideas, and concepts is a core skill.
- Currency (i.e., accurate, up-to-date knowledge) is the intent of all connectivist learning activities.
- Decision-making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision (Siemens, 2005).

Siemens' (2005) third principle is integral to this study. The third principle of connectivism addresses learning that may occur through the use of non-human devices (e.g., mobile devices), and learning and knowledge rest in the opinions and experiences of teachers (Siemens, 2005). Connectivism is a framework for teachers to facilitate continual learning while also nurturing and maintaining connections with their students (Siemens, 2005). According to Siemens (2005, 2006a, 2006b, 2008), behaviorism, cognitivism, and constructivism are three broad learning theories most often used to create instructional environments; however, these theories were developed in an era when learning was not affected through technology. The theory of connectivism put forth by Siemens (2005, 2006a) and Downes (2020) was based on the understanding that

information is rapidly changing and altering the foundation of decisions and learning, with new information continuously being collected by people.

Connectivism uses the integration assumptions explored by lifelong learning, individual thinking, experiences, and individuals' perspectives (Downes, 2020). The networking processes provide an experience that is considered the best teacher of knowledge (Siemens, 2005, 2006b). The application of connectivism in the current study was appropriate for framing the exploration of the integration of mobile devices in everyday life. The connectivism learning-based model provided an excellent framework for this study to aid the understanding of how teachers value the integration of modern technology—particularly mobile devices—in the classroom setting, while also encouraging student learning in a digital age (Downes, 2005, 2008a, 2008b; Siemens, 2005, 2006b, 2008).

Literature Review Related to Key Concepts and Variable

Applying Connectivism to Mobile Learning

Eight key principles comprise the theory of connectivism. Utecht and Keller (2019) examined the eight principles of connectivism by using their researcher experience to explore the theory. Utecht and Keller held 24 years as K-12 teachers and 20 years as public speakers and authors of research related to responsive teaching and educational technology in over 100 school districts throughout 30 states and 20 countries. These authors demonstrated that educators and students gain insight related to the principles of connectivism in the education context. Utecht and Keller provided examples

of K-12 educators' application of each principle at higher education institutions that are explored individually below.

The first principle of connectivism is that learning and knowledge rest in teachers' diversity of opinions (Siemens, 2005). Utecht and Keller (2019) described an example of the theory as the Wikipedia "talk page" that allows for student discussions regarding the placement of facts and the use of evidence, citations, or references to support claims. The tools on Wikipedia demonstrate how knowledge creation systems are useful tools for students and teachers to embrace. These tools also empower public discourse, promote investigative skills, and enhance analytical abilities. The first principle of connectivism demonstrates that the development of technological environments can help create a space to share facts, opinions, and the synthesis of ideas with the intended outcome of promoting learning, knowledge, and diversity of opinions (Siemens, 2005; Utecht & Keller, 2019).

Contemporary core literacy skills include the ability to connect information to appropriate sources and create new, diverse, and comprehensive assessments of a topic. This type of processing learning and connecting information is the second principle of connectivism. For example, individuals that upload data on the internet—such as government research, scientific and community data—further the development of knowledge (Utecht & Keller, 2019). The process of connecting data, informational sources, and developing meaning from data is also the framework for learning information in the contemporary world. For example, one suburban school district with roughly 11,000 students in Washington State aimed to create mindful approaches to

ensure an increase of voter-approved funding (Utecht & Keller, 2019). For this purpose, the administration connected information related to voter data that was published on the internet by each county. The students were interested in which precincts had the highest voter turnout and developed a renewed understanding of voter registration and associated sociocultural and economic variables. The provided example is one of many possible outcomes that occur when information is taken from various sources and creates something new and meaningful. This learning process of connecting specialized nodes or information sources exemplifies the second principle of the theory of connectivism (Siemens, 2005; Utecht & Keller, 2019).

The third principle considers the process of learning through nonhuman appliances such as mobile phones. Utecht and Keller (2019) provided the example of an international school in Luxembourg that investigated the use of lunch data to predict students' mood and learning preparedness based on what they ate. The school system introduced a transaction tap-card connected to student identification codes. The student codes provided a collection of meal options during the school year. Teachers were provided access to the data as a means of incorporating feedback to improve the program. Feedback included how students acted and performed after lunch. The rise of social media and information analytics has created a bettered understanding of how applications for learning can be used to enhance decision-making processes and create new information. Technological insights allow for improved student engagement. Also, the use of nonhuman appliances can create meaning from rapidly changing data (Siemens, 2005; Utecht & Keller, 2019).

A significant amount of data exists on the internet, and these data require filtering based on individual needs, quality of the sources, and user preference. (Utecht & Keller, 2019). The capacity to learn, unlearn, and relearn information quickly is another core skill. Thus, teachers need to educate students on learning and understanding the quality and meaning of data on the internet. For example, the use of search engines is a valuable skill for students that enhances educational achievement. Teaching students research methods, such as "site," is one way to help learners to perform deep searches on the internet to find various perspectives on a given topic. For example, searching "VietnamWar.gov" results in U.S. governmental perspectives of the Vietnam war; however, students must also understand that differing sights hold some biases towards the information that is presented regarding a specific context. Search engines such as Google, DuckDuckGo, and Bing have become the default research tool for learners. Technology leaders are rapidly evolving the available technologies. The capacity to know more has significant value that can be used to think critically about the knowledge one possesses (Siemens, 2005; Utecht & Keller, 2019).

The fifth principle refers to creating meaningful connections through continual learning. One such example provided by Utecht and Keller (2019) includes the rural region of Washington. In this region, a kindergarten teacher used the hashtag #flipgrid-fever and the Flipgrid app to link her students with similarly aged children worldwide to discuss books they read in class, practice number sense, and learn about other cultures. Educators that used this hashtag demonstrated the strength of connections when collaboration occurs through time and space (Siemens, 2005; Utecht & Keller, 2019).

The value of the internet is not limited to the information obtained, but also the interactions generated, the real-time communication, and the ability to facilitate a just-in-time learning environment (Siemens, 2005; Utecht & Keller, 2019).

Since the advent of the internet and the free flow of knowledge, the notion that learning is an individual endeavor has become invalid (Siemens, 2005; Utecht & Keller, 2019). With today's interactive existence of technology resources and applications, along with over 4 billion internet-connected users, few learning experiences are conducted individually (Utecht & Keller, 2019). Thus, connectivism offers a learning model that identifies tectonic social changes where learning is no longer an internal, individualistic practice (Downes, 2005, 2008a; Siemens, 2005, 2006a; Utecht & Keller, 2019).

The sixth principle of connectivism refers to examining and identifying connections throughout multiple fields of study. One such example involves a social studies teacher in Washington's urban school district who expressed concern about students using their school-issued computers to fact check his presentation in real-time. While the teacher lectured, the students would interrupt him and contradict him based on instant web searches. Instead of welcoming the modern wired world and rethinking how to use this instant access to knowledge as a form of support for his students, the teacher wanted to ban computers from his classroom (Utecht & Keller, 2019).

The provided example presents a real-time connectivism scenario of how modern schooling and technology has rapidly changed the learning environment. Throughout the modern connected world, many opportunities inside learning environments are available to students which allow for the exploration of new connections between ideas. Newly

developed concepts are then used to construct meaning for learning and growth (Siemens, 2005; Utecht & Keller, 2019). These principles allow for the growth of connections between fields, ideas, and concepts that emerge among the interactions between students and teachers (Siemens, 2005; Utecht & Keller, 2019).

Society produces an abundance of information every 2 days that is comparable to all known data. The phenomenon of abundant information in the contemporary world is referred to as "half-life of knowledge," or the time span from when knowledge is gained to obsoletion. The current shrinking half-life of knowledge is combated by organizational research focused on developing new instruction methods and delineating current and accurate information (Siemens, 2005; Utecht & Keller, 2019). Studying the location of new, reliable, and current information is a difficult task.

The opportunity to obtain current information is simplified in part by technological processes that allow for the objective evaluation and assessing of data. Technological techniques and research methods place knowledge at the forefront of user access and are now integrated into search engines. The improvement of research methods, for the layperson and academic, reflects the competencies that modern students and teachers use to obtain quality information (Siemens, 2005; Utecht & Keller, 2019). The first theory of connectivism involves learning about experience and opinions. The seventh principle considers how teachers should keep the knowledge fresh, reliable, and up-to-date in today's fast-paced information landscape (Siemens, 2005; Utecht & Keller, 2019).

Data evolve continually as new information is modified, analyzed, and developed. The effect of continual data is a constant reality of shifting truth. The knowledge shift occurs rapidly, which requires the continual consideration of contemporary learners (Siemens, 2005; Utecht & Keller, 2019). Thus, teachers should encourage students to remain informed of the broad range of available content, such as personal expressions and the growing diversity of opinions. The eighth principle's key message is that it is essential to assess what to know and consider how the information changes in the reflection of new knowledge. For some explorations, a correct response may exist, but this could change quickly based on new opinions, facts, and decisions (Siemens, 2005, 2006a, 2006b). In this new era, deciding who to learn from and, more importantly, whether a source can be trusted are essential questions that must be considered. The process of making effective decisions also requires considering the information sources and the flux of changing data available in the information age (Siemens, 2005; Utecht & Keller, 2019).

The eight principles of connectivism are a transformation to a just-in-time learning environment and represent an immense potential for teachers and students (Utecht & Keller, 2019). The increase of information and connectivism resulted in a new subset of core literacy skills and principles that provide teachers with an amazing incentive to engage students (Utecht & Keller, 2019). Teachers can now encourage and model connected learning for their students. In both local and international contexts, collaboration is no longer limited to individual relations (Siemens, 2005; Utecht & Keller, 2019).

The Processes of Learning

The process of learning and considering information is a critical foundation for student engagement and academic success. Smidt et al. (2017) explored a model development of learning processes, content, and environments in sixth to eighth grade students. STEM-related courses were assessed through a framework that guided pedagogical processes regarding how to learn, what to learn, and why to learn. Smidt et al. focused on the following four principles of connectivism proposed by Downes (2005, 2008a, 2008b, 2010b): learner agency, resource openness, network connectivity, and opinion diversity. In the following subsections, each of these principles is discussed to provide context to the learning processes that underly educational environments and connectivism.

How to Learn

The "how to learn" method comprises four techniques for operationalizing research in networked learning environments, including agency, openness, connectivity, and diversity (Smidt et al., 2017).

The idea of agency or autonomy is identified using concepts of choice, expression of the self, control, and independence. An autonomous learning environment refers to one where students are expected to choose among resources, connections, and information to improve (Smidt et al., 2017).

The connectivist notion of openness refers to open communication transmitted through networks to gain knowledge; share resources, ideas, and abilities; and create new information and insights (Smidt et al., 2017).

In networked learning environments, connectivity encourages students to take advantage of internet resources, find and create connections among resources, and seek answers through discussion. Additionally, students are encouraged to seek knowledge in their peer networks (Smidt et al., 2017).

Diversity enables students to seek different opinions and solutions by connecting to other students and their teachers, both within and beyond the traditional classroom setting. Opinion diversity is operationalized by encouraging and promoting the expression of a range of perspectives and approaches to problem-solving efforts where students with diverse cultural, social, and ethnic backgrounds can work towards a common goal (Smidt et al., 2017).

What to Learn

Problem-based learning (PBL) creates a motivational setting through student-led learning and is oriented around an open-ended problem. In this approach, focusing on what to learn compels students to buy into their learning (Smidt et al., 2017). Increased engagement through PBL strategies has been shown to improve achievement and self-efficacy among middle school students and boost their intrinsic goal orientation, task value, use of elaboration learning strategies, critical thinking, and peer learning, as compared to non-PBL instruction (Smidt et al., 2017).

Why Learn

According to Smidt et al. (2017), under the framework of connectivism, technology is treated simply as a device unaware of its meaning and users. The why-to-learn concept incorporates contextual importance of information and technologies to

draw on connectivism. Contextually responsive strategies help students understand when topics are personally, socially, culturally, and geographically relevant, which improves information retention and thereby boosts the retention of knowledge (Smidt et al., 2017).

The explored modalities presented provide an overview of learning environments used by educators to engage students. Smidt et al. (2017) improved the collective understanding of connectivism by employing a model to test the effectiveness of improving student-learning outcomes. Their model demonstrated that social technologies narrow opportunity and achievement gaps for all learners, including socioeconomically diverse learners who have been traditionally marginalized in STEM education.

Application of Connectivism in Education Environments

Connectivism is considered a critical foundation for furthering learning environments that meet the needs of students. Graham and Fredenberg (2015) studied the application of connectivism behaviors of 35 Alaskan teachers enrolled in an open online class. The core participants included teachers pursuing a Master of Education Technology degree and teaching K-8 math instruction courses. These authors adopted a gradual approach to relinquish control to participants after 15 weeks (Graham & Fredenberg, 2015). The researchers analyzed themes related to student development of connectivism practices, including "master," "emerging," "awareness," and "resistance." Statements that reflected and represented a recognition of the importance of diversity and various viewpoints were deemed "masters," and most of the participants fell into this category (Graham & Fredenberg, 2015). Participants who showed that knowledge is fluid and changes but did not identify specific strategies for ongoing independent professional

development (PD) were ranked as "emerging" (Graham & Fredenberg, 2015). Those participants who demonstrated the course and course materials' benefits and expressed that the course was valued were ranked as "awareness" candidates (Graham & Fredenberg, 2015). Lastly, several participants never ascended above the "resistance" stage, and furthermore demonstrated resistance to the practice in connectivism learning, exhibiting outright hostility and annoyance toward the course, and were thus labeled as "resistance" candidates in the study (Graham & Fredenberg, 2015). Graham and Fredenberg's findings were characterized by the participants' willingness to handle various communication mediums and coordinate and prioritize information and tasks to achieve personal and group goals. This study of connectivism revealed that the learning process is continually changing; thus, the instructional methods of teachers must also continue to evolve. The modernized teaching materials and learning environments that are demonstrated through participatory action serve to bring learners into contact with new resource roles that are central to the concept of educational technology.

Researchers have also demonstrated that implementing new technologies could help create better connections between students and teachers. In a project-based study of two elementary schools in Eastern Europe, Homanova et al. (2018) aimed to contribute to the implementation of network technologies in sixth and seventh grade classes during the 2017-2018 school year. The participating teachers identified three thematic areas: internet environment, family environment, and school environment. The students contrasted, analyzed, and further acquired knowledge gathered from different sources or connections using mobile devices to record video images, pictures, or effects (Homanova et al., 2018).

In terms of connectivism, Graham and Fredenberg (2015) demonstrated that educational practices that use the domains of connectivism contribute to a creative learning environment. The findings of Homanova et al. (2018) also demonstrated how mobile devices could aid in producing new knowledge through creative learning activities. The use of modern technologies illustrated that students could better evaluate information and make meaning out of shifting data.

Connectivism is based on the belief that learning extends beyond the person and overcomes an isolated strategy (Downes, 2005, 2008b; Siemens, 2005, 2006a, 2006b). Homanova et al. (2018) found a training paradigm to encourage cooperation through shared communication networks and prepared students for a professional environment. This integrative teaching model connected schools in a virtual network world in meaningful circumstances that offered specific advantages for each school and students, such as interconnections, collaboration, and real-time learning (Homanova et al., 2018; Siemens, 2005, 2006a, 2006b).

