CASE STUDY OF HIGH SCHOOL MATH AND SCIENCE TEACHERS' BELIEFS ABOUT

USING WRITING TO LEARN AND THEIR BELIEFS ABOUT THEMSELVES AS

WRITING-TO-LEARN PRACTITIONERS

by

Virginia Elizabeth Dunker

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

The purpose of this qualitative case study was to document and explore high school math and science teachers' beliefs and instructional practices concerning Writing-to-learn (WTL), or students learning content through writing. Two theories guided this study: Bandura's (1977) theory of self-efficacy and Vygotsky's (1978) sociocultural theory. Data collection included interviews with 10 participants: five math teachers and five science teachers, a focus group comprised of three math teachers and four science teachers from the sample, and participants' journal responses for four weeks. The setting for this study was in an urban high school in the southeastern United States. The student population was approximately 700 students in Grades 6-12, and the school offered a diverse curriculum including health sciences, engineering, and advanced placement courses with an emphasis on preparation for college and career. The four questions to guide this research were: (a) What are math and science teacher's beliefs of their capabilities to teach and use WTL? (b) How do math and science teachers describe themselves as teachers of WTL? (c) What are math and science teachers' beliefs on the effectiveness of writing to support learning? (d) What are the math and science teachers' instructional support needs from the state department of education, administration, and the school district for implementing writing in their classrooms? From the data analysis, five recurring themes emerged from the data analysis: belief about the effectiveness of using WTL, general beliefs about WTL, self-perception as a WTL teacher, belief in the ability to use WTL, and need for support to use WTL. These themes were consistent with relevant literature regarding math and science teacher self-efficacious beliefs about using writing as a tool for learning content.

Keywords: teacher efficacy, writing-to-learn, writing in content areas, teacher beliefs about content area writing

Dedications/Acknowledgments

"Be still and know that I am God; I will be exalted among nations; I will be exalted in the earth" (Psalm 46: 10 *NIV*).

This dissertation would not have been possible without my Lord and Savior Jesus Christ. Christ has been my strength, my faith, my hope, and my enduring love and support. He carried me every step of the way. He constantly reminded me to be still and trust in His gracious wisdom and guidance. I dedicate this dissertation to my loving and ever-faithful husband Cory Dean Dunker, who has been my constant support, my encourager, and my heart, and I thank him for never giving up on me. I also dedicate this dissertation to my late mother Mary Poole Sanders, who taught me more about love, life, and perseverance than anyone, and I thank her for sharing her strong, quiet spirit and for setting an example for how to be a Godly woman. I also dedicate this dissertation to my late father, Kenneth "Bo" Sanders, from whom I acquired the ability to stay strong and the ability to laugh at myself. I thank my family and friends for their love, patience, and encouragement. Words truly cannot express how much love, encouragement, prayer, and support my family has given me. I thank my five children Erin, Glen, Ryan, Cameron, and Evan for listening, praying, loving, understanding, and for cheering me on.

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List of Abbreviations

Advanced Placement (AP)

College-and Career-Ready Standards (CCRS)

Common Core State Standards (CCSS)

National Math and Science Initiative (NMSI)

Personal Teaching Efficacy (PTE)

Science, Technology, Engineering, and Mathematics (STEM)

Writing Across the Curriculum (WAC)

Writing-to-Learn (WTL)

Writing to Learn Mathematics (WTLM)

CHAPTER ONE: INTRODUCTION

Overview

In the past decade, there has been a focus on new standards at the state and national levels. These standards demonstrate a renewed interest in writing as a process and as a tool for learning across all content areas in all grade levels. One of the reasons for this is the growing concern over students graduating from high school lacking basic literacy skills but in particular basic writing skill. As secondary science and math teachers prepare their students to become college and career ready, they must focus their instruction on using writing as a learning tool, including having students analyze, interpret, make conjectures, construct arguments, and communicate their findings or answers through writing in order to prepare students to be college-and-career ready (SCDE Standards, 2015). With the push for new state assessments being tied to American College Testing (ACT), writing has become an essential part of the high school curriculum since the state's primary goal for graduates is to be college and career ready. Teachers are required to develop the knowledge and skills necessary to engage students in the literacy tools of reading, writing, listening, speaking, and thinking in each content area. In order for students to reach their highest potentials, teachers must have sufficient knowledge of how to teach across the standards to address student needs. However, math and science teachers are not always prepared to use writing, a required standard in their content areas. For many content teachers, this focus on writing places a challenge for them in how they plan instruction and engage their students in learning. The general problem is despite high school seniors lacking the written skills needed for college or the workplace there is a lack of focus on writing in all content area classes (Dana, Hancock, & Phillips, 2011).

This study offered some insight into math and science teachers' beliefs and instructional practices concerning WTL and potential direction for professional development and best practices for these content teachers. This chapter includes the background of the problem, the problem statement, the purpose and significance of the study, and the research questions that guided the study. Because writing has become a prominent component of math and science curricula, current research indicated a need to explore how the implementation of math and science state standards affect teacher efficacies and instructional practices and writing across the curriculum in the areas of math and science.

Background

Now more than ever, teachers are expected to help their students excel on all state and district mandated tests. As secondary science and math teachers prepare their students to become college and career ready, they must focus their instruction on using writing as a learning tool, including having students analyze, interpret, make conjectures, construct arguments, and communicate their findings or answers through writing in order to prepare students to be college-and-career ready (SCDE Standards, 2017). Math and science teachers are expected to cover state standards that include writing in their content areas, and how they should approach teaching these standards is not always addressed. However, how students perform on local, state, and national assessments are a reflection on how well an individual school is performing. A need exists for additional research in the areas of how instructional practices implement standards and how the implementation of standards affects teachers' efficacies.

Historical Context

Since the implementation of Common Core State Standards (CCSS, 2010), the South Carolina Department of Education's (SCDE, 2015) College and Career Standards for

Mathematics and the National Math and Science Initiative (2016b) for Advanced Placement (AP) courses, there has been a strong emphasis on students writing in these core subjects. There is a rising concern if America can keep pace with the competitive global economy, so there has been an increased push over the past decade for Science, Technology Engineering, and Math (STEM) courses in high schools across the country (National Center for Education Statistics, 2009). Recently the AP schools within the state have bought into the high-stakes learning environment, the rigorous curriculum, and the foundational instructional practices required by the National Math and Science Initiative (NMSI) grants and by the state's department of education's math and science state standards. All math and science teachers are required to implement writing which supports the rigorous standards of AP and the state's math and science standards, including critical thinking and communication skills, as well as practice for ACT writing and free response writing on AP exams. Thus, over the past decade, high school math and science teachers have been required to increase rigor using writing as part of the course curriculum. For the purpose of this study, writing across the curriculum (WAC) and WTL have been referenced in parallel when referring to writing across the curriculum. The idea of WAC, also known as WTL, has been around since the 1970s, but content teachers, particularly at the high school level, have continued to focus their instruction on content and reading, paying little attention to the ways their students engage with writing. WTL strategies are informal and short writing tasks designed to help students think through key concepts or ideas central to a particular topic, which offers formative assessments of content synthesis and comprehension.

