Integrated Science, Technology, Engineering and Mathematics Curriculum and Teacher Efficacy: A Qualitative Study

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Abstract

The problem is the lack of an explicit curriculum to support teacher efficacy in providing science, technology, engineering, and math (STEM) instruction. The need for teacher efficacy is especially salient when providing STEM instruction because STEM education remains largely undefined and sometimes lacks clear standards. This study sought to explore and understand: (a) the support teachers need from the curriculum to become efficacious in providing STEM learning experiences; (b) the role of an integrated STEM curriculum to support teacher efficacy at an international school; and (c) the responsibility of school leaders, including curriculum writers and principals, to support teacher efficacy when using an integrated STEM curriculum for instruction. Although much of the existing literature has emphasized a need for efficacious teachers in the classroom, the role of an integrated STEM curriculum in supporting teacher efficacy development is unknown. The conceptual framework developed by Kelley and Knowles, in conjunction with Bandura's self-efficacy theory, served as the theoretical framework for the study. This study used interviews and field notes to gather data from a convenient sample of 11 teachers and six school administrators who volunteered to participate in the integrated STEM initiative at the research site. An emergent methodology was used to analyze the data to understand the experiences and the meanings teachers and administrators attributed to teaching with an integrated curriculum. The findings confirmed an integrated STEM curriculum is essential in developing teacher efficacy for teaching students STEM skills. The curriculum provided a common language for teachers and school administrators and supported teachers' comfort with STEM instruction.

Keywords: teacher efficacy, explicit curriculum, integrated STEM, localized curriculum, Sphero

Dedication

I dedicate this dissertation to my aunt, Rowena, who has always been a constant source of positive influence in my life. Your sacrifices over the years have positioned me on the path toward self-actualization and personal growth. You are forever my ultimate exemplar. To my son, Morgan, my every sacrifice for you has been worthwhile.

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Chapter 1: Introduction

This basic qualitative study sought to understand teachers' efficacy when using a localized, integrated science, technology, engineering, and mathematics (STEM) curriculum at an international school (i.e., foreign national and high school) in China. Bandura (1977) and Amor et al. (1976), described *teacher efficacy* as a teacher's belief in their ability to attain the desired learning outcome of student learning and engagement in the classroom. The classroom teacher has an enormous influence on students' behavior, performance, and interest in schools, and this influence is especially true for students' choices to pursue STEM careers (Craig et al, 2019). In a study conducted in Australia, Dawes et al. (2015) found teachers were the most influential in students' intentions to study STEM-based courses, as 22.82% of the 831 Grade 12 students identified their classroom teachers as the reason for choosing to study STEM-based courses. Kızılay et al. (2019) found, from a group of 2,129 enrolled in five universities across Turkey, the classroom teacher was influential in students enjoying STEM-related courses. Such evidence has suggested students' decisions about STEM are indirectly influenced by classroom instruction and teacher competency.

Classroom teachers have a notable influence on student interest in and understanding STEM (Brophy et al., 2008); as such, efficacious teachers may leverage this influence to guide students to the desired 21st-century skill of STEM literacy. Teacher competency is closely linked to their self-efficacy beliefs. For this reason, school administrators need to be purposeful in developing an instructional framework that factors in available resources and students' needs. This framework may take the form of a localized curriculum integrating STEM-based courses articulated in the British Columbia K–9, World School and integrated STEM curricula designed by Sphero. Using this explicit curriculum, schools may support teacher efficacy to provide a rich

STEM learning experience for students (Sibuma et al., 2018). These rich learning experiences, such as inquiry-based learning structures and projects in the Sphero curriculum, are designed to empower learners of all backgrounds and interests.

There is overwhelming evidence of the benefits of integrating the curricula, including preparing students for the real world by connecting content areas (Navy & Kaya, 2020). This benefit includes modeling that failure is not bad while preparing students for future opportunities; however, many teachers do not have the requisite skills to identify opportunities for integration in the STEM-based course curricula, nor the authority to make these decisions based on the instructional guidelines of their school. As a result, having an explicit curriculum integrating STEM courses may help support teacher efficacy for the classroom teacher. This basic qualitative study was conducted to explore how an integrated STEM curriculum may help support the development of teacher efficacy among international teachers at a school in China while teaching. The research revealed an increase in the majority of the classroom teacher participants' feelings of confidence in guiding students through learning experiences that integrate multiple STEM components.

Ejiwale (2013) explained issues with the implementation of STEM education are global. These issues span a lack of inclusivity, industry demand higher than supply, teacher motivation, curriculum reform, and integration (Hyun Kyoung et al., 2021; Malyn-Smith et al., 2010). In a study involving 798 articles on STEM education published in 36 journals between 2000 and the end of 2018, Li et al. (2020) noted a high interest in both teaching and learning STEM. Further research in this area can uncover what factors contribute to teachers' confidence and effectiveness in the classroom, as this is an area of STEM education still relatively unexplored. The background and statement of the problem, purpose and significance of the study, research questions, conceptual framework, definitions of terms, assumptions, scope and delimitations, limitations, and chapter summary are outlined in the following sections.

Background of the Problem

The importance of the role of STEM in the economic development of any region was articulated by the National Science Foundation in the 1990s. Since then, decision makers have become alerted to the education system's shortcomings worldwide to produce graduates with foundational skillsets to fill the gap in the STEM workforce (Help Wanted, 2013; Singer et al. 2016). Williams (2011) explained students being ready to cope with the global market is closely linked to STEM literacy skills such as critical thinking, flexibility, and collaboration. These skills are at the core of 21st-century education that aims to prepare students to handle tomorrow's real-world problems. Many countries (e.g., United States, China, Singapore, and Turkey) focus on implementing STEM education (Teo & Ke, 2014). These world powers hold the belief STEM skills are linked to their country's continued global success (McGarr & Lynch, 2017). For this reason, educators are challenged to create a learning environment where students can access STEM content, leading to STEM literacy for all graduates to meet these gaps.

Navy and Kaya (2020) found it necessary for school administrators and policymakers to align curriculum and pacing guides to help STEM teachers feel supported in the classroom. Although researchers investigated some of the issues, schools still face challenges in implementing successful STEM education programs; for example, Chiu et al. (2021)—using a sample of 60 teachers and 358 secondary school students—found providing teachers with sustained support enhanced their capacity to support students' needs in STEM education. Tschannen-Moran et al. (1998) explained an effective teacher could achieve meaningful educational outcomes through persistence, enthusiasm, commitment, and instructional behavior.

To support these teachers, a fundamental upheaval in STEM education is required for systemic change in teachers' purpose and instructional methods (Aguilera et al., 2021; Buxton et al., 2017; Thibaut et al., 2018). This instructional change begins with providing teachers support to be effective by developing an explicitly integrated STEM curriculum and assessing how its implementation may support teacher efficacy (Fallon et al., 2020; Kelley et al., 2019).

Providing a curriculum that integrates STEM content intended to support teacher efficacy is a two-pronged approach to addressing some of the significant issues in STEM (Falloon et al., 2020; Öztürk, 2021). For example, classroom teachers need support to make the connections among disciplines clear for students; The National Academy of Engineering and National Research Council (2010) recommended an explicit integration of STEM to increase student motivation and achievement. Teacher effectiveness is vital for classroom success, and the curriculum supports all the crucial components of the teacher's role to sustained efficacy. Hence, a locally designed, integrated STEM curriculum may be one method school leaders use to support the teacher efficacy of international teachers at a school in China.

Statement of the Problem

The problem was the lack of an explicit curriculum to support teacher efficacy in providing STEM instruction. STEM curricula have typically used a traditional design that is segregated and disciplined-based, underpinning the background of the problem (Ortiz-Revilla et al., 2020). Further compounding the problem, STEM skills are no longer limited to STEM disciplines; almost any job in the 21st-century economy requires problem solving, communication, and critical and creative thinking, which are advanced STEM abilities (Bybee, 2019; Colegrove, 2017). Diverse students (e.g., international students) are particularly at risk in the traditional STEM classroom (Fallon et al., 2021; Rodriguez & Rivas, 2018), grounding the importance of the problem that was studied. Although data are available on curriculum reform and its effects on student progress and performance, little is known about its effects on teacher efficacy. This basic qualitative study helped fill the gap in the existing literature about teacher efficacy and curriculum design.

Purpose of the Study

This basic qualitative study aimed to explore and understand teachers' feelings of efficacy when using a localized, integrated STEM curriculum at an international school (i.e., foreign national and high school) in China. The purpose was to determine if curriculum design affects teacher efficacy and student performance in STEM courses. This basic qualitative study collected data using two measurement methods: interviews (i.e., semistructured and focus group) and field observations in the classroom. In this study, a convenience sample of 17 participants provided data for identifying emerging patterns. Data collected from 11 teachers and six administrators helped determine the effect of an integrated curriculum on STEM teacher efficacy.

The research was set at an international school in China. Results emerging from this basic qualitative study will help school leaders at this international school understand the role of an integrated STEM curriculum to support teacher efficacy. Additionally, leaders may now know how best to use an integrated STEM curriculum to support group efficacy in teachers and other staff members. This study contributes to international school community evidence on using an integrated instructional model to improve students' performance and STEM teacher retention at the secondary level. The research will be shared systemwide with: (a) curriculum development personnel at the head office; and (b) implementation teams comprising individual school principals and supporting leaders, such as educational coordinators and vice principals.

Additionally, this study may be shared in journal articles or scholarly works on platforms such as the *International Journal of Teacher Education and Professional Development*.

Significance of the Study

One significant challenge with STEM education is its lack of agreed-upon guidelines or frameworks (Aguilera et al., 2021; Bybee, 2013). This study provided initial evidence that developing a localized integrated STEM curriculum might increase student achievement and improve teachers' abilities to guide students to desired learning outcomes related to STEM education. Integrating STEM practices is not straightforward and poses many challenges, especially in instructional practice (Thibaut et al., 2019). This basic qualitative study provided one method on how Kelley and Knowles's (2016) integrated STEM education framework may guide integrated instruction in STEM courses. The study also provided a way to address the lack of systematic review of instructional practices in integrating STEM education.

Research Questions

Research questions for a qualitative study should allow access to the thoughts and feelings of the study participants (Merriam & Tisdell, 2016). Because there is little research on the role of an integrated STEM curriculum in fostering teacher efficacy, a qualitative research design helped to understand this phenomenon. This qualitative study used the following research questions at an international school in China:

Research Question 1: Do teachers feel supported when teaching an integrated STEM curriculum at an international school (foreign national and high school) in China?

Research Question 2: Do teachers experience increased teacher efficacy when teaching from an integrated STEM curriculum at an international school (foreign national and high school) in China?

Research Question 3: What benefits can school leaders and curriculum writers see in providing an integrated STEM curriculum to teachers at an international school (foreign national and high school) in China?

Theoretical Framework

Teacher efficacy in managing integrated STEM learning is better supported when an articulated curriculum encapsulates students' needs and teachers' pedagogical skills (Cheng & So, 2020). This study built upon Bandura's (1986) social cognitive theory, specifically the construct of self-efficacy. The social cognitive theory was applied to STEM teachers and extended to include the curriculum design. Self-efficacy is a component of Bandura's (1986) social cognitive theory; he explained observing a behavior change is one way to determine self-efficacy in people. Bandura (1997) suggested the belief in personal abilities defines self-efficacy. He theorized people with high self-efficacy are more effective in the teaching profession because of the characteristics and behaviors students can emulate. Possessing these traits is especially useful for students in STEM-related courses at secondary and postsecondary levels (Park et al., 2019).

Curriculum design is essential, as teacher preparation, specialized certification, and professional development influence teacher efficacy (Chu & Garcia, 2014); thus, developing an explicit curriculum that supports teacher efficacy is essential for effective STEM instruction. An integrated STEM curriculum pulls together the main components of the school, including the course content, students' needs, available resources, and teaching skills (Gale et al., 2020; Tan & Lee, 2022). Course integration is an emerging approach to curriculum design (Knipprath et al., 2018) and is supportive of teacher development and student achievement, particularly in STEM (Chung, 2021). Likewise, teachers demonstrate signs of improvement in self-efficacy when implementing an integrated STEM curriculum (Sibuma et al., 2018). STEM curriculum is necessary for comprehensive school initiative and purposeful support toward teacher efficacy (Roehrig et al., 2021). Integration of STEM courses is essential in supporting the development of teacher efficacy in secondary schools (Du et al., 2019).

An explicit curriculum may help teachers develop high self-efficacy. Teachers with high self-efficacy are more likely to be prepared for instruction, use differentiated instruction, and build self-efficacy and achievement in the classroom (Jenlink, 2020). As the implementers of the curriculum, teachers may benefit from support through a localized curriculum. For example, teachers of mathematics and science have expressed confidence to support students in learning challenging content when the courses are interconnected rather than insolated (Ozben & Kilicoglu, 2021; Zorlu & Zorlu, 2021). Furthermore, teachers are more willing to share best practices, hold students to high expectations, and teach STEM creatively when the curriculum caters to the school's unique student needs (Balgopal, 2020).

Bandura's (1986) self-efficacy theory and Kelley and Knowles's (2016) conceptual framework combined to provide the theoretical framework for this basic qualitative study. The literature review in Chapter 2 expands on teacher efficacy, integrated STEM curriculum, teacher efficacy and instruction, and how Bandura's social cognitive theory of self-efficacy benefits teachers of STEM courses. Additionally, current and contrary information about the effects of the curriculum design in supporting teacher efficacy are also contained in Chapter 2.

Definitions of Terms

The following definitions help in understanding this study:

Explicit curriculum is defined as a detailed curriculum that has been carefully designed, piloted, and tested by teachers and students, and then presented or published in curriculum materials for teachers and learners. Because explicit curriculum exists in some print forms, others can replicate it (Burton, 1998).

International school is defined as a school that is independent of any national system of education and offers a curriculum that is different from that of the host country (Hill, 2015).

Localized curriculum is defined as “freedom for schools or local education authorities to adapt this curriculum to local conditions, and relating the curriculum and the processes of teaching and learning to the local environment” (Council of the Great City Schools, 2017, para. X).

Self-efficacy is defined as the component of self-concept that concerns individuals’ beliefs in their capabilities and competencies to handle a given task (Bandura, 1997; Schwarzer, 2015).

Self-efficacy belief is defined as one’s confidence in their ability to complete a task (Bandura, 2001).

Sphero is defined as transforming K–12 education with accessible tools that encourage exploration, imagination, and perseverance through STEAM and computer science (PRWeb, 2022).

STEM is defined as an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply the different disciplines of science, technology, engineering, and mathematics in contexts that make connections among school, community, and the global enterprise. These contexts enable the development of STEM literacy and the ability to compete in the new economy (Brown et al., 2017).

Teacher self-efficacy is defined as a teacher’s belief in their capability to bring about desired student engagement and learning (Bandura, 1977). Teachers who believe they are competent to teach their students are considered to have strong self-efficacy beliefs in teaching, whereas teachers who doubt their ability are deemed to have low or weak self-efficacy beliefs in education (Bandura, 1977).

Assumptions

Merriam and Tisdell (2016) defined assumptions in a qualitative study as methods accepted as true by the researchers and peers who read the work. One key characteristic of qualitative research is “holistic, multidimensional, and ever-changing” (Merriam & Tisdell, 2016, p. 242); subsequently, three assumptions were made about this basic qualitative study. The first assumption was each participant would be provided with the opportunity to participate in the data collection process. Another assumption was teachers participating in the study would answer truthfully about their feelings when using an explicit, localized curriculum to teach STEM-based courses. In this basic qualitative study, the relationship between integrated curriculum and the extent to which it supports the development of teacher efficacy was explored. The third assumption was that studied data would determine the role curriculum plays in teacher efficacy at an international school in China.

Scope and Delimitations

Theofanidis and Fountouki (2018) explained scope and delimitations in research refer to the extent to which the research questions are explored and variables and factors excluded from the study, respectively. For this reason, the investigation was restricted to teachers and students of an international school in China. The three research questions guiding this basic qualitative research were addressed in the scope of an international school in China using data collected over 1 semester of instruction. The limited number of participants reduced the generalization of the study; however, data from this study can be of interest to similar schools in the system and other institutions looking to adapt STEM practices.

This basic qualitative study was limited to teachers, school administrators, and students at an international school in China. This study did not cover students' academic progress nor their performance in STEM courses. As a result, students' academic records were excluded from the analysis, which investigated how an explicitly integrated STEM curriculum may support teacher efficacy at an international school in China.

Limitations

Creswell and Guetterman (2019) explained some elements of validity might be affected by certain limitations in a qualitative research study. Having worked as a STEM educator for the last 16 years, certain unconscious and conscious biases likely existed. These professional biases may have influenced the literature review included in Chapter 2, the data collection process, and the interpretation of results. Urquhart (2013) explained more often than not, literature reviews are summaries and, therefore, are not necessarily complete. As the theory emerged, additional research was conducted to investigate the result to help eliminate force-fitting, emerging data to study.

Although a semistructured interviews were conducted to collect data that allowed for further probing to address the research questions, a second limitation arose. Not all participants were asked to explain specifically their feelings of efficacy while using the explicitly integrated STEM curriculum. Additionally, there was the possibility of interjecting personal opinions during the interviewing process. Bracketing was used to mitigate and prevent a close relationship with the research topic and the participants (Tufford & Newman, 2010) and allow for an objective representation of the data related to the participants' experiences and views (Braun &

Clarke, 2013). The process of bracketing allowed for additional triangulation and provided necessary credence to the results (Creswell & Guetterman, 2019; Merriam & Tisdell, 2016). Through consistent self-reflection through journaling, personal assumptions and prior knowledge remained separate, which facilitated the documentation of the authentic experiences of participants. Finally, the research was conducted over one semester, so extended relationships were not established with participants. The limited time only allowed for each participant to be interviewed once; however, multiple interviews would have been preferred.

Chapter Summary

The goal of this chapter was to provide an introduction to this basic qualitative study. Included in this chapter was discussion on the background and statement of the problem, purpose, and significance of the study; research questions; theoretical framework on which the study was designed; definitions of pertaining terms; assumptions; and the scope, delimitations, and limitations of the researcher. Multiple stakeholders, such as school administrators, teachers, and policymakers, may benefit from the results of the study. This basic qualitative study was conducted to explore and describe how an integrated STEM curriculum supports teacher efficacy at an international school in China. The literature search strategy; theoretical framework; social cognitive theory; and a comprehensive review of existing literature on teacher efficacy, integrated STEM curriculum, contrary literature, and gaps in current literature are outlined in Chapter 2.

Chapter 2: Literature Review

The steady decline in enrollment in science, technology, engineering, and mathematics (STEM) disciplines at the postsecondary level has been in an unsettled phase for several years (Hira, 2019; Smith & White, 2019). The background of the problem was the traditional design of STEM curricula that has tended to be segregated and disciplined-based. Teachers as implementers of the curriculum often lack the support and requisite knowledge to create interactions among these disciplines (El-Deghaidy & Mansour, 2015). The problem was the lack of an explicit curriculum to support teacher efficacy in providing STEM instruction. The purpose of this basic qualitative study was to explore and understand teachers' feelings of efficacy when using a localized, integrated STEM curriculum. This literature review covers the literature search strategy, theoretical framework, and an overview of the related literature.

Literature Search Strategy

Various search engines from the American College of Education library were used to conduct this literature review, including Science Direct, SAGE Research Methods –Cases, and Education Leadership Review. The search terms included *self-efficacy, teacher efficacy, integrated STEM, STEM and diverse learners, STEM curriculum reform, challenges in the STEM classroom, STEM education, the best practices in STEM classroom*, and other topic-related text. Additionally, the use of peer-reviewed articles and other credible internet searches helped to understand the integrated STEM curriculum, self-efficacy, and its relation to teacher-efficacy. Understanding these concepts from their origins helped identify the evolution and connection with the integrated STEM curriculum to foster the development of teacher efficacy. The integrated STEM curriculum and high teacher efficacy were frequent themes related to students' high performance in STEM courses, which helped focus the theoretical literature review. Peer-reviewed articles related to STEM education and teacher efficacy were also used to locate other scholarly sources appropriate to the literature review.

Theoretical Framework

The theory explored in this study's theoretical framework was the social cognitive theory of Bandura (1977), specifically the self-efficacy component. Additionally, this basic qualitative study incorporated Kelley and Knowles's (2016) integrated STEM education framework. Self-efficacy is grounded in Bandura's (1977, 1986) social learning theory research concerned with the personal capability to effectively perform an assigned task to attain a desirable outcome. Teachers need support to develop efficacy; as such, a curriculum that supports teacher efficacy in integrating STEM instruction was also relevant to the study. Kelley and Knowles's (2016) STEM conceptual framework, which sought to clarify the integration of science, technology, engineering, and mathematics, was also essential in this study. Consequently, Bandura's self-efficacy theory and Kelley and Knowles's conceptual framework combined to provide the theoretical framework for this basic qualitative study.

Social Cognitive Theory

Social cognitive theory was applied to STEM teachers and extended to include the local curriculum design. Bandura (1977) defined self-efficacy as the belief in an individual's abilities. Specific to this study was the self-efficacy component of Bandura's (1986) social cognitive theory that explained observing a behavior change is one way to determine self-efficacy in people. Bandura (1977) listed these attributes of self-efficacy as: (a) demonstrating the ability to think soundly, (b) showing interest and commitment in any task, (c) striving for high aspirations, (d) attracting the support of the community, (e) being self-motivated to set goals and a design plan of action, (f) overcoming complex challenges, and (g) envisioning a successful outcome.