The evolution of technology has created both challenges and opportunities for change in the educational setting. Utecht and Keller (2019) concluded that knowledge in today's world is becoming a characteristic measured by how fast one can learn, unlearn, and relearn information. Embracing this shift to just-in-time learning environments is an opportunity for teachers and their students to engage in globally and locally relevant technology-integrated content (Smidt et al., 2017; Utecht & Keller, 2019). Today's students have grown up in a world of information overload, which is the case in both K-12 and university classrooms. Although research and learning are core skills to be taught,

technology inclusion is a unique skill that requires training for classroom inclusion (Utecht & Keller, 2019). The contemporary inclusion of technology now means that it is unnecessary to restrict collaboration to in-person interactions (Homanova et al., 2018; Siemens, 2005, 2008; Utecht & Keller, 2019).

Connectivism provides a model that can be implemented for mobile and traditional learning in and out of the classroom due to the demand for real-world relevance (Downes, 2010b; Siemens, 2005). Informational relevance (i.e., accurate and reliable knowledge) has furthered the emphasis on connectivism as a means for facilitating continual learning and recognizing connections between ideas and concepts (Utecht & Keller, 2019). Connectivism is a key learning theory for framing how technology creates relationships that are beneficial for academic achievement.

Student achievement and educator initiatives towards connectivism can be reached through the use of technological initiatives such as mobile devices. Wright (2017) investigated how three New Zealand secondary urban teachers used mobile devices in the classroom. The educators developed skills and knowledge through the use of iPads for professional growth and classroom practices to improve the learning of their students. The three participating teachers—who taught music, French, and mathematics—were enthusiastic about experimenting with the new iPad-based teaching methods. These educators were aware that the study was within the school's objective of becoming a BYOD school (Wright, 2017). Preparation, interactions, digital trust, and competence of individual teachers were examined during familiarization with the mobile devices. Wright found that mobile devices made it easier for teachers to spend more time

with individual students due to the more streamlined direction of the entire class. The respondents lacked confidence in the use of mobile devices but felt that mobile devices supported their teaching practices in the classroom. The participants unanimously experienced personal and professional benefits through the betterment of peer collaboration (Wright, 2017). Teachers' reflections recommended future studies to assess student feedback regarding mobile device usage to determine preferences regarding mobile device learning. Interviews with educators also demonstrated that students preferred a combination of electronic devices with traditional learning formats (Wright, 2017).

Connectivism is well-demonstrated when considering the experiences of teachers and students in the classroom. In Wright's (2017) study, the findings demonstrated the development of emerging technologies that scaffold upon previous knowledge. Wright's respondents were closely linked to their context of practice when analyzed in their professional learning and shared experiences with colleagues. The respondents reiterated the value of pedagogical knowledge and growth encouraged by the value of external agents to support teachers' learning processes and efforts to increase student achievement (Wright, 2017). Thus, when evaluating teacher skills and knowledge inconsistencies, the first approach should focus on one's knowledge and decide which gaps exist (Downes, 2005, 2008a, 2010b; Siemens, 2006b). Notably, each teacher not only evaluated their skills and knowledge, but the overall organizational inconsistencies. The findings of studies such as these have indicated potential options for developing other teachers' pedagogical practices with mobile devices.

Teacher Experiences with Integration of Mobile Devices

In this section, I review literature that reflects the contemporary assessment of teachers' inclusion of technology in the classroom. Wright (2017) previously indicated that providing PD allowed teachers to implement new teacher technologies and strengthen professional teacher-development programs for mobile device-enhanced instruction. During technology training sessions, teachers were able to learn within a shared environment to develop professionally. Teachers felt valued when working with peers and shared experiences with their associated subject department colleagues (Wright, 2017).

Researchers have also demonstrated that the incorporation of technology into pedagogical approaches could aid teacher engagement outcomes. Chen (2019) investigated BYOD implementation at an East Asian school that included 1,500 public elementary students (aged 7-12 years old) and their teachers. After 3 years of observations and interviews, Chen found that teachers had to continuously remind students to recharge and pack their laptops before going to school and persuade parents to buy new laptops for students with broken technology. Chen also found that the internet network was not reliable, which reduced students' learning time and forced teachers to deal with devices more than the learners. Their results demonstrated challenges teachers faced in the BYOD program, leaving them reluctant and inconsistent with support for the program. Teachers expressed negative feelings toward the broad influences of BYOD on school practices and classroom cultures. Chen found that the BYOD program was useful

for instruction, but also encouraged distracting behavior, such as returning to school with a broken laptop.

The difficulties that technology inclusion can bring, such as poor internet connection, is reflected in similar studies that examine digital devices' effectiveness in increasing learner motivation, engagement, and access to learning opportunities. Laxman and Holt (2016) investigated two schools in New Zealand, including seven teachers and 39 students from 10 to 12 years of age. Using semistructured interviews, Laxman and Holt reported that teachers felt that digital devices had the capability to enhance classroom engagement and active learning. Like Chen (2019), Laxman and Holt found teachers reluctant to use digital devices because they had to monitor distracting behaviors, such as playing video games, accessing personal social media accounts, and web surfing. Educators also noted instructional challenges and hesitancy towards technology inclusion during internet inconsistencies requiring the development of backup lesson plans (Laxman & Holt, 2016).

Technology inclusion is also critical for rural regions that lack student engagement strategies. In the case study of Lee et al. (2015), the investigators examined rural high-school educators that participated in one-to-one computing technology. Teachers' perceptions were gathered through open-ended observations, field notes, and interviews. Data were analyzed using *a priori* coding categories and selective coding. Lee et al. found that poor internet reliability was a key issue for educators. In response, teachers created alternative lesson plans to address the challenges of unreliable circumstances (Lee et al., 2015). Similarly, Chen (2019) found similar results.

Technology inclusion can come with unique challenges, but the innovative efforts of teachers can serve to reduce the frustration of these scenarios.

PD showed promise for the inclusion of mobile phones in teaching pedagogies. Ekanayake and Wishart (2015) examined 18 secondary teachers' perceptions of a 3-day PD session for incorporating mobile phones into the classrooms that introduced teachers to mobile phone characteristics and features, including strategies for using the devices for science lessons. Ekanayake and Wishart found that PD workshops enabled teachers to recognize the potential of mobile phones to enhance science teaching and learning. Teachers engaged in practical activities that tested a range of different functions for implementing science lessons (Ekanayake & Wishart, 2015). The mobile phones were also incorporated as tools during activities in the classroom to engage students. Ekanayake and Wishart indicated that PD decreased teachers' initial concerns regarding technology inclusion in the classroom.

Preservice teachers that are provided training are also more likely to use technology, as shown by Ekanayake and Wishart (2015). Liu et al. (2015) investigated the collaboration between three pre-service teachers and their accredited junior high school mentor teachers (one special education teacher, a biology teacher, and a mathematics teacher) related to technology integration. Mentors and preservice teachers individually and collectively adopted new concepts in their classrooms and monitored the success of their efforts by jointly reviewing their work, considering outcomes, and reflecting upon teaching efforts (Liu et al., 2015). Liu et al. and Ekanayake and Wishart

shared similar results regarding the importance of teachers' collaboration and sharing during training to make positive changes in technology integration.

To understand how technology is integrated into the classroom, it is critical to gather teacher experiences. In an exploratory study, Pribeanu et al. (2020) investigated 16 Eastern European science teachers' experiences regarding the use of mobile technologies in their science classes. Teachers reflected on their experiences in an open-ended questionnaire regarding mobile technologies/devices used in the classroom, how teachers achieved meaningful use in their teaching/learning, and the hindrances/limitations of the teaching process technologies/devices. Teachers expressed positive perceptions about the value of technology inclusion. Ekanayake and Wishart (2015) and Pribeanu et al. agreed that the primary hindrance related to mobile devices in the education process is teachers' lack of skills for using mobile devices and inadequate PD for bettering their proficiency.

Preservice teacher perceptions also indicated that mobile learning technology is effective for engaging students in the classroom. Bai (2019) examined 23 elementary preservice teachers' perceptions and intentions regarding mobile learning during and following an instructional technology course where they used their mobile phones in their course-related work. The participants reviewed and selected applications for usage in their teaching practices and collaboratively created a website dedicated to the educational use of the selected technologies. Participants' data included online discussions about their views on mobile learning, lesson incorporation plans, and perceived teaching difficulties. After the course, the authors surveyed participants regarding their perceptions and the resultant lesson plans. Teachers valued the opportunity to master the use of the apps

before introducing them to students and appreciated having a clear understanding of assessment and evaluation of the selection process of apps.

BYOD studies have emphasized the importance of educator experience in efforts to better inform the process of incorporating mobile devices in learning (Wright, 2017). Parsons and Adhikari (2015, 2016) employed sociocultural approaches to investigate 195 students aged 13-14 and 125 parents, along with 117 subject teachers for 2 years. Parsons and Adhikari's sociocultural framework explored (a) technological infrastructure, (b) the "agency," or ability to act on the world, and (c) the "cultural practice," or the areas that benefit learning. The social-cultural framework framed the relationships between digital devices, infrastructure, stakeholders, and the learning environment. The results of Parsons and Adhikari's (2015) study showed that BYOD classrooms allowed students to self-manage their learning, which allowed for a greater agency. Parsons and Adhikari (2016) identified difficulties regarding technology inclusion and usage by educators, such as connectivity issues, software problems, and device support.

Wright (2017) and Parsons and Adhikari (2015, 2016) similarly revealed improvement in students' and teachers' digital skills, collaboration for learning activities, and advancement in students' and teachers' social and personal development through the use of BYOD. Teachers and students believed that BYOD was a practical way to promote positive outcomes quickly, access information, and provide communication and collaboration (Parsons & Adhikari, 2015, 2016). The wireless infrastructure was problematic, due to slow bandwidth and internet outages in classrooms (Parsons & Adhikari, 2016). In Wright's (2017) and Parsons and Adhikari's (2015, 2016) studies, the

authors unraveled the relationships between mobile devices, infrastructure, and the types of anxieties that can occur with teachers in a BYOD learning environment with an age group of 13- to 14-year-old students.

Teachers often became frustrated with technology. Hur et al. (2015) surveyed 386 U.S. student teachers to understand their perceptions about mobile device integration. Most participants (84.5%) indicated that they were average technology users, while about 10% considered themselves to be expert users. The student teachers had multiple educational majors, including 55 students majoring in early childhood, 191 in elementary, 21 in special education, and 119 in secondary education. The results showed that 72% of student teachers felt that mobile devices were practical and useful in the classroom, and integration would be beneficial (Hur et al., 2015). Thus, the level of expertise and user experience can impact how teachers perceive BYOD in the classroom.

Students' comfort with technology can also impact inclusion. In a private school in India, O'Bannon et al. (2017) sampled 103 middle school students and 14 teachers to explore how mobile device usage can be facilitated in the classroom, student and teacher impressions of mobile device features that help school-related work, and the advantages and obstacles to mobile device use. O'Bannon et al. found that 86% of the teachers preferred to use mobile devices instead of not using mobile devices in their schooling environment. Almost 93% of teachers agreed that mobile phones support student learning. O'Bannon et al. found that most teachers were experienced users of technology, while the remaining teachers reported themselves as proficient users. In conjunction, 48% of students were proficient in using mobile devices, while 37% of students reported that

they were experienced users of technology (O'Bannon et al., 2017). The investigative approach in this study showed valuable insight into the strengths and weaknesses of using mobile devices as an educational resource for classroom teachers and students. The results reported by Hur et al. (2015) and O'Bannon et al. indicated the relevancy of integrating mobile device capability into the classroom. Thus, the proficiency levels of teachers and students can impact the inclusion and efficacy of BYOD in the classroom.

Researchers have indicated that mobile devices and associated features are useful for encouraging the engagement of students in the classroom and creating motivation, creativity, and student/teacher productivity (Hur et al., 2015; O'Bannon et al., 2017). Gkamas et al. (2019) analyzed the opinions and concerns among 905 Greek primary and secondary teachers regarding the integration of a BYOD model in the educational process. Gkamas et al. investigated different specialties such as engineering science teachers (41%), natural science teachers (19%), humanities and social science teachers (11%), and kindergarten teachers (2%), with 8% making up other specialties. Of these specialty teachers, 3% taught in kindergarten schools, 30% taught in primary schools, 28% taught in secondary schools, 27% taught in high schools, and 13% taught in technical high schools (Gkamas et al., 2019). Forty-four percent of teachers responded that they wanted to bring their smartphones to school and use them for educational purposes, while 52% wanted to bring their android tablets. Also, 87% of teachers believed that a BYOD model would positively affect their productivity, while 81% of teachers predicted that student productivity would increase (Gkamas et al., 2019). Gkamas et al. found that laptops were the most popular mobile devices among teachers,

and the familiarity with the technology was high. Similarly, smartphones and Android tablets showed high usage (Gkamas et al., 2019). BYOD was indicated as useful for adaption based on the familiarity of devices among educators.

The research reviewed in this section indicated that BYOD is useful for classroom education. Gkamas et al. (2019) and Parsons and Adhikari (2016) confirmed that the implementation of BYOD increased positive collaboration among students and teachers. Gkamas et al. and Parsons and Adhikari identified teachers' perceived intent and readiness of BYOD integration and the actual lived teacher experience of BYOD integration in the school classroom. Hur et al. (2015) and O'Bannon et al. (2017) identified positive teacher perceptions and attitudes towards mobile device usage. Additionally, Bai (2019) and Ekanayake and Wishart (2015) indicated that incorporating mobile learning into teacher education allowed novice teachers to immediately use mobile devices in the classroom.

Mobile Devices for Learning

Researchers have shown that mobile devices in the classroom can effectively promote student learning and engagement (Thomas & Muñoz, 2016). Thomas and Muñoz surveyed 628 high school students in a large urban Midwest school district. All student participants attended high schools that had completed the first year of a mobile phone integration initiative designed to allow high school teachers and students to use cell phones in the classroom for instructional purposes (Thomas & Muñoz, 2016). Using Likert surveys, Thomas and Muñoz reported that 91% of students owned smartphones, while the remainder of students (9%) owned basic mobile phones. Also, 88% of teachers

owned smartphones with data plans. Thomas and Muñoz also found that 90.7% of surveyed students used their mobile devices for school-related assignments, while 70% believed that mobile devices support their learning objectives. The participating students reported that their phones were used for school-related work: 91% reported using the phone as a calculator, 91% used it for internet access, 84% used the calendar function, 80% used the alarm/timer, 74% used educational apps, and 41% used it to create surveys (Thomas & Muñoz, 2016). Thomas and Muñoz identified multiple student-reported benefits associated with mobile devices in the classroom, including (a) 70% of students thought mobile devices increased student engagement, (b) 79% said it motivated them to learn, (c) 81% said it made them more productive in doing their schoolwork, and (d) 82% stated it made them more creative. The majority of students own and use smartphones; however, the diversity of reasons for using the smartphone varied greatly according to application and the context of the educational setting.