In a qualitative study of teachers' beliefs, experiences, and the demands of writing standards, Bell-Nolan (2015) recommended additional research in the areas of how instructional practices implement standards and how the implementation of standards affect teachers'

efficacies. National standards for WAC have changed significantly since its popularization in the 1970s (Britton, 1970). This case study aimed to determine teachers' beliefs about using writing as a tool for learning math and science. Troia, Lin, Cohen, and Monroe. (2011) suggested there are many influences over teachers' instructional choices that create variance among them, but two personal traits stand out: theoretical beliefs and self-efficacy. Teachers who have positive self-efficacious beliefs about using writing as a tool for learning content can contribute to student learning, and teachers understand writing is a valuable tool for assessing students' understanding content. Thus, teachers' attitudes towards using WTL can have a positive or negative impact on student achievement. Additionally, writing used as a tool for learning content continues to be prevalent in high school courses since schools are offering AP courses, writing is a part of math and science state standards, and students are taking national tests such as the ACT and SAT that require writing assessments.

Social Context

Nowadays many American schools have AP courses so students can take college-level courses before high school graduation. Advanced coursework in high school has become an increasingly popular option for students because they would like to get a head start on their college coursework or to better prepare them for learning at the college level easier (Sadler, Sonnert, Hazari, & Tai, 2014). In Georgia, AP and STEM courses have been in place in most high schools. In addition, the SCDE (2015) claimed,

> Students enjoy the challenge of taking Advanced Placement courses with enthusiastic classmates and teachers; high school faculty find Advanced Placement courses enhance their students' confidence and academic interest as well as their school's reputation; and

college faculty report Advanced Placement students are far better prepared for serious

academic work. (p. 1)

Thus, WTL is an integral part of most high school courses within the state. Studies have shown

that WTL benefits students' academic achievement. Also, people can have a lasting interest in

activities they feel self-efficacious doing, and self-efficacy can influence the choices people

make and how they persevere to accomplish given tasks (Bandura, 1991).

Theoretical Context

WTL, or students learning content through writing (Emig 1977; Fry & Villagomez, 2012;

McDermott & Hand, 2013; Whitehead & Murphy, 2014), received greater attention since the

implementation of Common Core State Standards (CCSS, 2010). Critical thinking,

communication, media literacy, problem-solving, and interpersonal and self-directional skills are

the focus of today's 21st Century literacy skills (Beers, Probst, & Rief, 2007, p. 151). These 21st

Century skills promote self-efficacious beliefs about one's personal ability to learn.

Empowering students to learn through WTL may promote a strong sense of purpose and

independence, and it can promote leadership and educational success. Although WTL is an

effective method for increasing student learning of content, there is little research at the high

school level to discover science and math teachers' perceptions of themselves as WTL

practitioners and their beliefs about using WTL.

Despite the positive benefits of WTL and the potential WTL has to increase students'

understanding of content as well as to provide ways of collaborative learning (Emig, 1977), little

is known about the application of these practices among high school math and science teachers

and their attitudes, beliefs, and perceptions of these practices (Gillespie, Graham, Kiuhara, &

Hebert, 2014). Thus, this case study explored how the implementation of math and science state

standards affect teacher efficacies and instructional practices and writing across the curriculum in the areas of math and science.

Situation to Self

I am a faculty member at the site where the research will take place. As a teacher with many years of practicing the WTL craft, I understand the positive impact the WTL approach can have on students, especially with at-risk students. At the local university, I served as co-director of a writing project sponsored by the National Writing Project which awarded six hours graduate credit to elementary, middle, high school teachers, and college instructors. The course focused on how to use writing effectively in the classroom and how teachers can employ best practices using writing as a tool to increase student achievement. The Writing Project site provided summer institutes for teachers to share their best practices using writing and to become teacher consultants for the National Writing Project. The core principle of the National Writing Project is to provide opportunities for teachers to understand the full spectrum of writing and to help them see themselves as writers (The National Writing Project, 2017). Also, my 30 years of experience with directing grants support writing across the curriculum have afforded me to work directly with researchers of writing across the curriculum including Art Young, Ken Macrorie, James Britton, Dixie Goswamie, Shirley Brice Heath, and Nancy Martin. Thus, I have always had a steadfast interest in and a passion for supporting writing as a tool for learning in schools where I have worked.

The central motivation for conducting this study is my love for writing. For over 38 years, I have been teaching language arts and using WTL tasks. I have encouraged and supported WAC because I have witnessed the positive influences WTL has on students' abilities to learn new content, on their attitudes towards learning, and their perceptions of learning.

Consequently, I have seen the promising benefits of WTL among a large sample of high school students and graduates over the years.

The philosophical assumption was ontological to study the nature of reality of how science and math teachers' beliefs towards using WTL affect their instructional practices and their students' learning. I understand teachers who do not teach language arts may have varying attitudes towards implementing various writing activities in their daily classroom practices.

The paradigm guiding this study is Vygotsky's (1978) sociocultural theory. Approaching this study from a social constructivist point of view revealed how the implementation of math and science writing standards affect high school math and science teachers' efficacies and instructional practices. This approach allowed for a study of the complexity of the participants' beliefs to be interpreted rather than simply to categorize the meanings of the participants.

Problem Statement

The problem this case study investigated was how using WTL fosters teachers' efficacies and their instructional practices and writing across the curriculum in the areas and math and science. There was a need to study the phenomenon of high school math and science teachers' self-efficacious beliefs concerning the use of writing in their content areas or how they are being prepared to implement best practices in writing in their content areas. Current research was sparse on high school math and science teachers' beliefs about using writing as a tool for learning math and science. The state's standards for math and science include critical thinking and writing skills, but the district does not have a clear understanding of teachers' beliefs about themselves as practitioners of WTL or their self-beliefs about using WTL, and there are no clear guidelines and no professional development opportunities offered in WTL.

With the emphasis placed on writing across the curriculum, research suggested all stakeholders—colleges, universities, schools, school districts, and state departments of education—need to do a better of adequately preparing teachers across subject areas to use writing in instruction rather than relying on teachers' personal efforts to do so (Amber et al., 2015; Gillespie et al. ,2014). High school juniors are required to take the ACT to better identify college and career preparedness and ACT writing sample prompts ask high school students to describe an issue relevant to them and to write about their perspectives (Jago, 2005). In light of these expectations teachers need to be prepared to assist students with understanding how to approach these ACT prompts as well as other writing tasks students may encounter.

In a qualitative study of teachers' beliefs, experiences, and pressures with writing standards, Bell-Nolan (2015) recommended additional research in the areas of how instructional practices implement standards and how the implementation of standards affect teachers' efficacies. Since there has been an increased push over the past decade for STEM courses in high schools across the country (National Center for Education Statistics, 2009) and within the school district, AP high school administrators have been created to set high standards and expectations for staff and students. Within the past decade, high schools have increased the number of AP courses being offered to students as college credit courses—math, science, English, and social studies—with AP teachers being expected to use writing consistently within those courses. Although WTL is an effective method for increasing student learning of content, little research has been done at the high school level to discover science and math teachers' beliefs about using WTL. Thus, high school math and science teachers need a clear understanding of what WTL activities can be most effective in their classrooms, and an understanding of the need for specific types of professional development seminars in order to

become self-efficacious practitioners of writing. This study should provide insight into math and science teachers' beliefs about WTL and their beliefs about themselves as practitioners of WTL.