Social cognitive theory and self-efficacy were relevant to this study and justified creating a STEM curriculum to support teachers having these traits while working with students. Self-efficacy is the genesis of teacher efficacy, an accurate predictor of student and teacher success in the STEM classroom. Gardner et al. (2019) suggested teachers with high self-efficacy are more effective in the education profession because those teachers display the characteristics and behaviors desirable for students to emulate.

Bandura’s (1977) self-efficacy theory provided the framework to explore STEM course teachers’ perceptions of self and the influence of self on effective instruction in the classroom (Dong et al., 2019). Baier et al. (2019) explained highly effective teachers exhibited traits relevant to the practical classroom. These traits include motivation, high goal setting, and persistence, all credited as characteristics influenced by an individual’s level of self-efficacy. Because self-efficacy plays an essential role in bridging the gap between thought and action, Bandura’s theoretical framework provided a model from which to measure the development of teacher efficacy while using the integrated STEM curriculum.

Teachers with high self-efficacy enjoyed experimenting with a new instructional methodology to meet students’ needs, which is critical for success in the 21st-century STEM classroom (Shoulders & Krei, 2015). Consequently, Bandura’s (1986) self-efficacy framework was considered suitable as a part of the theoretical framework for this basic qualitative study to guide the design of a localized, integrated STEM purposed as a support strategy in developing teacher efficacy. Flores et al. (2018) and Jenlink (2020) explained efficacious teachers might motivate students into action. Similarly, Dolighan and Owen (2021) identified a positive correlation between teachers’ high self-efficacy and job satisfaction. As a result, classroom teachers with a strong sense of self-efficacy are less likely to be stressed, experience teacher burnout (Cooper, 2019), and maintain a student-centric classroom through high levels of student engagement.

Integrated STEM Education Framework

A research-based framework proposed by Kelley and Knowles (2016) clarified the full potential of integrated STEM education. The researchers used a pulley system that connected situated learning, engineering design, scientific inquiry, technological literacy, and mathematical thinking. Kelley and Knowles proposed the integrated approach to STEM instruction helped increase student motivation and engagement. Also, the integrated instructional strategy developed students' understanding by building connections across abstract concepts and ultimately making learning more relevant and connected to real-life problems (Brown & Bogiages, 2019). In the study, the framework designed by Kelley and Knowles (2016) provided an explicit instructional structure, which may support the development of teacher efficacy when providing interconnected instruction for STEM courses. Furthermore, Kelley et al.'s (2021) integrated STEM instruction pathway design is an alternative to the traditional approach of teaching STEM courses in isolation.

Kelley et al. (2020) suggested teacher self-efficacy may be impacted positively by implementing integrated STEM lessons as significant gains in overall STEM instruction. Furthermore, Sibuma et al. (2018) found individual pedagogical content knowledge courses, such as engineering, also improved when the integrated STEM curriculum was implemented. However, Balgopal (2020) cautioned school leaders about implementing an integrated curriculum and recommended implementation be a part of schoolwide reform. He further argued schoolwide reforms are most impactful to meet the unique needs of students and provide necessary professional growth for teachers in all areas (Balgopal, 2020). Teacher efficacy, in particular, is an essential component of professional growth; therefore, implementing curriculum reform is a proactive way to meet the needs of both educators and students in the 21st-century classroom.

In response to the demand to train secondary school students to enter STEM-based university programs, classroom teachers have needed a curriculum supportive of instructional competency. According to Mihai et al. (2017), gaps in teacher knowledge, skill development, and motivation are factors the curriculum addressed, resulting in a change to instructional practice. Through this lens, it became apparent that the use of the integrated STEM curriculum can support teacher efficacy. Curriculum design is one technique school administrators and policy developers may implement to increase student achievement and participation in STEM courses in high schools (Bergeron & Gordon, 2017) by fostering teacher efficacy with its design. It may be concluded that practice may become a part of the school culture through an explicitly integrated STEM curriculum to increase teacher efficacy and, by extension, increase student performance in STEM courses.

Research Literature Review

The idea of teacher efficacy dates back to two significant studies from Armor et al. (1976) and Berman et al. (1977), both facilitated by Rand Corporation, an independent research entity responsible for education interventions. From this research, teacher efficacy was defined as the extent to which teachers believed they could control the reinforcement of their actions. Subsequently, Bandura’s (1986) self-efficacy view provided further context for teacher efficacy belief development and was used as a theoretical framework about efficacy throughout this basic qualitative study.

Teacher Efficacy

Tschannen-Moran et al. (1998) combined Bandura’s (1986) social cognitive theory of self-efficacy and Rotter’s (1954) proposal about the locus of control around a person’s decision to adopt healthy behavior. The researchers added the perspective of self-efficacy to education in the form of teacher efficacy. The research emphasized teacher efficacy may be viewed as the classroom teacher’s internal perspective about being an effective educator by organizing and executing teaching-related tasks as required (Tschannen-Moran et al., 1998).

According to Liu (2021), teachers’ shared beliefs about their current abilities to complete a teaching task effectively were influenced by school leadership, student abilities, and materials. Kelley et al. (2020) expanded these materials to include items such as an integrated curriculum, which articulates the content, assessment, and all components guiding instruction in the classroom. Although it is unclear how curriculum design improves teacher efficacy, the key traits of success (e.g., emotional well-being, effort, motivation, and resilience) are all grounded in efficacy beliefs (Bandura, 1977, 1993). Teachers may benefit from an articulated curriculum for STEM courses at the secondary level and may see an improvement in group efficacy among teachers, which is critical to success. The curriculum, integrated or otherwise, supports teacher development inclusive of teachers’ efficacy in both new and experienced staff.

According to research by Bandura (1977, 2012), a person’s individual belief has more impact on actions and accomplishments when compared to actual capabilities. Actions and accomplishments translate to students’ progress and performance in the classroom. Demonstrating these abilities related to efficacy is especially applicable and essential to the teaching profession (Schippers et al., 2020); therefore, providing proper support leading toward confidence in teaching abilities is essential in even the most effective school, especially in the STEM classroom. Furthermore, teacher efficacy is considered one of the most significant predictors of students' motivation, progress, and performance (Thompson, 2018). The emerging strategy of an integrative approach to instruction tailored may support teacher efficacy (Thibaut et al., 2019) as students learn content from teachers who also teach students self-efficacy skills through classroom interactions.

As one of the main catalysts in student learning, the efficacious teacher is influential enough to outweigh environmental influences. For this reason, Bandura's (1986) theory about efficacy beliefs was valuable in this qualitative study, as teachers' beliefs can significantly override environmental factors (Bandura, 1986, 2012) and influence student engagement, progress, and performance in STEM classrooms (Seals et al., 2017). Researchers have found the most effective STEM teachers have an in-depth knowledge of STEM content (Churches & Lawrance, 2021) and appropriate pedagogical skills. Similarly, Margot and Kettler (2019) stated teachers needed a quality curriculum framework and specialized knowledge of teaching STEM content and pedagogical content knowledge. These two factors, when combined, may support teacher efficacy in secondary schools.

Importance of Teacher Efficacy

Students rely heavily on a skilled educational professional to access the STEM curriculum differently (Tucker et al., 2005), which means teacher efficacy is vital. Teacher efficacy influences instructional planning and guides students to attain desirable outcomes. Thornton et al. (2020) emphasized teacher efficacy is a personal judgment of the capabilities of classroom teachers to bring about desired outcomes of student engagement and learning. Similarly, an efficacious teacher can be effective in the classroom no matter the challenge, and students with highly efficacious teachers generally outperform their peers (Dolighan & Owen, 2021). Still, future studies are needed to show how underperformance in STEM courses may benefit from curriculum reform if focused on developing teachers with high self-efficacy.

Teaching is one area of the school environment where self-efficacy is most influential, as efficacy affects all aspects of the daily operations of the classroom teachers—including the way the teachers plan and guide students' learning. Although professional development, teacher preparation, and specialized certification are factors prompting teacher efficacy (Toran, 2017), efficacious teachers influence how students respond to the learning environment (Pearman et al., 2021). An explicit curriculum may be essential to support teacher efficacy in providing effective STEM instruction.

Significantly, classroom teachers with high levels of self-efficacy believed they could provide effective teaching to all students irrespective of diversity (Shaukat et al., 2019). Bandura (1977) argued efficacious classroom teachers used appropriate instructional strategies to improve students' performance. Gardner et al. (2019) also explained teachers who set challenging goals and maintained a solid commitment to attain them often had high self-efficacy. These traits are especially critical in the STEM classroom. Hoogsteen (2020) and Thornton et al. (2020) reiterated a teacher's self-efficacy and confidence are related to successful student performance via problem solving for required courses.

Rubie-Davies et al. (2020) stated when classroom teachers set high expectations, they encourage meaningful participation of students; provide care and support to students; and exhibit the trait of resiliency, a crucial trait of teachers with high efficacy. Kutsyuruba et al. (2019) defined resilience as the ability to bounce back successfully after failure, an essential skill both teachers and students need for success in the classroom and beyond. Students usually thrive in any learning environment where they can take risks; this learning environment is desired as a safe space (Prashanti & Ramnarayan, 2020). For a safe learning space to flourish, both teacher and student need to develop resilience, which is beneficial for the rigor of learning to occur (Turner & Braine, 2015). The integrated STEM curriculum supports teachers' conceptualizations of the teaching task, and what constitutes evidence of success may also depend on the teaching domain being considered.

Development of Teacher Efficacy

Teachers with high efficacy are essential in the classroom. In a study of 217 teachers, Mosoge et al. (2018) found a positive correlation between high teacher efficacy and student performance. This group of teachers is more likely to persist for an extended period, especially when working with challenging students, and are more willing to try new instructional methods (Thornton et al., 2020). According to Bandura (1977, 1986, 1993), four sources of self-efficacy are: vicarious experience, physiological state, social persuasion, and mastery experience. Mastery experience was particularly relevant to this qualitative study, as it involves people's use of experiences to help foster self-efficacy. Several factors influence teacher efficacy, such as work experience, work environment, and curriculum design (Specht & Metsala, 2018; Young et al., 2018); therefore, using a qualitative research design was justified to conclude the role of curriculum design on teacher efficacy.

Teacher Efficacy and Instruction

Teachers are the implementers of the curriculum and may benefit from support through an explicit, localized curriculum that helps teachers develop high self-efficacy. Teachers with high self-efficacy are more likely to be prepared for instruction, use differentiated instruction, and build self-efficacy and achievement in the classroom (Jenlink, 2020); for example, the teachers of two core STEM components (e.g., mathematics and science) expressed confidence to support students learning challenging content when the courses were interconnected rather than isolated (Ozben & Kilicoglu, 2021; Zorlu & Zorlu, 2021). The teachers were also more willing to share best practices, hold students to high expectations, and teach STEM creatively when the curriculum catered to the school's unique students' needs.

Pas et al. (2010) investigated factors affecting teacher efficacy using a large sample of 600 teachers. Among the most influential factors were teacher preparedness and school environment. Further, Holt (2019) suggested defining curriculum at the local level may improve teacher preparedness, supporting teacher efficacy beliefs. As mentioned in the theoretical framework of Kelley and Knowles (2016), the implementation of an integrated STEM curriculum may influence schoolwide teacher group efficacy. Consequently, designing a local integrated STEM curriculum that outlines the academic content in a cohesive learning paradigm based on real-world applications is one way to increase teacher preparedness.

Definition of Integrated STEM Curriculum

Since the introduction of the acronym STEM by scientific administrators at the United States National Science Foundation in 2001, educators, researchers, and policymakers have discussed STEM education and its critical role in the global economy. These conversations have propelled STEM education to the center stage of the K–12 educational program and beyond; however, despite various reports outlining the importance of STEM, there is still confusion and a general lack of understanding of what this acronym means (Falloon et al., 2020) and how it should be presented in the classroom. STEM education holds different meanings for various stakeholders, such as policymakers, teachers, school administrators, students, and parents. Government entities and policymakers, for instance, have invested in STEM education to create a pipeline to produce people who can fill the gap in the STEM workforce (Techakosit & Nilsook, 2018). In 2015–2016, of the 1.8 million bachelor's degrees awarded in the United States, about 331,000 (18%) were in STEM fields, explaining the over 2.4 million STEM-related jobs that remained unfilled, according to the National Science Board (2012). Margot and Kettler (2019) credited this shortage of STEM-qualified individuals to an unrefined instruction practice that has failed to make real-world connections and prepare students for STEM pathways and careers.

The classroom teacher is responsible for implementation, but many teachers struggle to determine what STEM looks like and how to best support students in acquiring STEM skills (Timms et al., 2018). At the same time, Asunda and Weitlauf (2018) noted parents' concerns about the nontraditional pedagogical approach, rigor, and project-based learning often associated with STEM education. Although parents are among the more critical stakeholders of student success, Gellert (2005) recommended parental access should be restricted as clients receive a service, thereby involving restricted access to specific decision making on certain matters of curriculum reform.

Adams and Hamm (2020) explained STEM education involves enhancing students' mathematics and science skills with precise technology and engineering design. Roberts and Schnepp (2020) clarified STEM education involved developing students' problem-solving skills through design across disciplinary boundaries. With these critical stakeholders' varied views on STEM education, Holmlund et al. (2018) concluded a worldwide definition is not critical and instead recommended establishing common elements among STEM courses through curriculum reform.

Implementing a localized, integrated STEM curriculum tailored to unique institution needs may be a proactive response, thereby addressing and eliminating some of these STEM-related concerns. Knipprath et al. (2018) argued course integration is an emerging approach to curriculum design that supports student achievement and teacher development. The integrated STEM curriculum combines all main components of the school, including the course content, students’ needs, available resources, and teaching skills.

Importance of Localized, Integrated STEM Curriculum

Koh et al. (2014) documented an instance of successful curriculum reform in the centralized education system in Singapore. The specific program explored was the Integrated Program, in which institutions are expected to redefine existing educational structures and redesign teaching and learning processes (Koh et al. 2014). At the core of this program is curriculum innovation to mirror the services needed by the population. From the case study, schools that embarked on this journey noted the significant bearing on all personnel involved, specifically improving teacher efficiency and student performance.

One notable finding was the curriculum innovation processes included schools’ visions and endeavors to find common ground for buy-in. Simmie (2014) documented curriculum reform at a secondary school in Ireland. This study showed the need for continued discourse about evidence-based teaching and teacher training. Additionally, Gorrara et al. (2020) found the most impactful curriculum design involved individual-directed learning by studying the new curriculum of Wales. Gorrara et al. (2020) concluded, when redefining the curriculum, the emphasis was placed on creating a curriculum focused on positioning learners at the center of decision making and promoting learning as a significant curriculum design decision.

Integrated STEM “is an effort to combine science, technology, engineering, and mathematics into one class which is based on connections between the subjects and real-world problems” (Stohlmann et al., 2012, p. 30). Best results in STEM teaching and learning are attained when the boundaries among individual disciplines re erased, and the subjects are taught as one. Several studies have concluded an integrated approach to STEM instruction improves students' performance (Margot & Kettler, 2019). Tailoring a localized STEM curriculum invites school leaders, educational coordinators, principals, and curriculum directors to create a fusion of individual courses offered at the institution based on big ideas. This method empowered local school administrators to consider the unique needs of students, available resources, and skills of classroom teachers (Fitzsimons et al., 2020).

To prepare students to enter university courses and careers in STEM, Falloon (2020) emphasized a holistic approach is necessary, as secondary school educators need a clearer understanding of instruction through an integrated curriculum. For educators to be effective in the STEM classroom, the meaning of the acronym STEM should be made and expanded to include integrated STEM (Bybee, 2019). According to Knipprath et al. (2018), the integration connected the classroom learning experience and the real world, resulting in STEM literacy. STEM literacy is the set of skills deemed necessary for both STEM and non-STEM professionals to function in an information-based and highly technological society. Although it is unclear about the influence of the integrative approach to STEM instruction on teacher efficacy, a holistic approach is essential for teaching and learning STEM (Thornton et al., 2020).

Model of Integrated STEM

Historically, STEM referenced each discipline with little-to-no connectivity between or among the branches of science, technology, engineering, and mathematics; however, changes in STEM instruction relied heavily on reform and involved a local cutting-edge curriculum that was attractive to all stakeholders (Atkinson & Mayo, 2010). Educational experts have shared that the four strands of STEM would create more meaningful learning when integrated (Rehmat &

Hartley, 2020; Zell, 2019), as teaching STEM courses separately does not reflect the natural connection among the four areas.

Kelley and Knowles's (2016) framework for STEM integration was used in this basic qualitative research. The researchers developed this framework to address the lack of a cohesive understanding of STEM education and respond to educators' challenges teaching the new generation. The framework addressed one prominent feature required in the 21st-century classroom: cross-curricular instruction. Students no longer learn course content in isolation; instead, learning tasks are designed as interdisciplinary activities (Tarbutton, 2018). Classroom teachers may benefit from an articulated curriculum that outlines the connection among STEM disciplines and may be essential in supporting teacher efficacy in secondary schools.

Termed *situated STEM learning*, Kelley and Knowles (2016) designed a block and tackle inspired by the mechanical system used to lift load; they drew on situated cognitive learning theory shared by Putman and Borko (2000). In the STEM reform context, situated STEM learning is the concept that understanding how knowledge and skills can apply is as vital as learning them (Kelley & Knowles, 2016). The four main components of the integrated STEM framework are known as a pulley. Each pulley bears its description while remaining highly interactive (Kelley & Knowles, 2016).

The first pulley is engineering design. Engineering design is a systematic approach to solving problems that occur naturally in almost all STEM fields. Engineering provides students with the opportunity to locate and build connections among all strands of STEM courses (Kelley & Knowles, 2016). The engineering design is a critical component of integrated STEM instructional practice and helps students develop self-regulation (Zheng et al., 2019). Modeling an integrated curriculum to include engineering design develops self-regulated learners, which

Zheng et al. (2019) described as one of the most beneficial features of the teaching–learning environment because students practice developing independent thoughts.

The second pulley is scientific inquiry. This pulley component prepares students to think like and get a feel for being real-life scientists (Kelley & Knowles, 2016). Scientific inquiry involves asking questions, making hypotheses, and conducting investigations using standard science practices (Kelley & Knowles, 2016). Moreover, scientific inquiry involves actively participating in STEM-based activities through active experiments (Abdurrahman et al., 2019). This pully is a systematic guide to STEM that fosters students' academic development and teacher efficiency.

Technological literacy, the third pulley Kelley and Knowles (2016) explained, represents the "T" in STEM and enhanced STEM learning. Technology literacy in STEM education outlines a student's technological and engineering literacy skills. This pulley provides students with an opportunity to think through technology as a vehicle to positively impact culture, society, economy, and the environment. Integrating technology enhances students' learning in STEM courses and increases teacher motivation once the appropriate technological tool is integrated into the learning experience (Xie et al., 2017).

The last pulley is mathematical thinking. Mathematical thinking is a crucial component of integrated STEM that helps students make sense of mathematics. In addition to gaining mathematics competency, students should recognize how to complete mathematical tasks, recognize why they need to learn mathematics, and make sense of observations mathematically. Integrated STEM involves making mathematics relevant to students' lives (Kelley & Knowles, 2016).

The design of the pulley system also includes the rope of community practice. Kelley and Knowles (2016) explained community practice is the thread weaving all the pulleys together. Community practice involves teachers working with community members such as scientists, engineers, and technologists (Gehrke & Kezar, 2017). Community practice is one fundamental principle in social cognitive theory, and this basic qualitative study creates the pathway for school administrators to support STEM teacher efficacy through an explicitly integrated curriculum. An integrated curriculum provides classroom teachers with a clear understanding of what to teach and how to teach it (Kelley et al., 2019). The intersection and connection across STEM disciplines may be identified through the curriculum and help teachers understand how they are uniquely similar and different. This content collaboration may eliminate a superficial connection among the disciplines and support deeper cooperation among the teachers in a collaborative culture. Adopting collaborative culture may improve teachers' individual and group efficacy, increasing content and collaboration without changing basic lesson structure (Zell, 2019). The localized, integrated curriculum eliminates confusion and improves teacher confidence, a characteristic of efficacious classroom teachers. The integrated curriculum provides a model of how STEM disciplines are connected (Kelley & Knowles, 2016); students focus on investigating and understanding the universe and use engineering to solve problems experienced while living, ultimately improving self-efficacy (Bandura, 1977). Teachers are more willing to share best practices, hold students to high expectations, and teach STEM creatively when the curriculum caters to unique students' needs, all of which are suggestive of the development of teacher efficacy.

Designing Integrated STEM Experiences

Curriculum implementation is one of the primary responsibilities of the classroom teacher. Interestingly, many classroom teachers experience challenges when teaching STEM courses. Perhaps one of the most valuable arguments supporting curriculum reform and STEM teacher efficacy was documented by Shernoff et al. (2017), who affirmed teachers did not know how to integrate STEM areas effectively. A well-written curriculum that reflects unique school needs may be one of the most critical components of schools, and STEM teachers need a guide to inform their instructional practice. Remillard (1999) identified curriculum design, construction, and mapping as processes crucial to developing and implementing a new curriculum. Bandura’s (1986) self-efficacy theory and Kelley and Knowles’s (2016) conceptual framework informed the design of an integrated curriculum as the blueprint for developing student competency and teacher efficacy for this basic qualitative study.

A straightforward instructional design supported teacher confidence when implementing a reformed curriculum (Gale et al., 2020), forming the foundation of purposeful, integrated learning experiences. Designing an integrated STEM experience relied on successful exemplars relevant to this basic qualitative study. One such example is from Queensland Curriculum & Assessment Authority (QCAA, 2021), which lists four stages for integrated instruction. In Stage 1, the curriculum is identified. Curriculum identification involves classifying the evidence of learning collected in the unit, selecting relevant content descriptions, and considering general capabilities and cross-curricular priorities. Stage 2, developing the assessment, includes identifying the problem and problem-solving skills, preparing the assessment design brief, and developing materials for the assessment technique. Stage 3 entails planning teaching and learning. The curriculum developer would identify and sequence the teaching and learning and create a teaching and learning plan at this stage. Finally, Stage 4 includes making judgments that create a task-specific marking guide and accessing resources to support development.