The age range of students also impacts how they use smartphones. Nikolopoulou's (2018) quantitative study examined 530 secondary school students at two public schools in Southeastern Europe, ranging from 12 to 18 years old, which was similar to the sixth to ninth grade ranges that were studied in the current investigation. Nikolopoulou revealed that the mobile phone was the primary device used by almost all students daily. This was followed by the laptop, which was reportedly used daily and weekly by 27.9% and 30%, respectively. The tablet was used by the fewest students, with 36.4% of students not possessing a tablet (Nikolopoulou, 2018). Nikolopoulou discovered that 86% of students found that learning to operate mobile devices was easy for them. The results indicated

that 84% of students thought mobile devices were useful in their learning, while 82% of students found that mobile learning enabled them to accomplish their learning activities more quickly.

In a more recent study, Nikolopoulou (2019) surveyed 179 Greek junior high students aged 13-15 years old during the 2018-2019 academic year. Three open-ended questions guided the study: (a) Do you think mobile devices (e.g., mobile phones, tablets) are an incentive/motivation for learning? (b) For what school subject(s) would you be more interested if you were using a mobile device in the classroom? And (c) Write examples of learning activities that you think (you know) can be done with a mobile device in the classroom. Nikolopoulou found that 80.4% of students perceived that mobile devices (e.g., mobile phone, tablet) would serve as an incentive and motivation for learning. Nikolopoulou found that physics, mathematics, history, and information technology subjects were ranked the most likely use of the mobile device. Students provided several remarks that the benefits of mobile phones were quick mathematical calculations, greater accuracy in physics measurements, and improved display of photographs for history lessons.

Similarly, Laxman and Holt (2017) investigated two schools in New Zealand with seven teachers and 39 students between 10 to 12 years of age to identify students' and teachers' perceived experiences with digital devices in increasing learner motivation, engagement, and access to learning opportunities. Using mixed methods, Laxman and Holt asked students to indicate whether they worked harder when using mobile devices in their schoolwork than without their mobile devices. Students' remarks reflected that they

felt they worked harder while using a mobile device, and they perceived that the process was faster and more enjoyable. Many teachers also expressed that the device helped provide independence, motivate students, and help some students with focusing. In some cases, mobile devices could be distracting because some students got too excited, which caused students to lose focus on the learning intention (Laxman & Holt, 2017).

Teachers' perceptions also reflect that mobile phones can be useful in teaching science-related topics. Lamanauskas et al. (2019) interviewed 16 European secondary science teachers' perceptions regarding the use of mobile technologies in physics, geography, chemistry, biology, and engineering. Lamanauskas et al. found that teachers reported positive attitudes towards using mobile technologies and devices in their classroom. All teachers agreed that mobile devices encouraged students to learn better, and cited benefits such as information being more memorable and quick content mastery. All teachers agreed that mobile devices increased learning motivation because mobile technology is attractive and relevant to learning, enabling continuous learning in and outside of class. Additionally, the authors found that the teaching process became more exciting and livelier when using mobile technology, which resulted in lower stress for students (Lamanauskas et al., 2019).

The qualitative survey findings from Thomas and Muñoz (2016), Nikolopoulou (2018), and Nikolopoulou (2019) indicated that students felt that mobile devices were useful when carrying out experiments or watching e-lessons; were helpful in searching the internet; and were helpful as calculators, stopwatches, and dictionaries. Students believed that mobile devices are an incentive and a motivation for learning and that

students' positive opinions are linked to their positive attitudes towards mobile devices (Nikolopoulou, 2018, 2019; Thomas & Muñoz, 2016). While studies in this section occurred in different schools around the globe, all authors found a perceived increase in motivation towards learning and learning tasks by students and teachers when they used mobile devices in the classroom. A vast majority of teachers and students had positive attitudes towards mobile devices (Laxman & Holt, 2017).

Using Mobile Devices to Support Student Engagement and Academic Achievement

The motivation to use mobile devices can be characterized by the need for better student outcomes and achievement in the classroom. Sinatra et al. (2015) demonstrated that student motivation to participate could be based on their interest in the lesson and the engagement tools, such as technology. As a result, the psychological investment towards technology can motivate students and contribute to proactive behavior (Sinatra et al., 2015). Secondly, engagement must be measured, considering individual and developmental differences and self-determination using a single method such as self-reports, observations, teacher ratings, or student ratings (Sinatra et al., 2015).

Research shows that numerous benefits occur when students are engaged and motivated. For example, Hart and Laher (2019) employed a study with a correlational design to explore the relationships between students' attitudes towards using mobile devices, access to technology, and academic achievement. The open-ended questionnaire was distributed to 276 8th-12th-grade students in South Africa. Academic achievement was assessed using the school's mid-year grades. Multiple regression analyses were conducted to determine whether access and attitudes predicted learners' academic

achievement. Hart and Laher found that 86% of students' attitudes were positive or highly positive attitudes towards the use of mobile devices. The overall attitudes towards mobile device use and access were statistically significant. Variations in the positive perception of the technology were explained by access, ease of use, and usefulness as predictors of wanting to continue/discontinue using mobile devices in a blended learning environment. The perceived value was also found to predict learners' eagerness to continue using mobile devices (Hart & Laher, 2019).

In a qualitative case study that consisted of 1,769 students from the 5th to 10th grades in 100 classrooms across 10 schools in Norway, Havik and Westergård (2020) investigated the associations between students' perceived classroom interactions and student engagement. After students self-reported through a web-based questionnaire during an ordinary 45-minute classroom period, Havik and Westergård found that Norwegian students have similar perceptions to U.S. students regarding student engagement. Havik and Westergård also found that classroom interactions among peers and teacher-student relations are important contributors to student engagement. Positive teacher-student interactions are a fundamental aspect of quality teaching, learning, and student engagement in which schools and teachers should show "pedagogical caring" (Havik & Westergård, 2020). Like Hart and Laher (2019), Havik and Westergård found that educators can enhance student engagement through strategies such as collaborative learning, creating meaningful activities, and accepting updated technology to reinforce student engagement.

Technological inclusion is also guided by the willingness of the administration to ensure teachers are supported in terms of devices and PD. Raman et al. (2019) provided a teacher overview of 375 principles and educators in a secondary school in Malaysia to explore the role of principal leadership in facilitating technology integration within the classroom. Using a cross-sectional survey, these researchers sampled 74 principals and 374 educators to assess whether there was a correlation between administrators' and educators' use of technology. Similarly, Yahya and Raman (2020) found that leadership skills were essential for the principals' use of technology and demonstrated the need for administrative efforts for the training and provision of technology.

The incorporation of mobile devices into instruction has steadily increased over the past 2 decades (Nikolopoulou & Gialamas, 2017). Nikolopoulou and Gialamas (2017) used a 25-item questionnaire to investigate 260 junior high school students' attitudes and self-efficacy in Eastern Europe (aged 12 to 15 years) regarding their mobile devices. These researchers found that mobile phones were widely used in their education population study. Mobile handheld devices were the most common device used by students several times in a school day, and three quarters of the students indicated they knew more about technology than their teachers (Nikolopoulou & Gialamas, 2017). Nikolopoulou and Gialamas found that the attitudes of the students were positive and identified "perceived usefulness," "affection," "perceived control," and "behavior" as factors influencing their attitudes towards mobile devices. Higher self-efficacy was related to optimistic views and emotions, a greater ability to use mobile devices, and positive attitudes towards learning and the use of mobile devices (Nikolopoulou &

Gialamas, 2017). Nikolopoulou and Gialamas also indicated that mobile device use was predicated by the self-efficacy of the students. Students were inspired and experienced greater connectivity and communication than traditional lecture-style classes. Nikolopoulou and Gialamas found that mobile devices increase students' motivation to participate in learning which ultimately leads to increased engagement and positive learning outcomes.

Research indicated that students and teachers felt that mobile devices were positive, useful, and increased collaboration. Higgins and BuShell (2018) also demonstrated that mobile technology could support student academic achievement. Higgins and BuShell's qualitative inquiry employed purposeful sampling of 207 high school students and four classroom teachers in a suburban public high school in the United States. Using the self-system theory of motivation framework, the researchers conducted semistructured interviews and administered questionnaires to determine what effect a one-to-one device for classroom instruction had on student-to-teacher relationships in three subject areas (social studies, math, and science). Higgins and BuShell found that both students and the teachers believed it was important to have a positive relationship and that positive relationships created a more engaging classroom.

Mobile devices can also aid in furthering student intention to inquire about new areas of learning. Song (2016) assessed 28 sixth-grade students divided into five groups of five to six members each. The researcher selected the topic of "black spots" (i.e., places where accidents are likely to happen in school) in the "Safety Is Fortune" science unit in order to examine the students' development of inquiry skills in science using

mobile devices. Students were grouped with mixed abilities and mixed types of mobile devices (Song, 2016). The students were enthusiastic and engaged in using BYOD but did not have prior experience using it for inquiry learning in science. The teacher facilitated direct student inquiries and allowed students to use smartphone devices to facilitate their inquiry (Song, 2016). Students developed research abilities independently while deepening their comprehension of subject knowledge in a learning setting assisted by mobile applications, which resulted in increased academic achievement, greater student engagement, and more favorable views of the learning process.

Technology can also be used to motivate students to improve in the classroom and increase their personal confidence. In a qualitative examination of 15 teachers and 103 middle-school students, O'Bannon et al. (2017) found that the appropriate use (i.e., only using the device for learning purposes) of technology motivates students to engage and learn more, while also enabling them to practice digital literacy. For example, mobile technology allowed more effective demonstrations of specific subject matter through videos and activities. O'Bannon et al. also discovered that technology can be used for demonstrating examples to engage students in a discussion. Similarly, Nikolopoulou and Gialamas (2017) qualitatively examined the attitudes of junior high school pupils towards mobile learning, finding that many students reported a positive attitude and higher self-efficacy when learning was accomplished with mobile devices. Most of the students reported that BYOD made learning fun in a way that was suitable to them. The authors concluded that the use of mobile devices motivated students to engage in the process of learning (Nikolopoulou & Gialamas, 2017).

Teachers' perceptions of mobile technology have indicated that barriers and constraints could increase frustration in the classroom. Nikolopoulou (2020) investigated 64 Greek secondary school teachers' perceptions of mobile device use in classrooms, using an open-ended questionnaire to understand benefits, constraints, and concerns. Through thematic coding, Nikolopoulou found that teachers identified perceived benefits as active involvement, motivation, the creation of an interactive lesson, easy access to knowledge, and familiarity of students with technology. The most common advantage was that mobile devices promote and increase student engagement (Nikolopoulou, 2020).

Students that struggle with boredom in the classroom also benefit from technology inclusion. Moeller et al. (2020) investigated the perceptions of 21,678 ninth to 12th grade U.S. students regarding the use of technology in their personal life and perception of their interest in using mobile technology in the classroom. Data were collected through open-ended surveys and a rating scale regarding the usage of technology. Forty percent of the students responded while being at school, 54.91% were at home, and 5.46% were in another after-school setting other than home (Moeller et al., 2020). The researchers found that the three most frequently mentioned feelings students experienced at school were tired, stressed, and bored. The participating students also reported being less engaged through traditional lecturing methods. The findings of Moeller et al. indicated that students are less engaged in school with traditional lecture-style settings.

Student engagement is a critical part of learning that supports academic achievement and ensures close interactions and understanding of concepts in class.

Technology usage can aid in encouraging students to be motivated in the classroom (Higgins & BuShell, 2018; Song, 2016). The use of mobile devices can, therefore, improve student engagement in class (Hur et al., 2015; Nikolopoulou, 2018, 2019, 2020; Nikolopoulou & Gialamas, 2017; O'Bannon et al., 2017). Investigating the use of mobile devices as learning devices for students can offer key insight regarding the strengths and weaknesses of mobile devices as an educational technology resource (O'Bannon et al., 2017).

Summary and Conclusions

In this literature review, the use of mobile devices in primary and secondary school learning was discussed. The beginning of this chapter included literature related to the principles of connectivism, the framework for the current study, and how this theory can be applied to learning in different ways through connections with society and information using mobile devices for learning. In this chapter, four themes have been highlighted, including the application of connectivism to mobile learning, teacher experiences with integration of mobile devices, mobile devices for learning, and using mobile devices to support academic achievement. Including technology in the classroom can aid students in terms of engagement, motivation, and improved student learning settings (Holstein et al., 2018; Liu et al., 2017).

Innovative technologies and mobile devices have been proven to increase the attention of students, as well as guide the integration with traditional learning methodologies methods (Engen et al., 2018; Kormos, 2018). Including technology in the classroom can enable teachers to meet the diverse needs of specific students. The use of

technology can aid creativity as well as provide opportunities to overcome challenges that students face in grasping specific concepts (Blau & Shamir-Inbal, 2017; Gençer & Samur, 2016; Yahya & Raman, 2020). Many educators struggle with technology inclusion due to a lack of user adaptability and proficiency with challenges in the workplace (Strycker, 2015; Vieira et al., 2019).

The results of the current literature review indicated that connectivism could be a paradigm that can be successfully applied to mobile and conventional learning in and out of the classroom because of its real-world relevance (Homanova et al., 2018; Siemens, 2005, 2008; Utecht & Keller, 2019). The research findings reviewed in this chapter demonstrated the importance of teacher experiences in efforts to promote the process of integrating mobile devices into learning (Bai, 2019; Ekanayake & Wishart, 2015; Hur et al., 2015; Nikolopoulou & Gialamas, 2017; O'Bannon et al., 2017), and how the incorporation of mobile devices into instruction can help increase student engagement and support student academic achievement (Higgins & BuShell, 2018; Nikolopoulou & Gialamas, 2017; O'Bannon et al., 2017). The ban on cell phones in the U.S. classroom resulted in many teachers being unable or unwilling to explore mobile devices' potential as instructional tools (Song, 2016). As paradigms shift in the educational technology field, researchers have advocated for more research and evidence of the benefits and barriers associated with mobile phones and the exploration of teacher experiences with the use of mobile devices (Nikolopoulou & Gialamas, 2017; O'Bannon et al., 2017; Song, 2016).

The gap in the reviewed literature indicates an opportunity for exploration for the gap in practice which can help meet the needs of students and teachers in terms of technology advancement in the classroom (Nikolopoulou, 2018, 2019, 2020). Using a basic qualitative design, I explored the experiences and perceptions of urban sixth to ninth grade level teachers' benefits and challenges associated with BYOD in enhancing student learning outcomes in the science classroom. The widespread use of the internet through mobile devices and the introduction of new technology and functions made it essential to explore teachers' and students' expectations about mobile learning acceptance (Nikolopoulou, 2018).

Previous assessments presented included both qualitative and quantitative assessments. Researchers have also demonstrated the use of mixed-methods approaches, which were used for addressing the nature of the phenomena regarding technology use in the school setting. For this study, a mixed-methodology approach was considered appropriate because it aligned with similar assessments. Further, the mixed-methodology approach offers the opportunity to explore both reported perceptions of educators and the surveyed effectiveness of the technologies. Through in-depth qualitative interviews, I explored the experiences of urban sixth to ninth grade science teachers with BYOD policies in order to understand how they use mobile devices as instructional tools in their science classroom to help enhance student learning outcomes. In Chapter 3, I present the methodology that I used to conduct this study. Trustworthiness concerns related to reputation, transferability, reliability, confirmability, and detailed ethical procedures are also discussed.