Purpose Statement

The purpose of this qualitative case study was to document and explore high school math and science teachers' beliefs and instructional practices concerning WTL, or students learning content through writing. With the emphasis placed on writing across the curriculum, research suggested all stakeholders—colleges, universities, schools, school districts, and state departments of education—need to do a better of adequately preparing teachers across subject areas to use writing in instruction rather than relying on teachers' personal efforts to do so (Amber et al., 2015; Gillespie et al. 2014). The need exists for additional research in the areas of how instructional practices implement standards and how the implementation of standards affects teachers' efficacies (Bell-Nolan, 2015). Findings of this research study have the potential of informing pre-service, novice, and experienced teachers as to how educators are using writing in science and math in an era of a narrowing curriculum, and the potential direction for professional development and best practices for high school math and science teachers.

Significance of the Study

The outcomes of this study informed high school math and science teachers of best practices in the areas of writing-to-learn (WTL), which provides an increase in student achievement, and may provide additional information to the limited body of current literature on high school math and science teachers' beliefs about WTL. Currently, most states are implementing Common Core State Standards (CCSS), and those that are not are implementing new state standards, which align, for the most part, with CCSS regarding the writing component. Because writing is a major component of these state standards across grade levels and content

areas, integrating writing in core subject areas such as math and science is central to addressing CCSS and for preparing students to be college-ready or functionally prepared for the workplace. In a study of teachers and students using WTL across a high school curriculum, Gillespie et al. (2014) found high school students are expected to use writing across the curriculum since CCSS emphasizes having students write to persuade, to explain, and to interpret complex information. High school teachers, who routinely employed WTL tasks to promote learning and to create a positive environment, witnessed a significant level of trust in the learning environment, which played a critical role in students' achievement (Usher & Pajares, 2008).

Understanding math and science teachers' beliefs about using WTL in their content area shed light on how they perceived their abilities to implement writing assignments that lead students to express their understanding of content through writing activities. People have a lasting interest in activities they feel self-efficacious doing, especially if they have mastered a particular task and self-efficacy influences the choices people make and how they persevere to accomplish a given task (Bandura, 1991). Exploring the beliefs of high school math and science teachers who use WTL activities contributed to the best practices for teaching STEM classes, math and science AP classes, as well as traditional math and science classes. The findings from this study have positive educational implications for the AP high schools' math and science teachers, administrators, the school district, and district professional development and curriculum leaders.

The significance of this study contributed to the body of knowledge about math and science teachers' beliefs about using writing as a tool for learning to advance the WTL pedagogical approach for increasing academic achievement among math and science students. The state's department of education standards in high school math and science require writing in

these content areas, yet the state's department of education has not mandated any professional development program for math and science teachers. The results of this study provide a clear understanding of what types of professional development are needed for math and science teachers to be more successful with writing in their content areas. Findings from this study offered insight into common writing-to-learn (WTL) practices among math and science teachers that promote successful learning and achievement for students in an AP high school. Identifying math and science teachers' perceptions of themselves as WTL teachers and their beliefs about WTL also contributed to promoting successful practices in other STEM or AP schools.

The significance of the study section contained a description of the contributions that the study makes to the knowledge base or discipline, both theoretically and empirically (i.e., How does it relate to other studies that are similar or that investigate the same issue?)

This section also included a brief description of the practical significance of the study; why it is important to the location, organization, general population, or sample studied.

Research Questions

The research questions were critical to the study since these questions presented the beliefs of high school math and science teachers. Thus, the focus of this study was to discover how high school math and science teachers' individual experiences and beliefs of the instructional value of using writing-to-learn (WTL) strategies with their students may shape the research. The research design was a qualitative collective case study. The research questions allowed me to present the voices of high school math and science teachers to describe their beliefs about WTL and their beliefs about themselves as WTL practitioners. Four questions guided this research:

1. What are high school math and science teacher's beliefs about their capabilities to teach using WTL activities?

Providing effective instruction is critical when students are beginning to use writing-to-learn activities. In a learning environment like an AP class or any math or science class where End-of Course (EOC), ACT, and AP scores are at stake "Teachers must feel competent as writers and as writing teachers in order to provide the kind of instruction and modeling that will help students develop into proficient writers" (Bifuh-Ambe, 2013, p. 137). People have a lasting interest in activities in which they feel self-efficacious (Bandura, 1991).

Realizing the beliefs of math and science teachers either positively or negatively affect student learning is important for school leaders to understand the impact of teachers' beliefs about using writing as a tool for learning. In a meta-analysis, Multon and Brown (1991) found a statistically significant relationship between self-efficacy beliefs and academic performance and suggested further research to evaluate classroom strategies that promote self-efficacy beliefs. Understanding the realities of why students are engaged in learning in math and science classes could show a positive result in increased achievement.

2. How do high school math and science teachers describe themselves as teachers of writing-to-learn?

In a national survey, Gillespie et al. (2014) suggested math teachers were more likely than all other subject-based teachers to have their students take notes while listening to teacher instruction to support learning and to have students write to solve math problems. Gillespie et al. (2014) also found that science teachers were more likely to have their students write lab reports to support learning. Science teachers were also more likely than math teachers to have students write out descriptions of scientific processes and science-related information, which included

written outlines, research reports, summaries of content-based ideas, and synthesizing information from multiple sources. Science teachers were more apt to instruct their students to write compare and contrast, cause and effect, and personal connections to support learning. While both math and science teachers use writing, Gillespie et al. (2014) lean toward positioning science teachers as the primary implementers of writing-to-learn practices. Math teachers are more likely to use writing-to-learn practices on a smaller scale. Understanding how high school math and science teachers describe themselves as teachers of WTL activities may reveal and bolster ways math and science teachers may become more confident in themselves as WTL practitioners.

3. What are high school math and science teachers' beliefs of the effectiveness of writing to support learning?

Traditionally schools have focused on linguistic and mathematical intelligence, but the current trend in education is to foster critical thinking and for students to be able to synthesize information both of which WTL fosters. Empowering students to learn through WTL promotes a strong sense of purpose and independence, and it promotes leadership and educational success "In the twenty-first century, literacy skills increasingly reflect technology use and the abilities necessary to problem-solve, collaborate, and present information through multi-media" (Pilgrim & Martinez, 2013, p. 60).

4. What are high school math and science teachers' beliefs about professional development and support they are given from the state department of education, administration, and the school district for implementing writing activities in their classrooms?

Gillespie et al. (2014) asserted one way of making sure teacher preparation in the use of WTL is improved is to require all teachers to take one or more courses on how to teach writing and use writing to facilitate learning. Affording teachers professional development and time to reflect on their practices and beliefs, along with having a supportive environment where they do not feel inordinate pressure to achieve results can lead to improving teacher quality (Bifuh-Ambe, 2013). The school and district leaders must realize math and science teachers' beliefs, as well as quality professional development, can affect teacher quality and student achievement. Understanding the strengths, weaknesses, differences, or tensions among the math and science teachers' WTL best practices can serve to strengthen district-level science and math curriculum and provide strong, enduring professional development for these core teachers

Definitions

The following terms were used throughout this study.

1. *Self-efficacy.* Self-efficacy is the belief in one's own ability to complete tasks and to succeed in a particular situation, both of which influence how people think, feel, act, or how they motivate themselves (Bandura, 1995).

2. *Writing to learn.* Students learn content through the use of varied writing assignments or approaches, and the writing can be formal or informal in nature (Emig 1977; Fry & Villagomez, 2012; McDermott & Hand, 2013; Whitehead & Murphy, 2014). It is also the act of making a subject or topic clear to oneself by reasoning through it in writing. It is a pedagogical approach that uses writing to facilitate learning in all content areas (Zinsser 1988).