Those stages aligned with Kelley and Knowles's (2016) conceptual framework for this basic qualitative study. Using engineering as the catalyst to pull all four disciplines on the same platform (Kelley & Knowles, 2016) coincided with Stage 1 of identifying the curriculum by QCAA and provided the systematic approach toward integrated instruction relevant to supporting teacher efficacy development. One example of successful curriculum implementation leading with engineering was NASA. Designed as an iterative process that engineers used to guide problem solving (May 2018), the engineering design process is widely adopted when implementing integrated STEM curricula. Finding the connection among STEM courses is essential for subject integration and teacher efficacy (Yildirim, 2018). The engineering design provides the opportunity to locate intersections and build connections among the STEM disciplines (Kim, 2021; Pressley, 2021). When teachers are provided with a clear pathway to instruction, teacher efficacy improves.

Timms et al. (2018) noted the main challenge experienced when designing an integrated learning experience when they studied STEM education in Australia. The researchers noted it was necessary to rethink the STEM curriculum. To rethink the curriculum, it was essential to consider the proposed model of how STEM disciplines were connected, with a significant focus on science to investigate and understand the universe with engineering to solve problems experienced while living (Timms et al., 2018). Consequently, using integrated curriculum shifts from across the world, the framework proposed by Kelley and Knowles (2016), was used to create a localized, integrated curriculum that fostered teacher efficacy while teaching STEM courses at international schools in China. The curricula were Next Generation Science Standards

(NGSS) and Engineering Design from the United States, “the Competencies and the Learning of Mathematics (KOM) project” (i.e., KOM is the Danish translation), and technology from an Australian curriculum. The description of each follows.

The NGSS from the United States was used for science. This interdisciplinary approach of NGSS, as described by Schneider et al. (2020), used the ideas and practices of engineering, specifically the component where every standard has three dimensions: disciplinary core ideas (i.e., content), scientific and engineering practices, and crosscutting concepts. For the mathematics disciplines, the KOM approach out of Denmark was used. KOM is an example of a curriculum reform that shifted from routine-based mathematics to conceptual understanding (Bybee, 2019). KOM provided a skill and application focus on mathematics, making integration with other STEM disciplines easier.

The “T” in STEM used for technology was adopted from the Australian curriculum. Bybee (2019) explained this arm focuses on systems thinking, a unified approach for students to develop the technical knowledge needed in modern society. Because technology is a dynamic discipline, the two-pronged approach used in Australia was most suitable for use in this basic qualitative study. The curriculum focuses on students developing their knowledge and understanding alongside experiences in related processes and production skills.

The last curriculum is Engineering Technology and Engineering Literacy (ETEL), another component adopted from the United States. ETEL integrated STEM components and gave students the capacity to use, understand, and evaluate the technology. Students understood technological principles and strategies needed to develop solutions and achieve goals (Xie et al., 2017). This system addressed both the “T” and “E” in STEM and was an interconnection that equipped students to function in modern society (National Assessment Governing Board, 2014).

Ultimately, systemic changes to the curriculum may support teacher enactment of curriculum reform. An integrated curriculum for instruction is an effective method that may improve student performance and, at the same time, improve STEM teacher efficacy while teaching.

Lesson planning is at the core of designing integrated STEM experiences. as it is the daily manifestation of the curriculum. The design of lesson plans impacts the effectiveness of learning outcomes and students' experiences (Wiggins & McTighe, 2005) and may affect the efficacy of the classroom teacher. With a lesson plan, the classroom teacher might feel more confident to guide students from the known to the unknown. Race and Even (2021) described three considerations when planning interdisciplinary lessons. First, educators should look for moments of curricular overlap. They should choose a theme that appropriately reflects the overlapping components, then plan shared summative assessment; conclude with building knowledge and inquiry for each discipline. Integrated STEM lessons may be teacher-designed or purchased commercially; however, Carter (2013) analyzed commercially produced STEM-based lessons (e.g., The Infinity Project, Project Lead the Way, and Math Trailblazers) and concluded some were not truly integrated. Consequently, for this basic qualitative study, an explicitly integrated curriculum was designed and used at the international school (i.e., foreign national and high school) in China to support the development of STEM teacher efficacy.

Integrated Curriculum as Curriculum Reform

Teo (2012) discussed the many complexities and irrationalities faced when reforming the curriculum in STEM areas. Teo used the recursive process of foreshadowing questions, data collection, interpretations of data, refining of questions, and more data collection to make sense of the reasons for students' underperformance in STEM courses. Despite continued investment and teacher training in the area, Teo pointed to non integration as a possible reason for students' continued underperformance in STEM courses. Effective STEM instruction relied heavily on reform into a cutting-edge curriculum attractive to all stakeholders, one of which was integrating courses.

Koh et al. (2014) noted one instance of successful curriculum reform in the centralized education system in Singapore—specifically, the Integrated Program—which was a redefinition of existing educational structures, including teacher and learning processes. At the core of this reform was curriculum innovation to mirror the services needed by the population. School personnel who embarked on this journey noted the tremendous influence on all involved, including teacher confidence and student performance. Simmie (2014) concluded curriculum reform involved individual-directed learning in a second study. The study, conducted at a secondary school in Ireland, revealed continued discourse about evidence-based teaching and teacher training was the most impactful curriculum design (Simmie, 2014). Curriculum reform was a method for local school administrators to address the issue of student underperformance in STEM courses.

Importance of Teacher Efficacy and Integrated STEM Instruction

In a quasi-experiment, Kelley et al. (2020) reported a significant increase in science teachers' feeling of efficacy when teaching using the integrated STEM curriculum. Data were collected about teacher self-efficacy using pretest, posttest, and delayed posttest survey assessments. The researchers used the Wilcoxon rank-sum test and determined science teachers in the experimental group improved efficacy. At the same time, there was no significant difference in the teacher efficacy of the control group. Conversely, Kelley et al. (2020) mentioned science teachers' significant impact was noted when teachers delivered lesson exemplars made by both teachers and students. Bandura (1977) suggested, self-efficacy beliefs influence overall work performance and teachers' demonstration of self-efficacy also affects students learning (Brown et al., 2021). As Kelley and Knowles (2016) proposed, lesson integration may continue to impact students' interests and learning while developing efficacy significantly among STEM teachers.

Blazar and Kraft (2017) explained teachers with low efficacy beliefs might not attempt new instructional methods. The classroom teacher is one of the most impactful people in a student's life; therefore, a teacher with high efficacy is needed. Efficacious teachers may have the ability to address one of the primary needs present in 21st-century classrooms: student diversity (Beasley et al., 2013). Student diversity speaks to differences in the classroom, and students need alternative ways to access the curriculum (Kressler & Kressler, 2020). Designing highly innovative learning experiences is one characteristic of the teacher with high efficacy and a best practice when working with diverse students (Tucker et al., 2005); therefore, school administrators can employ the localized, integrated curriculum for STEM courses to help teachers attain this professional goal. When these infrastructures are in place (e.g., a tailored curriculum) educators may be supported to improve efficacy. If teachers are not comfortable in the classroom, school administrators and policymakers may respond with tangible schoolwide practice to improve teachers' comfort and student academic performance at the same time (Xie et al., 2017).

Kelley et al. (2020) explained teacher professional development could significantly impact teacher self-efficacy when implementing an integrated STEM curriculum. Teachers are one of the main catalysts in the classroom, and their instructional practices, beliefs, and attitudes have a profound impact on students' interests and, to some extent, performance. It is important to note teachers believe motivating students is one of the main ways to influence students' academic and cognitive development (Bandura, 2012). For this reason, self-efficacy is essential for the successful implementation of an integrated STEM curriculum. Zheng et al. (2019) explained instructional leadership plays a critical role in supporting teachers' confidence and ability to execute the job effectively.

Contrary Literature

Not all educational researchers have supported the need for an explicit curriculum to develop teacher efficacy. In a Chinese classroom, where the belief about STEM is more progressive than others, Dong et al. (2019) illustrated teachers' challenges were linked to intrinsic beliefs about the courses rather than the design of the curriculum. The researchers explained effective STEM instruction depends on the diverse content knowledge of the teachers, and single-subject teachers often struggle to implement the blended curriculum because of their limited background (Dong et al., 2019). Moreover, integrating STEM courses introduces additional classroom problems, negatively impacting teacher efficacy (Ryu et al., 2019). Although research about implementing an integrated STEM curriculum on teacher efficacy is still at the initial stage, researchers have agreed the limitation of interdisciplinary understanding and a lack of role models are challenges introduced by curriculum integration.

Chen et al. (2021) refuted the commonly held notion that low teacher efficacy leads to adverse outcomes in the classroom. Instead, they suggested teacher doubts are necessary and are even a source of motivation, resulting in teachers changing their instructional practice. Additionally, the overly confident teacher with high efficacy traits, could develop a false sense of certainty, leading to teacher burnout and unwillingness toward teamwork.

Stohlmann et al. (2012) concluded teachers' comfort levels rather than curriculum design affect their motivation when teaching STEM courses. Holmlund et al. (2018) identified one of the main issues in STEM education as limited content competencies, resulting from an unclear understanding of STEM by policymakers. For example, in research with a population consisting of a total of 927 fifth-grade students (i.e., 472 girls and 455 boys) Küçükalioğlu and Tuluk (2021) found high teacher efficacy had no significant impact on students' achievement in mathematics, and by extension, STEM courses. In conclusion, the main issues in STEM education are heavily influenced by factors that exist primarily outside of the classroom and often outside the circle of teacher control. Neither curriculum reform nor teacher efficacy development may significantly influence STEM education.

The Gap in the Literature

Integrating STEM may be necessary to build teacher confidence to guide students to success (Gale et al., 2020). Although there is research on curriculum reform and students' underperformance in STEM courses, little is known about the effect of curriculum reform on teacher efficacy; therefore, there is a gap in existing literature about teacher efficacy and curriculum design. Liu and Liao (2019) listed several factors that resulted in teacher efficacy development—namely, school leadership, confidence in course knowledge, and social persuasion. Lastly, Ngidi and Ngidi (2019) concurred with Liu and Liao (2019) and revealed additional factors related to teacher efficacy development, such as personal traits and the ability to manage a classroom. Notably, no mention was made about the role of curriculum design, or more specifically, the integrated STEM curriculum and how it may foster teacher efficacy. As such, there remains a gap in literature on the integrated STEM curriculum and how the use of this curriculum can foster teacher efficacy. This basic qualitative research helped fill this gap in the literature about teacher efficacy and STEM instruction.

Chapter Summary

More research is needed to understand further and address the use of the integrated STEM curriculum to develop teacher efficacy. The issue in many schools is the lack of a focused approach toward STEM instruction, resulting in disjoint instruction (Kelley et al., 2019) and teachers experiencing burnout in the classroom (Cooper, 2019). Feelings of happiness after teaching helped to increase teacher efficacy. Some studies have revealed teacher happiness increased regardless of years of experience when there was a clear expectation about what to teach and how (Kelley et al., 2020; Thornton et al., 2020). Without clear instructional guidance, teachers experience high stress and anxiety levels, resulting in low efficacy. An articulated curriculum may help to facilitate efficacy and change the notion of a secondary institution where teachers can model the desirable behaviors of self-efficacy for students to emulate. School leaders should strive to create a working environment that facilitates teacher effectiveness in the classroom. The role of integrated STEM to provide relevant support or teacher efficacy is unknown. Effective STEM education is vital for students' future success; this study aimed to fill the knowledge gap and determine if a localized, integrated curriculum facilitates STEM teacher efficacy.

An overview of the basic qualitative research is provided in Chapter 3, which contains the research design and rationale; the role of the researcher; and research procedures, including population and sample selection, instrumentation, and data collection. Data analysis, reliability, validity, and ethical procedures are also included.

Chapter 3: Methodology

Eckman et al. (2016) theorized teachers with in-depth knowledge are more effective when providing science, technology, engineering, and mathematics (STEM) instruction in the classroom. Teachers having specialized knowledge in STEM, complemented by requisite pedagogical skills (Shulman, 1987) when teaching STEM courses, may benefit from an integrated curriculum (Margot & Kettler, 2019). This basic qualitative study at an international school in China sought to understand the role of using an integrated STEM curriculum for instruction and how it supports the development of teacher efficacy.

Cheng and So (2020) asserted STEM teacher efficacy in managing instruction may be improved by integrating STEM-based courses. The problem was the lack of an explicit curriculum to support teacher efficacy in providing STEM instruction. The curriculum comprises all components of school, as these elements help to provide the standard language for stakeholders to communicate students' needs and available resources while leveraging teachers' pedagogical skills. The purpose of this basic qualitative study was to explore and understand teachers' feelings of efficacy when using a localized, integrated STEM curriculum.

The following research questions guided this basic qualitative research study:

Research Question 1: Do teachers feel supported when teaching an integrated STEM curriculum at an international school (foreign national and high school) in China?

Research Question 2: Do teachers experience increased teacher efficacy when teaching from an integrated STEM curriculum at an international school (foreign national and high school) in China?

Research Question 3**:** What benefits can school leaders and curriculum writers see in providing an integrated STEM curriculum to teachers at an international school (foreign national and high school) in China?

The methodology for this basic qualitative study about the role of an integrated curriculum and the development of teacher efficacy is described in this chapter. Also detailed in this chapter are the research design and rationale, the role of the researcher, research procedure, instrumentation, data collection, data analysis, reliability and validity, and ethical procedures.

Research Methodology, Design, and Rationale

A qualitative research methodology uses an inquiry process to explore social or human problems (Creswell & Creswell, 2018) and is the best way to analyze words and report detailed views of participants (Johnson et al., 2020; Sutton & Austin, 2015). When using a qualitative method to investigate the problem of teacher efficacy in providing STEM-based instruction, a complex and holistic picture may emerge by conducting the study in a natural setting (Sutton & Austin, 2015). Compared to a quantitative research method, which provides a snapshot of the phenomenon, the qualitative approach increases the probability of not overlooking certain teacher experiences (Bird, 2019; Rahman, 2017). The main advantage of selecting the qualitative research methodology for this study was it is most often used to represent complex social issues in a straightforward way (King et al., 2021).

The specific research design was a basic qualitative study to understand the integrated STEM curriculum's role in supporting the development of teachers' efficacy. Through a basic qualitative design, the experiences and meanings teachers and administrators attribute to these experiences while working with an integrated curriculum could be more sufficiently understood (Merriam & Tisdell, 2016). The basic qualitative study helped adequately capture the perspectives of the classroom teachers and school administrators, who were critical participants in this study.

Conducting a basic qualitative study was the most effective method to determine the impact of the integrated STEM curriculum on teacher efficacy in providing instruction in the natural setting of the classrooms (Merriam & Tisdell, 2016) from the perspective of the participants (i.e., teachers and school leaders). This research design best represented emerging data about the impact of the integrated STEM curriculum on teacher efficacy to show the need for curriculum reform to support student learning via an inductive process. The study revealed classroom teacher and school administrator perspectives on the integrated STEM curriculum and the extent to which this curriculum supports teachers' efficacy at an international school in China.

Role of the Researcher

Merriam and Tisdell (2016) explained in qualitative research, "The researcher is the primary instrument for data collection and analysis" (p. 16). As the human instrument, the researcher may have shortcomings in the form of bias. One role of the researcher is to reduce potential bias and conflicts of interest by identifying and addressing them (Billups, 2021). Motivated by understanding the impact of the integrated STEM curriculum in supporting teacher efficacy, I established trustworthiness in all aspects of this basic qualitative research.

There were potential biases and conflicts of interest, as I am a senior leadership team member at the high school research site. Also, two teachers at the foreign national school work directly with my children. For this reason, all teachers in the Applied, Design, Skills, and Technology (ADST) department at the high school were excluded from the sample along with Grade 1 and Grade 3 teachers at the foreign national school. The research was conducted through a STEM afterschool initiative, thereby reemphasizing participants’ right to choose to be a part of the study as all afterschool activities are optional.

Lincoln and Guba (1985) explained one of the primary roles of the researcher is to report data from participants’ perspectives and not the researcher's. Reporting in this manner allowed the feelings and thoughts of the participant about the integrated STEM curriculum and its impact on teacher efficacy to be accessed, analyzed, and presented accurately and in an unbiased way through the process of self-awareness and self-reflection by the researcher (Morrow et al., 2001). I further secured the credibility, reliability, and validity of this basic qualitative research by following all American College of Education guidelines, such as conducting proper field testing and following APA guidelines when reporting research findings.

Research Procedures

The site principal was asked to an informal face-to-face meeting and was provided with details about the potential research process and procedure. Afterward, the site permission letter template (see Appendix A) found in Student Commons at the American College of Education was modified and emailed (see Appendix B) to the site principal. Permission to conduct this basic qualitative research is included in Appendix C. The evidence of granted permission and other relevant documents were included in the dissertation proposal and submitted to the American College of Education Institution Review Board (IRB) for approval. Approval from the IRB was obtained before any data were collected. Once approval was received (see Appendix D), data were collected from the population and sample using the data instruments and process described in this section.

Population and Sample Selection

The research was set at an international school in China. The school population consisted of 60 British Columbia-certified international teachers between the international high school and the foreign national school. The intention was to learn how implementing an integrated curriculum supported teacher efficacy when teaching students STEM skills from these potential teacher participants' perspectives.

A total of 13 classroom teachers, two school principals, two systemwide coordinators, one vice principal superintendent, and one educational coordinator for the international program made up the sample for carrying out this basic qualitative study (see Appendix E). This participant pool was a convenience sample of the nearest and available participants for the research (Creswell & Creswell, 2018). The participants were selected using a single-stage cluster sampling method. This step ensured one teacher was selected from each cluster, or in this case, grade level, from among the teachers who responded to the call for participants for the afterschool STEM initiative at both schools. The systemwide coordinators, principals, superintendent, and assistant superintendent were invited to participate if available for the focus group interview at the time of the research. This sampling method for selecting participants provided an overarching look at the systemwide instructional practice in STEM instruction and helped explain how the integrated curriculum supports teacher efficacy.

An email (see Appendix F) with a permission letter, recruitment letters, and informed consent form (see Appendix G) was emailed to the school principal to invite potential participants to face-to-face meetings on site. At this meeting, participants had the opportunity to ask questions in an onsite, face-to-face meeting. The goal of the meeting was to inform participants about their rights and other regulations, which were adhered to during the research (see Appendix H). Participants were informed about the right to discontinue without penalty and that withdrawal was possible at all points during the research (O'Sullivan et al., 2021). The duration, procedure, potential risks, and benefits were made available to each participant. After the meeting, the research purpose was shared with participants through the recruitment letter. All materials were available at the face-to-face meeting to allow participants to sign and return the disclosure form. Informed consent was collected electronically using Survey Monkey.

Instrumentation

Abawi (2013) explained instruments allow for the collection of accurate and systematic information about research participants. The instruments used depend on the design and purpose of the research. For this basic qualitative study, two instruments, interviews (i.e., semistructured and focus group) and field observations (i.e., classroom), were used to identify patterns and determine the effects of the integrated curriculum on STEM teacher efficacy.

Semistructured Interview

Interviews involve asking participants questions and collecting data by listening to the responses (Merriam & Tisdell, 2016). One-on-one, open-ended interviews were conducted with teachers at the beginning and end of the semester. The 1-hour semistructured interviews consisted of prepared, open-ended questions in response to the emerging themes. Teacher efficacy in the classroom is a complex issue, with most information being opinion (Galanis, 2018; Yildiz, 2020). Consequently, a semistructured interview was one of the most authentic methods to collect data to represent this phenomenon. This instrument allowed for the collection of complete information, resulting in a deeper understanding of teachers' and school administrators' perspectives on how curriculum integration could support teacher efficacy in STEM classrooms (Galanis, 2018; Yildiz, 2020).

Focus Group

Two focus group sessions were conducted at the research site. One group contained the school administrator, evaluation coordinators, superintendent, and assistant superintendent, who discussed the impact of integrated curriculum and STEM teacher efficacy. The second group consisted of teachers sharing their experiences from the integrated curriculum. Using these focus groups provided an opportunity to cross-check one individual's opinion with other opinions gathered (Galanis, 2018; Yildiz, 2020). Focus group interactions enriched the quality and quantity of information needed (Galanis, 2018; Yildiz, 2020) about the impact of the integrated curriculum on both teachers and students at the research site.

Field Observation in the Classroom

The appropriate qualitative observation entails naturalistic inquiry. These observations focus on how people react in the classroom's real-life situations (Fry et al., 2017). Observing the teaching and learning environment throughout the semester helped explain how integrating STEM courses support teacher efficacy in the classroom. Observation as a data collection tool leveraged the use of senses to gather data directly in a short period, and also added reliability to this basic qualitative study (Fry et al., 2017). The observation checklist used in this basic qualitative study was developed in collaboration with subject matter experts (SME). For each field observation, the "look for" cues in each lesson were indicators of elements of the efficacious teacher. These elements included active learning, differentiation, scaffolding, making authentic connections of lesson content to the real world, and integrating appropriate content and skills.

Field Testing

After a thorough search of the literature and the Internet, no appropriate instrument was located to accurately capture data to answer the research questions Collaborating with the subject matter experts (SME), interview questions for both the semistructured and focus group discussion and the field observation (i.e., classroom) checklist were validated. Three SMEs participated following the field test procedure outline in the American College of Education student commons. The instruments used to collect data must be valid and reliable; SMEs provide content validity to accurately represent participants' perspectives (Zamanzadeh et al., 2015).