Chapter 3: Research Method

The purpose of this exploratory qualitative study was to explore the experiences and perceptions of urban sixth to ninth grade level teachers regarding the benefits and challenges associated with BYOD in enhancing student learning outcomes in the science classroom. In Chapter 3, I describe the research design and rationale, including my role as the researcher. In this chapter, I present details of the selected methodology, including participant selection, instrumentation, recruitment, participation, data collection, and data analysis procedures. This chapter also includes a description of the measures that I employed to minimize ethical concerns and ensure that the findings of the study were trustworthy.

Research Design and Rationale

Through this study, I addressed the following research questions:

RQ1: How do urban sixth to ninth grade level science teachers use BYOD in their classroom, and what are the benefits?

RQ2: What are the challenges associated with using BYOD by teachers in urban sixth to ninth grade level school science classrooms, and how can these challenges be overcome?

I employed a basic qualitative research design to answer research questions and investigate the central concept of urban sixth to ninth grade school science teachers who use BYOD as instructional tools to enhance student learning outcomes in the science classroom. A basic qualitative inquiry aligned with the purpose of this study, as it allowed me to understand the target population's experiences on the phenomenon of

BYOD with mobile devices in an urban school setting. Although this design can inform practice, it also seeks to broaden knowledge (Lapan et al., 2011).

I considered alternative research designs for this study but concluded that using a qualitative design would be most appropriate for the purpose of describing the experiences and perspectives of participants, as opposed to quantifying the effect of the BYOD technique through a quantitative approach. The qualitative approach allows for the exploration of noncategorical approaches to describe and present participants' perceptions and feelings through interviews (Elyisi, 2016). The use of a qualitative methodology is considered an appropriate approach for exploring a phenomenon based on the reported and described experiences of individuals (Tracy, 2019). A quantitative methodology traditionally uses an experimental method that numerically quantifies a phenomenon, which does not align with the purpose of exploring perspectives of participants through describing their experiences (Elyisi, 2016). A quantitative method uses deductive logic, in which the researcher develops a hypothesis and collects evidence as an inquiry into the study (Elyisi, 2016). After analysis and examination, results are exchanged, and the results reveal whether the researcher's assumptions are correct. A quantitative approach would not have been appropriate because this approach would not have allowed for an exploration of the participants' experiences in a natural setting and, further, would not be appropriate to evaluate participants' interactions and experiences (Elyisi, 2016). For educational studies, scholars have recommended first observing teaching methods to see how the method affects students and teachers before conducting interviews. Input via interviews from the participants can help form a researcher's

orientation and perspective. This method is not feasible within the framework of quantitative analysis methodology, as a formalistic order approach does not allow for a variety of ways of understanding the study topic (Elyisi, 2016).

The rationale for my use of a basic qualitative design was based on my goals of investigating, explaining, and understanding urban sixth to ninth grade level science teachers' experiences using mobile devices in the classroom. Ravitch and Carl (2016) supported using a basic qualitative design when the research objective is to gain a more comprehensive understanding of a specific issue. Qualitative research provides perceptions of different societal problems and supports the development of theories for potential quantitative exploration (Patton, 2015). According to Mohajan (2018), a qualitative design helps researchers learn new views, opinions, and experiences due to its primary focus on people's problems. The qualitative design utilizes various forms of structured and semistructured techniques for data collection. Some of the standard practices used in gathering data during qualitative design include individual interviews, questionnaires, group discussions, and journal exercises (Mohajan, 2018). Through this study, I sought to understand urban sixth to ninth grade teachers' opinions regarding BYOD, especially using BYOD strategies towards enhancing student learning outcomes. My use of a qualitative design aided the exploration of teachers' experiences and views (Patton, 2015). In gathering data, I examined teachers' use of BYOD policies when incorporating mobile technology into their classrooms to support student learning outcomes. I conducted individual interviews to gather the required information.

Role of the Researcher

In qualitative research, the researcher's role entails helping participants understand the research requirements (Mohajan, 2018). Qualitative research is a method for gathering data that explores human experiences, perceptions, and sociocultural phenomena (Mohajan, 2018). The core purpose of qualitative research implies that data collection is facilitated through a human instrument (Mohajan, 2018). As the researcher, I was responsible for each part of the research process. I recruited the participants, designed the instrument, conducted and transcribed the interviews, and analyzed and interpreted the data. I also conducted thematic data analysis using MAXQDA management software.

I had no personal relationship with the targeted population, which prevented issues revolving around participant relationships, insider bias, and unfavorable results. I avoided being in a supervisory or instructor relationship capacity to mitigate my research expectations. To enhance this study's trustworthiness and ethical issues, I obtained approval and guidance from the Walden University Institutional Review Board (IRB) to minimize conflicts.

Methodology

In scientific research, the methodology delineates the measures and procedures that the researcher uses and the type of data that are collected (Prigol & Behrens, 2019). In Chapter 3, I describe the methodology and design that guided this study, the rationale for participant selection, as well as the procedures for instrumentation, data collection,

and data analysis. I also describe the measures that I took to minimize ethical concerns and to ensure the integrity and trustworthiness of the findings.

Participant Selection

As part of this study's purpose, I explored the experiences of my target population (i.e., urban sixth to ninth grade level science teachers) when using BYOD to enhance student learning outcomes in the science classroom. Potential participants for this research were selected through purposive sampling. As a qualitative selection technique, purposive sampling usually begins with identifying the particular phenomenon and the characteristics of the population under examination (Lavrakas, 2008). Purposeful sampling is a commonly used technique in basic qualitative designs for the most efficient use of scarce resources (Palinkas et al., 2013). I based the criteria for participant selection on any urban sixth to ninth grade science teacher who has taught any science subject domain in the past five years and lives in the Southwestern United States. I verified the inclusion criteria using school websites, which identified potential participants and their subject domains.

There are no exact sample size guidelines in qualitative research (Patton, 2015). The basic qualitative study's sample size was 10 to 15 respondents while recruiting for maximum respondents. As a contingency, if I did not obtain 15 respondents in my first attempt to recruit, I would have followed the same procedures as described in the participant selection and identified participants who met my inclusion criteria until the minimum number of respondents was reached (Boddy, 2016). In addition, previous researchers conducting qualitative investigations similar to the current study have

recruited sample sizes between 10-20 participants (Wright, 2017). When researchers collect enough data to answer their research questions and discover no new information or ideas, referred to as data saturation, the sample size is satisfactory (Patton, 2015). Thus, 10 respondents represented a sufficient sample size to produce comparable findings and validate the emerging trends and conclusions in this basic qualitative study (Boddy, 2016).

To identify potential participants, I conducted web searches for the names of sixth to ninth grade level schools within urban settings in the Southwestern United States. Within each school website, I identified potential participants that matched my inclusion criteria. I emailed an invitation letter to all teachers who met the inclusion criteria based on my web search. These individuals were asked to affirm that they met the inclusion criteria. Those individuals that met the criteria were included, and those that did not were excluded and thanked for their time.

For science teachers who responded positively and accepted the invitation, I emailed the informed consent form, which provided a brief synopsis of my study and the nature of their involvement. After receiving the executed consent form, I scheduled a web conference with each interested participant, which was recorded. I also invited them to ask any further questions to ensure the voluntary nature of their participation.

Instrumentation

The following paragraph details the key data collection instrument, a self-developed interview guide, which outlined defined procedures and prewritten questions (Rubin & Rubin, 2012). Qualitative work is primarily focused on participants'

experiences and expectations in events (Mohajan, 2018; Ravitch & Carl, 2016). Interviews centering on these experiences served as the primary source of data to address the questions posed in this research (Rubin & Rubin, 2012).

Interview Guide

I created an interview guide to ensure a consistent analysis of the important concepts of this study (see Appendix A; Thomas, 2017). The interview questions were structured as open-ended and intended to create an atmosphere that encourages transparency and sharing. In alignment with the problem and purpose statement, the questions were designed to explore the experiences of urban sixth to ninth grade science teachers regarding the use of mobile devices in their classrooms to support students' academic achievement.

Interview Questions

I used interview questions to ask about the participants' teaching experience and to build rapport (Thomas, 2017). To answer the two research questions for this study, I constructed interview questions that enabled me to build rapport, ensure authenticity, and elicit information from participants about urban sixth to ninth grade level science teacher experiences. When creating the interview guide, the interview questions were designed to address the two study questions in appropriate depth.

Studies such as those of Nikolopoulou (2018, 2019, 2020), Nikolopoulou and Gialamas (2017), and Parsons and Adhikari (2015, 2016) guided the development of the interview questions. A sample interview question is: Do you let your students use their mobile devices in your classroom for classroom assignments, homework, lab

experiments, or any type of school related activities? After developing the interview guide, I sought expert review from a local school district director of curriculum and a local science department chairperson. The experts also reviewed the interview questions' quality, format, flow, and alignment to the research questions, and provided suggestions to enhance the interview process and maximize the clarity of the questions. The developed interview items were presented to each participant in the same format in order to increase credibility.

Procedures for Recruitment, Participation, and Data Collection

For recruiting purposes, I used the chain sampling approach, a form of purposeful sampling, to choose participants. Using a web search, I located urban sixth to ninth grade level schools in the Southwestern United States. For recruitment, I sent out an email with an invitation letter. The invitation letter contained my contact information (Patton, 2015). I sent a consent form via email, including a brief synopsis of the research, the purpose of their participation, and a request for verification that they met the inclusion criteria. I arranged an appointment for the web-conferencing interview through email. Each participant's computer needed an internet connection, a microphone and/or camera, and web-conferencing functionality. During the interview, I reminded the participants that the process would be recorded. During the interview process, I followed an interview guide (see Appendix A) to ask the developed interview questions (see Appendix A). I utilized a responsive interview technique (Rubin & Rubin, 2012) to guide the interviews, which lasted approximately 30–45 minutes each. All interviews were audio-recorded through the web-conferencing software. If more than 10 participants contacted me, an email was

sent to the eleventh response and higher that they would be placed on a waiting list and would be contacted for an interview if needed.

After the interviews, the data were transcribed and uploaded into MAXQDA qualitative data management software. I provided a summary of the transcriptions for the participants' review, approval, and/or comments. For these purposes, I created a summary of the transcriptions. I waited 5-10 days for participants to review the summaries. If participants did not respond in this window, then the information was assumed to be correct. All data—including audio interview recordings, transcription of interviews, transcription summary, and research field notes—were stored in the MAXQDA qualitative management software, which was password-protected on a secure server.

Data Analysis Plan

Many scholars seek to explore people's perceptions, beliefs, values, or experiences with real-world problems. Such psychological aspects are statistically challenging to quantify, and therefore require basic qualitative approaches (Percy et al., 2015). In basic qualitative research, the researcher is considered a crucial tool for data collection and analysis. For qualitative research experiments using a basic approach, the aim is to explain the results using concepts and literature that inform the project (Packer, 2011). For example, applying connectivism to mobile learning is grounded in the connectivism learning theory to show how teachers can support emerging technologies. Secondly, teachers' rationale behind the integration of mobile devices in the classroom is based on the idea that mobile technologies can enhance classroom opportunities. Thirdly, the utilization of mobile devices for student learning is based on the idea that many

students and teachers identify mobile devices as positive and beneficial for instructional purposes. Finally, the use of mobile devices to support academic achievement is based on the idea that students feel more inspired and motivated when using their mobile devices, which leads to positive learning outcomes. With the expectation of exploring these concepts from the literature further, the data from the interviews connected the purpose of the study to the research questions.

In qualitative studies, the goal is to generate knowledge about a particular phenomenon, which necessitates uncovering common patterns and ideas within the human experience (Thomann & Maggetti, 2017). The data gathered through interviews were subjected to comparative analysis guided by grounded theory (Glaser & Strauss, 1967). This approach includes continually comparing data with other information to uncover similarities and differences, thus aiding in data conceptualization. For example, by comparing the accounts of different teachers who had similar experiences, the aim was to find commonalities that would result in key themes. The comparative analysis provides researchers with the means for evaluating the causal contribution of different situations to a result of interest or theme (Thomann & Maggetti, 2017). For this reason, I applied basic qualitative strategies established in constant comparative techniques in order to draw conclusions based on the collected data, evidence, and facts.

I employed Rubin and Rubin's (2012) and Saldaña's (2015) methods to review the interview transcripts. I used MAXQDA software, which is designed for qualitative, quantitative, and mixed-method approaches for data analysis, data management, and discrepant case sampling and coding. MAXQDA aided me in grouping and coding text,

but only served as an assistive technology for the research. I used MAXQDA tools to identify analogous texts and apply codes to terms or short sentences that reflected the attributes from data collected from the interviewee. Coding is an inductive method through which researchers create codes during their study. I developed codes by identifying and grouping analogous words, texts, and phrases. Saldaña (2015) defined coded data as descriptive codes, which involve looking for similarities in coded data to organize classes of codes into groups or themes (Saldaña, 2015). I created a coding list with the definitions of my codes. For example, if a teacher identified the use of BYOD as "positive," then the text was coded as "positive outcome of BYOD." Due to the concise and interpretative nature of qualitative study, and in order to avoid research bias, I used emerging coding methods. Emerging coding enables researchers to experience in-the-moment reactions and helps remove natural tendencies to lean on prior knowledge that may cause the researchers to filter knowledge (Saldaña, 2015).

Trustworthiness

Qualitative analysis relies on precision and validity measures to determine the feasibility of the study; however, it is also important to consider the trustworthiness of the investigation (Butin, 2010). Qualitative researchers must determine that their data and findings are credible, dependable, transferable, and confirmable. Thus, the following strategies helped me to maintain the concept of trustworthiness in order to confirm the findings (Butin, 2010; Korstjens, & Moser, 2018).

Credibility

Credibility serves to ensure that qualitative studies' findings are credible from the study subject's point of view. In order to maintain authenticity and credibility for this study, I used research techniques from Butin (2010), Rubin and Rubin (2012), Saldaña (2015), and Thomas (2017), such as semistructured interviews. This type of interview is a strong qualitative research technique that allows the researcher to develop the questions based on important points for discussion. To ensure credibility, I asked each interview question in the same order to ensure that the guide was applied in a uniform approach to each participant (Rubin & Rubin, 2012; Thomas, 2017). Member checking is the practice of restating, summarizing, or paraphrasing the information obtained from an interviewee to ensure that what has been interpreted or published is accurate (Butin, 2010; Thomas, 2017). In this study, I used member checking to increase the credibility of the findings by providing participants the opportunity to review the summary of their interview transcripts.

Reflexive notetaking, or journaling, can make it easier to interpret unforeseen study discussions and increase participants' understanding of their role to make the interview results more accessible, uncover ineffective or poorly applied techniques, and increase self-awareness, which helps researchers to develop ways to address challenges and concerns (Meyer & Willis, 2019). Notetaking was used throughout this study to document my personal bias, make notes on key points that each participant remarked, and detail each step of the data collection and analysis process.