3. *Writing-to-learn strategies.* Techniques used by teachers to aid students in constructing understanding and knowledge through writing. Hand and Prain (2002)

stated "writing enhances students' conceptual knowledge, develops scientific literacy,

familiarizes students with the expectations, conventions, and reasoning skills required

of scientific writing, and also engenders positive attitudes towards being a writer on

scientific issues" (p. 737).

Summary

Part of the school district's mission is to nurture and support students and to build

community partnerships that enhance the academic students' academic experiences. WTL

promotes a sense a collective community of learners and teachers and provides students with an

audience for their writing other than the teacher. This sense of community promotes self-

efficacy among teacher and students as they learn from one another.

High school students in math and science classes are expected to use writing to

demonstrate their knowledge of science content, and if students are to meet the writing demands

stated in the core standards, they need regular opportunities across the learning day to engage in

a range of writing tasks. These authentic writing engagements should be designed to enhance

students' knowledge, and effective teachers know that building stamina, discussion, and

knowledge are integral for developing stronger writers (Fisher & Frey, 2013). This study

explored the needs of math and science teachers to be more successful with writing in their

content areas. This study explored insight into common WTL practices among math and science

teachers that promote successful learning and achievement for students in an AP high school.

Identifying math and science teachers' perception, attitudes, and beliefs about WTL contributed

to promoting successful practices in other STEM or AP schools.

Thus, the focus of this case study was to explore how the implementation of math and

science state standards affect teacher efficacies and instructional practices and writing across the

curriculum in the areas of math and science. The research design was a qualitative case study. Personal interviews, a focus group interview, and participants' response journals were utilized to achieve the results of this study.

CHAPTER TWO: LITERATURE REVIEW

Overview

The study focused on AP high school math and science teachers' beliefs about being teachers of WTL and their beliefs about using writing as a tool for learning math and science content. Understanding high school math and science teachers' beliefs about writing in their content areas may shed light on how math and science teachers perceive writing integration and their abilities to utilize the WTL approach in order for students to understand more deeply the content. Because of the emphasis placed on writing across content areas specifically supporting the math and science state standards and the expectations for teachers to implement writing in the AP highs schools, all content areas are implementing writing tasks.

Bandura's (1977) theory of self-efficacy was the basis of the framework for this study, and Vygotsky's (1978) sociocultural theory framed this study. The literature reviewed on WTL, teacher self-efficacy, and the professional development needs of math and science teachers by various practitioners of WTL. The first component is what WTL is and why WTL can be beneficial to students' academic achievement. The second component is math and science teachers' self-efficacious beliefs as teachers of WTL. The third component may be the need for professional development for math and science teachers in an AP high school. The literature review will include the following information in this order: (a) curriculum expectations for high school math and science teachers; (b) WTL and the benefits of WTL; (c) self-efficacy, adolescent self-efficacy, math and science teachers' self-efficacy; (d) math and science teachers' perceptions and beliefs about WTL; and (e) the need for ongoing professional development for high school math and science teachers on best practices in using WTL.

Theoretical Framework

The theoretical framework for this study was Bandura's (1977) self-efficacy theory which stated that people must believe in themselves to accomplish a goal or task and to persevere through difficulties that they encounter during varied, challenging experiences. This theory of self-efficacy, which deals with one's concern with how well one can execute a course of action required to deal with prospective situations, is grounded in social cognitive theory. Another theory guiding this study was Vygotsky's (1978) sociocultural theory which operated on the premise that people gain knowledge from their lived experiences, and they learn by doing rather than simply observing.

Self-efficacy Theory

Bandura's (2001) theory of self-efficacy supported the idea of personal agency, "to personally make things happen by one's action" (p. 2), embodies the idea of the self being an influence on one's behavior within a social environment. Bandura (1993) suggested that what a person believes results in four processes: (a) cognitive, (b) motivational, (c) affective, and (d) selective activity. In the cognitive process, individuals with high self-efficacy create thoughts that visual success prior to experiencing a challenging task. A person with a low self-efficacy might visualize failure or defeat before attempting a challenging task, causing negative thoughts in one's mind. Bandura (1993) asserted that even when a person's mental abilities and knowledge are similar, low self-efficacy is a negative cognitive influence over one's successfully attaining a goal. The emotional state of an individual also directly influences an individual's success or failure in accomplishing a task. The higher one's self-efficacy, the more apt an individual will be to face and endure accomplishing one's goals. Thus, individuals with high

self-efficacy demonstrate belief, assertion, and confidence in their ability to achieve goals (Bandura, 1993).

Sociocultural Theory

Another theory guiding this study was Vygotsky's (1978) sociocultural theory which operated on the premise that people gain knowledge from their lived experiences, and they learn by doing rather than simply observing. Vygotsky (1978) emphasized the collaborative nature of learning and the importance of cultural and social interactions. Vygotsky's (1978) sociocultural theory asserted that interaction leads to cognitive development, and this cognitive development depends upon the zone of proximal development. To ensure students are learning in their zone of proximal development, teachers must provide new learning opportunities for students to work slightly beyond their current level of ability or skill. The zone of proximal development posits that when a student is in this zone of learning, the student may need assistance to achieve a task or to move through the zone of proximal development. Vygotsky (1978) believed a student who is in the zone of proximal development could move through a course of learning with assistance three ways: with the assistance from a knowledgeable person, through social interaction with a tutor or teacher, or by scaffolding learning or supportive activities given by a teacher, tutor, or a more competent peer to support the student as he or she moves through the zone of proximal development. The idea is that individuals learn best when working with others or collaborating. During collaboration with more skilled individuals, students begin to internalize or learn new concepts. Vygotsky (1978) asserted that if a learner can complete a more difficult task jointly with a more skilled individual, then the learner will likely be able to complete the same task independently on a different occasion. For scaffolding to be effective, teachers should help students develop strategies they can apply to new or novel problems they will encounter.

Vygotsky (1978) underscored the importance of language and communication is a social context, and he saw the importance of social interaction as a motivating force for persons to transition to a higher level of thinking. According to Vygotsky (1978), some students can write independently while other students may need guidance since some students do not write at the same pace or the same level of ability. Writing can be a socially mediated activity and is a reflection of one's social cognitive development. Vygotsky (1986) claimed that the process of writing involves social and cultural interaction, giving an individual an inner voice, internalized thoughts, and an outward voice in the form of the written word. Vygotsky (1978) stressed that writing assignments should be meaningful in order to arouse an intrinsic need in students, and writing should be a part of a task relevant to life. This mode of learning allowed students to use imaginative ways, such as to create a poem relating to the content, and which enhanced the learner's social experiences through reading and listening or poetry performance within the classroom setting. Writing is creative and critical thinking and places students in the zone of proximal development since it allows for interaction, synthesis of ideas, facts and experiences that students know personally. Writing can be the vehicle through which the learner can naturally feel free to express themselves. It supports time and space and cooperation for students to move naturally through their zone of proximal development. For teachers who provide authentic writing opportunities WTL can offer and a safe and exciting learning environment where students can freely practice WTL activities will lead to students' having positive learning experiences and positive self-efficacy. Thus, approaching this study from a social constructivist point of view revealed how the implementation of math and science writing standards using WTL fosters high school math and science teachers' efficacies and instructional practices.