The SMEs were education experts including: (a) a lecturer at a teacher's training institution, (b) a high school vice principal, and (c) a mathematics evaluation coordinator for this basic qualitative research. Communication (see Appendix I) was sent to SMEs describing the research design, research questions, and instruments. A tabular form was used to create a feedback log (see Appendix J) to track feedback and modifications based on SME comments (see Appendix K). Following these processes, the final instruments were created in the form of pool of interview questions and observation checklist (see Appendix L).

This basic qualitative study aimed to explore and understand teachers' efficacy when using a localized, integrated STEM curriculum. The research instruments were built in alignment with the research questions. The research design was basic qualitative, which Merriam and Tisdell (2016) described as "individuals construct reality in interaction with their social worlds" (p. 24). For this reason, the research questions were open-ended to allow participants to give in-depth information about the integrated curriculum and assess the extent to which the curriculum supports teacher efficacy. The instrument used for the field observation also aligned with the research questions, containing a checklist developed with the ideal STEM learning environment characteristics and free journaling to allow open-ended documentation. To capture firsthand accounts of the effects of integrated curriculum and teacher efficacy, the field observation instrument served a valuable purpose.

Data Collection

This basic qualitative study aimed to explore and understand teachers' efficacy when using a localized, integrated STEM curriculum. The focus of a qualitative inquiry, such as this basic qualitative study, requires instruments to gather data to reveal the underlying meaning of the phenomenon being studied (Yu et al., 2014). Interviews (i.e., semistructured and focus groups) and field observations (i.e., classroom) were the most appropriate instruments to accurately capture participants' feelings of efficacy and perspectives on how the integrated curriculum supports its development. The three research questions were adequately answered using these instruments. The selected tools accurately collected data to measure the nonquantifiable data in this basic qualitative study.

Interviews: Semistructured and Focus Groups

The interview protocol was semistructured and began with open-ended questions about the teachers' perspectives on designing and implementing STEM learning experiences in the classroom. The interview format helped ensure participants shared ideas freely (Büyüköztürk et al., 2012) to answer the questions without constraints (Yıldırım & Şimşek, 2008). Although the data collection instrument was comprehensive to collect data relevant to this researcher, additional open-ended questions were added to explore more about the topic or fill the gaps as they emerged.

The exact format of the semistructured interview was followed at the beginning and end of the research period. Interviews were conducted face-to-face at the research site and one-on-one, and each interview session was approximately 1hour. The semistructured interviews were conducted individually to determine the teachers' perspectives and experiences on integrating curriculum to support teacher efficacy. The computer-assisted qualitative data analysis software

(CAQDAS), Delve, kept track of the interview data. Delve also assisted with coding and annotation (Dalkin et al., 2021) to help organize the interview data.

Additionally, an online tool, Go Transcribe, was used to transcribe the interview recording into text. The validity method included member checking to ensure the accuracy of the interview data. The reviews of the transcribed interviews took place within 7 days of each interview. Interviewees who wanted to represent their thoughts and feelings accurately had the right to strike any interview content. Conducting member checks is one method to ensure the validity and reliability of a basic qualitative study (Birt et al., 2016). Each transcribed interview and other electronic data were password protected while stored.

Two focus group sessions were hosted at the research site toward the end of the study's time frame. Macnaghten and Myers (2004) explained focus group interviews are advantageous in qualitative research about topics people could not discuss in daily life but have sufficient experience and knowledge regarding the topics. The first group consisted of the school principal, librarian, teachers, mathematics systems evaluator, and director of the system research consortium. The discussion focused on the impact of an integrated curriculum on STEM teacher efficacy, the support teachers need, and the systems necessary for developing efficacious teachers at the research location. The discussions were recorded using the CAQDAS tool, Delve, and participants signed the consent form to permit participation and recording. The second focus group consisted of school leaders who signed a consent form permitting data collection and recording using the Delve tool.

All participants were invited to a debriefing meeting and thanked for their contributions to this basic qualitative study. During this meeting, participants were told all identifiable information would be removed before publishing research findings and noted ways in which participants could get in touch should concerns or questions arise. The thank-you note (see Appendix M) was sent to all participants.

Field Observation in the Classroom

Observing the teaching and learning environment throughout the semesters facilitated the collection of data about how an integrated curriculum may support STEM teacher efficacy in the classroom. Classroom observations provided additional information about the impact of the integrated curriculum on teacher efficacy. The observation format was naturalistic because teachers and students were observed in the natural setting of the classroom. The observation format helped guarantee the validity of the data gathered, generate new ideas (Ryan, 2019), and confirm emerging data during the triangulation process. Using the observation instrument, highly descriptive notes were taken and coded after each observation. Select classroom sessions were recorded to assist in note taking after the observation. Classroom teachers and school leaders gave permission for an observation by using the informed consent form.

Data Analysis

The goal of the data analysis process is to make sense of the data collected using the research instruments. This process involves fusing, simplifying, and making sense of what participants said and noticed during field observations (Merriam & Tisdell, 2016). The goal was to use emerging themes cutting across the data to answer the research questions through inductive and comparative data analyses.

The emergent methodology was used to understand the impact of the integrated curriculum in supporting STEM teacher efficacy in the classroom. In this basic qualitative study, the emergent method helped gradually build the structure (Bradley, 1993) of teacher efficacy and the impact of the integrated curriculum on supporting its development in STEM-based courses.

Codes were established during the research process to analyze the data (Williams & Moser, 2019).

Interviews: Semistructured and Focus Group

A system for coding and cataloging transcribed interviews was developed before analyzing the data collected. Deductive coding was used to analyze and understand participants' views by breaking them down into manageable chunks of data (Charmaz, 2014). Inductive coding helped ensure a thorough analysis of the interviews and prevented premature overemphasis on single aspects of the interview (Williams & Moser, 2019). Using coding in the basic qualitative study was critical to focus the interview analysis on participants' experiences in a holistic way.

Coding was completed manually using a computer-assisted qualitative data analysis software, Delve. The software was used to search for keywords and phrases compared to the manually coded themes and categories. The software was not the primary source of coding, but served as one of multiple components of a researcher-led process (Elliott-Mainwaring, 2021). The software helped contextualize the emerging data and was used as a safe place to store and sort the data.

At each phase of coding, comparisons were made by analyzing, reanalyzing, and comparing new data to existing data constantly (Williams & Moser, 2019). In this basic qualitative study, interviews were examined in two phases: initial and line-by-line coding. In Phase 1, the essence of the data was identified and coded accordingly using the Microsoft Word comments feature using participants' own words. After gaining an overall idea of the data, line-by-line coding allowed for digging deeper (Elliott-Mainwaring, 2021) and adding details using values coding. The goal was to capture the richness of participants' perspectives about the use of integrated curriculum to support the development of teacher efficacy.

Field Observation in the Classroom

Code categorization and identification of themes were used to analyze data field notes collected line by line. The field notes were reviewed at the end of each observation by making comments about emerging evidence and consistently comparing the notes to transcribed interviews to inform the following data collection and reveal gaps in the data. From this process of constant comparison (Seidel & Urquhart, 2013), themes about teacher efficacy and integrated curriculum emerged naturally; hence, the themes were identified accurately, allowing for communication of participants' perspectives.

By reviewing everything coded from interviews and field observations, an accurate representation of participants' perspectives on using an integrated curriculum to teach STEM courses was possible. Coding of interviews and classroom observation video recordings was done in batches of three at a time, allowing for reflections and adjustments as needed in response to the theories in the emerging data. As new data emerged, they were compared to other data sources to help understand the effect of integrated curriculum on STEM teacher efficacy. Data collection and analysis occurring simultaneously prevented unfocused and repetitive data (Merriam & Tisdell, 2016).

Reliability and Validity

The study's credibility, dependability, transferability, and trustworthiness were established using triangulation. The triangulation process involves comparing interviews to determine teacher efficacy areas, conducting classroom observations throughout the semester, and holding focus group discussions (Santos et al., 2020).

Transferability

The data collected were reported clearly and systematically which facilitated the transferability of this basic qualitative study to other schools looking to adopt STEM practices. There are 16 similar high schools and two other foreign national schools in the school system in which this basic qualitative study was conducted. Because these sites share almost identical settings, transferability may also contribute to the reliability and validity of the research.

Trustworthiness

The trustworthiness of basic qualitative research depends on the information seen and heard during the data collection process. One way to establish trustworthiness is to eliminate researcher bias, which requires interpretation of the data collected objectively (Lincoln & Guba, 1985). For this basic qualitative study, transcribing entire interviews and manually coding them helped ensure a deep understanding of the content so participants' intent could be accurately represented when data were reported.

Credibility

Capturing the interviews on a digital recording ensured participants' interview data were reported accurately and without addition or elimination. Consistent comparison of emergent data from participants' interviews and classroom observation was used to establish the credibility of this basic qualitative study by highlighting specific codes and categories of analytical value (Abdalla et al., 2018; Cutcliffe & McKenna, 1999).

Ethical Procedures

Permission was obtained from the site principal to conduct the research involving teachers and school leaders at the institutions. The IRB of the American College of Education approved the research before any information was collected. Once approval was received, participants were sent the recruitment letter, and arrangements were made for an initial face-to-face meeting at the research site.

All participants received the informed consent form. Each participant signed and returned the form before data were collected. Additionally, participants confirmed consent orally before their interview. They also gave permission for the interview and observation to be recorded. Obtaining informed consent was crucial, as it protected the rights of human subjects participating in the research (O'Sullivan et al., 2021). Participants' personally identifiable information was removed following the CITI guidelines. This basic qualitative study adhered to the three ethical principles of The Belmont Report (i.e., of justice, respect of person, and beneficence) to protect the rights of the human subjects in the research (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979).

Data will be stored for 3 years as mandated by the U.S. Department of Health and Human Resources. During these 3 years of storage, recorded material will be stored electronically in a password-protected database provided by Delve, the CAQDAS platform. Video recordings of lessons were stored electronically on a password-protected hard drive. All paper documents, such as signed consent forms for participants' journals, were scanned and kept on a password-protected file on a hard drive. The physical copies of any researcher-related document and the hard drive were stored in a locked cabinet. The stored information will only be accessed for this qualitative study. All data were kept confidential. The recorded materials will be erased after 3 years, following final approval by the research committee, minimizing any future risks related to confidentiality. All hard copies will be shredded and disposed of carefully.

Chapter Summary

The goal of this chapter was to describe the research methods used to answer the research questions of this basic qualitative study. A discussion of the procedures and description of the study participation, data collection methods, instrumentation, data collection, and data analysis were included in this chapter. This basic qualitative study aimed to explore and understand teacher efficacy when using a localized, integrated STEM curriculum. All participants shared their experiences and feelings about STEM teacher efficacy and integrated curriculum. Data collection, treatment, intervention fidelity, data analysis and results, reliability, and validity of the study are outlined in Chapter 4.

Chapter 4: Research Findings and Data Analysis Results

The core aspects of teaching involve planning, instructional methods, content, and assessments guided by the curriculum. The curriculum is the thread that connects all aspects of school; as such, the curriculum may play a key role in supporting teachers' efficacious beliefs. Teacher efficacy is essential for both teachers and students. Every aspect of teaching is influenced by teacher efficacy, and teachers who feel a high sense of teacher efficacy are more effective in the classroom (Toran, 2017; Vasquez-Salgado et al., 2018). Morrison et al. (2015) explained teachers play an essential role in guiding students toward desired educational goals; however, one issue is inconsistency in the definition and implementation of science, technology, engineering, and math (STEM) education (MacDonald et al., 2021; Timms et al., 2018). The National Academy of Engineering and National Research Council (2010) explained an explicit STEM integration may increase students' motivation and achievement and classroom teachers' ability to support this goal.

This chapter contains the results of the basic qualitative study conducted to answer the following research questions:

Research Question 1: Do teachers feel supported when teaching an integrated STEM curriculum at an international school (foreign national and high school) in China?

Research Question 2: Do teachers experience increased teacher efficacy when teaching from an integrated STEM curriculum at an international school (foreign national and high school) in China?

Research Question 3: What benefits can school leaders and curriculum writers see in providing an integrated STEM curriculum to teachers at an international school (foreign national and high school) in China?

A two-pronged strategy for resolving the challenges of teacher efficacy in providing STEM education may be addressed through a clearly defined curriculum focused on STEM instruction while supporting teacher efficacy. The National Academy of Engineering and National Research Council (2010) explained direct STEM integration will increase students' motivation and achievement; however, conceptualizing integrated STEM education may be difficult for teachers and school administrators who may need assistance in making links between disciplines evident to students (Danilewicz et al., 2019; İrtem & Hastürk, 2021; Li et al., 2021). As a result, a locally tailored explicit STEM curriculum might be one strategy used by school officials to teacher efficacy.

One problem this study sought to explore related to the lack of an explicit curriculum to support teacher efficacy in providing STEM instruction (Hayes et al., 2020; Ryu et al., 2019; Thornton et al., 2020). The background of the problem was the traditional design of STEM curriculum is segregated and disciplined-based (Abdurrahman, 2019; Pajk et al., 2021) rather than one with a transdisciplinary approach that includes problem-based, research-based, and project-based (Slavinec et al., 2019; Zell, 2019) learning to meet the needs of the 21st-century learner and educator. This basic qualitative study aimed to explore and understand teachers' feelings of efficacy when using a localized, integrated STEM curriculum at an international school (i.e., foreign national and high school) in China.

This chapter provides a discussion on whether the analysis conducted was consistent with a basic qualitative study and how the analysis connected to the research questions. Also included are sample demographics, the process used to analyze the transcripts from the 12 individual interviews, and three focus group transcripts conducted to uncover codes and themes. Tables and figures, included in the appendices section, present detailed code and theme data, graphics and vignettes from the individuals, and focus group interviews emphasizing critical themes and resultant theory.

Data Collection

After receiving approval from the IRB, the site principals sent the notice requesting participants in the weekly Monday Mailbag. A total of 60 teachers and school administrators interested in participating in the research were invited to a meeting. The research process was described at the meeting, and the list of activities each potential participant would be expected to complete was shared. A paper copy of the consent form was issued to all potential participants.

The informed consent was signed and returned by 35 participants. After eliminating 15 teachers who did not meet the research criteria described in Chapter 3, the final 19 research participants were selected. The sample consisted of 13 classroom teachers (68%) and six school administrators (32%). Teachers from both the foreign national school and international high school campuses were represented in the sample, with eight (42%) affiliated with the international school and five (38%) attached to the foreign national school. Participants who were administrators were two (10%) school principals, one (5%) vice principal, two (10%) system coordinators (i.e., curriculum evaluator and STEM), and one (5%) educational coordinator.

The 19 research participants were interviewed for this research study. The 13 teacher participants were interviewed in semistructured and focus group formats. One focus group contained teachers affiliated with the international high school, and one included teachers at the foreign national school. The school administrators participated in one focus group (i.e., four participants) and one small group interview (i.e., two participants). The interviews (i.e., semistructured and focus groups) served as the primary data source. Almost all interviews were conducted face-to-face on the research site and were completed over 2 weeks. One teacher interview was conducted remotely using the Microsoft Teams platform. Ten participants were interviewed in two focus group sessions. One session contained all administrative participants, and the other included all teacher participants. Both sessions had a hybrid format because some participants joined the research onsite and others joined online using Microsoft Teams. All participants gave consent for the interviews to be recorded using a traditional recorder and Microsoft Teams (i.e., video and audio recording).

After every four discussions, the batch of four interviews was coded manually and reviewed for emerging themes. The original interview protocol and subsequent interview question changes through the study period were kept recorded for continual review. Detailed notes were used in the observation checklist from 13 classroom observations conducted during the study. Field notes were reviewed after each observation and compared to the transcribed interviews. Additionally, themes and emerging evidence were also sought from 26 lesson video recordings submitted by the teacher–participants.

There were two main deviations from the data collection methods initially described in Chapter 3. First, not all participants were asked the same interview questions. As themes and codes emerged, some interview questions were amended to more accurately capture participants' feelings about integrated curriculum and teacher efficacy. Second, a focus group and one interview were conducted using a hybrid format and not face-to-face as planned due to the availability of participants. Two participants had to leave during the focus group meeting with administrators due to a local school emergency. These participants were critical to the study; therefore, a small interview was arranged with participants to gain their perspectives on the benefits of providing an integrated STEM curriculum to classroom teachers.

Data Analysis and Results

The emergent method gradually developed the structure (Bradley, 1993) of understanding teachers' feelings of efficacy when using a localized, integrated STEM curriculum from the data collected. A thematic coding system was developed for coding and cataloging transcribed interviews manually (Gibbs, 2018) in batches of four. Through deductive coding, participants' views were broken down into manageable chunks of data (Cruz & Tantia, 2017), and themes were identified by open coding. This process allowed time to add or clarify questions before moving on to additional participants. Supplemental questions from the open coding analysis throughout the individual interview process were also recorded.

Focus group data were analyzed using a framework analysis, which allowed for the interconnection among the data collected through individual interviews and field observation. Using the five-stage process described by Ritchie and Spencer (1994), transcriptions were read thoroughly to allow for familiarization immediately after the focus group sessions. Afterward, themes were identified by writing memos in the margin of the text in the form of short phrases, ideas, or concepts arising from the texts and beginning to develop categories. Data were further examined to highlight and sort out essential quotes and then compared with the other data collection methods.

Following the recommendation of Williams and Moser (2019), inductive coding was used to help prevent focusing on one aspect of the data prematurely. This process allowed the data analysis process to reach saturation, reducing researcher bias and contextualizing the emerging data so participants' perspectives could be represented holistically (Elliott-Mainwaring, 2021).

Transcripts were uploaded into computer software, Delve and NVivo, for further analysis. Each interview and focus group were coded manually again using the software and then compared to the initial codes during the collection phase. This step ensured consistency in the key points emphasized during the coding process. Selective coding was used as the next phase to find categories emerging from the similarities in the open codes. The data were summarized during the analysis process from coding (open, selective, and theoretical; see Appendix N).

Additionally, word-count queries and source code data in the NVivo software were other selective coding tools. Theoretical coding resulted from the relationships in and across the open and selective codes. A process of mapping the research questions with the interview and focus group questions to glean emergent codes and final themes was undertaken (see Appendices O and P).

Results

Data collected from 11 classroom teachers and six school administrators were used to prepare the final result of this basic qualitative study about teacher efficacy and integrated STEM curriculum.

Research Question 1: Do teachers feel supported when teaching an integrated STEM curriculum at an international school (foreign national and high school) in China? This first research question examined if teachers felt supported when using the preprepared lessons (see Appendix Q) modified from the Sphero STEM curriculum at the international and foreign national school. Codes emerged from the raw data provided by participants, and two significant themes that emerged following the interview questions and coding are described in the following sections.

Support Through Curriculum Design

In the preinterviews and focus group discussions, classroom teachers expressed a shift in their feelings of support during the research process. For example, in an April 2022 preinterview, FNST-01 said:

> I am a trained elementary school teacher; however, this is my 1st year teaching upper grades at [school name]. I use much teacher-pay-teacher [*sic*], but I would like someone to explain the content or concepts because sometimes I ask a question, and it is just crickets in the classroom. I would like to know how to guide students in exploring the content?

In the May 2022 focus group with teachers, FNST-01 continued:

> What I loved about the curriculum that we used during this time is that it had many activities that I could use with different types of learners. I followed the plans as is for maybe the first three lessons after I found it was easy for me to adapt based on how I teach and my students learned. The WeChat group was beneficial as I was able to ask questions when Sphero was not working or when I had problems with understanding STEM-related concepts, which I still do not know, but I now know where to find information.

Admin-03 also noted during the May 2022 focus group:

> The curriculum was very flexible so that some teachers could use it as designed; other teachers could quickly adapt based on their preference. The activities seem rather useless; you ask students to drive the bot, starting it through like, say, a maze. Nevertheless, the students' STEM literacy is developing, and teachers can use it in just about any course: math courses, creative thinking. And the learning task may be integrated into just about any course, class, or grade level.

Integration of Simplified STEM Instruction

At the local level, the curriculum is one tool school administrators may use to communicate what STEM education means in their institution and help define what it might look like in different classrooms or courses. As HST-02 noted in an April 2022 preinterview, “I am a STEM teacher because I have always taught STEM-based courses like mathematics and computer science. To me, that makes me a STEM because I do teach two of the STEMs, although I do not integrate them.” In that same April 2022 preinterview, HST-04 said:

> I am a STEM teacher because my students always work together in my math classroom. I have not received any training to be a STEM teacher, but I believe I do a good job of doing STEM in my class.

In the May 2022 focus group with teachers, FNST-01 noted:

> Having a preprepared curriculum as a guide was very useful because I do not have the time to search online for lesson activity to figure out what work and does not work. It was nice to have something already put together and gives the framework of what a lesson could look like. I would be able to adapt from there and focus my time on other things.

In another May 2022 focus group, this time for administrators, Admin-06 stated:

> When I read the lesson plans, I fell in love with the objectives written as “I can statement.” I feel that it empowers students and classroom teachers who are essentially learning about Sphero with the students. I like the simplicity in the curriculum design, and I can see how the curriculum may be easily used across all [school name]. I am interested in introducing this program to department heads across the system. I like the photos and videos I notice in the WeChat group. I like the opportunity for consistent collaboration of teachers, which I think is good for teacher confidence and competence.