Coding in qualitative research is the assigning of labels or statements to elements or aspects of the data. From a constant comparison, the collected data were marked with codes—that is, abbreviations, names, marks, and/or colors—that defined their essential facets. For data analysis, I developed emerging themes and used these to address the research questions (Saldaña, 2015; Thomas, 2017). I also established credibility by ensuring the openness and honesty of the study participants.

Transferability

Transferability is similar to the notion of objective validity, indicating that the analysis findings can be applied to other situations (Patton, 2015). My responsibility as a researcher was to provide an in-depth explanation so that the reader can determine whether my study results can be applied to their own context. This is called a transferability judgment. This implies that the reader—not the researcher—makes the transferability judgment (Korstjens & Moser, 2018). In this case, examining how urban sixth to ninth grade science teachers use mobile devices in their classrooms to support students' academic achievement added new data that may be useful for the support of educators and the incorporation of technology into the learning process.

Dependability

Dependability constitutes the accuracy and repeatability of a study. Patton (2015) referred to dependability as the consistency and stability of findings over time. A researcher must demonstrate why the research is evolving and how those changes impact the analysis (Patton, 2015). Qualitative researchers use various approaches to systematize, organize, and interpret non-numerical data. Researchers are increasingly

using computer tools to analyze their qualitative data. Qualitative data management software such as MAXQDA offers insights into qualitative datasets without implying interpretations. There are a wide range of available resources to promote an in-depth systematic study of many media forms, regardless of the chosen method of analysis. Thus, the reflexive notetaking and journaling that I conducted through the interviews and the use of MAXQDA software helped to maintain an audit trail through the processes of content and comparative analysis (Korstjens & Moser, 2018). Qualitative data and text management software tools make it possible to sort, structure, and analyze large amounts of text or other data quickly; facilitate the handling of the resulting interpretations, analysis, and evaluation; and to chronologically catalog incidents or procedures that provide supporting evidence and history, thereby authenticating security or mitigating challenges to preserve the integrity of the data (Given, 2008). Through MAXQDA, I produced an audit trail that detailed the steps taken to identify analogous codes, define codes, create groups, and identify emergent themes. These themes were associated with code tables that demonstrate how the data were used to address the research questions.

Confirmability

Confirmability is meant to assess whether the analysis is fair and impartial (Patton, 2015). I used several methods to ensure that my research was free of bias and prejudice, such as the debriefing and clarifying techniques outlined by Butin (2010), Rubin and Rubin (2012), Saldaña (2015), and Patton (2015). I performed participatory debriefings in which I addressed my personal perceptions, attitudes, stereotypes, and

experiences using member checking to reinforce and bolster the confirmability of the current findings.

Ethical Procedures

Walden University requires all researchers to submit their research proposal to the Institutional Review Board (IRB) to ensure the study's adherence to established ethical standards. Before collecting any data, I obtained IRB approval number 04-13-21-0727593. I also complied with all institution ethical standards, including local, state, and federal regulations. I maintained the confidentiality of information collected by me from the participants and any indirect correspondences. I ensured data protection and privacy and also reviewed and explained the consent form and provided answers to any questions to the participants. Study participants often have reasonable expectations concerning the protection of their privacy. I protected the privacy and safety of participants by keeping all identifying information private. Information related to the names, workplaces, or the positions held by participants were not revealed. Each participant's name, their workplace, and other identifying data were replaced with pseudonyms.

Seeking informed consent was also another ethical procedure that I observed while conducting this study. Research participants have a practical expectation that the investigators will inform them about the nature of the study. When provided with such information, potential respondents may choose if they want to participate. Ethical research issues primarily involve the researcher's responsibility to preserve participants' privacy and to publish the results.

Summary

In Chapter 3, I outlined the methodological details of this study. I discussed the basic qualitative research approach for this study, which focused on the challenges that teachers face in integrating BYOD to enhance student learning outcomes in urban sixth to ninth grade level science classrooms. I outlined how decisions were made concerning participant selection, tools, data collection, data analysis, and trustworthiness, including the responsive sampling technique that I used. I collected data from participants using semistructured interviews following a self-developed interview guide. I used coding to illustrate the emerging subjects from the transcribed interview data and developed a data analysis plan to ensure the trustworthiness of the findings. In Chapter 4, I present the results of the study, including data from the participant recruitment and selection stage and a summary of the sample demographics.

Chapter 4: Results

The purpose of this basic qualitative study was to gather the experiences and perceptions of urban sixth to ninth grade level teachers regarding the benefits and challenges associated with BYOD in enhancing student learning outcomes in the science classroom. To derive meaning from urban sixth to ninth grade level teachers' perceptions and experiences associated with using BYOD in the science classroom, the framework of the theory of connectivism was applied. This study sought to answer the following research questions:

RQ1: How do urban sixth to ninth grade level science teachers use BYOD in their classroom, and what are the benefits?

RQ2: What are the challenges associated with using BYOD by teachers in urban sixth to ninth grade level school science classrooms, and how can these challenges be overcome?

The chapter includes the following sections: a description of the setting of the study and the participants' demographic information to provide the context of the study. The data collection and data analysis procedures, as well as the evidence of trustworthiness, are also briefly described. The results section contains the themes that emerged from the coding and constant comparative processes applied to the interview data. Lastly, a summary concludes this chapter.

Setting

The setting of this study was urban science classrooms. Specifically, this study involved sixth to ninth grade urban science classrooms in the Southwest United States.

Sixth to ninth graders, generally considered junior high school students, are students who are generally allowed mobile phones, laptops, and internet access for the first time (Sung et al., 2016). Mobile learning technology has been advancing in the urban science classroom since the beginning of the 21st century; however, empirical research about the phenomenon remains scarce (Crompton et al., 2016).

I initiated interviews with 13 participants from my home office using GoToMeeting, a web-conferencing software tool on my personal password-protected computer. Nine participants were at home during the interview process, while four participants were in their classroom or office when participating in the interview. The average interview length was 31 minutes. During the web conference interviews, I conducted the interview in a home office setting, but the participants were given their location choice for the interview. During the data collection period, no personal or organizational conditions influenced participants. All schools but one of the urban science classrooms in this study were Title I schools in the Southwest United States. Participants in this study had BYOD policies in which students used mobile devices for classroom assignments, and all schools encouraged the use of school-issued mobile devices such as Chromebooks. A summary of the participants' demographics is shown in Table 1.

Table 1

Participant Demographics

Participant	State	Subject	Years Taught
1	Arizona	Science(s) and Math	1
2	Nevada	General Science(s)	15
3	Arizona	ESL Science(s)	11
4	Arizona	STEAM Science(s)	7
5	New Mexico	Physical Science(s)	8
6	Arizona	General Science(s)	13
7	Arizona	General Science(s)	8
8	Nevada	General Science(s)	19
9	Arizona	SPED & ESL Science(s)	17
10	Nevada	STEAM Science(s)	15
11	Arizona	General Science(s)	16
12	Nevada	General Science(s)	11
13	Arizona	STEAM Science(s)	6

Data Collection

Upon receiving IRB approval on 04/12/2021 with approval number 04-13-21-0727593, I sent email invitations to urban sixth through ninth grade science teachers throughout the Southwestern United States. The participants who responded to the email invitation were then sent a consent letter. I sent a total of 13 consent letters. When I received participant consent emails, I emailed participants to set a date and time to complete interviews. Data collection was initiated on April 12, 2021 and completed on June 01, 2021.

The interviews were conducted with 13 purposively selected urban sixth to ninth grade science teachers who instructed any science subject domain in the past five years and lived in the Southwestern United States. Before the interviews, all the participants met the criteria for participant selection, signed the informed consent form, and agreed to

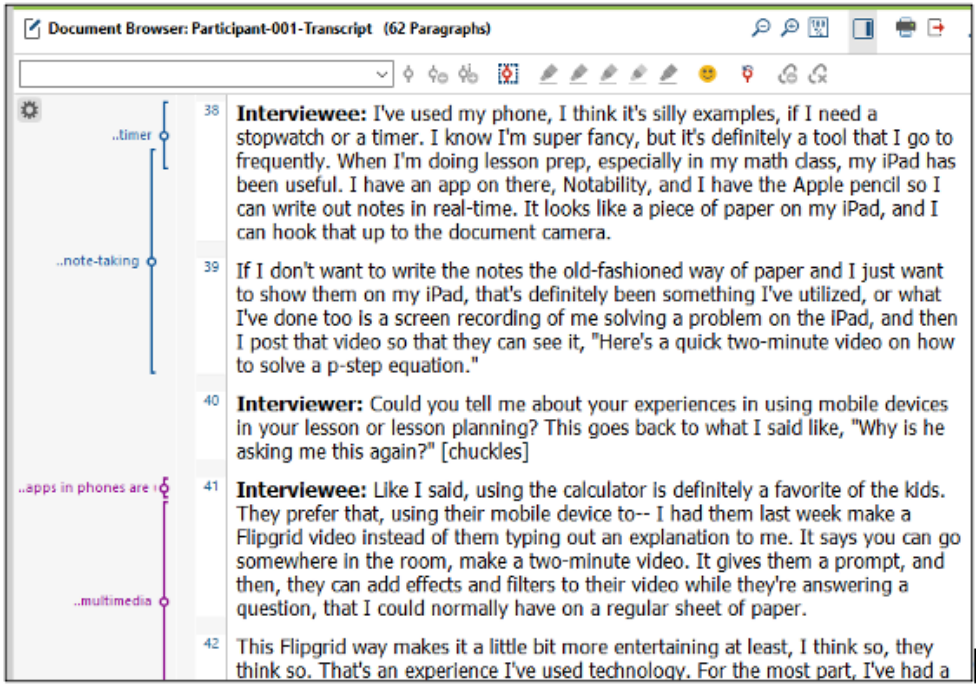
member checking the transcription of their interview recording. The data collection method utilized in this study was semistructured individual interviews. This open-ended protocol elicited open-ended feedback from participants. I also used a hard copy of the interview guide for notetaking, journaling, and reflecting during data collection and analysis, which established an audit trail to maintain the dependability and confirmability of the study. To maintain participant confidentiality, I recorded interviews using the GoToMeeting recorder software, which is password protected. I transferred audio recordings to my password-protected desktop computer after each interview. No variation in data collection occurred that was outlined within Chapter 3, and I did not encounter any unusual circumstances in the data collection process.

Data Analysis

The data analysis involved transcribing the audio recordings and coding the transcripts using the constant comparison method. Data analysis began immediately after the interview of the first participant. I transcribed the first interview recording and imported the transcript to MAXQDA. Then, I read the transcript in its entirety before rereading the transcript line-by-line in search of small meaning units or codes. An example of the coding Participant 1's transcript using MAXQDA is shown in Figure 1.

Figure 1

Screenshot of Coding Participant 1's Transcript



In the descriptive coding process, the codes served as descriptive labels for the contents of the texts. I then proceeded to categorize the codes. Categories are clusters of codes with similar meanings (Glaser & Strauss, 1967). As seen in Figure 1 above, the sample codes are color-coded. The codes "timer" and "note-taking" were colored blue, and the codes "apps in phones are useful" and "multimedia" were colored purple. The codes in blue showed similarities in describing the features of mobile devices that the teachers found useful while in class, whereas the codes in purple represented the functions of mobile devices that were beneficial to the students. Overall, these two categories plus the category of the general challenges in using mobile devices emerged from Participant 1's transcript.

Simultaneous with analyzing Participant 1's transcript, I also began interviewing the next participant. The codes and categories that emerged from Participant 1's transcript

were added to the follow-up questions and coding process of Participant 2's transcript. The analysis of Participant 2's transcript also resulted in the categories of the features of mobile devices that the teachers found useful while in class and the functions of mobile devices that were beneficial to the students. The general challenges in using mobile devices did not emerge from Participant 2's data, but a new category, school-issued device, was generated. The analysis of Participant 3 to 8's transcripts did not yield any new categories, but the transcripts of Participants 9, 10, 11, and 13 generated the category impact of the Covid-19 pandemic on remote and face-to-face learning. This category revealed that seven teachers perceived teachers and their students were "forced" into using personal mobile devices amidst the closing of face-to-face classes and beginning of virtual learning.

The categories were then analyzed in search of thematic meanings. I identified patterns in the data based on the similarities. Overall, the categories revealed seven overarching themes. Codes were related to a category and a theme such that no discrepant cases emerged from the analysis. A complete list of codes, themes, categories, and definitions is provided in Appendix B. The themes are further described and detailed in the Results section below.

Results

The results of this study show the experiences and perceptions of urban sixth to ninth grade level teachers regarding the benefits and challenges associated with BYOD in enhancing student learning outcomes in the science classroom. In this section, I will present results by the overarching themes illustrated in Table 2.

Table 2

Overarching Themes

Theme	Number of References in the Transcription
1. Benefits of mobile devices	65
2. Challenges of mobile devices	45
3. Use of school-issued device in school	42
4. General challenges in using mobile devices for learning	15
5. Benefits of mobile devices for students	119
6. Challenges of mobile devices for students	37
7. Impact of Covid-19 on learning in general	19

Benefits of Mobile Devices

Teachers expressed that they benefitted from the use of their mobile devices. Participants discussed the efficiency and convenience of using their mobile devices at work. Additionally, participants appreciated communicating with students and parents, increasing productivity with their mobile devices.

For seven teachers, the main benefit was the contribution of the devices on their efficiency at work. Specifically, the participants emphasized that personal mobile devices, especially mobile phones, were more conveniently accessible than other communication devices and work materials. Five teachers noted that they could easily access their files through the cloud services, give out assignments, and reply to students and parents when using their mobile phones. Participant 10 highlighted the efficiency of being able to multi-task and collect students' work "instantaneously" and in an organized manner.

According to Participants 4 and 11, assignments and schoolwork were accessible on mobile devices, making it easier to access them instead of using traditional pen and paper. Participant 4 shared, "Many of my assignments, I put into a web-based program called Go Formative. What it does is as they're working on their assignment, they can access it on a phone, on a computer, on a tablet, or anything." Participants 1 and 11 revealed that they used mobile devices for assessments. Participant 11 specified that the their school used a downloadable app where you could take pictures of the students' work or video student activities in real-time. Participant 6 added that the app they used, ClassDojo, also served as a "communication device" with the students' families. As for the mobile phone itself, Participant 12 noted that students behaved well in the classroom, explaining, "They also know that I can just pull up [contact details of students' parents] and talk to their parents or text their parents at any time."

In utilizing apps and programs installed on their mobile devices, the participants shared that they could handle their classes more effectively. As their mobile devices served as remote clickers or dual screens for their presentations, Participants 4 and 13 were able to roam around the classroom and monitor their students' activities. Some participants used the term "untethered." Participant 4 reiterated that using the iPad allowed time to walk around the classroom, checking and monitoring students, rather than standing in front of the desk when teaching with a laptop.

Participant 13 perceived that using mobile devices in the classroom avoided the need for one student to sit in front of the computer and click on the PowerPoint presentation of the lecture. Additionally, when speaking about the benefits of using a

mobile device, Participant 13 stated, "It makes you available to walk around the room. You can encourage discussion; you can maybe connect to the more quiet kid. Definitely mobility; it makes you more mobile as a teacher."