This study demonstrated how math and science teachers employed writing as a tool for learning content, and how they felt that writing has a positive impact on their students' learning content. Furthermore, this study suggested that the math and science teachers in this study felt that they could "personally make things happen" (Bandura 2001). They felt that the writing experiences they presented their students within their respective courses benefited their students' learning. In turn, this made them feel successful as teachers. It gave them a deeper and closer understanding of their students' critical and creative thinking about contact through the writing, reading the writings aloud, and through getting to know their students' cognitive abilities on a deeper level. This experience supported Vygotsky's (1978) assertion that writing involves social and cultural interaction, giving an individual an inner voice, internalized thoughts, and an outward voice in the form of the written word.

Related Literature

A review of the literature outlined the circumstances math and science teachers may encounter within their curriculum standards using writing as part of their instruction while the state's department of education has established a statewide emphasis on reading instruction. The literature review provided the state department of education's curriculum expectations related to this study, a review of math and science teacher self-efficacy, teachers' beliefs about using WTL, the benefits of WTL for math and science teachers, and their need for professional development.

This literature review encompassed the state mandates and teacher requirements. Then, the literature reviewed defined writing-to-learn and its benefits for both teachers and students. This study revealed math and science teachers' efficacious beliefs about using writing as a tool for learning content. The literature reviewed for this study defined self-efficacy and personal teaching efficacy and revealed the importance of student and teachers having self-efficacious

beliefs. This study uncovered the impact of math and science teachers' self-efficacy and beliefs about using WTL as it relates to students' achievement, willingness to learn, and motivation. The literature also includes background information on WTL, the benefits of WTL, math and science teachers' beliefs about using WTL, background information on self-efficacy, and the summary.

State Mandates and Teacher Requirements

The state's department of education has required teachers to prepare students to be college and career ready by the time they graduate from high school. To ensure students graduate on time with the literacy skills they need to be successful in college and careers, the state's department of education has increased the rigor in math and science by including the writing component and by using benchmark testing three to four times per school year, with each including a writing component. However, the National Center for Education Statistics (2012) revealed less than a third of the students in the United States have proficient, or grade-level writing skills; and the National Commission on Writing (2003) reported writing has become neglected, with reading and math taking priority (Harris, Graham, Friedlander, Laud, & Dougherty, 2013).

In a survey completed by 250 K-12 teachers from eight states of teachers' perceptions about their preparedness to teach CCSS in writing. Hall, Hutchison, and White (2015) suggested elementary teachers reported to be more prepared than middle and high school teachers and teachers across content areas should benefit from professional development efforts. There is a great emphasis on writing, but no call for teacher preparation to use writing instruction. There is a writing standard connection to all core standards, and teacher evaluation is tied to student achievement. In many cases, students are taking benchmark tests throughout the school year so

that districts can collect data a students' gains in learning. These benchmark tests often evaluate students' abilities in narrative, expository, persuasive writing. A major focus of teacher support and evaluation among the state's public school teachers has been a more direct connection between teacher practices and increased student learning through the incorporation of student academic growth measures into classroom-based teachers' evaluation and effectiveness ratings.

In 2010, the Elementary and Secondary Education Act released a blueprint for college and career standards and assessments expectations. The United States Department of Education (2010a) called on all states to adopt state-developed standards in English language arts, mathematics, and science that build toward college and career readiness by the time students graduate from high school, and to have high-quality statewide assessments aligned with these standards. School districts were to work with their four-year public university system to certify mastery of the standards build toward college and career readiness. According to Gillespie et al. (2013), approximately 87 % of all public-school students in the United States must now become proficient at using writing to help them analyze and to think about the information presented in class and in the texts they read in order to be globally competitive. The new CCSS addressed concerns about the ability of students to write in content areas and the state's standards for high school math and science courses. The state has required high school math and science teachers to prepare students to be college and career, as supported by the CCSS and the states college and career standards. This need for students to be both college and career ready has placed an even greater demand on teachers and students.

In some cases, CCSS is holding teachers accountable for students achieving college and career readiness standards as they are tied to CCSS-aligned test scores (Wilcox, Jeffery, & Gardner-Bixler, 2016). Also, Partnership for Assessment Readiness for College and Careers will

produce assessments requiring students to use writing to demonstrate their understanding subject area(s) content materials (Gillespie et al., 2014). Math and science teachers have received college and career standards and stipulations to produce positive learning outcomes among their students, but they have not been given ongoing professional development to secure their knowledge and beliefs about using writing as a tool for learning in their courses.

To promote the importance and power of writing in math and science content areas, understanding subject-specific literacy and teachers' beliefs about writing to learn content must be a critical component of the curriculum to help students to become college and career ready. Understanding the perceptions of teacher beliefs regarding increased learning through WTL experiences offered in math and science classrooms and benefits of WTL is essential in helping teachers' self-efficacious beliefs.

In addition to the revisions of the state standards assessments, the mastery of mathematics, science, and technology has become an essential part of the overall revision to the state's standards that claims to prepare students for postsecondary science and math-related degrees. "America needs to increase the number of students pursuing STEM fields in their academic studies and careers, and improve preparation for the next generation of engineers, scientists, mathematicians, and technicians" (United States Department of Education, 2010c). United States Department of Education (2010b) stated in order for students "to thrive in the classroom, in college, and in a career, our educational system must continuously develop and embrace the very best practices, policies, and ideas" (p. 1).

Zinsser (1988) explained the importance of using various forms of writing to help students learn new material across the curriculum. Toby Fulwiler (1987) urged that if schools were to teach critical and independent thinking, then schools should question the role of writing

throughout the curriculum, instead of having students become passive receivers of information. Thus, this innovative practice of using writing as a tool for learning could help students to graduate ready for college and career.

Students being able to think critically about what they are learning leads to having a deeper understanding of the content. WTL activities provide content area teachers critical thinking strategies that help students to articulate their ideas. If the students in AP schools are expected to be college and career ready, then they will need not only good reading skills but also good writing skills. However, math and science teachers in STEM or AP high schools are required to increase rigor through writing, but there are no professional development opportunities offered by the state's department of education for writing instruction across the curriculum, even though writing is a component of the math and science standards. CCCS emphasized the use of report writing and writing via technology (Gillespie et al., 2013) and other forms of writing in science and math to help students to be ready for college and career.

Yoo (2016) asserted the need for an examination of teacher experiences and beliefs rather than the examination of how teacher efficacy develops or evolves within each teaching experience or teaching program. Thus, there is a need to understand math and science teachers' beliefs about WTL and their beliefs about themselves as WTL practitioners. The focus of this study will be to discover science and math teachers' beliefs about WTL, and their beliefs about themselves as WTL practitioners.

Writing-to-Learn

WTL can be beneficial to students' academic achievement, and the need for professional development for NMSI teachers in an AP high school. Zinsser (1988) defined WTL as a pedagogical approach using writing to facilitate learning. Researchers described WTL as

students learning content through writing or the act of making a subject or topic clear to oneself by reasoning through it in writing.