In the teacher focus group in May 2022, HST-02 noted:

> I think my idea of STEM instruction has evolved from being a part of this research process, and I am grateful for that. For some reason, I equated STEM to technology. Now I see it is more than that and even easier than I think. For example, in my classes, what I did was use the first sets of lessons, but then I realized that I could modify the lessons I received to make them more appropriate for my courses. So I changed it, then I could not believe it when we learned how to add sound. My students made a presentation about digital citizenship, and the bot was rolling and explained the ideas of digital citizenship. They had fun and were very engaged, which I liked.

Research Question 2: Do teachers experience increased teacher efficacy when teaching from an integrated STEM curriculum at an international school (foreign national and high school) in China? The second question explored teachers feeling of efficacy and how they evolved during the research process. The goal was to learn if teachers' feelings about their efficacy improved by using the curriculum to guide instruction. After reviewing field notes and interview transcripts, the emergent codes converged into two themes: teacher efficacy through curriculum design and teacher efficacy development.

Teacher Efficacy Through Curriculum Design

As teacher efficacy grows, it may have a positive impact on students' performance and decisions to stay in STEM-based courses and careers. In the April 2022 preinterview, HST-08 noted:

> This is my first time hearing the word teacher efficacy, but as you read the definition, I think my perspective of my teacher efficacy is average. I find that I can engage some of my students, but I am not so sure about my STEM instruction. Most of my students are

> English language learners, specifically bridging students, and the low English level affects engagement.

FNST-03 stated:

> I have a lot of STEM training from my time working in the United States; in my former school district, we had an instructional coach who would guide us in teaching STEM activities. I even do this daily in my classroom, and my students build bridges and design roller coasters [showed researcher models]. I am a mathematics and science elementary school teacher, so I am comfortable teaching STEM. I do struggle with engaging my low-level English students.

In the May 2022 focus group with administrators, Admin-02 stated:

> I think, unfortunately, overall teacher efficacy on our campus is low. However, my opinion is general and from an observation perspective. From the internal [endorsement team] classroom visits, many of our teachers seem not to be able to engage students, especially the ones who are struggling. Moreover, the ones who are high performing. It is a difficult balance if you ask me. We receive several complaints about teacher quality, so I am happy that a program like this exists as it could help, but I wish how it could help remote teachers as they need more support, I think. But this is a start, so it is something.

In the teacher focus group from May 2022, HST-05 noted:

> I am a confident teacher; I am very organized, and I think I can teach students anything in science. Maybe because I used to be in the industry because I am a biologist and used to work for a big company before coming to [school name] so I know my stuff, and I rehearse my lessons before teaching. The lessons were suitable, but I had to make them my own. I changed them for my class, you did not include this lesson, but I was teaching

> anatomy and found an excellent lesson on the Sphero activity site you have us. It was so fun; my class was noisy, but the kids were learning, and even my most dormant student tried, and I liked that a lot; it made me feel good like I was helping the students.

Teacher Efficacy Development

Developing teacher efficacy begins with each teacher and expands to include all team members. Whether in STEM or other areas, efficacious teachers positively impact the school learning environment. According to HST-03's response from the April 2022 preinterview:

> Growing up, I had an unknown learning challenge; you could call it a disability. My teachers did not know, so I struggled a lot in school. So I always look out for my struggling students. I go through the lesson and pretend to be teaching myself, and I think, well, if I can understand, with my disability, then my students will understand. That makes me confident because I know the content of science very well.

HST-07, in the April 2022 focus group with teachers, stated:

> When I checked the WeChat group, teachers shared their classroom progress with other people in the research. I noticed my students were in other classes, so I thought, wait, they are gonna know the activities before they come to my class. I had to make some quick changes, and I surprised myself because I was able to build different lessons by using the lesson structures. I was surprised that the lesson examples [name of researcher] shared gave me a structure so I could adapt on my own. As I saw from the examples, I picked lessons I liked, aligned with [name of school curriculum], and made modifications for my top students, struggling students, and ELLs.

During that same focus group, FNST-04 admitted:

> I was nervous and even considered withdrawing from the research. I am an ELL teacher; I did not know math, science, or any of these so-called STEMs. All right, so I do not know if you guys noticed, but I think I started using the lessons last, and I did not share in the group because I figured the way I was doing the lessons was not so good. I think my efficacy, is that the word, is getting better, but it is not where it needs to be. But I like my progress, though; I am reading more and watching the videos shared, and I think this is a good start for me to be an effective STEM teacher.

In the May 2022 administrator focus group, Admin-01 mused:

> I wondered why you invited me to be a part of this study because I am an English specialist and never considered that I could contribute anything to STEM. But I see things like cooperation, problem-solving, and reflective thinking, and I said these are not STEM things; it is for everyone, every teacher. I peeked into a few classes, and I liked what I saw and think this is one way that I can support my teachers through clear curriculum guidelines, so we are all speaking the same language during instruction. I think this is 21st-century teaching, not perfect, but it is good.

Research Question 3: What benefits can school leaders and curriculum writers see in providing an integrated STEM curriculum to teachers at an international school (foreign national and high school) in China? The third question explored the benefits of the integrated STEM curriculum from the perspectives of school leaders and curriculum writers. In STEM education, as with many areas of school operations, school leaders must support classroom teachers as they strive to meet the diverse needs of the teachers on their team. The emergent codes converged into two themes: curriculum design to support STEM integration and materials needed for successful implementation of STEM education.

Curriculum Design to Support STEM Integration

Innovation plays a role in implementing STEM curriculum, and proper curriculum design in STEM helps to increase teacher efficacy once appropriately done. In the May 2022 focus group with teachers, FNST-05 noted:

> I am a 1st-year teacher, and I have no experience outside of my teaching practicum, which was done in Australia, a different system than here at [school name]. We only have the principal, and he does an excellent job of helping me, so I feel fortunate. If you remember when you came the first time to look for people, you somehow missed me, but I was talking with the principal as I was stuck on coming up with ADST activities for my Grade 6. This project was perfect because ADST is very STEM-oriented, and your research helped me see what a good lesson looked like. Also, sorry for taking long, but I always separated the STEM, like math and science, like that, but now I see I can teach them together without confusing myself and my students. You, [principal name], and the curriculum helped me.

In the administrator focus group in May 2022, Admin-01 stated:

> I was happy to have something to help my teachers. I have been in a couple of classes, and the teachers were excited, and because I knew the lessons, I could give suggestions, which is something I can continue to build on. My background is in social studies, so I rely on the [curriculum name] to build the ADST program, which everyone has to do for their grade level. These lessons and this curriculum fit into this well, and I notice teachers use SPHERO outside of ADST blocks; between April and now use of SPHERO has been good at our school. Maybe we are so small, but even teachers who did not join the research are now using SPHERO.

Materials Needed for Successful Implementation of STEM Education

One of the primary purposes of K–12 STEM education is to help prepare students for postsecondary studies in STEM and careers in STEM. During the May 2022 administrator focus group, Admin-06 noted:

> So typically, when I think about STEM, I think expensive, especially when I think of using robots in the classroom. This year, for instance, just for this campus, we ordered three programmable robots, which cost 6,000 RMB. But as you shared the research plan with me, Sophia, I noticed you purchased about 15 SPHERO at less than 300 each. So anyway, I just think that the materials we need to bring STEM alive in the classroom may be less expensive than we realize. Therefore a simple curriculum like this is an inexpensive, effective place to begin.

In an April 2022 preinterview, FNST-01 explained:

> So, we are learning about sustainability, and so I like that almost all activities may be done using found materials. I do not know how you guys implemented your lessons and the materials you used, but I rarely used the materials contained in the supply box; my students and I were creative in finding random materials around the classroom, or outside or at home. Come to think of it, isn't that a part of STEM? Maybe creative thinking or even problem solving.

Reliability and Validity

Gregory (2013) explained it is vital to establish reliability and validity procedures before initiating the research process. Reliability is necessary because other researchers may obtain similar results if the same type of research is undertaken in the same way (Gibbs, 2012). If the study cannot be replicated under the same circumstances, it is reasonable to assume it is unreliable. Additionally, Gregory (2013) explained that validity speaks to the likelihood of the research being realistic and not far-reaching. Another component of reliability and validity is saturation. The point of saturation came when observing more data would have not led to the discovery of more information related to the research questions (Lowe et al., 2018).

After the 10th interview, no new information or themes emerged from the data; this number aligned with Guest et al. (2006), who established 10 as an acceptable minimum number for saturation. Three sources of participant-generated data were provided through semistructured interviews, focus groups, and field observation. The researcher's self-reflection notebook was the fourth source of data used to identify potential biases and evaluate participant replies in the context of the research location (Ortlipp, 2008). Following each interview (i.e., semistructured and focus group), all five levels of self-reflection were completed: reacting, reconsidering, reevaluating, reframing, and reintegrating (Alschuler, 2016) to help identify, manage, and reduce the researcher's bias.

Credibility and Dependability

Credibility and dependability are among the strategies used to create reliability and validity in this study. Credibility creates internal validity of the research, which Korstjens and Moser (2018) explained as necessary to place confidence in the study and its findings. Triangulation and saturation strategies were used to ensure the credibility of the findings. Dunn (2017) explained credibility through triangulation means using several sources of data and methods to uncover emerging themes and patterns during the research process. The majority of data were gathered through data transcription; field notes from classroom observations were used to create a deeper understanding of participants' feelings and ideas about teachers' efficacy when using a localized, integrated STEM curriculum at an international school.

The field notes and researcher's notes captured body language, facial expressions, and intonations that phrases and words could not capture (Merriam & Tisdell, 2016; Tumilty, 2022); for example, the body language of Participant HST-06 suggested feeling overwhelmed as she explained how challenging it was to engage students in science content due to low English proficiency. Participant HST-06 excitingly showed a sample of students' final work completed during the research project.

Through triangulation of the data, trustworthiness of the research was maintained, as it helped minimize misinterpretation by the researcher (Fusch et al., 2018; Merriam & Tisdell, 2016). Furthermore, dependability spoke to the participants' perspectives and recommendations after the study; this step ensured data consistency and that findings could be repeated at another time (Amankwaa, 2016; Ozen, 2018).

Transferability

Korstjens and Moser (2018) explained transferability addresses how the research results may transfer to other contexts with other participants. This same basic qualitative study could be done at other foreign national and international schools. For increased transferability, the research procedures, findings, and participants' experiences are described in detail in this study.

Trustworthiness

Several methods were used to create the trustworthiness of this basic qualitative study. Korstjens and Moser (2018) described the trustworthiness of research as honesty, truthfulness, and overall worth of trust in a research study. A detailed journal was maintained to document all the steps involved in this basic qualitative study. The journal allowed for keeping track of all tasks and establishing transparency, which is vital for the trustworthiness of the research. For example, use of a journal kept track of how participants were selected, managed informed consent, and established confidentiality. Additionally, audit trails in the form of all data collected—including questionnaires, interviews, and interviewer notes—allow the study to be replicated in the same way, using the same format, and potentially yielding similar results (Dunn, 2017; Peterson, 2019).

Chapter Summary

The purpose of this basic qualitative was to explore and understand teachers' feelings of efficacy when using a localized, integrated STEM curriculum at an international school in China. The study revealed six major themes emerging from participants' interviews (i.e., semistructured and focus group), researcher's notes, and field notes. The themes answered the research questions by addressing teachers' feelings of efficacy while working with an integrated STEM curriculum and the benefits school leaders identified when teachers are provided support via curriculum design. Further details about research findings are discussed in Chapter 5, including the conclusion about teachers' feelings of efficacy when using an integrated STEM curriculum and the benefit administrators see in providing teachers with this type of support.

Chapter 5: Discussion and Conclusions

This basic qualitative study aimed to explore and understand teachers' feelings of efficacy when using a localized, integrated science, technology, engineering, and math (STEM) curriculum at an international school in China. This study provided initial evidence that developing a localized curriculum helped improve teachers' abilities to guide students to the desired STEM learning outcomes. The central research questions and key findings from this basic qualitative study are outlined in the following paragraphs.

Research Question 1 examined if teachers felt supported when teaching an integrated STEM curriculum at a school in China. The data analysis indicated teachers felt supported when teaching from an explicitly integrated STEM curriculum. Teacher participants felt all aspects of teaching—including planning, instructional methods, content, and assessment—were supported using the Sphero curriculum. The curriculum provided a framework and allowed classroom teachers to begin and make adjustments to meet the needs of their students. One teacher noted increased student engagement while teaching from the integrated STEM curriculum. Additionally, the teacher described a change in perspective about STEM as more than asking students to solve problems using technology to plan lessons reflective of at least two of the strands in STEM, thereby developing the practice of an integrative approach to instruction. One teacher noted increased comfort in integrating STEM in the classroom, particularly regarding student engagement. Also, the teacher noted a change in perspective toward STEM, as it requires more than just the use of technology when teaching.

Research Question 2 explored increased efficacy and integrated STEM curriculum and asked: Do teachers experience increased efficacy when teaching from an integrated STEM curriculum at an international school (foreign national and high school) in China? Teachers perceived using an integrated STEM curriculum increased their feelings of efficacy. The detailed step-by-step lesson designs adapted from the Sphero curriculum were appreciated by all teachers and resulted in feelings of efficacy in positively teaching STEM-based content. Notably, some teachers stated they would like to see English language learners' (ELL) instructional strategies embedded into all STEM curricula, as ELLs represent the majority of the student population at the studied site.

Research Question 3 explored the benefits school leaders and curriculum writers noted in providing an integrated STEM curriculum to teachers at an international school in China. Data analysis revealed collaboration across the department was evident when using the integrated STEM curriculum. Outside the classroom, the concepts and contents of STEM are not separate; relatedly, a curriculum that mirrors real-life benefits teachers and students. Providing an integrated curriculum serves as an instructional blueprint for teachers to help prepare students to meet workforce needs. One administrator noted a prevalent concern about the gender gap; an integrated curriculum might be one way to address this and other gaps in the field to provide students with exposure to real-life applications of STEM skills and concepts. Students would better understand the variety of STEM competencies and be more prepared when they begin their jobs due to the collaboration and integration of STEM disciplines. Key competencies (e.g., critical thinking, creativity, and communication) would also be enhanced. A discussion of findings, interpretations, limitations, recommendations, implications for leadership, and conclusions from this basic qualitative study follow.

Findings, Interpretations, and Conclusions

STEM education is still new to most teachers, rendering effective implementation of STEM in the classroom challenging and, at times, intimidating (Guzey et al., 2017). Donohoo et al. (2018) explained outside of individual and external factors (e.g., student ability and socioeconomic status), teacher efficacy is among the strongest predictors of student achievement in STEM-related subjects and beyond. The data analysis of this basic qualitative study uncovered key themes to exploring and understanding teachers' feelings of efficacy when using a localized, integrated STEM curriculum concerning the research questions.

A thorough comparison of the research themes and major findings related to teacher efficacy and integrated STEM curriculum can equip teachers with the competencies needed to prepare students to meet increasing demands for STEM-related jobs (Vu & Feinstein, 2017). STEM-related occupations are projected to make up more than one fifth of all jobs and will continue to grow in coming years (Fayer et al., 2017). Teachers need appropriate, professional support to implement STEM-incorporated employability skills (e.g., critical thinking and problem solving) to prepare young people to occupy these jobs (Flynn, 2017). In the following section, the themes as aligned with the research questions are compared to the existing literature on teacher efficacy, integrated STEM curriculum, and the theoretical framework as outlined in Chapter 2.

Discussion of Literature Review and Themes

The themes identified in the research in Chapter 4 supported the literature review in Chapter 2. Table 1 shows the common themes of teacher efficacy and integrated STEM curriculum concerning the general role in supporting effectiveness in developing students' STEM-related content.

Table 1

Literature Review Themes and Research Themes

Literature review theme	Related Chapter 4 theme or subtheme
Teacher efficacy.	Teacher efficacy through curriculum design. Teacher efficacy development.
Integrated curriculum as curriculum reform.	Integration simplified STEM instruction. Curriculum design to support STEM integration.
Importance of localizing Integrated STEM curriculum.	Support through curriculum design. Materials needed for successful implementation of STEM education.

Teacher Efficacy Development Through Curriculum Design

Abong (2015) described the curriculum as the organ of education that helps to improve the quality of education at any institution. This study aimed to gain in-depth information to understand and explore participants' perspectives on the integrated STEM curriculum and how the curriculum supports teachers' self-efficacy. Turner et al. (2019) explained that teachers need guidance when asked to implement new pedagogy in the classroom. The results indicated although other factors (e.g., years of service and content knowledge) are essential in the STEM classroom, a well-designed curriculum greatly influences teachers' efficacious beliefs. The data from this research study revealed that although some participants were experienced teachers, having a document as a point of reference from which to either follow as designed or modify increased their willingness and confidence in guiding their students toward success. Apriliani (2020) concurred a curriculum is a tool that supports the skills of educators and, by extension, the development of teacher efficacy.

Masarik (2017) explained that curriculum design in STEM education provides enrichment and empowerment for students and teachers. Based on the data collected through interviews and field observation, there was a significant change in teachers' self-efficacy after using an integrated STEM curriculum. These results aligned with various findings described in Chapter 2 that appropriate professional support can significantly increase teachers' confidence, knowledge, and efficacy (Kelley et al., 2020; Noben et al., 2021). Curriculum design is the foundation of effective teaching; Du et al. (2019) explained STEM should be designed to include elements relating to pedagogy, content knowledge, and teachers' attitudes and beliefs. Data suggested most teacher participants noted increased feelings of competency when using the Sphero curriculum in their classroom. This increase in efficaciousness among participants reinforced Ke et al.'s (2019) arguments about a general increase in teachers' effectiveness with appropriate professional support.

Teacher Efficacy Development

Hoi et al. (2017) explained there are multiple sources of teacher efficacy, and it is vital to create a working environment that consistently supports teacher efficacy. Notably, although each participant received the same professional support, their teaching self-efficacy developed differently. After the first three lessons, some participants displayed increased efficacy as they modified the given curriculum and felt confident to modify the lessons to suit their students' needs. Others explored the lessons available on the Sphero website, created their teacher account, and continued working with the curriculum outside the research period. At the end of the study, almost all participants displayed traits that correlated with the efficacious teacher, including being prepared, taking risks, and setting high expectations for themselves and their students (Tschannen-Moran & Hoy, 2001).

Du et al. (2019) explained that curriculum design influences teachers' efficacious beliefs and development. Zee and Koomen (2016) described efficacious teachers as intrinsically motivated, open-minded, innovative, and curious. The teacher participants in this research study demonstrated competence and confidence in their abilities to perform actions that lead to positive student outcomes. These traits were made evident by participants as the research progressed. Notably, almost all participants prepared complete lessons suitable for STEM-based course content that aligned with their unique teaching styles. Importantly, teacher efficacy does not develop linearly; such efficacy is cultivated over time by acquiring complex teaching skills and knowledge. However, factors such as available teaching resources and support received from school leaders play a crucial role in high levels of teacher efficacy (Alibakhshi et al., 2020).

Integration Simplifies and Supports STEM Instruction

The ideas of STEM education are still unclear and may have different meanings depending on the context of use (Falloon et al., 2020; Öztürk, 2021). Gonzalez and Kuenzi (2012) explained vast inconsistency exists in the definition of STEM, which Kloser et al. (2018) also confirmed. The latter explained the ambiguity surrounding the meaning of STEM is due to the lack of consensus regarding STEM skills, how students best acquire these skills, and how teachers may guide students in acquiring these critical skills. As such, clarification on what accounts for STEM and how these disciplines are related is necessary (Kloser et al., 2018). The data collected in Chapter 4 confirmed the localized, integrated STEM curriculum adopted from Sphero provided teachers with consistency and a basic framework for STEM instruction, as described in Chapter 2.

Although STEM seems to be at the center of education worldwide, De Meester et al. (2018) explained STEM integration remains an emerging approach to STEM instruction. The research findings in the current study aligned with the literature reviewed in Chapter 2, demonstrating an integrated curriculum design, such as Sphero, provides teachers with the blueprint needed to effectively teach students STEM skills (De Meester et al., 2018). Acquisition of STEM competencies (e.g., problem solving, collaboration, and teamwork) is essential for young people. The U.S. Department of Education (2015) emphasized high school graduates need to be prepared to think critically and deeply to become educators, innovators, researchers, and leaders with the skills to solve the world's challenges. A localized curriculum, such as the one used in this study and described by participants in Chapter 4, simplified and supported STEM instruction. Participants explained the Sphero curriculum increased students' interest in STEM and supported teachers' feelings of efficacy.

Curriculum Design to Support STEM Integration

Katal and Singh (2022) described curriculum design as the international and structured curriculum arrangement within a class or course. The administrative participants expressed the localized curriculum modeled from the integrated STEM curriculum, Sphero, provided a precise language for teachers to understand and realize schoolwide expectations surrounding STEM. The curriculum served as a standard reference from which classroom teachers, irrespective of course content, planned and guided students toward a deeper understanding of STEM instruction to develop STEM literacy among students.

The administrative participants shared that classroom teachers' instruction and teacher self-efficacy benefited from the Sphero curriculum because the curriculum was well-articulated, rigorous, and coherent. Each teacher participant could plan daily lessons using the curriculum as a guide. The sample lessons provided a clear road map for teachers to build on the content students knew and capitalize on their interests and experiences, thereby providing an opportunity to keep students engaged in the real-life, rigorous learning experiences of high-quality STEM instruction.