The participants perceived that personal mobile devices benefitted teachers in terms of increasing efficiency at work. Teachers perceived that mobile phones provided easy access to what teachers needed. Five teachers talked about accessing their files through their mobile phones using cloud services. Seven teachers commented that they used their mobile phones to make quick announcements of assignments for their students and reply to parents' inquiries and comments. Urban sixth to ninth grade level science teachers rarely used their mobile devices for lesson planning and preferred to use school-issued devices or desktop computers. Additionally, eight participants revealed that they used their mobile devices for assessments, note-taking, timing class activities, and tracking students' work. In summary, teachers expressed perceived benefits of mobile devices that included:

- efficiency to get work done
- easily accessible and available, making BYOD convenient
- opened up other avenues to communicate with students and parents
- allowed for increased productivity

Challenges of Mobile Devices

The use of personal mobile devices for learning had some challenges for the urban sixth to ninth grade level school science participants. Teachers found a challenge in guiding and supervising students while using their mobile devices. Challenges also

included teacher privacy concerns and finding a middle ground between separating their work from their personal life while using their mobile devices.

Eight participants believed that teaching the students to use their devices properly and responsibly was challenging. Apart from the device, three teachers found it challenging to teach their students how to use the internet responsibly. Participants 9, 10, and 11 reported that teachers had no control over students' personal mobile devices. Participant 10 reiterated that this lack of control was not a problem for school-issued devices due to the tracking program installed. Additionally, Participant 10 expressed uncertainty about who would be accountable for lost or broken school-issued devices.

Five of the participants emphasized the need for teachers to regulate students' use of personal mobile devices. Participant 3 contended that "guidelines" needed to be established early in the school year and explained to the students. Participant 6 shared that teachers needed to teach students a routine in which the mobile devices, when used in classes, are tools for learning rather than for recreation. For science class, Participant 6 revealed a challenge in teaching the students to have the "level of maturity" to understand that mobile devices in the classroom were for educational purposes.

Three teachers found students' computer literacy, access to credible resources, and separating texting from academic writing to be problematic. Participant 1 shared, "Some students are not always literate in some of these programs." and recommended that teachers needed to learn about using the devices so that they could teach their students. Participant 1 also noted that some students did not know how to use Google properly and could not use keywords to refine their searches.

Participant 4 revealed that the students' lack of computer literacy was surprising considering that many students did not know how to use Google for research and complete basic tasks such as cutting and pasting or sending an email. The same participant found challenges dealing with students' computer literacy skills in the classroom describing the students' confusion using Google search, copy and paste functions, and emails. For academic writing, Participant 9 shared that students were prone to using non-scholarly language even before using of mobile devices. Participant 9 stated that some students did not know how to differentiate the language they used on their phones, such as "wanna, gonna" and "academic writing."

Another challenge for teachers when using personal mobile devices was related to using their devices for work. Five participants contended that using personal mobile devices for work-related activities might compromise their privacy. The participants commonly shared that they found it challenging to separate their work life from their private life. Participant 5 noted that using personal mobile phones for work made the phone a public record. Similarly, Participant 4 highlighted, "A few of the issues that I find is it has both of my accounts, work, and personal on there."

Other challenges included the teachers' own ability/inability to use the mobile device and the explaining instructions to English as second language (ESL)/English language learner (ELL) students. Nine participants reported challenges in using personal mobile devices to teach students to use their devices properly and responsibly. In addition, teachers who use personal mobile devices for work have the task of separating reported having difficulty

separating their work life and private life. In summary, teachers expressed perceived challenges of mobile devices that included:

- guiding and supervising students was difficult using their devices
- teacher privacy could be compromised
- separating work items from personal life aspects

Use of School-Issued Devices in School

Teachers expressed examples of how school-issued devices provided benefits and challenges for their students. Perceived benefits included adopting a one-to-one ratio of a device to students, compatibility with automatic connectivity, and school curriculum design. However, teachers also expressed challenges such as limited access to programs, applications, and websites, including outdated hardware and software.

Similar to personal mobile devices, the use of school-issued mobile devices also had advantages and disadvantages. The participants' interview responses revealed that they thought that challenges prevail over the benefits of school-issued devices. While eleven participants shared that their schools had BYOD programs, they did not encourage students to use their mobile phones in class. Participant 3 explained, " I did [encourage the use of mobile phones] all the time when I taught high school. I don't in middle school since the school is very strict on where they're supposed to have their phones." In Participant 1's experience, the school itself did not encourage the use of mobile devices. Participant 1 noted, "They are allowed to bring their device to school. However, with our probate plan, they're encouraged to not use them."

Furthermore, three participants talked about using school-issued devices when in school. Participant 4 shared, "I have the district provided laptop that I'll do my actual creating worksheets, doing meetings, anything under the teacher umbrella that needs to be done on a computer." Ten participants stated that their schools had sufficient devices for the students. Some participants reported that they had a one-to-one ratio or one-to-two ratio of devices to a student. Participant 13 reported, "Yes, with Covid this year, the pandemic, every student was given a laptop to use for the school year… I think [my] set has 38 laptops." Three participants shared that students currently had one-to-one access to school-issued mobile devices such as Chromebooks because of the pandemic. Before the pandemic, Participant 2 stated that Chromebooks were only available in "carts" and "were mostly used for testing."

The benefits of using school-issued devices highlighted compatibility. Specifically, Participant 13 shared that school-issued devices were automatically connected to the school network. Participant 13 stated, "Yes, the school computers and their personal laptops, they automatically connect to the school Wi-Fi." Additionally, school-issued devices functioned in line with the intended curriculum design. Participant 6 contended that personal devices such as phones were not "optimal" for school purposes because curriculum designers specifically designed the curriculum using the Chromebook provided by the school in mind. The school-issued Chromebook has features such as split-screen that are not available on all mobile devices.

However, school-issued mobile devices also presented challenges. Two participants noted that school-issued devices had limited access to programs,

applications, and websites. Participant 6 expressed that school-issued devices came with "blocks" on websites or software that students could not access.

Participant 11 shared that teachers also experienced being "locked out" of certain websites such as YouTube. Moreover, school-issued devices were older models compared to personal mobile devices, and that requesting to fix broken school-issued devices seemed troublesome. Participant 7 reiterated, "A lot of times the school-provided hardware is outdated." Participant 13 also stated, "Some of them do prefer to bring their own. Part of the reason is the school-issued laptops are lower-end, they're slow." Participant 9 shared that the district's allotted time to repair the devices conflicted with class schedules and meetings in terms of fixing broken school-issued devices.

Ten participants perceived that school-issued devices were designed to be used in school. Ten participants also stated that the schools had sufficient mobile devices for each student. According to two participants, school-issued devices had no problems with connecting to the school network, and their functionality aligned with the curriculum design. However, school-issued devices had limited access to learning resources such as programs, applications, and websites. School-issued devices were also older models compared with personal mobile devices, and that requesting to fix broken school-issued devices took time. In summary, teachers expressed perceived benefits use of school-issued devices in school that included:

- adopting a one-to-one ratio of devices to students was sufficient
- compatibility with automatic connectivity was easier with school-issued devices
- the school curriculum is designed with school-issued devices in mind

However, teachers also expressed perceived challenges in the use of school-issued devices in school that included:

- school-issued devices limited access to programs
- school-issued devices limited access and download of applications and websites
- school-issued devices are outdated and require the constant update of hardware and software that takes time

General Challenges in Using Mobile Devices for Learning

Teachers also revealed general challenges in using mobile devices for learning. The challenges of connectivity, limitations in battery and memory, and the rules and policy standards regarding mobile devices for learning emerged when using personal and school-issued devices. The participants also linked these challenges as experiences of both teachers and students.

Participants reported that mobile learning devices relied on connectivity. Whether in school or at home, users encountered problems when their internet connection had issues. At school, Participant 7 elaborated, "Using a lot of phones and laptops, specifically, if they are using the school's provided Wi-Fi, things might take longer to load than they would otherwise." Participant 11 added that there were "dead spots" in school, which meant that the Wi-Fi signal did not reach such areas. In general, Participant 13 reported that connectivity was the most significant issue experienced with mobile devices.

Likewise, mobile devices typically had limitations in battery and memory. Participant 1 described such problems as "technical stuff." Participant 12 experienced

problems with batteries and memory space and shared that students commonly shared the same problems. In addition, Participant 12 stated that finding a compatible charger was also an issue. Participant 1 shared a daily challenge, "…remembering to have their device charged and ready to go and working properly when devices are being utilized all the time." Participant 1 added that another potential problem was the compatibility of personal devices with school-issued mobile devices because of owning Apple products contrary to the brands of school-issued devices. However, the participant has not personally encountered compatibility problems.

Thirdly, the schools lacked standard rules and policies about mobile devices. In addition, the existing policies involved complicated issues regarding student privacy and legal safety concerns. Two participants shared that as minors, their students needed written permission to download applications and even appear on the school's public social media pages. Participant 3 elaborated that some applications can only be legally used when the user reached a certain age; otherwise, the user required parental permission.

Eight participants expounded on the challenges both teachers and students encountered when using personal and school-issued mobile devices. Eight participants reported that mobile devices used for learning required internet connectivity. Whether in school or at home, learning may be interrupted when the internet connectivity had problems. Furthermore, mobile devices had limitations in terms of battery and memory capacities. Some personal devices and school-issued devices also had compatibility problems, which made students' and teachers' work non-transferrable to a different

device. The policies on using mobile devices also lacked standardization, and existing policies were perceived to be complicated when the legal concerns for students' privacy and safety were involved. In summary, teachers expressed perceived general challenges in using mobile devices for learning that included:

- user connectivity
- limitations with battery and memory space
- rules and policies standards regarding mobile devices for learning

Benefits of Mobile Devices for Students

Teachers expressed many examples of how BYOD devices provided benefits for their students. The benefits included increased engagement, better access to learning resources, quicker accomplishment of tasks, and improvement of 21st century skills. Additionally, teachers perceived that students were more familiar and comfortable using their own mobile devices than school-issued devices.

Teachers believed that students were more engaged using personal mobile devices for learning than when listening to lectures. Five responses highlighted student preferences for using BYOD over traditional pen and paper activities. Participant 13 shared, "When we [students and the teacher] do assignments, we've done worksheets and online assignments. They [the students] are much more motivated to do the online work." Participants used terms like excited, immediate rewards, cool, and more when describing how students enjoyed using their mobile devices to complete assignments in the classroom.

Participant 12 elaborated that students were excited and motivated to use their mobile devices in class because, "They almost had an immediate reward. It's cool to be able to use your phone." Similarly, Participant 2 perceived that the students thought using personal mobile devices for learning was a "treat."

When describing how students used their mobile devices to complete science assignments and assessments, participants talked about sharing lessons, recording, internet use, and using apps like Kahoot or Quizizz. Four participants perceived that the multimedia aspect of presenting lessons when using personal mobile devices increased students' engagement during lessons. Participant 6 considered the different apps and software to be multimedia that helped engage students' interest in the lessons. According to Participant 5, the use of mobile devices in the class contributed to students' engagement in activities, describing them as "interactive", "competitive," and sharable on social media.

When discussing students' perceived benefits, Participant 13 shared that they made iPad video lessons for all instruction so that if a student was absent, they could review missed classes on Canvas (a learning management system). Participant 13 talked about how students valued multimedia, including videos. Participant 4 perceived that multimedia was helpful for student engagement in lessons due to the images and colors that break up chunks of texts. Participant 4 noted that being able to minimize texts was especially helpful for ELL students.

Participants 1 and 4 perceived that personal mobile devices increased student engagement because they could share lessons differently, leading to differentiated

instruction using photos and videos. According to Participants 3 and 6, access to information was more convenient with personal mobile devices. According to Participant 7, students in sixth to ninth grade belonged to a generation of learners interested in mobile devices who preferred learning with them over sitting in lectures. However, eight of the participants emphasized that personal mobile devices may only increase student engagement in lessons when used responsibly. Participants described responsible use as knowing how to search and use learning resources on mobile devices. Participant 6 emphasized the importance of students finding answers to their questions. Apart from the curriculum-based lessons, the participants also perceived that students learned "necessary" 21st century skills when using their personal mobile devices. Participant 13 termed these skill as "necessary in any job."

However, five participants did not associate the use of personal mobile devices with student's academic performance. Participant 13 perceived that students with personal mobile devices had families who supported their academical endeavors. Some participants did not always see a "correlation"(Participant 6) between personal mobile devices and academic performance. Five participants believed that personal mobile devices increased motivation and engagement, which then increased academic performance. Participant 6 explained that a personal mobile device was like a "Swiss Army knife" with several functions that were not useful when not used properly, and part of improving 21st century skills is teaching students to use their personal mobile devices responsibly and properly. In summary, teachers expressed perceived benefits of mobile devices for students that included:

- increased engagement and motivation
- easy access to learning resources, such as calculators, measuring applications, and interactive labs
- quick task completion, such as quizzes, exit tickets, and interactive games
- 21st century skill practice that allows for collaboration, social skills, creativity, and critical thinking

Challenges of Mobile Devices for Students

Teachers perceived that students also encountered challenges when using their mobile devices. Perceived student challenges included mobile device distraction towards learning, socioeconomic issues among the students, and loss of novelty, especially at the time of distance learning, when students had no choice but to use their mobile devices to attend classes.

Ten participants shared that mobile devices may be a distraction due to the students' internet access. Participant 5 emphasized that when students use the internet on their mobile devices, they may experience distractions from learning. Participant 7 expressed texting and the internet as a "temptation" for students, while participant 10 noted that students struggled with spending too much time on the device and "impulsively clicking things".

Apart from the contents and functions of the personal mobile devices, ten participants believed that the mobile devices posed a challenge for students. Six participants perceived that not all students had personal mobile devices, and second, not all students owned the same type of mobile devices. Some students whose families were

doing economically better tended to have newer and higher-end devices, while students from financially challenged families tended to own older devices. As a result, teachers perceived that students might perceive personal mobile devices as a status symbol and compare their devices with their peers. Participant 2 explained, "I think the challenges are that not all of them have mobile devices and that they are embarrassed to use their own mobile devices if it's very old." Participant 10 stated that not all students have access to devices of the same model and that some devices were not as efficient as others. Additionally, Participant 10 perceived that the inequality in access was a challenge in BYOD, as students whose families were financially struggling had less efficient devices than students from families who can afford better-performing devices. In addition to social status, two participants perceived that newer devices tend to function faster and have more features than older devices, impacting students' engagement and overall performance.

Five participants perceived that the students' use of mobile devices was a "novelty." When the novelty wears off, three teachers believed that the students' interest would also begin to wane, especially during distance learning when students spent all their time doing schoolwork on their mobile devices. Participant 10 shared that some students were "growing tired" of being in front of a screen, which translated to making the devices less engaging than older students experienced. In summary, teachers expressed perceived challenges of mobile devices for students that included:

- mobile device distraction towards learning
- socioeconomic issues among students

- loss of novelty

Impact of Covid-19 on Learning

Discussions with participants included many remarks related to the impact of the Covid-19 pandemic on BYOD use. Participants perceived that distance learning contributed to increased use of personal mobile devices and that the pandemic positively impacted utilizing technology in the urban sixth to ninth grade level science classroom.