Emig (1977) supported WTL as a unique mode of learning since it has the power to connect the learner to the learning through writing, listening, reading, performing, and talking through and about the process. Fry and Villagomez (2012) defined WTL as a mode of learning that helps the student connect to the learning in creative ways, making the subject matter more relevant and meaningful. This form of creative thinking helps the learner make the subject or topic clear simply by reasoning through it in the writing, providing favorable results and increased student achievement (Fry & Villagomez, 2012). Using creative writing to enhance critical thinking can positively influence learning which has an impact on both teacher and student efficacy. Thus, there are mutual benefits to using writing as a tool for learning content.

Benefits of WTL

The use of writing as a tool for learning has the potential to increase student achievement, thus increasing teacher and student self-efficacy (Austin, 2010; Fife, Bond, & Byars-Winston, 2011; McDermott & Hand, 2013). The research revealed WTL activities afford students to read more extensively and carefully, to think more deeply about the content, and to be engaged in class discussions about the content and WTL strategies had a positive impact on high-stakes student test scores (Fisher & Frey, 2008). Romano (1987) suggested that writing is a personal and unique tool for learning language personal and distinct for each writer, and writing is capable of creating and reinforcing content knowledge. Waters (2014) claimed WTL is a means of constructing knowledge of content as well as making a record of knowledge, both of which enhances student learning.

Romano (1987) asserted,

These personal links help us [the learners] to establish a vested interest in our learning . . . what is impersonal we must somehow make personal. Then we will learn. Expressive writing, an individual voice deliberately working to create meaning, is as personal as you can get. (p. 23)

Romano (1987) further claimed students who readily and habitually use their personal language for learning possess a most powerful educational tool, and teachers should have them write to discover, create, and explore knowledge and to use writing to help them overcome difficult concepts. Thus, the students take full ownership of their writing. Furthermore, teachers must build a community of writers within their classrooms where they and their students not only feel efficacious with their writing, but teachers and students also feel safe and comfortable with each other's writings.

Burke (2009) suggested that students should read to learn new ideas, but they should write to discover what they know and need to learn about their topic. When students can convey their conceptual understanding of scientific or mathematical knowledge through creative WTL means, then students are more apt to retain the knowledge they have constructed, and they have a sense of ownership and self-belief about their ability to learn new information. Fulwiler (1987) asserted ". . . if we want writing (and thinking) skills to become useful, powerful tools among our students, we must ask them to write (and think) in context . . ." (p. 10). Fulwiler also asserted that when students are asked to write more, they are being asked to think more about a concept, to express themselves without fear, to think freely about a concept, and to be trusted their voices will be valued. Young (2006) believed reflective writing is critical to the learners' gaining a deeper understanding of their learning and thinking, and reflective writing affords students to apply what they have learned in all areas of their lives, making the learning evening

meaningful and providing teachers insight into what their students are actually learning. Also, WTL activities must be meaningful to the students so that they feel a sense of ownership. This feeling of ownership increased student's self-efficacious beliefs about their ability to learn new content.

Thompson (2013) explained the connection between writing as a co-constructed activity and Vygotsky's (1978) sociocultural theory asserted social interaction leads to cognitive development, and this cognitive development depends upon the zone of proximal development. Writing can be a socially mediated activity and reflects one's social cognitive development. This mode of learning allowed students to use imaginative ways, such as to create a poem relating to the content, and which enhanced the learner's social experiences through reading and listening or poetry performance within the classroom setting. Vygotsky (1986) claimed the process of writing involves social and cultural interaction, giving an individual an inner voice, internalized thoughts, and an outward voice in the form of the written word. This shared experience supported Zinsser (1988) in that students need spaces for writing that promotes learning and critical thinking. Thus, writing serves as a reflection of one's social cognitive development. Vygotsky (1978) asserted that writing assignments should be meaningful in order to arouse an intrinsic need in students, and writing should be a part of a task relevant to life. McDermott & Hand (2013) asserted that expression of self-identity through poetry writing illustrated the idea of social construction of identity as defined by Vygotsky (1978). The social interaction can lead students to develop a sense of identity and self-efficacious beliefs about their ability to learn new material. Writing is a social action that promotes learning and influences interaction between students and social interaction, which can influence self-efficacy.

According to Peary (2012), of the three arms of discourse identified by James Britton, poetry or creative writing enhanced critical thinking in all content areas. Learning and creative thinking go hand-in-hand. Creative writing can give students their voice and encourages them to take risks to see ideas in new ways. Creative thinking allows students to become part of the narrative, the poem, or the argument, engaging them in critical thinking, and transforming them into characters and affords them to become onlookers of these characters. Students can contemplate themselves in all sorts of imaginative realms through expressive communication. They can also become part of their peers' assignments and vice-versa, creating powerful social and cognitive learning experiences. Today's 21st Century literacy skills focused on critical thinking, communication, media-literacy, problem-solving, and interpersonal and self-directional skills (Beers et al., 2007). WTL affords students to free up their choices about their writing. Thus, writing and learning are interrelated, but the writing must be meaningful, exciting, and engaging for the individual student. Students must have the freedom to make personal choices about their creative thinking decisions.

Martin (1983) stressed students need to be given a wide range of personal experiences in writing, to think freely and deeply about the content, just as freely as they were able to do before they went to school. When students can use their real, authentic voices in their writing, this unique approach can empower them to think deeply and freely about the content (Elbow, 1998). Writing can increase students desire to learn more about content in order to make sense of why they are learning what they are learning (Culham & Wheeler, 2003)

WTL is a form of creative thinking about a subject. It can be in the form of poetry, journal responses, narratives, quick writes, or any other form of writing that allows students to focus on the learning, to gain insight, and to make meaning of the subject matter. As students

write, they make discoveries about the subject as they develop ideas or write to solve a problem. Affording students opportunities to write and to verbalize meaning, as well as have their peers provide evaluative feedback, in order to gain a sense of their scientific literacy can afford teachers a more comprehensive formative assessment of their students' abilities to understand the content (Tomas & Ritchie, 2015). Writing is creating, or a form of creativity, and writing creatively with purpose can allow students to develop meaning, to reflect on the learning to gain a deeper understanding, not only about themselves, but also about the content, and to synthesize the knowledge gained in the classroom (Wiseman, 2011).

When students who are struggling in their academics are given WTL as a tool to learn across the curriculum, they can find personal meaning in this learning approach. Furthermore, Romano (1987) claimed that WTL not only provides revealing information learned, but writing is also more useful for learning new content. In a mixed-methods study, Whitehead and Murphy (2014) found students who used WTL in chemistry became more focused on the content, their writing became more thorough, and their writing helped them to understand the content. In addition, McDermott (2010) found that students were more successful at learning science and learning became more meaningful to them when given opportunities to think about the learning using writing-to-learn activities. Non-traditional writing tasks can provide a bridge between "denotative outlooks typical of the discipline of science and typical student thinking, again with the potential for improving student learning" (McDermott, 2010, p. 219). Students' WTL products can reveal students' understandings of content knowledge or concepts within a course, and WTL strategies can provide students varied opportunities to make meaning of content knowledge. Others asserted that the focus of reaching the reluctant student should be:

to help students to learn how to ask relevant questions, to seek clarification, and articulate

their own ideas requires that teachers become more facilitators than instructors as they

help students move toward independence by utilizing practices that foster engagement

that can lead to self-direction and self-efficacy. (Lent & Gilmore, 2013, p. xxiii)

The National Writing Project and Nagin (2006) asserted that the most effective WTL

assignments go beyond having students write about personal experiences. Teachers can create

confident students when the writing is authentic or belongs to the students:

Such work resembles the kind of problem solving that adults face in their everyday lives

and helps prepare the student to be critical, analytical thinker. In [WTL] assignments, it

means asking the student to construct knowledge through analysis, synthesis, and

interpretation. (National Writing Project & Nagin, 2006, p. 49)

Burke (2009) also contended writing allows students to make discoveries about what they

know or need to know about the content, making the learning activity more effective and

engaging. WTL can provide ways for students to reflect, analyze, and synthesize what they have

learned. Quantitative studies have shown positive correlations between WTL practices and test

performance (McDermott & Hand, 2013; Whitehead & Murphy, 2014).