Support Through Curriculum Design

This study's conclusion that curriculum design is essential to support teachers in effectively carrying out STEM instruction in the classroom aligned with literature indicating a well-designed curriculum positively impacts lesson designs (Race & Even, 2021; Wiggins & McTighe, 2005). The daily lesson plan was how teachers communicated and guided students to desirable learning outcomes in all aspects of school, including STEM competencies. Gale et al. (2020) concluded teacher confidence is supported through a straightforward instructional design. Some participants, teachers, and administrators highlighted the lesson plans in the localized STEM curriculum used during this study. All participants described ways the sample lessons helped strengthen classroom instructions, whether the plan was used as given or modified based on course content or learner needs. Participants cited sample lesson plans that reflected all components of a well-designed STEM lesson. The lessons were hands-on, addressed everyday problems, aligned to their courses, and included the programming component on the "T" (i.e., technology) in STEM that is often missing from other STEM-related lessons.

In this study, participants emphasized the need for continuity in support. Even though the curriculum was provided, participants expressed the need for support from curriculum writers to help eliminate misunderstandings of the expectations. Throughout most interviews, teachers shared, in some instances, the curriculum provided could be unclear and confusing. At the same time, some teachers admitted to not always consulting the curriculum and relying on their expertise based on experience to support their lesson planning and instruction.

Materials Needed for Successful Implementation of STEM Education

Although all participants expressed ownership for sourcing and preparing relevant materials for instruction, participants explained it was helpful to have ready access to the materials provided during the research. Specifically, the materials available during this study included: (a) pre-prepared lesson plans available in hard and soft copies; (b) programmable robot ball, Sphero Sprk+; (c) found materials, such as straws, zip ties, and cardboard used during lessons; (d) access to the online Sphero lesson resources; and (e) access to the researcher (i.e., curriculum organizer). Underlying all of these articulated resources was an inference of support in the administrator–teacher relationship.

The emphasis on the need for continued support in the classroom was consistent with literature related to developing a culture of STEM instruction across schools. Wieselmann et al. (2021) referred to the importance of school leaders in developing STEM-focused schools. These components included leadership, reform-based instructional strategies, and teachers' professional learning (Wieselmann et al., 2021). This study's conclusion emphasized the importance for teachers and administrations to have a localized curriculum tailored to meet the needs of their students. Understanding the professional needs of teachers aligned with literature that each teacher's efficacious beliefs are unique (Mosoge et al., 2018; Specht & Metsala, 2018; Young et al., 2018). School personnel must focus on the specific needs of their teachers and integrate those needs into curriculum design. An integrated curriculum may be the catalyst for change and reform toward effective teaching within their schools in STEM instruction.

Theoretical Framework Analysis of Findings

Bandura's (1986) self-efficacy theory and Kelley and Knowles's (2016) conceptual framework guided this study and data analysis. The self-efficacy survey based on Bandura's social cognitive theory assisted in developing the interview questions. In contrast, Kelley and Knowles's conceptual framework assisted in adapting lessons from the Sphero curriculum for the localized, integrated curriculum. In total, 11 teacher participants used the integrated sample lessons in the classrooms over the research period. Yin (2011) explained participants in social constructivist research might help the researcher understand a phenomenon by sharing the understanding of a lived experience. Collaboration with the researcher, administrators, and other participants allowed the construction of meanings based on their experiences working with the Sphero curriculum, as described in Chapter 4.

The localized, integrated STEM curriculum developed for this research was built on the conceptual framework articulated by Kelley and Knowles (2016). Teachers often struggle with making connections across the STEM discipline. Data collected confirmed an articulated curriculum provided teachers with the blueprint for providing STEM instruction to students. Participants expressed the lesson plans had key features of connecting disciplinary content while allowing students to explore real-world scenarios. These experiences also allowed students to build transferrable knowledge (Nielsen & Davies, 2019). Additionally, each participant noted the curriculum design enabled them to promote STEM literacy by developing and executing cohesive learning experiences that use course knowledge while simultaneously facilitating growth in problem-solving skills (Almarode et al., 2019).

As described in the theoretical framework section of Chapter 2, sample lessons reflected Kelley and Knowles's (2016) suggestion about the nature of STEM education and how it is best integrated into the schoolwide curriculum. The curriculum design aligned with English's (2017) perspective about STEM education: though there must be integration, the integrity of each discipline should be maintained.

Limitations

This study had limitations preventing the results from applying to all international schools interested in implementing a localized, integrated STEM curriculum to support teacher efficacy. A limited school population diminished the sample; the study took place in China, where strict COVID-19 global pandemic protocols limited travel to nearby schools in the system. The smaller population hindered the study outcome and reduced the confidence level due to the specificity of the sample. The time frame for the conducted research was Term 4 of the 2021–2022 academic school year, which added some undue stress, particularly for teachers at the foreign national school who lost some instructional time due to provincial testing and the systemwide Applied Design Skills and Technology initiative.

Data were constrained to what could be acquired during the research time. Moreover, data were dependent on the honesty and opinion of the participants, even though gathering teachers' perspectives on the topic was valuable, and collecting administrators' perceptions on the same topic provided additional affirmation (Patton, 2014). The assumption was teachers participating in the study conducted at least 10 lessons using the curriculum provided during the research period. Also, it was assumed administrative participants reviewed the curriculum thoroughly to share their feelings about the integrated STEM curriculum and teacher efficacy. All participants were full-time employees of the studied school. The study did not include teachers and administrators outside of the school system.

Recommendations

Practical and applicable recommendations emerged from the findings of the study. Teachers need adequate and ongoing support to help cultivate the necessary STEM skills students need to function effectively in the 21st century. Understanding the need for a well-defined STEM curriculum that factors available resources, students' needs, and teacher competencies is necessary to support teacher efficacy in providing STEM instruction. Adapting existing curricula, such as Sphero, is a way for school leaders and curriculum writers to spark enthusiasm for STEM implementation schoolwide and increase teacher competency in STEM-related courses and across all courses. STEM literacy is vital for all 21st-century graduates who are digital citizens. An adaptable, localized curriculum across various courses will help equip students with core STEM-related skills necessary for success.

Allowing teachers the opportunity to share their experiences would help teachers understand a curriculum serves as a guide that may be adapted to meet students' unique needs. A shift in school culture empowers teachers to know standardization with curriculum does not mean sameness in all tasks and learning experiences within the classroom. Inquiry-based instruction, such as that of the localized, integrated STEM curriculum, can increase students' acquisition of the key competencies outlined by the research site, which comprise a subset of 21st-century skills embedded in each lesson.

Recommendations based on the study findings include additional research on how teachers tailored the curriculum to meet the needs of ELLs during STEM instruction. A qualitative study with a case study design could be conducted to analyze teachers' levels of efficacy before and after using an explicit STEM curriculum for instruction. Future research in teacher efficacy and curriculum design over a continued period could support school leaders and teachers at other international schools.

Implications for Leadership

This study's findings provided confirmation and extended knowledge of previous research. Teacher efficacy through curriculum design, teacher efficacy development, integration of simplified STEM instruction, curriculum design to support STEM integration, and support through curriculum design emerged as themes. Bandura's (1986) self-efficacy theory was supported by the themes of support for the development of teacher efficacy. Kelley and

Knowles's (2016) conceptual framework guided the adaptation of the Sphero curriculum for a localized, integrated STEM curriculum.

One implication was the need for an explicit writing curriculum to guide instruction in both STEM-related courses and non-STEM-related courses. This study provided evidence that curriculum design is crucial in supporting teacher efficacy, which has been corroborated by myriad research that demonstrated such a relationship exists between teachers' self-efficacy on pedagogy (Martin et al., 2012; Tschannen-Moran & Woolfolk Hoy, 2001; Weshah, 2012).

Conclusion

Although perspectives on the role of an integrated STEM curriculum to support teacher efficacy varied from each participant, the six common themes were the prominent factors in data collection for this basic qualitative study. Because supports for teacher efficacy and the role of the curriculum change with time, the themes in this provided timely and iterative insights. Findings about teachers' feelings of efficacy when using a localized, integrated STEM curriculum at an international school yielded six themes: (a) support through curriculum design, (b) integration of simplified STEM instruction, (c) teacher efficacy through curriculum design, (d) teacher efficacy development, (e) curriculum design to support STEM integration, and (f) materials needed for successful implementation of STEM education. Some participants experienced a feeling of increased efficacy while working with the integrated STEM curriculum, some teachers noted a change in students, and some administrators felt the curriculum is vital to teachers' effectiveness in the classroom. These themes helped develop a greater understanding of teachers' feelings of efficacy when using a localized, integrated STEM curriculum.

This study sought to explore and understand teachers' feelings of efficacy when using a localized, integrated STEM curriculum at an international school (i.e., foreign national and high school) in China. Data collection through the study indicated the need for a localized, integrated STEM curriculum to support teacher efficacy in developing students' STEM literacy. Additional data showed a positive relationship between teacher curriculum design and teachers' feelings of support and efficacy while teaching. Participants expressed increased feelings of comfort working with the adapted Sphero curriculum and found it easy to modify based on their course content and the needs of their students.

Educational leaders, specifically curriculum writers, could use the data from the study to improve their course design. Implications of the study include the necessity for teachers to have a clear blueprint in the form of a curriculum with sample lesson plans that are easily adaptable to meet the needs of learners. Teachers need the opportunity to collaborate with colleagues and a space to share best practices for teaching STEM and other courses at all levels of the K–12 systems.

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Appendix A

Site Permission Letters

AMERICAN COLLEGE of EDUCATION

October 24, 2021

[redacted]

Re: Permission Request

Dear [redacted]

My name is Sophia Morgan, and I am a doctoral candidate at the American College of Education writing to request permission to carry out a basic qualitative research study involving international teachers at [redacted] Schools.

This data collected will be used for my dissertation research related to ***Integrated STEM Curriculum and Teacher Efficacy: A Qualitative Study.***

The purpose of the study will be to investigate and understand the role of the integrated STEM curriculum in fostering teacher efficacy in the classroom.

Additional participants could include:

- Superintendent or Assistant Superintendent
- System Coordinators of Mathematics, Science, ADST,
- School Principals or Vice Principals or Member of the Local School Leadership team at the [redacted] School.
- Study participants: Approximately 20 classroom teachers from both institutions.

Important Contacts for this study include:

Principal Investigator: Sophia Morgan
Email: [redacted]
Phone: [redacted]

Dissertation Chair: Timothy Rodriguez
Email: [redacted]

Thank you for your attention to this issue and prompt response. I appreciate your time and consideration of my request.

Regards,
Sophia Morgan

AMERICAN COLLEGE *of* EDUCATION

March 13, 2022

[redacted]

Re: Permission Request

Dear [redacted]

My name is Sophia Morgan, and I am a doctoral candidate at the American College of Education writing to request permission to carry out a basic qualitative research study involving international teachers at [redacted]

This data collected will be used for my dissertation research related to ***Integrated STEM Curriculum and Teacher Efficacy: A Qualitative Study.***

The purpose of the study will be to investigate and understand the role of the integrated STEM curriculum in fostering teacher efficacy in the classroom.

Additional participants could include:

- Superintendent or Assistant Superintendent
- System Coordinators of Mathematics, Science, ADST,
- School Principals or Vice Principals or Member of the Local School Leadership team at the [redacted] School.
- Study participants: Approximately 20 classroom teachers from both institutions.

Important Contacts for this study include:

Principal Investigator: Sophia Morgan
Email: s[redacted]
Phone: 1[redacted]

Dissertation Chair: Timothy Rodriguez
Email: t[redacted]

Thank you for your attention to this issue and prompt response. I appreciate your time and consideration of my request.

Regards,
Sophia Morgan

Appendix B

Email to Site Principal

11/2/21, 12:04 PM Mail - Sophia Morgan - Outlook

Site Permission Packet

Sophia Morgan [redacted]

Wed 10/27/2021 2:55 AM

To: [redacted]

2 attachments (72 KB)

Permission Letter.docx; Recruitment Letter.docx;

He[redacted]

Thanks for speaking with me about conducting my dissertation research at the[redacted]S. I am attaching here the Permission and Recruitment Letter, which contains more information about my research plan. Also, I will be sharing with you the Informed Consent Form in the next couple of days.

Please do not hesitate to reach out to me if you have any questions.

Thanks for working with me.

Sophia

Best,

Sophia Morgan

[redacted]

Appendix C

Granted Site Permission

[redacted]

March 14th, 2022

To Whom It May Concern,

Sophia Morgan is a doctoral candidate at American College of Education (ACE) and has requested permission to interview myself (the Principal of the school) and classroom teachers [redacted]. This information will be used for her dissertation research related to Integrated STEM curriculum, and a qualitative study on its impact on teacher efficacy. The purpose of the basic qualitative study will be to investigate and describe the impact of using a localized integrated curriculum for teaching STEM courses to foster teacher efficacy.

[redacted] willingly agrees to collaborate with Sophia Morgan on this project, and is looking forward to more information on next steps.

Sincerely,

[redacted]

[redacted]

Re: Site Permission Packet

[redacted]

Thu 11/4/2021 11:23 AM

To: Sophia Morgan [redacted]

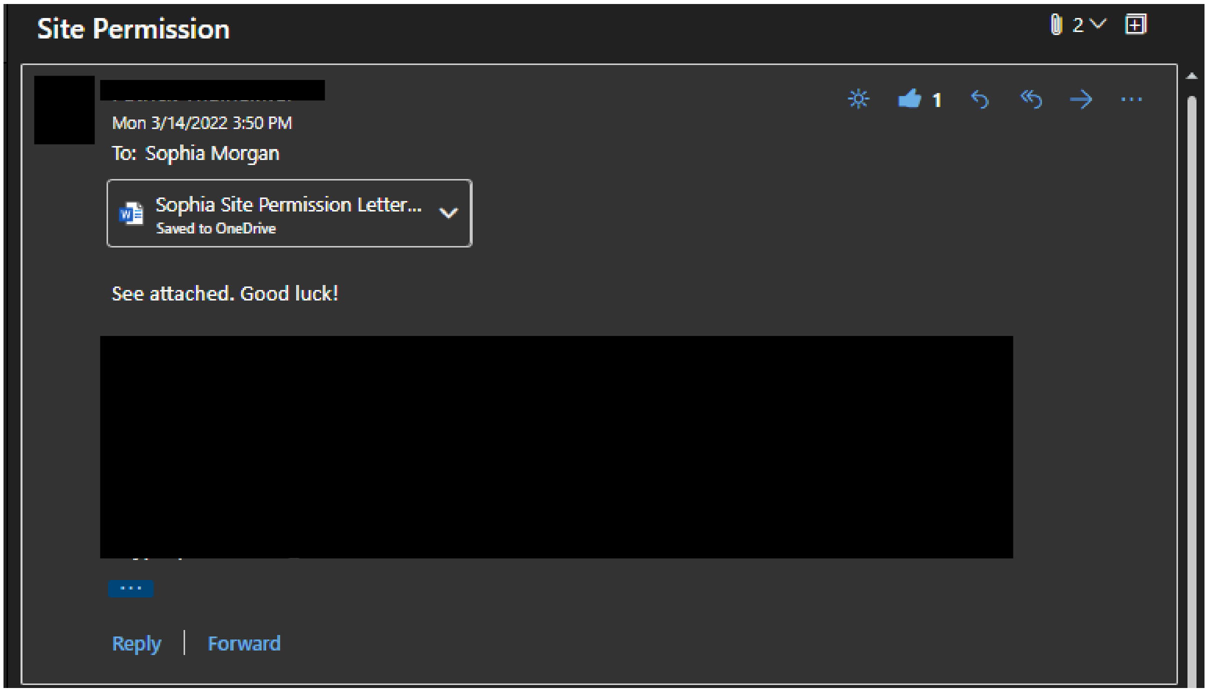
Hi Sophia,

[redacted] willingly agrees to collaborate with you on this project, and are looking forward to more information.

Thank you,

____

[redacted]


Site Permission

[redacted]
Mon 3/14/2022 3:50 PM
To: Sophia Morgan

Sophia Site Permission Letter...
Saved to OneDrive

See attached. Good luck!

[redacted]

Reply | Forward

[redacted]

March 14, 2022

Dear Sophia Morgan:

I hereby grant you site permission to conduct your research at [redacted]

It will be a basic qualitative research study involving international teachers at [redacted]

This data collected will be used for your dissertation research related to ***Integrated STEM Curriculum and Teacher Efficacy: A Qualitative Study.***

I wish you good fortune in obtaining ethical permission to continue.

Warm regards,

[redacted]

Appendix D

IRB Approval

AMERICAN COLLEGE of EDUCATION

March 30, 2022

To : Sophia Morgan
Timothy Rodriguez, Dissertation Committee Chair

From : Institutional Review Board
American College of Education

Re: IRB Approval

"Integrated STEM Curriculum and Teacher Efficacy: A Qualitative Study"

The American College of Education IRB has reviewed your application, proposal, and any related materials. We have determined that your research provides sufficient protection of human subjects.

Your research is therefore approved to proceed. The expiration date for this IRB approval is one year from the date of review completion, March 30, 2023. If you would like to continue your research beyond this point, including data collection and/or analysis of private data, you must submit a renewal request to the IRB.

Candidates are prohibited from collecting data or interacting with participants if they are not actively enrolled in a dissertation sequence course (RES6521, RES6531, RES6541, RES6551, RES6561, RES6302) and under the supervision of their dissertation chair.

Our best to you as you continue your studies.

Sincerely,

Erin Maurer
Assistant Chair, Institutional Review Board
American College of Education

Appendix E

Research Participants

Table 2

Participants' Subject and Years of Experience Teaching STEM courses

Participants Pseudonyms	School	Subject/Role	Years Teaching
Teachers			
HST – 01[1]	International High School	Physics 11	26 years
HST- 02	International High School	Computer Science 10	14 years
HST – 03	International High School	Environmental Science 11	15 years
HST - 04	International High School	Foundations of Mathematics 10	20 years
HST – 05**[2]	International High School	Science 10	Five years
HST – 06	International High School	Science 10	Eight years
HST – 07	International High School	Mathematics 10	14 years
HST – 08	International High School	Foundations of Mathematics 10	Ten years
FNST - 01	Foreign National School	Grade 8 – 9	Five years
FNST - 02	Foreign National School	Kindergarten	One year
FNST – 03	Foreign National School	Grade 2	14 years
FNST- 04	Foreign National School	Grade 4 – 5	Three years
FNST – 05	Foreign National School	Grade 6	One year
Administrators			
Admin – 01	International High School	Educational Coordinator	30 years
Admin – 02	International High School	Acting School Principal	15 years
Admin - 03	System	System Coordinator Director of research Consortium Curriculum Writer – Science and Mathematics	19 years
Admin – 04	International High School	Vice Principal Mathematics Department Liaison	10 years
Admin – 05	Foreign National School	Principal	11 years

[1] HST – 01* - No longer attached to the school and discontinued after pre-interview

[2] HST – 05** - Withdrew from study after pre-interview

Participants Pseudonyms	**School**	**Subject/Role**	**Years Teaching**
Admin – 06	System	System Coordinator of ADST[3] and STEM	Five years

[3] ADST – Applied Design Skills and Technology

Appendix F

Recruitment Letter

AMERICAN COLLEGE of EDUCATION

Recruitment Letter

Date October 26, 2021

Dear Participant

I am a doctoral student at American College of Education. I am writing to let you know about an opportunity to participate in a dissertation research study.

Brief description of the study:

Description of criteria for participation:

Your participation in the study will be voluntary. If you wish to withdraw from the research at any time, you may do so by contacting me using the information below.

I may publish the results of this study; however, I will not use your name nor share identifiable data you provided. Your information will remain confidential. If you would like additional information about the study, please contact the following

Candidate Contact Information:

Sophia Nicole Morgan
Email: [redacted]
Phone: [redacted]

Chair Contact Information:
Timothy Rodriguez
E-mail: [redacted]

If you meet the criteria above, are interested in participating in the study, and would like to be included in the potential participant pool, please use the link below to access, review, and accept the informed consent.

Here is the link to give consent to participate

https://www.surveymonkey.com/r/V6ZZPHM

Thank you again for considering this dissertation research opportunity

Sophia Morgan

Appendix G

Informed Consent Form

AMERICAN COLLEGE of EDUCATION

Informed Consent Updated

Prospective Research Participant: Read this consent form carefully and ask as many questions as you like before deciding whether you want to participate in this research study. You are free to ask questions at any time before, during, or after you join in this research.

Project Information Project Title: **Integrated STEM Curriculum and Teacher Efficacy: A Qualitative Study**

Researcher: Sophia Morgan
Organization: American College of Education
Email: xxxxx@xxx.edu or xxxxx@xxx.com
Telephone: XXX-XXX-XXXX

Date of IRB Approval: Please note that the American College has approved this research study of the Education Institutional Review Board. The IRB approved this study on **March 30, 2022**. A copy of the approval letter will be provided upon request.

Researcher's Dissertation Chair: Timothy Rodriguez
Organization and Position: American College of Education, Dissertation Chair

Email: xxxxx@ace.edu

Introduction

I am ***Sophia Morgan***, a doctoral candidate student at the American College of Education. I am researching under the guidance and supervision of my Chair, ***Dr. Rodriguez***. I will give you some information about the project and invite you to be part of this research. Before you decide, you can talk to anyone you feel comfortable with about the investigation. If you have questions, ask me to stop as we go through the information, and I will explain. If you have questions later, feel free to ask me then.

Purpose of the Research

The purpose of this basic qualitative study is to explore and understand teachers feeling of efficacy when using a localized, integrated STEM curriculum.. You are being asked to participate in a research study as you will provided important evidence that will assist with determining if an integrated STEM curriculum may supports of teacher efficacy Conducting this qualitative study will show the relationship between integrated STEM curriculum and teachers feeling efficacious.