Seven participants perceived that the Covid-19 pandemic impacted students' use of mobile devices for learning. Four participants perceived that distance learning contributed to increased use of personal mobile devices. As such, teachers and students alike could "bridge the gap in [the] digital divide" (Participant 9). Participant 12 articulated that the pandemic positively impacted utilizing technology in class, as the participant realized that the students could use technology for learning.

However, Covid-19 also resulted in distance learning which removed the physical presence of teachers. As the participants' students were in junior high school, five participants perceived that the students needed physically monitored to make sure they were paying attention to lectures and were on track with their assignments. Two participants shared that some students did not have parental supervision. Participant 13 commented that some students performed worse during remote learning, linking causes like lack of teacher's presence and home-based distraction. Participant 9 shared if the student happened to be home by themselves and teachers could only monitor learning remotely, the student could decide to close the computer, stating, "If I were a kid, I would just probably watch TV."

In addition, five participants perceived that the students' poorer academic performance during the distance learning period might not necessarily result from their use of personal mobile devices but the impacts of the pandemic. Some students may have experienced having loved ones who got sick or passed away, while some students may have had financial difficulties due to Covid-19. Three participants perceived that these obstacles might have impacted the students' academic performance. Participant 13 explained that the increase of students getting Ds and Fs was likely due to Covid-19 rather than using mobile devices for learning. Participant 13 reasoned that several students' families were negatively affected by the pandemic, including parents losing their jobs and students themselves getting jobs to help sustain the family's needs.

However, as a side comment, Participant 11 shared that Covid-19 may have had positively impacted helping students with mental health needs. Participant 11 cited that the school hired two social workers to help students have someone to talk to. The decision to hire social workers, Participant 11 believed, was a result of the pandemic.
In summary, this study reported that personal mobile devices were inevitable during the distance learning period resulting from the Covid-19 pandemic. Six participants perceived that students were able to cope with distance learning and using their mobile devices with the advantage of improving their skills in using their devices. However, five participants also believed that the pandemic was the root cause of students' poorer academic performance. Five participants perceived that the pandemic had an emotional, mental, and financial impact on some students, influencing their academic performance

during distance learning. In summary, teachers expressed perceived impact of Covid-19 on learning that included:

- increased use of personal mobile devices
- positively impacted utilizing technology

Evidence of Trustworthiness

To ensure the trustworthiness of this study, I used techniques to increase credibility, transferability, dependability, and confirmability. Credibility refers to the extent in which the study findings accurately represent the participants' point of view (Rubin & Rubin, 2012; Thomas, 2017). To establish credibility, I used the techniques of prolonged engagement and member checking. Prolonged engagement entailed my repeated immersion in the data through closely reading each line of the transcript multiple times. I also maintained a standard set of questions to apply some uniformity when questioning the participants. The semistructured nature of the interviews allowed for the use of an interview protocol to guide the line of questioning. Member checking involved allowing the participants to confirm that the transcription and interpretation of the data were accurate.

Next, transferability refers to the extent in which the study findings may be applicable to another context. I established transferability using the application of transferability judgment (Korstjens & Moser, 2018). In the Results section, I provided a thick description of the participants' demographics, the setting of the study, the data collection process, and the data analysis procedures such that readers can draw their

conclusions about the context of this study and whether the findings from this context apply to a different context.

Dependability refers to the consistency of generating the same findings over time. The use of a qualitative data management software helped achieve dependability through development of an automated audit trail. The audit trail entailed a transparent visualization of the step-by-step procedures involved in this study. The data management software MAXQDA contained all the files used in generating the results of the study. The software also laid out all the codes under a category and all the categories under a theme such that readers can trace how the theme emerged from the coded text.

Lastly, confirmability refers to the extent in which other researchers can verify the study findings (Patton, 2015). Establishing confirmability involved stating potential biases, such as my role as the researcher, as well as my personal perceptions and experiences relevant to the phenomenon under investigation. Using a reflexive journal, I recorded and described my personal biases during the data analysis process. Listing the potential biases helped me identify my preconceptions about the BYOD phenomenon in the classroom so that I was able to set aside my thoughts and focus the analysis on the data alone.

Summary

Chapter 4 described the setting, data collection, and data analysis. Chapter 4 also contained the presentation of the results that addressed the purpose of exploring the experiences and perceptions of urban sixth to ninth grade level teachers regarding the

benefits and challenges associated with BYOD in enhancing student learning outcomes in the science classroom and evidence of trustworthiness.

Results showed that the participants' use of mobile devices in the classroom depended on their purpose during the lesson (e.g., research, calculator, timers). Nonetheless, results showed that participants perceived that mobile devices had benefits for students and for themselves. Results also showed that all participants perceived that using personal mobile devices was also challenging for the students in terms of using their mobile devices other than for educational purposes resulting in distraction. Results showed that the benefits for the students appeared to outweigh the challenges. Results also showed that personal mobile devices were especially challenging for teachers in terms of privacy, having no control over the students' personal devices, separating their work and personal lives, and teaching their students to use their mobile devices responsibly.

According to the results, urban sixth to ninth grade level science teachers reported students benefiting from the use of mobile devices in terms of learning 21st century skills (i.e., computer literacy), receiving immediate feedback on their work, accomplishing tasks quicker, having better access to learning resources, being more comfortable and knowledgeable in using their own devices than when using traditional learning methods or school-issued devices. Additionally, the teachers perceived that students became more engaged in lessons and activities, resulting in potential improvement of academic performance when using personal mobile devices than when sitting through traditional lectures and presentations.

For teachers, the benefits focused on increased efficiency in their work. Specifically, the tools they needed to plan their lessons, search for teaching materials, contact parents, and communicate with students outside the classroom were within their reach when using their mobile phones, laptops, and tablets. Some teachers perceived that using personal mobile devices may also save them time due to the convenience of accessing what they needed.

The participants' schools reportedly had a sufficient one-to-one ratio of student to school-issued devices; nonetheless, all but one of the participants shared that their schools allowed BYOD practices within the school environment. However, the challenges with school-issued devices were that the devices tended to be older than the students' personal devices, and that they have limited programs, apps, and access to websites. Furthermore, requesting to fix damaged school-issued devices took time.

Lastly, in using either personal or school-issued mobile devices, urban sixth to ninth grade level science participants typically believed challenges were bound to exist. The main challenge reported by the participants was connectivity. Challenges were also found in the limited memory and battery of the devices when used in class and the compatibility of school-issued devices with personal devices. The participants also identified the lack of standardized policies in BYOD programs and safety and privacy concerns related to school-issued devices.

The interpretation of the findings is discussed in the next chapter. The discussion centers on the interpretation findings based on the connectivism framework and related

literature. The next chapter also contains limitations, recommendations, implications, and conclusion of this qualitative study.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this basic qualitative study was to gather the experiences and perceptions of urban sixth to ninth grade level teachers regarding the benefits and challenges associated with BYOD in enhancing student learning outcomes in the science classroom. In this study, I explored the phenomenon of BYOD with mobile devices in an urban school setting. This study was designed to address the problem teachers face when integrating BYOD to enhance student learning outcomes. The design of this study involved 13 urban sixth to ninth grade science teachers who taught any science subject domain in the past five years and lived in the Southwestern United States. The key findings derived from the thematic analysis of the interview data collected from the 13 participants centered on the benefits and challenges associated with using sixth to ninth grade science classrooms. The participants commonly perceived the benefits of BYOD on students' engagement, motivation, and performance and teachers' efficiency at work. The perceived challenges were commonly the teachers' responsibility in teaching the students how to use the device properly and responsibly, as well as the students' ability to remain focused on schoolwork while using their personal devices. The participants also perceived additional benefits associated with using school-issued devices, which included the benefits of overcoming the challenges in integrating BYOD in learning. However, the use of school-issued devices had limitations that were not encountered when using a personal device. Overall, the participants recommended a regulated use of mobile devices in learning by suggesting the development of standardized policies in BYOD programs and safety and privacy concerns related to school-issued devices.

A discussion of the findings is included in this chapter. The findings presented in the previous chapter provided the basis for interpreting the findings in the next section. This chapter also details the limitations, recommendations, implications, and conclusions of this study.

Interpretation of the Findings

The findings were interpreted through the lens of the connectivism learning framework by Siemens (2005, 2006a, 2006b) and related literature. The literature review in Chapter 2 highlighted a gap in the practice on the benefits and barriers associated with mobile phones and the exploration of teacher experiences with the use of mobile devices (Nikolopoulou & Gialamas, 2017; O'Bannon et al., 2017; Song, 2016). The third principle of the connectivism learning framework indicates that learning and knowledge rest in the teachers' facilitation of students and the use of nonhuman devices such as mobile devices (Siemens, 2005). This principle and the gap in practice led to the development of the two research questions that guided this study and the themes that emerged from the data to answer the two research questions. The findings of this study aligned with the following main themes in the literature review: application of connectivism to mobile learning, teacher experiences with integration of mobile devices, mobile devices for learning, and using mobile devices to support academic achievement.

The Application of Connectivism to Mobile Learning

The connectivism learning framework has eight principles that have been explored empirically in the education context (Siemens, 2005; Utecht & Keller, 2019). When students bring their mobile devices to school, students and teachers are both given

the space to contribute to knowledge creation (Corbett & Spinello, 2020). The informal resources accessible from personal mobile devices may serve as supplementary learning materials to formal classroom tools (Goria et al., 2019). According to Smidt et al. (2017), learning involves learner agency, resource openness, network connectivity, and opinion diversity. Siemens (2005) stated that in connectivism, learning occurs within and beyond the learner. The findings of this study support the principles of connectivism and the learning process in that urban sixth to ninth grade science teachers typically found benefits of students' use of personal mobile devices for increased engagement, better access to learning resources, a quicker accomplishment of tasks, and improvement of 21st century skills, as well work efficiency when teachers used mobile devices. Participants emphasized the benefits of using personal mobile devices for learning when the Covid-19 pandemic forced schools to implement remote learning. With the convenience and connectivity offered by using personal devices, the findings of this study revealed that teachers and students could easily access and share information. Furthermore, teachers had the means to provide students with real-time feedback despite remote learning.

Shrivastava (2018) suggested that the concept of connectivism also involves how learners acquire and retain information through their meaning-making experience when using technology. The findings of this study underscored that learning was perceived to occur when sixth to ninth grade students properly and responsibly use their mobile devices. In connectivism, students have the autonomy to access various tools and resources to make sense of the lesson (Utecht & Keller, 2019). The participants of this study emphasized the possibility of using multimedia for the delivery of lessons.

Teacher Experiences with Integration of Mobile Devices

Teachers play an important role as facilitators of learning between students and personal devices – human learners and nonhuman appliances. Therefore, teachers' experiences integrating mobile devices are vital to students' continual learning (Goldie, 2016; Van Ostrand et al., 2020). This study revealed that teachers found personal mobile devices increased their work efficiency and present benefits for their students in terms of increased engagement, better access to learning resources, quicker task accomplishment, and improved 21st century skills. Connectivism empowers individuals, and their connections expedite contemporary and continuous learning, including the requisite skills to function in the digital age (Siemens, 2017). Twenty-first-century skills highly involve the learners' ability to communicate and cooperate (Jirasatjanukul & Jeerungsuwan, 2018). This study revealed that when teachers use personal mobile devices, they move away from learning in a traditional classroom and realign to a networked digital environment where students communicate and cooperate. Participants reported that when they used multimedia modes of instructional delivery, students showed increased levels of engagement and motivation, promoting communication and cooperation (Mattar, 2018). According to Oddone et al. (2019), "A key principle of connectivism is that knowledge extends across multiple nodes within nebulous digital environments" (p. 104). The use of personal mobile devices in learning contributed to developing a new learning process that involved actively engaging connections among students, teachers, and devices (Siemens, 2017).

Nonetheless, the use of personal mobile devices also posed challenges for teachers. The literature review indicated that the use of technology for learning was met with "resistance" (Graham & Fredenberg, 2015). Siemens (2008) wrote that information outgrows humans' ability to manage, interpret, and use knowledge. The findings of this study highlighted the importance of teachers acting as facilitators for students to learn relevant 21st century skills and the responsible use of devices and accessibility with the devices. These findings aligned with Rice's (2018) recommendations in which the implementation of connectivism required teachers' guidance when students accessed the vast resources on the internet.

Teachers themselves might experience challenges when using mobile devices. In this study, the teachers reported being regularly challenged by the students' responsible use of personal mobile devices. Additionally, the teachers described challenges associated with curriculum alignment in virtual classes during the pandemic. In the literature review, the introduction of new instruction delivery methods and new learning resources was linked with teachers' need to adapt (Bryson & Andres, 2020; Graham et al., 2019; Trust & Whalen, 2020).

Mobile Devices for Learning

Researchers suggested that personal mobile devices shift learning control from the educators to more autonomous learners (Goldie, 2016). Researchers found that students tend to have increased motivation for learning when they can explore the learning materials on their own while in a blended learning environment (Aurangzeb, 2018; Pellerin, 2018). In this study, the teachers perceived that they could provide students with

more options when delivering instructions using mobile devices than in the traditional classrooms. Teachers shared their use of multimedia to explore which learning materials allowed their students to perform better academically or have better class engagement. Researchers described this phenomenon as affordances or the fundamental use of a tool (Evans et al., 2017; Pellerin, 2018). The access to multimedia was considered an affordance of using mobile devices for learning (Pellerin, 2018; Pellerin et al., 2019).

Pellerin (2018) detailed the impact of the use of multimedia on learner autonomy. The study involved seventh grade social studies students tasked to use an audio or video format to demonstrate what they have learned from the class. The students selected a podcast where they cooperated and collaborated to fulfill such roles as host and soundman. The researcher found that the students could grasp the lesson's content, apply 21st century skills of communication and cooperation, and keep their classmates engaged. In this study, learner autonomy did not emerge as a theme, but the participants implied outcomes of using mobile devices linked to independent learning. Participant 1 stated that with personal mobile devices, all students were presumed to have equal access to the information on the internet with personal mobile devices, which they may utilize as needed. Participant 4 cited that students absent during lectures could independently view the video recording on personal mobile devices.

The use of personal mobile devices for learning focused not only on subject area contents but also "netiquette" or the proper use of internet resources (Loewen, 2016). Students also learn 21st century skills essential for future employment (Grundke et al., 2018; World Economic Forum, 2020). The focus on 21st century skills can help the

phenomenon of using mobile devices for learning, as it provides teachers with a pedagogical anchor despite the trends and rapid changes in using technology for learning (Koh, 2019). Several researchers posited that mobile devices for learning were simply one of the trends in education (Geer et al., 2017; Jahnke et al., 2017; Parrish & Sadera, 2020; Young, 2016; Zheng et al., 2016). The central purpose of integrating mobile learning devices, according to the World Economic Forum (2020), was that "Education models must adapt to equip children with the skills to create a more inclusive, cohesive and productive world" (p. 4). Therefore, teaching middle school students to use their devices properly and responsibly was just as important as teaching them the subject area content (Brown et al., 2020).