In a study of graduate students, Bintz (2010) found putting original poetry to music, even

to simple tunes like "Wheels on the Bus" or "I'm a Little Teapot" helped students retain new

science content knowledge, especially challenging material (p. 686). Graves and Kittle (2005)

found quick-writes allowed students to uncover topics, to find ideas worth writing about, and to

free themselves to write openly and honestly about any given subject while creating diversity

among the writers and allowing students' thinking to guide them. Rudd (2012) found that

students who participated in poetry slams (a freestyle way of writing poetry) developed a deeper

sense of individual identity and group identity. Thus, WTL can offer students the self-expression of their learning through their personal forms of written communication whether thinking and writing from different points of view, writing original poems, personal narratives, essays, or fiction. Quick-writes provide students with opportunities to reflect on their learning.

Students who are using WTL in high school math or science classes are learning their way through the subject matter in meaningful and personal ways, instead of having students parrot science facts or math functions back to the teacher. WTL activities focus on producing nontraditional writing assignments such as poems, brochures, letters, journals, and summaries to develop student understanding (McDermott, 2010). Not only can WTL strategies become useful in helping students grasp content area concepts and knowledge, but it can also stimulate passive learners, provide formative assessment, and require students to think deeper about the content. Whitehead and Murphy (2014) found that students who used WTL in chemistry became more focused on the content. Students' writing became more thorough and helped them to understand the content. "Research shows that teachers who give students assignments requiring authentic intellectual work see greater gains on standardized tests" (The National Writing Project & Nagin, 2006, p. 49).

Also, original poetry writing can offer a bit of playfulness can help students to feel comfortable in their space or classroom. However, students must feel safe to compose and to share their poetry. Wiseman (2011) advocated having students write original hip-hop, a poetic form that students are familiar with, because a familiar genre would help to develop students' critical thinking skills and build on their language skills. Thus, WTL can promote higher-level critical thinking skills through creative and expressive writing.

The research suggested there is a strong need for written forms of mathematical communication, especially in an age where students are increasingly using technology to communicate (Freeman, Higgins, & Horney, 2016). With today's math and science curriculum standards necessitating writing in these content areas and with increasing technological change, students are required to know more information at a rapid pace. In most cases when students are independently using technology as a component of their learning process, they must be able to use self-directed learning where self-efficacy, according to Bandura (1995), affects students' belief in themselves to accomplish tasks. Brown (2015) asserted interdisciplinary physics, chemistry, and biology methods of creative expression such as writing poetry results in stimulating students' imagination and knowledge of science, since creativity of a scientist, for example, draws from imagination, original thought processes, and creative expression which carries with these thoughts a sense of freedom to conceptualize and enrich the science learning. McDermott and Hand (2013) suggested multi-modal writing tasks improved conceptual understanding of science and improved science competency. Also, McDermott (2010) maintained that students were more successful at learning science and learning became more meaningful to them when given opportunities to think about learning using WTL activities. Non-traditional writing tasks could provide a bridge between "denotative outlooks typical of the discipline of science and typical student thinking, again with the potential for improving student learning" (McDermott, 2010, p. 219).

The National Council of Teachers of Mathematics affirmed writing plays a crucial role in the standards for both middle and high schools and must set standards in writing to improve the quality of K-12 instruction (The National Writing Project & Nagin, 2006). WAC has supported every core subject must be using writing as a tool for learning. Advocates of writing across the

curriculum have supported writing is a powerful tool for learning content in all disciplines in elementary, middle, secondary schools, and higher education. For the teacher, WTL activities have become forms of formative and summative assessments. Additionally, writing and self-efficacy are interrelated social cognitive skills. Students should have opportunities to write and learn for themselves, and they should be given autonomy to make personal choices about the writing or discourse in order to promote their self-knowledge and self-awareness, thus increasing self-efficacy. Creating spaces for learning and for promoting critical thinking for adolescent students, especially for those students who feel that a curriculum is devoid of relevant information (Wiseman, 2011) can increase self-efficacy and writing self-efficacy, a belief one can write. WTL can allow students to use their own language to create meaning with what they are learning through writing or thinking on paper.

Using WTL across the curriculum can foster critical thinking, creative expression, and the use of the imagination like WTL with poetry. Thus, teachers' attitudes towards using WTL can have a positive or negative impact on student achievement. The search of the literature revealed that WTL could have a positive impact on student achievement, student self-knowledge and self-awareness, curriculum standards, WAC, student, and teacher self-efficacy, and WTL provided teachers formative and summative assessments. The literature also revealed students' who employed WTL activities had positive attitudes towards their learning, and these WTL practices helped them to develop their skills as writers, readers, thinkers, and speakers (Fry & Villagomez, 2012). Furthermore, teachers who use WTL and have success with using this tool can feel positive about themselves as practitioners of WTL.

Math and Science Teacher's Beliefs about Using WTL

Math and writing are two topics not typically associated with one another. However, writing in high school math and science has been firmly established in the United States K-12 curriculum standards, and WTL strategies in math and science can be vital tools to help students both develop mathematical and scientific ways of thinking and communicating their mathematical and scientific reasoning effectively.

Science teachers' beliefs about using WTL. Whitehead and Murphy (2014) suggested that writing in science might challenge some science teachers and found teachers remained committed to using writing because of teachers' belief in the power writing had to increase knowledge. In four-year a case study of teachers' challenges and concerns about implementing WTL within science classrooms, Hand and Prain (2002) reported teachers believed students saw WTL assignment as more authentic and engaging, but there were three major concerns the science teachers had about WTL:

- How effective WTL was for assessment of student learning

- How to set up appropriate WTL tasks

- Teachers' perceptions of their changing roles from delivering content to facilitating learning through WTL

Thus, this study confirmed the need for effective professional development on the use of WTL for science teachers.

In an evaluative case study, Kravchuk (2015) asserted that science teachers' collaborating with WTL strategies promoted a positive impact on teachers' use of WTL as an instructional method. The research revealed teacher collaboration promoted a positive attitude toward WTL, and teachers developed greater confidence in using WTL strategies and recognized student

achievement had a positive effect on students' belief in their capabilities to complete tasks (Kravchuk, 2015).

Research provided additional concerns secondary science they encountered when implementing WTL strategies (Kravchuck, 2015):

- Doubt in the lesson and the WTL process

- Comfort with teaching writing in science

- Time to engage in the lesson

The review of the literature revealed science teachers know their content, but they often do not have the needed skills to teach the use of writing in science that will help them give meaning to the science content skills. Since high school science teachers often feel they are not always expected to use writing within their courses, they do not consistently employ it. Teachers feel like they lack the specific skills to do so. Kravchuck (2015) reported most science teachers have little to no experience or training in using writing in the classroom and recommended those who provided professional development should consider the kinds of writing teachers might want to include in their classroom. Thus, science teachers would benefit from ongoing support and professional development in using writing as a tool for learning science content.