Research Design and Procedures

The study will us a qualitative methodology and a basic qualitative research design. The recruitment letter requesting teacher participants in a STEM driven afterschool initiative will be disseminated to participants in the high school and foreign national schools. The study will comprise 20 participants who will participate in interviews and classroom observations to be conducted at a site most convenient to the participants. After 4 weeks of data collection, a debrief session will occur involving participants and researcher. Participants will be selected to share their feelings of efficacy specific to using the integrated curriculum when planning STEM driven learning experience for students.

Participant selection

You are invited to participate in this research because of your experience as a classroom teacher who can contribute much of the data needed for this basic qualitative study about the integrated STEM curriculum and teacher efficacy. This characteristics meets the criteria for this study. The participant section criteria for this study are classroom teachers at the high school and foreign national schools who volunteer for STEM based afterschool initiative.

Voluntary Participation

Your participation in this research is entirely voluntary. It is your choice whether to participate. If you choose not to participate, there will be no punitive repercussions.

Right to Refuse or Withdraw

Participation is voluntary. If you wish to end your involvement in the research study, you may do so by sending me an email explaining that you are opting out of the study. There will be no repercussions for leaving the study.

Procedures

We are inviting you to participate in this research study. If you agree, you will be asked to sign the attached consent form. The type of questions asked will range from a demographical perspective to direct inquiries about feelings of comfort and competency while using the integrated curriculum to teach STEM courses. Additionally, you will be asked to record any four lessons that may be used for classroom observation by the researcher.

Duration

The interview (individual and focus group) portion of the research study will require approximately 60 minutes to complete. If you are chosen to be interviewed or participate in focus, the time allotted for interview will be at a location and time convenient for you. Prior to an interview, you will be asked to provide permission to have the interview recorded for the sake of having accurate transcripts for data. A follow-up debriefing session will take place at the end of the period. The data gathering process should not exceed one term (9 weeks)

Risks

The researcher will ask you to share personal and confidential information, and you may feel uncomfortable talking about some of the topics. You do not have to answer any question or participate in the discussion if you don't wish to do so. You do not have to give any reason for not responding to any question.

Benefits

Although there will be no direct financial benefit to you, your participation will likely help us find out more about teacher efficacy when using an integrated curriculum. The potential benefits of this study will aid the curriculum reform in providing STEM instruction.

Confidentiality

I will not share information about you or anything you say to anyone outside of the researcher. During the defense of the doctoral dissertation, data collected will be presented to the dissertation committee. The data collected will be kept in a locked file cabinet or encrypted computer file. Any information about you will be coded and will not directly correlate, which directly identifies you as the participant. Only I will know your number, and I will secure your information password-protected file.

Sharing the Results

The results will be available for each participant at the end of the research study. It is anticipated to publish the results so other interested people may learn from the research.

Questions About the Study

If you have any questions, you can ask them now or later. If you wish to ask questions later, you may contact Sophia Morgan at xxxxx@mapleleafedu.com. This research plan has been reviewed and approved by the Institutional Review Board of the American College of Education. This committee's role is to ensure that research participants are protected from harm; if you wish to ask questions about this group, email xxx@ace.edu.

CERTIFICATE OF CONSENT

I have read the information about this study, or it has been read to me. I acknowledge why I have been asked to be a participant in the research study. I have been provided the opportunity to ask questions about the study, and any questions have been answered to my satisfaction. I certify I am at least 18 years of age. I consent voluntarily to be a participant in this study.

Print or Type Name of Participant: ______________________________

Signature of Participant: ______________________________ Date: _________________

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily. A copy of this Consent Form has been provided to the participant.

Print or type name of lead researcher: ____
Signature of lead researcher: _____________________________________

Date: _______________________________

PLEASE KEEP THIS INFORMED CONSENT FORM FOR YOUR RECORDS

Appendix H

Informed Consent Signature

Paper Consent

CERTIFICATE OF CONSENT

I have read the information about this study, or it has been read to me. I acknowledge why I have been asked to be a participant in the research study. I have been provided the opportunity to ask questions about the study, and any questions have been answered to my satisfaction. I certify I am at least 18 years of age. I consent voluntarily to be a participant in this study.

Print or Type Name of Participant: ____________________________

Signature of Participant: ____________________________ Date: ________________

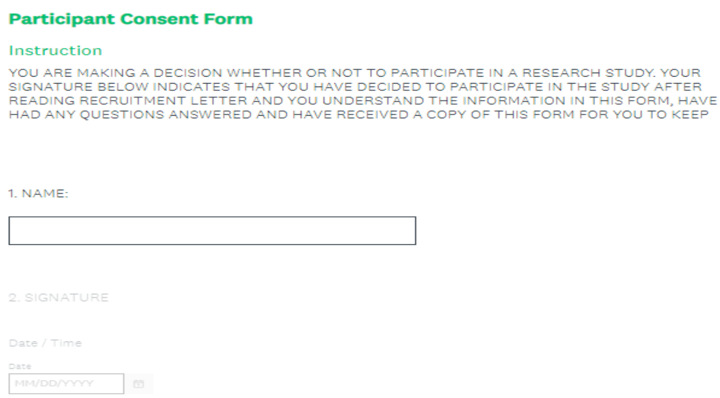
I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily. A copy of this consent form has been provided to the participant.

Print or type name of lead researcher: ____
Signature of lead researcher: ___________________________________

Date: _____________________________

PLEASE KEEP THIS INFORMED CONSENT FORM FOR YOUR RECORDS

Electronic Consent



Participant Consent Form

Instruction

YOU ARE MAKING A DECISION WHETHER OR NOT TO PARTICIPATE IN A RESEARCH STUDY. YOUR SIGNATURE BELOW INDICATES THAT YOU HAVE DECIDED TO PARTICIPATE IN THE STUDY AFTER READING RECRUITMENT LETTER AND YOU UNDERSTAND THE INFORMATION IN THIS FORM, HAVE HAD ANY QUESTIONS ANSWERED AND HAVE RECEIVED A COPY OF THIS FORM FOR YOU TO KEEP

1. NAME:

2. SIGNATURE

Date / Time

Date

MM/DD/YYYY

Appendix I

Subject Matter Expert Contact

Subject Matter Expert

Sophia Morgan <[redacted]
Sat 11/6/2021 8:50 AM
To: [redacted]

1 attachments (16 KB)
Subject Matter Experts Documents.edited.docx;

Hello [redacted]

Attached here are the proposed instruments I want to use to collect data for my dissertation. When you get a chance, please review and let me know any feedback you might have.

Best,

Sophia Morgan

[redacted]

Subject Matter Expert

Sophia Morgan [redacted]
Sat 11/6/2021 8:52 AM
To: [redacted]
Hello [redacted]

Attached here are the proposed instruments I want to use to collect data for my dissertation. When you get a chance, please review and let me know any feedback you might have.

Best,

Sophia Morgan

[redacted]

Subject Matter Expert

Sophia Morgan [redacted]

Subject Matter Expert

Sat 11/6/2021 8:53 AM

To: [redacted]

Hello [redacted]

Attached here are the proposed instruments I want to use to collect data for my dissertation. When you get a chance, please review and let me know any feedback you might have.

Best,

Sophia Morgan

[redacted]

Appendix J

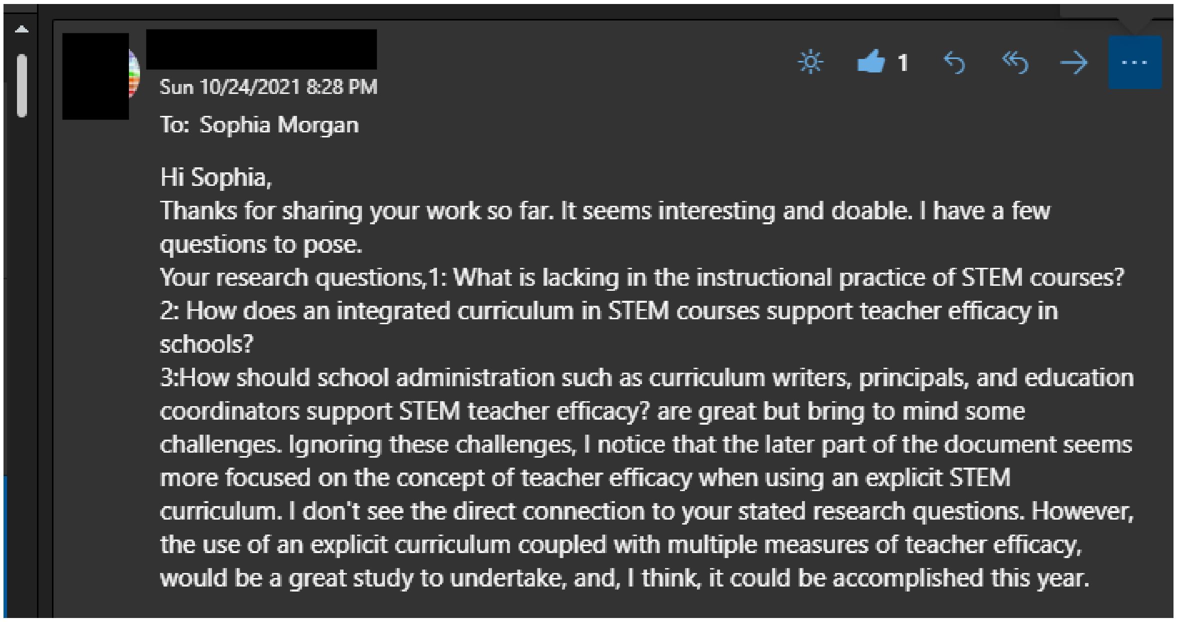
Subject Matter Expert Feedback Table

Contents	Expert 1	Expert 2	Expert 3	Action
Research Design: Qualitative Design	Consider using a mixed methodology that will allow for quantitative and qualitative techniques. For example, instead of using interviews to gauge teachers' comfort level, use a Likert's styled questionnaire. This Likert questionnaire will provide baseline data.	No feedback	No feedback	None – Qualitative design is more idea to capture the unedited thoughts of the classroom teachers' prominent participants.
Participants: Teachers and school leaders at the Foreign National School	No feedback	Consider including the other two foreign national schools in the system. Expanding the research may help increase the reliability of data, and also, the analysis may be used to change system-wide practice rather than just at a single school.	Consider expanding the research to include the middle school teachers. Outside of the language barrier, inclusion will help establish the credibility of research findings, especially because performance and participation in STEM courses are high. Give room to compare best practices in Eastern and Western-styled classrooms.	
Research Questions	Suggestions for improvement including in the picture below.	None	Rewrite research questions to refer to STEM teacher efficacy and integrated curriculum consistently	Modified based on feedback

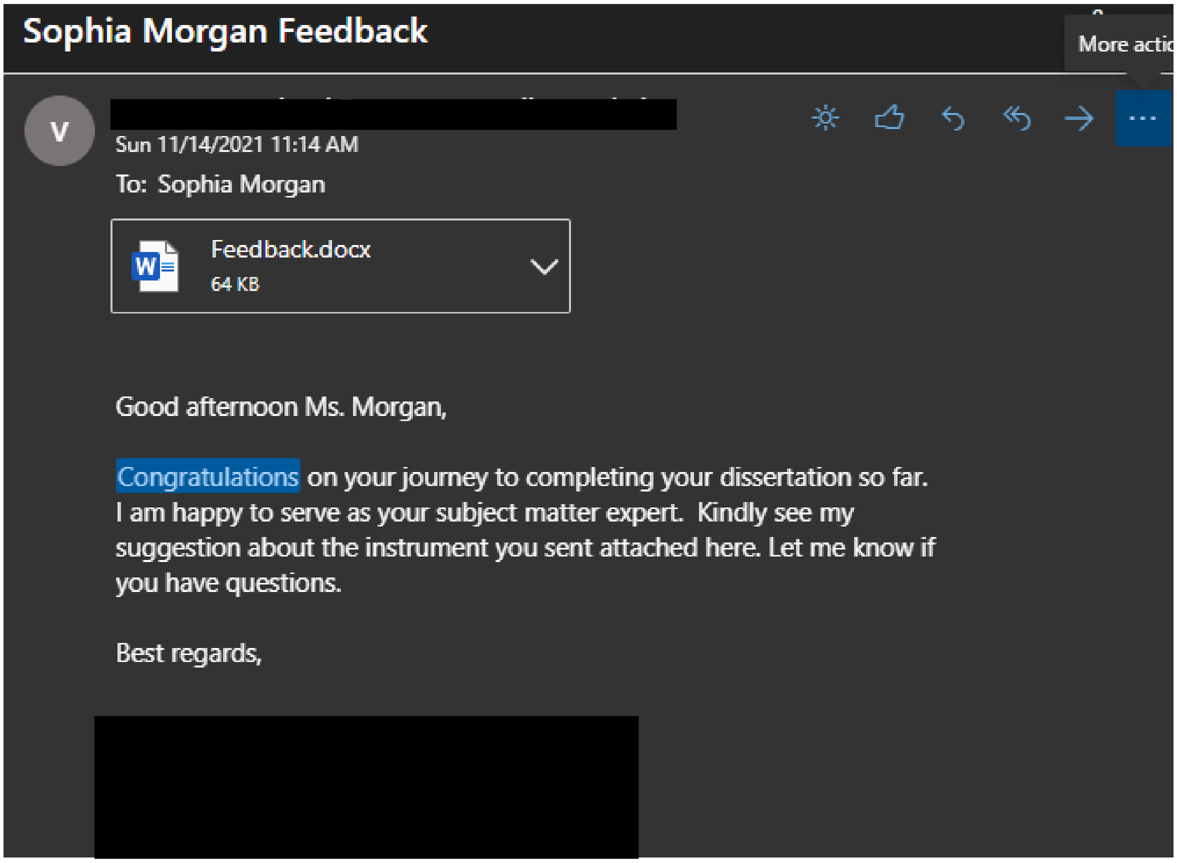
Instruments: Interview questions	Received	Modified based on feedback	Modified based on feedback	Changes were made according to David's suggestions. I will design an open-ended questionnaire based on feedback from the other two experts.

Appendix K

Subject Matter Expert Feedback


[redacted]
Sun 10/24/2021 8:28 PM
To: Sophia Morgan

Hi Sophia,
Thanks for sharing your work so far. It seems interesting and doable. I have a few questions to pose.
Your research questions,1: What is lacking in the instructional practice of STEM courses?
2: How does an integrated curriculum in STEM courses support teacher efficacy in schools?
3:How should school administration such as curriculum writers, principals, and education coordinators support STEM teacher efficacy? are great but bring to mind some challenges. Ignoring these challenges, I notice that the later part of the document seems more focused on the concept of teacher efficacy when using an explicit STEM curriculum. I don't see the direct connection to your stated research questions. However, the use of an explicit curriculum coupled with multiple measures of teacher efficacy, would be a great study to undertake, and, I think, it could be accomplished this year.


Sophia Morgan Feedback

More actic

V [redacted]
Sun 11/14/2021 11:14 AM
To: Sophia Morgan

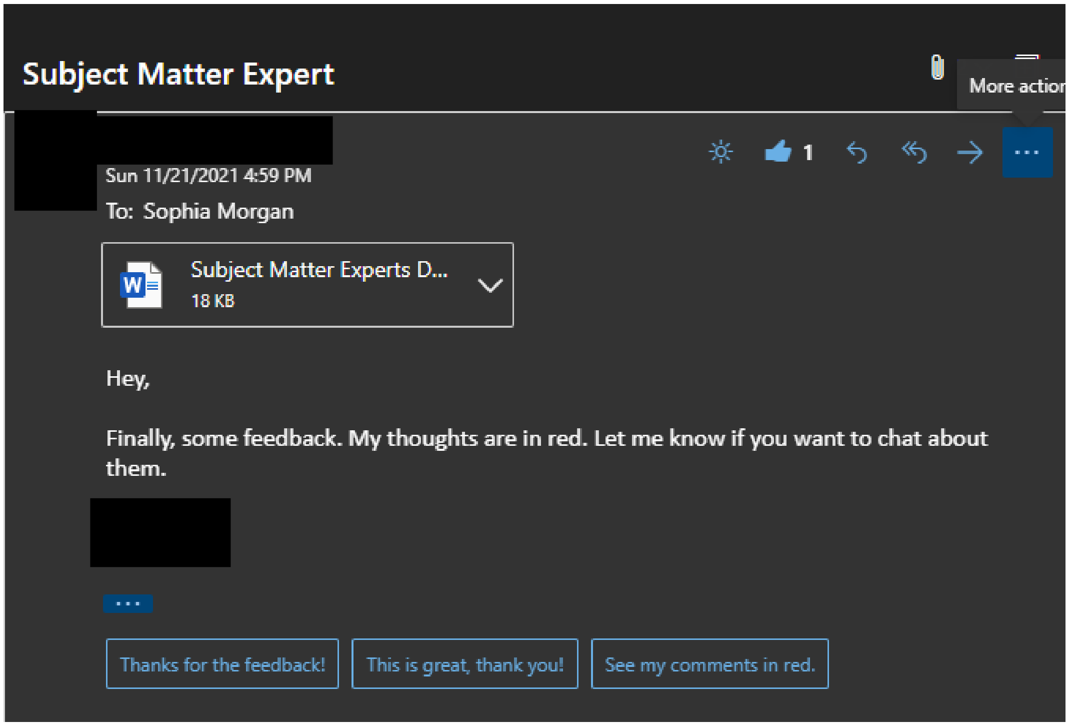
Feedback.docx
64 KB

Good afternoon Ms. Morgan,

Congratulations on your journey to completing your dissertation so far.
I am happy to serve as your subject matter expert. Kindly see my suggestion about the instrument you sent attached here. Let me know if you have questions.

Best regards,

[redacted]



Subject Matter Expert

More actions

[redacted]

Sun 11/21/2021 4:59 PM

To: Sophia Morgan

Subject Matter Experts D...
18 KB

Hey,

Finally, some feedback. My thoughts are in red. Let me know if you want to chat about them.

[redacted]

Thanks for the feedback! | This is great, thank you! | See my comments in red.

Subject Matter Expert Aaron Comments that remain (page 152

Topic: Integrated STEM Curriculum and Teacher Efficacy: A Qualitative Study

I think it would be good to establish what is precisely meant by teacher efficacy (and maybe you do this elsewhere). To me, efficacy would be the teachers' ability to reach a goal or desired result, so my question would be what is the desired result? Is an Integrated STEM curriculum actually beneficial to the desired result? Does integrating STEM mean less depth for a single subject because of the added breadth? And if so, does that mean the original desired outcome from a single subject is no longer attainable? Does this matter?

Research Questions

The following research questions guide the study:

Research Question 1: What support do teachers need from the curriculum to provide STEM learning experiences in the classroom? Does support need to be from the curriculum? Only from the curriculum? I think the specific, narrow (explicit?) definition of curriculum would mean that the support and help would come from teacher's schemes of work and not the curriculum proper per se.

Research Question 2: How might an integrated curriculum support STEM teacher efficacy in schools? Again, what is the intended outcome? Couldn't it also be true that an integrated curriculum could be a hindrance or burden?

Research Question 3: What is the role of school administrators such as school principals, curriculum writers, and education coordinators to support STEM teacher efficacy?

Instrumentation

Interview Question

a) What does the term STEM mean to you?

b) How comfortable are you teaching these courses?

   i. Science

   ii. Technology

   iii. Engineering

   iv. Mathematics

How do you plan on comparing or analyzing the data you receive? It seems very subjective. Additionally, what if a teacher is comfortable in some aspects of a subject like math and not in others?

c) If you could choose a method to improve your classroom instruction, what would you choose and why?

d) How would you change the current curriculum that you are teaching?

e) Describe your lesson planning process.

f) How often do you include STEM-based activities in the classroom?

g) If given preplanned STEM lessons, how likely would you be to use them in your classroom? (Preinterview) What changes did you make to preplanned lessons? Why?

h) If you could choose a member of the school administrative team to support instruction, who would it be and why?

i) In terms of curriculum, what would you need? For what?

Focus group questions guide

Goal: To determine how participants felt about using an integrated curriculum.

1. How would you describe your experience during this study?
2. In what ways has your instructional practice changed after using the curriculum. This seems like a strange question. It almost seems like you're going after two different things.

It seems like you want to change the curriculum (what is taught) and this will have the effect that it changes teacher practice (how they teach). Does what someone teaches determine how they teach? Maybe.

3. How do you feel more comfortable carrying out STEM lessons using this curriculum? What if they don't feel more comfortable?
4. Describe your most challenging lesson? How did you manage? What role did the curriculum play in helping you overcome the challenge? What if the difficulty is from students and not the curriculum or how it was taught?
5. Would you want to continue teaching with an integrated curriculum? What support do you need from school leaders? But no additional support from the curriculum?
6. What is your expectation from teachers? How do you think you could support them?
7. Overall, how would you rate the experience?
8. Is there anything else you would want to share with me?

Observation

Determine teacher efficacy in carrying out instruction

a) The teacher demonstrates in-depth knowledge of the STEM contents.
b) Instruction is well designed and carried out in alignment with the lesson's purpose.
c) Students are guided to engage in high-level learning in STEM content. What is high level learning? I know there is a lot of love for Bloom's Taxonomy (I'm not sure if this is where you're going with this) but I think there are good and solid arguments against it. Essentially that thinking is not so easily distributed in an orderly hierarchy and something like understanding can really have incredible depth (as opposed to the shallow usually assigned by Bloom).

d) Lessons are appropriately and effortlessly adapted to meet the needs of diverse learners.

What if a lot of effort went into adopting the lesson?

e) Assessments are appropriate and aligned with lesson content.

Observation Note

Subject Matter Expert Vennesa Comment

Topic: Integrated STEM Curriculum and Teacher Efficacy: A Qualitative Study

The following research questions guide the study:

Research Question 1: What support do teachers need from the curriculum to provide STEM learning experiences in the classroom?