Using Mobile Devices to Support Academic Achievement

Utecht and Keller (2019) found that using technology in learning was beneficial for students' academic achievement through the advantages of teacher connections on using digital resources in meaningful ways. The participants of this study emphasized the various ways they used digital resources that enhanced their students' engagement, motivation, and academic performance. Specifically, the participants shared the use of multimedia to create activities relevant to the lessons to keep the lessons "interactive" and "competitive" (Participant 5). Participants were also able to apply differentiated instructions to small groups, which helped teachers identify students' strengths.

Nonetheless, the participants circled back to emphasizing the responsible use of mobile devices to increase academic achievement. When students were given free rein over their devices, they might do activities that could distract them from the lessons.

Several researchers found that as long as access to digital information was regulated by a teacher, resources, including social media, could help provide students with quality information (Greenhow et al., 2019; Shaw et al., 2016; Tsybulsky, 2020).

To achieve the teachers' capacity to impart knowledge using new technology, researchers emphasized providing the teachers with professional development and meeting their personal and contextual requirements to work effectively (Chou & Block, 2019; Moreira et al., 2019). In this study, few teachers were concerned with computer literacy and perceived that the school system already prepared them to integrate mobile devices for student learning. However, teachers were concerned about safety and privacy concerning using personal mobile devices. Safety and privacy concerns included their own and their students as expressed by their parents. Due to having no regulations to address the safety and privacy concerns, several schools preferred to forgo personal mobile devices completely and provided school-issued devices, which presented a separate set of challenges (i.e., old models, incompatibility, one-to-one student to device ratio).

Limitations of the Study

The primary limitation of this study was the timing. The study was conducted during the implementation of remote learning forced upon by the Covid-19 pandemic. The pandemic may have presented a unique context in which teachers worked at home and students learned at home. The initial intention of this study was to explore the BYOD phenomenon in a classroom setting. Instead, the phenomenon involved using personal mobile devices for learning remotely – that is, at home. While participants shared that the

school provided mobile devices such as Chromebooks to students on a one-to-one ratio, the devices were used outside the school setting. Thus, mobile devices might present different scenarios when used at home and in the classroom.

Unexpectedly, the participants of this study also cited students' socioeconomic background as a potential influence on the challenges in using personal mobile devices for learning. The participants revealed that students from low-income families tended to have older devices or no personal devices, while students whose families were doing financially better tended to have new gadgets. In addition, one participant perceived that students with new devices tended to be academically supported by their families, as they were provided with additional tools for learning. These findings were challenges associated with the BYOD programs but were beyond the scope of this study.

Another limitation was the inclusion of science teachers who taught ESL and Special Education (SPED) classes. In particular, science teachers of ESL students identified a challenge in teaching their students the content in English while teaching their students the proper and responsible use of personal mobile devices for learning. The exploration of the challenges and benefits of ESL students' use of BYOD was beyond the scope of this study.

This study also had methodological limitations. The qualitative design limited the findings to descriptions of the benefits and challenges associated with the BYOD phenomenon. The findings did not provide causal relationships between the use of personal mobile devices and the benefits and challenges of BYOD that emerged in this study. As a result, the findings were also limited to the context of urban sixth to ninth

grade level classrooms. Other contexts such as different grade levels and different geographical locations might yield different results.

Recommendations

Future researchers are recommended to explore the phenomenon of BYOD in the classroom setting upon the return of face-to-face classes post-pandemic. The participants of this study already hinted at the need to monitor and regulate students' use of personal mobile devices for learning and that monitoring the use of devices at school and at home might reveal different findings. Furthermore, the findings of this study presented scholars with recommendations to compare the benefits and challenges of using personal mobile devices and school-issued mobile devices for learning.

A similar basic qualitative design could be conducted with teachers employed in schools from a different context. For instance, an investigation of the BYOD phenomenon could be conducted in a rural, low-income school that might not have the resources to provide the students with a one-to-one ratio of mobile devices. As such, students in these schools might have no choice but to use their own devices. However, the findings of this study also indicated that students from low-income families tended to experience challenges with using outdated devices that had compatibility problems with the programs used for lessons.

Future researchers may also consider investigating the BYOD phenomenon as experienced by urban sixth to ninth grade level students. A similar basic qualitative design could be applied to a sample of at least 13 students. Documents such as assessment records and report cards may be collected to triangulate with the interview

data. This recommendation may support or counter the findings of this study in which the teachers elaborated their perceived challenges and benefits of BYOD on the students.

Moreover, future researchers may explore the BYOD phenomenon outside of the urban sixth to ninth grade level science classroom. For example, participants who taught ESL science classes indicated that ESL students encountered difficulty understanding instructions. In contrast, participants perceived that personal devices helped ESL students learn due to the multimedia resources that did not confine the lessons to text-based information.

Lastly, a quantitative correlational study could be conducted to measure the impact of using personal mobile devices on the benefits and challenges presented in this study. For example, the study may be conducted with teachers to measure their perceived work efficiency and threat to safety and privacy. Students could also be surveyed to gather self-reported responses on how personal mobile devices impacted their academic performance, engagement, motivation, and distraction.

Implications

The potential impact for positive social change is to support urban sixth to ninth grade level science teachers in managing BYOD use. This study highlighted the successes and challenges experienced by this population in implementing BYOD during remote learning due to the Covid-19 pandemic. The findings of this study can add to the body of knowledge on connectivism learning in that the teachers' roles in facilitating connections between students and nonhuman devices were emphasized. The findings indicated a need to support the teachers' professional development in teaching students

how to use their devices for learning. Teachers may also be supported by learning how to guide students to filter the information available when accessing resources online.

This study also contributes to positive social change for urban sixth to ninth grade level students in increasing their skills in the digital age and their academic performance. Using personal mobile devices was beneficial in providing multimodal methods of learning such that students can be engaged, motivated, and academically successful. Furthermore, students were exposed to the proper and responsible use of mobile devices and information on the internet; thus, students tend to develop 21st century skills. These skills are considered necessities for employment in several office jobs.

This study also has practical implications in the development of new pedagogies involving personal mobile devices. 2020-2021 presented a different experience for teachers and students due to the necessity of remote virtual learning, which may have forced them to utilize personal mobile devices for learning. Remote or distance learning has been utilized in the education setting but is often used in a blended learning environment. This school year showed that full-time remote virtual learning was possible and that personal mobile devices for learning had advantages for middle school students. New pedagogies may include a design specifically to enhance 21st century skills among students. Additionally, new pedagogies may require new systems and policies. Policymakers and educational leaders are recommended to use trends involving mobile devices in learning as the basis for policy development.

Moreover, while personal mobile devices were perceived to benefit teachers in increasing efficiency at work, the teachers preferred to use school-issued devices for

safety and privacy reasons. The study's participants also emphasized that students' parents were also concerned with their children's safety and privacy when using their mobile devices. Thus, implications of this study include the development of a standardized regulation that could help teachers monitor and regulate students' use of their devices.

Conclusion

This study revealed that science teachers in an urban sixth to ninth grade level were aware of the benefits and challenges of using BYOD. Unexpectedly, the teachers were met with the context of remote learning brought on by the Covid-19 pandemic. As such, the students' and teachers' use of personal mobile devices became virtually unavoidable. While several schools were able to provide Chromebooks, the participants of this study reiterated that, regardless of school-issued or personal mobile device, the use of technology and digital resources presented the same challenges in teaching students to be responsible. The teachers reiterated the need to teach students to handle their devices properly and access and use information responsibly. Participants did not believe that personal mobile devices were directly associated with improved academic performance. The participants of this study contended the need to monitor and regulate the students' access to technological resources. The recommendations and implications of this study could contribute to the support for teachers in implementing BYOD, which could benefit the students.

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Appendix A: Interview Guide & Questions

Introductory Statement

[Read to interviewee]

The purpose of this exploratory qualitative study is to explore the experiences and perceptions of urban sixth to ninth grade level teachers' benefits and challenges associated with Bring Your Own Device (BYOD) in enhancing student learning outcomes in the science classroom. The information you provide today will be kept confidential and secured in a safe place for five years upon, which it will then be purged and destroyed. This interview will last between 45 to 60 minutes and will be recorded with your permission.

[Turn on computer recording software and test.]

Pseudonym Name: [ ]
Interview Date: [ ]
Interview Start Time: [ ]
Interview Finish Time: [ ]
Courses Currently Teaching: [ ]

Interview Question Guide

Interview Questions	**Research Questions Correlations (RQ)**
Question 01: a) What grades do you teach? b) What types of subjects are you currently or have you taught? c) What types of sciences have you or do you currently teach? d) Do you currently own a mobile device(s) and if so what kind? e) Are students allowed to bring their own mobile devices to school (BYOD)? Yes/No (Explain) f) What percentage of students do you think bring mobile devices to your classroom? a. Less than 25% b. 25% c. 50% d. 75% e. More than 75%	**Rapport Builder** **Field Notes/Comments:**

f. Other (please describe) g) What types of technology do you use or have used in your classes to promote academic achievement?	
Question 02: Do you let your students use their mobile devices in your classroom for classroom assignments, homework, lab experiments or any type of school related activities? <u>Follow-up inquiry</u> a. Yes (Scaffold) b. What are some of the way's students use their own mobile devices for schoolwork? c. What are some of the benefits for students in using their own mobile device for school related work in your classroom? <u>Follow-up inquiry</u> a. No (Scaffold) b. What are some of the reasons you do not, or will not allow students to use their own mobile devices in your classroom? c. Do you see mobile devices as a favorable or unfavorable contribution to learning? (Explain)	**Question functions to guide analysis RQ 1.** **Field Notes/Comments:** **<u>Follow-up inquiry</u>** **Sub Question** **Question functions to guide analysis RQ 2.**
Question 03: Do you use any personal mobile devices in your classroom to help you with your lessons or lesson planning? If no, please explain why not. <u>Follow-up inquiry</u> a. What type of mobile devices do you use for your school related work?	**Question functions to guide analysis RQ 1 & 2.** **Overlapping question (Teachers could state challenges and/benefits)** **Field Notes/Comments:**

b. Can you please tell me how you use your mobile device(s) for school related work?	
Question 04: Could you tell me about your experience(s) in using mobile devices in your lessons or lesson planning?	**Question functions to guide analysis RQ 1 & 2.** **Overlapping question (Teachers could state challenges and/benefits)** **Field Notes/Comments:**
Question 05: What are some of the challenges in bringing and using your own mobile device(s) for school related work?	**Question functions to guide analysis RQ 2.** **Field Notes/Comments:**
Question 06: What are some of the benefits in bringing and using your own mobile device(s) for school related work?	**Question functions to guide analysis RQ 1.** **Field Notes/Comments:**
Question 07: How do you use your own mobile device(s) in your class to promote student learning?	**Question functions to guide analysis RQ 1.** **Field Notes/Comments:**
Question 08: How do student's use their own mobile device(s) in your class to promote student learning?	**Question functions to guide analysis RQ 1.** **Field Notes/Comments:**
Question 09: Please explain some of the <u>challenges</u> in allowing students to bring their own mobile devices to your classroom for school related work.	**Question functions to guide analysis RQ 2.** **Field Notes/Comments:**
Question 10: Please explain some of the <u>benefits</u> in allowing students to bring their own mobile devices to your classroom for school related work.	**Question functions to guide analysis RQ 2.** **Field Notes/Comments:**
Question 11: Could you please explain why or why not BYOD should be used in your classroom? **<u>Do not interrupt.</u>** <u>(Let participant explain)</u> Exiting Question.	**Question functions to guide analysis RQ 1 & 2.** **Overlapping question (Teachers could state challenges and/benefits)** **Field Notes/Comments:**

Is there anything you would like to add to this interview?	

[Read to interviewee]
I would like to thank you for your time and support. If you have any questions, comments or concerns about this research study, please contact me anytime.
Again, the information you provided today will be kept confidential and secured in a safe place for five years upon, which it will then be purged and destroyed.
[Turn off computer recording software and test.]

Appendix B: List of Codes, Categories, and Themes

Theme	Theme Definition	Category	Code	Code Definition
Benefits of mobile devices for teachers	This theme refers to the advantages resulting from using personal mobile device when used by teachers	Teacher's use of personal mobile device	more efficient and organized	features of mobile devices increase
			phone is more accessible for work	convenient access
			for assignments	giving students tasks
			for assessment	giving students assessments
			to reach parents	responding or communicating with parents
			to motivate students	stimulating students
			can roam around to check on students	being untethered
Challenges of mobile devices for teachers	This theme refers to the problems associated with the teachers' use of personal mobile devices	Teacher's use of personal mobile device	teach students to use their devices responsibly	proper and liable use of the devices
			separating private life and work life	potential to mix personal things and work things
			managing connectivity of personal devices	personal devices were not automatically

Theme	Theme Definition	Category	Code	Code Definition
				connected to the school Wi-Fi
			problems with ESL students	explaining instructions in English might be an obstacle for ESL students
Use of school-issued device in school	This theme refers to the general impacts of using the mobile devices provided by the school	Use of school-issued device	challenges of using school-issued device	school-issued devices had different problems from personal mobile devices
				school-issued devices had different advantages from personal mobile devices
				the school had enough devices to provide for the students
General challenges in using mobile device for learning	This theme refers to the issues experienced by both teachers and students when using both personal and school-issued mobile devices	General challenges in using mobile device for learning	problems with connectivity	issues with connecting to the school network
			limitations in battery and memory	running out of battery and storage space, finding

Theme	Theme Definition	Category	Code	Code Definition
				chargers for the devices
			student privacy and safety legal concerns	need for parental consent when doing activities related to the devices
			compatibility of school-issued device with personal device	some features of personal mobile devices might not work in school-issued devices and vice versa
Benefits of mobile devices for students	This theme refers to the advantages resulting from using personal mobile device when used by students	Students' use of personal mobile device	learn 21st century skills	acquiring skills related to computers and the internet
			students receive immediate feedback	getting rewards or praises
			students accomplish tasks quicker	having the tool to finish schoolwork faster
			students have better access to learning resources	easier, more convenient, and equal availability of resources for learning
			personal mobile devices can potentially improve	not directly impacting academic performance

Theme	Theme Definition	Category	Code	Code Definition
			academic performance	
			students are more engaged	increased interest and motivation
			students are more familiar using their own device	acquaintance with one's own belonging
			mobile devices have lost the novelty	
Challenges of mobile devices for students	This theme refers to the problems associated with the students' use of personal mobile devices	Students' use of personal mobile device	mobile devices have lost the novelty	getting tired of using mobile devices
			success of using personal devices depends on the students	impact of mobile devices depended on the student
			students compare their devices	not all students have the same device, devices become a social status symbol
			devices can be a distraction	having access to non-educational materials
			some uses of phones are blocked by parental control	limited accessibility
Impact of Covid-19 on	This theme refers to the	Impact of Covid-19	poorer academic	the pandemic had an

Theme	Theme Definition	Category	Code	Code Definition
learning in general	general influences of Covid-19, particularly the distance learning, on the students	Pandemic on Learning	performance might be an impact of Covid-19	influence on the students' academic performance
			bridge the gap in digital divide	students and teachers alike learn the use of computers and the internet
			some students are not monitored by parents	students are unmonitored when at home