Research Question 2: How might an integrated curriculum support STEM teacher efficacy in schools?

Research Question 3: What is the role of school administrators such as school principals, curriculum writers, and education coordinators to support STEM teacher efficacy?

Instrumentation

Interview question

j) What does the term STEM mean to you?

k) How comfortable are you teaching these courses?

   v. Science

   vi. Technology

   vii. Engineering

   viii. Mathematics

l) If you could choose a method to improve your classroom instruction, what would you choose and why?

m) How would you change the current curriculum that you are teaching?

n) Describe your lesson planning process.

o) How often do you include STEM-based activities in the classroom?

p) If given preplanned STEM lessons, how likely would you be to use them in your classroom? (Preinterview) What changes did you make to preplanned lessons? Why?

q) If you could choose a member of the school administrative team to support instruction, who would it be and why?

r) In terms of curriculum, what would you need?

Focus group questions guide

Goal: To determine how participants felt about using an integrated curriculum.

9. How would you describe your experience during this study?
10. In what ways has your instructional practice changed after using the curriculum.
11. Do you feel more comfortable carrying out STEM lessons using this curriculum?
12. Describe your most challenging lesson? How did you manage? What role did the curriculum play in helping you overcome the challenge?
13. Would you want to continue teaching with an integrated curriculum? What support do you need from school leaders?
14. What is your expectation from teachers? How do you think you could support them?
15. Overall, how would you rate the experience?
16. Is there anything else you would want to share with me?

Observation

Determine teacher efficacy in carrying out instruction

f) The teacher demonstrates in-depth knowledge of the STEM contents.

g) Instruction is well designed and carried out in alignment with the lesson’s purpose.

h) Students are guided to engage in high-level learning in STEM content.

i) Lessons are appropriately and effortlessly adapted to meet the needs of diverse learners.

j) Assessments are appropriate and aligned with lesson content.

Observation Notes

Sophie, just two things I would add or maybe edit.

1) In the focus group question, I would probably ask how were the student's reaction after the lesson.?
2) What does the term STEM mean to you? Is there a better way you could word it? Maybe What is the relevance of the acronym STEM, to you.

Apart from that everything seems good.

Subject Matter Expert Dave Comment

Data Collection Instruments

Final Research Questions:

Research Question 1: Do teachers feel supported when teaching an integrated STEM curriculum at an international school in China?

Research Question 2: Do teachers experience increased teacher efficacy when teaching from an integrated STEM curriculum at an international school in China?

Research Question 3: What benefits can school leaders and curriculum writers see in providing a STEM integrated curriculum to classroom teachers at an international school in China

Purpose of the Study

This basic qualitative study aims to explore and understand teachers' feelings of efficacy when using a localized, integrated STEM curriculum at an international school in China.

The pool of Interview question

1. What does the term STEM mean to you?
2. How comfortable are you teaching these courses?
   i. Science
   ii. Technology
   iii. Engineering
   iv. Mathematics
3. If you could choose a method to improve your classroom instruction, what would you choose and why?
4. How would you change the current curriculum that you are teaching?
5. Describe your lesson planning process.
6. How often do you include STEM-based activities in the classroom?
7. If given pre-planned STEM lessons, how likely would you be to use them in your classroom? (Pre-Interview) What changes did you make to pre-planned lessons? Why?
8. If you could choose a member of the school administrative team to support instruction, who would it be and why?
9. In terms of curriculum, what would you need? *to feel supported in teaching STEM*
10. Can you speak to changes in your feeling or ability throughout this research period? At the beginning of using the curriculum? During? Towards the end?
11. In this research, ***Teacher Self-efficacy*** is defined as a teacher's belief in their capabilities to bring about desired student engagement and learning (Bandura, 1977). Teachers who believe they are competent to teach their students to have strong self-efficacy beliefs in teaching. Do you view the curriculum supported your teacher efficacy? If yes, in what way? If not, why?
12. Do you think there are areas of your instructional practice that explicit curriculum enhances or limit? Can you describe?
13. What was your most memorable experience working with a localized curriculum? What were some of the challenges? Did you feel the curriculum designed helped you feel confident in addressing these concerns? Describe? Give us some examples?

Focus group questions guide

Goal: To determine how participants felt about using an integrated curriculum.

1. How would you describe your experience during this study?
2. In what ways has your instructional practice changed after using the curriculum. ?
3. How ? do you feel more comfortable carrying out STEM lessons using this curriculum?
4. Describe your most challenging lesson? How did you manage? What role did the curriculum play in helping you overcome the challenge? ✓
5. Would you want to continue teaching with an integrated curriculum? What support do you need from school leaders?
6. To admin? What is your expectation from teachers? How do you think you could support them?
7. Overall, how would you rate the experience?
8. Is there anything else you would want to share with me?

Observation

Determine teacher efficacy in carrying out instruction

1. The teacher demonstrates in-depth knowledge of the STEM contents.
2. Instruction is well designedand aligned with the lesson's purpose.
3. Students are guided to engage in high-level learning in STEM content.
4. Lessons are appropriately and effortlessly adapted to meet the needs of diverse learners.
5. Assessments are appropriate and aligned with lesson content.

Observation checklist

Criteria	Notes + Evidence
The teacher is well prepared for instruction. (Is the teacher organized? lesson plans and materials are linked to curriculum)	
The teacher knows the subject matter. (Science, Technology, Engineering, and Mathematics)	
The teacher has a clear purpose for instruction.	
The teacher has reasonable control of students' behavior.	
The teacher can follow the curriculum guide to achieve desired learning outcomes.	

The teacher seems comfortable and confident in providing STEM instruction.	
The teacher can gain the corporation of almost all students, even students seemingly struggling with the course content.	
Students positively respond to the classroom teacher.	
The classroom teacher can communicate well with students both verbally and non-verbally.	
Other	

Appendix L

Data Collection Instruments

Pool of Interview Questions

1. What does the term STEM mean to you?
2. How would you change the current curriculum that you are teaching?
3. Describe your lesson planning process.
4. How often do you include STEM-based activities in the classroom?
5. Do you consider yourself a STEM teacher?
6. In terms of curriculum, what would you need to feel supported in teaching STEM?
7. Do you feel or think the curriculum supported your teacher's efficacy? If yes, in what way? If not, why?
8. Do you think there are areas of your instructional practice that explicit curriculum enhances or limits? Can you describe it?
9. Would you want to continue teaching with an integrated curriculum?
10. What support do you need from school leaders?
11. How comfortable are you teaching these courses? Science, Technology, Engineering, and Mathematics
12. If you could choose a method to improve your classroom instruction, what would you choose and why? If given pre-planned STEM lessons, how likely would you be to use them in your classroom? (Pre-Interview) What changes did you make to pre-planned lessons? Why?
13. Can you speak to changes in your feeling or ability throughout this research period? At the beginning of using the curriculum? During? Towards the end?

14. Did you feel or think the curriculum supported your teacher's efficacy? If yes, in what way? If not, why?
15. What was your most memorable experience working with a localized curriculum? What were some of the challenges? Did you feel the curriculum design helped you feel confident in addressing these concerns? Describe? Give us some examples.
16. How would you describe your experience during this study?
17. In what ways has your instructional practice changed after using the curriculum?
18. Do you feel more comfortable carrying out STEM lessons using this curriculum?
19. Describe your most challenging lesson? How did you manage? What role did the curriculum play in helping you overcome the challenge?

Focus group questions guide

Goal: To determine how participants felt about using an integrated curriculum.

1. How would you describe your experience during this study?
2. In what ways has your instructional practice changed after using the curriculum?
3. Do you feel more comfortable carrying out STEM lessons using this curriculum?
4. Describe your most challenging lesson? How did you manage? What role did the curriculum play in helping you overcome the challenge?
5. Would you want to continue teaching with an integrated curriculum? What support do you need from school leaders?
6. What is your expectation from teachers? How do you think you could support them? (Administrative Participants)
7. Overall, how would you rate the experience?

8. Is there anything else you would want to share with me?

Observation

Determine teacher efficacy in carrying out instruction

1. The teacher demonstrates in-depth knowledge of the STEM contents.
2. Instruction is well designed and aligned with the lesson purpose.
3. Students are guided to engage in high-level learning in STEM content.
4. Lessons are appropriately and effortlessly adapted to meet the needs of diverse learners.
5. Assessments are appropriate and aligned with lesson content.

Observation Checklist

Criteria	**Notes and Evidence**
The teacher is well prepared for instruction (Is the teacher organized? lesson plans and materials are linked to curriculum).	
The teacher knows the subject matter: (science, technology, engineering, and mathematics).	
The teacher has a clear purpose for instruction.	
The teacher has good control of students' behaviour.	
The teacher is able to following curriculum guide to achieve desired learning outcomes.	
The teacher seems comfortable and confident in providing STEM instruction.	
The teacher is able to gain corporation of almost all students, even students who are seemingly struggling with the course content.	

Students respond the classroom teacher in a positive way.
Classroom teacher is able to communicate will with students both verbally and nonverbally.
Other

Appendix M

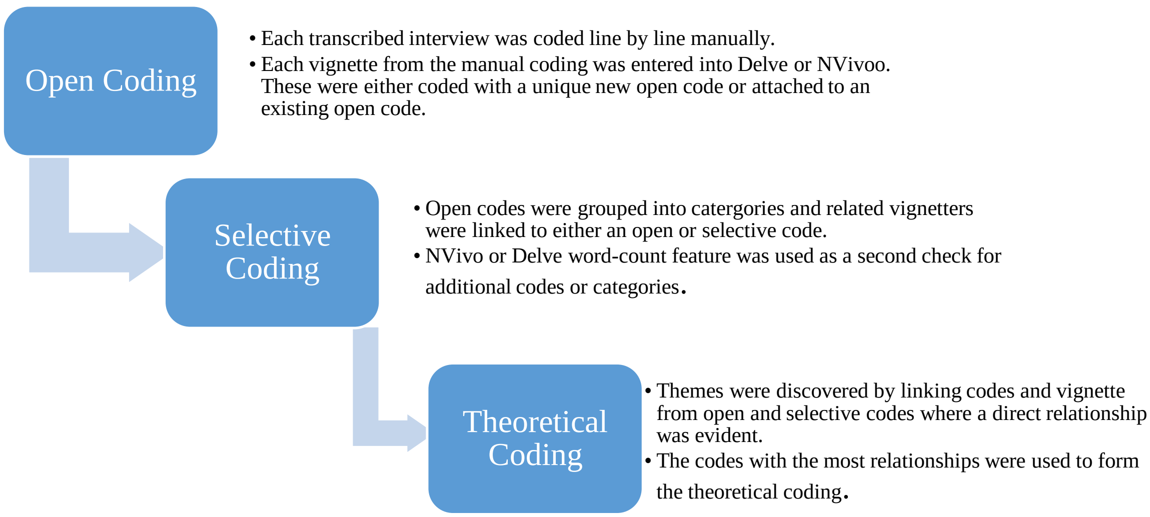
Thank You Note

Appendix N

Data and Analysis Process

Figure 1

Data and Analysis Process



Appendix O

Mapping of Research Questions to Interview and Focus Group Questions

Table 3

Mapping of Research Questions to Interview /Focus Group Questions

Research Question	**Interview Questions /Focus Group Questions**
RQ1: Do teachers feel supported when teaching an integrated STEM curriculum at an international school (foreign national and high school) in China?	1. What does the term STEM mean to you? 2. How would you change the current curriculum that you are teaching? 3. Describe your lesson planning process. 4. How often do you include STEM-based activities in the classroom? 5. Do you consider yourself a STEM teacher? 6. In terms of curriculum, what would you need to feel supported in teaching STEM? 7. Do you feel or think the curriculum supported your teacher's efficacy? If yes, in what way? If not, why? 8. Do you think there are areas of your instructional practice that explicit curriculum enhances or limits? Can you describe it? 9. Would you want to continue teaching with an integrated curriculum? 10. What support do you need from school leaders?
RQ 2: Do teachers experience increased efficacy when teaching from an integrated STEM curriculum at an international school (foreign national and high school) in China?	1. How comfortable are you teaching these courses? Science, Technology, Engineering, and Mathematics 2. If you could choose a method to improve your classroom instruction, what would you choose and why? If given pre-planned STEM lessons, how likely would you be to use them in your classroom? (Pre-Interview) What changes did you make to pre-planned lessons? Why? 3. Can you speak to changes in your feeling or ability throughout this research period? At the beginning of using the curriculum? During? Towards the end? 4. Did you feel or think the curriculum supported your teacher's efficacy? If yes, in what way? If not, why? 5. What was your most memorable experience working with a localized curriculum? What were some of the challenges? Did you feel the curriculum design helped you feel confident in addressing these concerns? Describe? Give us some examples. 6. How would you describe your experience during this study? 7. In what ways has your instructional practice changed after using the curriculum? 8. Do you feel more comfortable carrying out STEM lessons using this curriculum? 9. Describe your most challenging lesson? How did you manage? What role did the curriculum play in helping you overcome the challenge?

Research Question	Interview Questions /Focus Group Questions
RQ 3: What benefits can school leaders and curriculum writers see in providing a STEM integrated curriculum to teachers at an international school (foreign national and high school) in China?	1. If you could choose a member of the school administrative team to support instruction, who would it be and why? 2. What are your expectations from teachers? Moreover, what are some things that you usually do to support them in meeting this expectation? 3. Generally speaking, how would you rank or rate your school-wide (team) teacher efficacy? Moreover, What are the factors that you consider in ranking this efficacy? Can you give examples? (Think specifically in teams of STEM instruction and developing students' STEM literacy) 4. What curriculum are you currently using? Moreover, How do you usually support classroom teachers in using this tool to inform or guide their instructional practice? How would you describe STEM instruction in your school? Is there anything you would change? Think specifically about curriculum design and how it may/may not affect implementation and teacher efficacy. 5. What strategies are you currently using to help increase teacher efficacy in your school or team? What role does the curriculum play? Do you have or use a localized curriculum? 6. Did you get a chance to review the lessons? What are some feedback/or questions you still have? Can you see any benefit, in terms of teacher efficacy, in providing these times of lessons for the classroom teacher? Why? How?

Appendix P

Origins of Themes Categories

Table 4

Origins of Theme Categories

Research Questions (RQ)	Interview Questions (IQ)/ Focus Group Questions FAQ	Emergent Codes	Themes
RQ 1	IQ 1- 9, FAQ 1, 4, 5, 7	Language Barrier Understanding the content Explanation of STEM-related content/concepts Curriculum Structure Experience with STEM Knowledge of STEM strands Design issues with current curriculum – time-consuming, costly	1. Support through curriculum design 2. Integration simplified STEM instruction.
RQ 2	IQ 10 – 18, FGQ 2, 3	Factors that affect self-efficacy/teacher efficacy Expectation Importance of teacher autonomy Adaptation and empowerment Save time Varied instructional Material Meeting diversity needs STEM Pedagogy Application of activities Cross-curricular integration of STEM skills Engaging the unengaged	1. Teacher efficacy through curriculum design 2. Self-efficacy and STEM teacher efficacy
RQ 3	IQ 19, FAQ 1 - 6	Established Guidelines and Expectations Increased teacher job performance Teacher efficacy increases overall school efficacy.	1. Curriculum design to support STEM integration 2. Materials needed for successful implementation of STEM education

Research Questions (RQ)	**Interview Questions (IQ)/ Focus Group Questions FAQ**	**Emergent Codes**	**Themes**
		Curriculum materials Creating a collaborative team to include administrators, curriculum writers, and coordinators	

Appendix Q

Participants' Guide and Sample Lesson

Participants' Guide

Welcome to "I think, therefore, I-STEM."

Here are the lessons selected from the SPHERO curriculum. Teachers may nurture students' curiosity and develop them into thinkers and lifelong learners with the help of Sphero Edu. Sphero Edu is a powerful toolset that supports learners and teachers in reinventing education. Through STEAM activities, the teachings in this research project integrate all subject areas. The development of learners' capabilities and 21st-century thinking talents will also occur through collaborative and creative initiatives.

This basic qualitative study aims to **explore and understand teachers' feelings of efficacy** when using a localized, integrated STEM curriculum at an international school (foreign national and high school) in China. These lessons are designed to seeminglessly integrate STEM content and skills and the core and critical competencies articulated in the British Columbia and World School Curricula.

Each lesson includes activities that will help to develop the following STEM skills in students:

1. Problem Solving Skills
2. Creativity Thinking Skills
3. Critical Thinking Skills
4. Communication Skills
5. Collaborative Skills
6. Refective Skills

Instructional Suggestions

In this program, you are asked to implement any ten lessons (sessions) in a suitable sequence.

In each session,

1. **Collaboration:** Break students up into small groups and delegate students to distinct, rotating roles.
   a) Engineer
   b) Programmer
   c) Designer
   d) Task/Team Manager

2. **Slow down**. Set guidelines for the Sphero robot speeds that kids should use. Fewer accidents and robots on the loose will result from slower speeds! You can also give each group or student a different window of time to run their own programs.

3. **Encourage collaboration through online tools**. Sphero Edu activities are designed to be self-guided. Through the Sphero Edu app, you can assign an activity to an individual student, a group of students, or an entire class. Encourage students to collaborate through online tools such as Google Docs to communicate and share ideas. Students can also attach their program to the Gallery at the end of an activity to share it with classmates. Visit: https://edu.sphero.com/cwists/category to create a teacher account and set up your class.

4. **Reflective Practice**: Encourage students to become reflective learners by engaging in a reflection after each session. For younger learners, I suggest reflection be oral and in a circle time format that allows them to share and learn from each other. For older learners, please give them the reflection questions, ***Student Skills Tracker***, and allow them to prepare an individual written reflection.

5. **Resources:** All the resources you need are included in this package; however, if you may need additional resources, visit https://sphero.com/pages/sphero-self-service-resources.

6. **Tailor:** Feel free to tailor lessons to accommodate your course content, and student pace or integrate them into other lessons. For example, Lesson 2: Draw 1 – Shapes (K – 2) may be modified using Shapes that are appropriate for that grade level, or Lesson 5: Pop Quiz (All) may be used in any course as an interesting way for students to work in teams and review course content. Kindly reach out to me if you need help with any modification, such as lesson replacement or preparation for instruction.

7. **Materials:** Sphero and all lesson materials are provided in the materials kit. Each lesson may be modified using found materials or any appropriate substitute.

8. **Engineering Process:** Two copies of the engineering process are provided; kindly choose the appropriate one to integrate into your lesson. The poster-sized document may be displayed in the classroom and used for whole-class instruction. For the typical A4-sized process, I suggest giving a copy to each team so they may consistently reference it during the design/redesign phase.

9. Remember to document and share experiences in the WeChat Group or Class Dojo.

Lesson 1: Meet Sphero (All)

Learning Objectives

1. I can identify key parts of Sphero and describe what it can do.
2. I can teach someone else about Sphero and how it works
3. I can connect my robot
4. I can aim my robot
5. I can drive my robot

Lesson Description

Exploration 1

For many students, this may be their first time seeing or handling Sphero. Have students examine and use their senses to describe what they see, feel, smell, and hear. Have them share one-word descriptions of what they observe (blue, small, plastic).

Introduce Sphero to them in a way that personifies their robot. For example:

"I want to introduce all of you to Sphero, the robot. Sphero is new to our school and will be a part of our classroom this term. What are some ways we can welcome Sphero to our class?"

or

"Meet Sphero. Sphero is on a special trip from its home planet of Spheropa. Sphero will be a part of our class so it can learn what kids on Earth learn in school. What are some things Sphero should know about our school and classroom?

Everyone is new to school at some point in their lives, and this is an opportunity to introduce empathy for others. Ask students about things they can do to make Sphero feel welcome and things Sphero should know about school (routines and expectations).

Exploration 2

Ask students what they see when they hold and look at Sphero. The Sphero logo (top LED light)? What do they see on the backside? Underneath?

Skills Building

Connect Robot

Let's begin by connecting your robot to the Sphero Edu app on your device. (Download app from App Store)

1. Open the Sphero Edu app and ensure that Bluetooth is enabled.
2. Tap the "Connect Robot" icon at the top right of your screen.
3. Select your robot type.
4. Hold your robot next to the device and select it to connect. If you use multiple robots, look for the robot with the strongest Bluetooth signal.

Aim Robot

Now that your Sphero robot is connected to Sphero Edu, let us practice aiming. All Sphero robots need to be "aimed" and oriented relative to your position so that forward for the robot and you are in the same direction.

1. Place your robot on the floor or a flat surface.
2. In the Sphero Edu app, select "Drive."
3. Tap the "Aim" button.
4. Drag the aiming ring until your robot's blue "tail light" points directly at you.

Drive Robot

Your Sphero robot should now be aimed and connected to the Sphero Edu app. From the drive screen, you can drive your robot.

- Drag the blue circle inside the gray circle to drive your robot and control its direction.
- The blue circle on the vertical line controls the speed.
- Change your Sphero robot's color by dragging the white circle around the color wheel.

Practice aiming and driving your robot by moving it from one side of the room to the other and back again.

Challenge

1. Using the cones, set up a course that will allow students to learn how to control their robots.
2. Use a blindfold and allow students to take turns giving each other directions.

Reflection

Have the students explore their feelings by discussing today's learning activities.

Here are some suggestions for guiding questions:

1. Name and describe three things that you enjoyed about the lesson today.
2. Identify and describe two things that you found most challenging.
3. Describe the steps you took to overcome these challenges?
4. Is there anything else you would like to share about this lesson?

Suggested Extended Activities

1. Sphero Activity Cards
2. Sphero Play Activities
3. Beginner's Programming Challenges

End of Lesson 1