Math teachers' beliefs about using WTL. Pugalee (2004) defined Writing to Learn Mathematics (WTLM) as expository writing that describes or explains math concepts. In a study on WTLM, Teuscher, Kulinna, and Crooker (2015) claimed that teachers who used WTLM more frequently had high self-perceptions of effectiveness, had positive attitudes, and agreed WTL helped to improve student achievement. "The more teachers used WTLM, the higher their perceptions of the effectiveness of it and the larger role they indicated for WTLM to help students develop positive attitudes about mathematics" (Teuscher et al., 2015). In a study of

high school math teachers' perceptions of using WTL, Teuscher et al. suggested there were

negative factors teachers revealed as to why they did not use WTLM:

- Pressure to complete a curriculum

- Lack of knowledge in using WTLM

- Student resistance to using WTLM

- Time constraints

- Students' ability to write

- Personal beliefs about teaching and learning math

Teuscher et al., (2015) suggested there were positive factors teachers revealed as to why

they did use WTLM:

- Their school promotes WTLM

- Their department promotes WTLM

- Positive learning results

- Student comprehension

- Advanced Placement exams require WTLM

- Increased critical thinking

- Differentiated learning

- Student communication

- A formative assessment tool (p. 69).

One possible conjecture is that WTLM is used more in AP programs that require students

to answer free-response questions on their assessments (College Board, 2017). Although the

majority of math teachers did not use writing as a tool to teach mathematics (Purcell, Buchanan,

Friedrich, National Writing, & Pew Research, 2013), Freeman et al. (2016) contended students'

using multi-modal writings—blogs, graphs, drawings, and other social, digital technologies—helped to advance students' thinking and communication skills in math.

In a study of preservice teachers using writing-to-learn strategies for mathematical learning, Kenney, Shoffner, and Norris (2014), hypothesized WTLM could be a tool for understanding the diverse ways students learned, and asserted that preservice teachers were able to see the value of using WTLM and were willing to accept writing as a method for teaching math. Most teachers who find a teaching tool that works to promote learning will use this tool consistently. If teachers see the value in specific modes of teaching, then the teachers consider this mode a best practice.

Need for professional development in WTL. Teacher s believe this a need for ongoing professional development for using WTL effectively for science and math teachers**.** Brindle, Graham, Harris, and Hebert (2016) suggested teacher preparation to teach or use writing in the classroom was rated lower than their preparation to teach reading, math, science, or social studies. Gillespie et al. (2014) suggested CCSS emphasis on the use of writing activities across the curriculum will require teachers to consider WTL activities; however, "teacher education programs, school systems, and departments of education must do a better job [of preparing teachers to integrate writing], especially in science and math" (p. 1071). Nadelson, Pluska, Moorcroft, Jeffrey, and Woodard (2014) highlighted the importance of teachers having a clear understanding and knowledge of CCCS would likely result in positive teacher perceptions and increased effectiveness in implementing CCSS. In a voter survey, Achieve, Inc. (2012) urged states to educate teachers better about CCSS implementation and assessments especially before each school year:

The more educators know about the CCSS, the more supportive they tend to be, both of

the new standards and assessments, which is why the state's implementation plan and

communications plan for the CCSS, and common assessments must be well aligned and

integrated. (p. 4)

In a study on the effect of professional development on teacher efficacy and teacher analysis of

their efficacy change, Yoo (2016) posited that professional development has a positive effect on

teacher efficacy and teachers' reflecting on their self-efficacy was essential to teacher

sustainability. The literature revealed teachers need adequate time to reflect on their beliefs and

their practices and have adequate professional development to improve their quality of teaching

as well as to keep teachers informed about best practices (Baron, 2015; Al-Bataineh, Holmes,

Jerich, & Williams, 2010). Teachers have often felt they have neither the ability nor the time to

provide WTL activities, but "professional development can foster teachers' writing proficiency

and in turn improve students' writing achievements" (Bifuh-Ambe, 2013, p. 137).

The National Commission on Writing (2003) recommended that every state should have

a comprehensive writing policy where writing is at the center of the curriculum, and all schools

should provide ongoing professional development to support and build a community of teachers

of writing across disciplines.

The National Writing Project and Nagin (2006) has insisted instructional leaders and

school administrators could play a vital role in endorsing and confirming writing to be used to

achieve a higher level of learning in their schools and districts. Locke, Whitehead, and Dix

(2013) advocated for providing teachers with professional development using a Writing

Workshop model that possess tenets like the National Writing Project to inspire teachers with

collective professional learning experiences, so they gain a sense of agency and belonging, and

increase their sense of efficacy as writers and teachers of writing. Also, to understand the perceptions of teacher beliefs of increased learning through writing to learn experiences offered in math and science classrooms, it will be necessary to consider teachers' attitudes about writing (Street & Stang, 2009).

As schools face implementing CCSS, integrating writing across the curriculum could be an integral part of core classrooms. The National Council of Teachers of English declared CCSS should provide a rich variety of reading and writing experiences fostering critical thinking and a respect for language equality to among diverse student body of students (Gilyard, 2013). Hand and Prain (2002) recommended: "effective professional development of teachers' understandings of writing-to-learn strategies represents a significant challenge that can only be met by programs that offer long-term support for change" (p. 755).

The current trend in education is to foster critical thinking and for students to be able to synthesize information both of which WTL can enhance. The literature supported writing promoted critical thinking and learning core content, and increased teacher and student self-efficacy and student achievement (Bifuh-Ambe, 2013; Freeman et al., 2016; Kravchuk, 2015; McDermott, 2010; McDermott & Hand, 2013; Teuscher et al., 2015; Whitehead & Murphy, 2014). Thus, teachers and students having positive self-efficacious beliefs about their classroom experiences can foster student achievement.

Self-Efficacy

Bandura (1977) defined self-efficacy as one's belief in the ability to accomplish tasks. Bandura (1995) asserted self-efficacy is the belief in one's own ability to complete tasks and to succeed in a particular situation, both of which influence how people think, feel, act, or motivate themselves. Bandura (1982) defined "perceived self-efficacy [as] concerned with judgments of

how well one can execute courses of action required to deal with prospective situations. Initially

called observational learning theory, Bandura's self-efficacy theory supported the idea of

personal agency, "to personally make things happen by one's action" (p. 2), embodied the idea of

self-being an influence on one's own behavior within a social environment. Bandura (1991)

supported the idea people have a lasting interest in activities they feel self-efficacious, especially

if they have mastered a task at hand, and self-efficacy can influence the choices people make and

how they persevere to accomplish a given task (pp. 257- 258). Bandura (2001) asserted unless

people believe they could create the desired or positive results and prevent those results with

their actions that might have negative consequences; they will not have the personal incentive to

persist through their struggles (p. 10).

Teacher self-efficacy. In their ability to perform specific teaching tasks, teacher

knowledge and self-efficacious beliefs, or performance accomplishments, can affect student

behaviors and learning outcomes. Bandura's (1977) social learning theory described how people

learn from one another through continuous reciprocal interactions with their environment. This

theoretical perspective can be useful in understanding the extreme influence of negative and

positive writing experiences over time. Teacher actions (e.g., showcasing work, giving positive

feedback) not only affect the self-confidence of developing writers but may also affect the self-

efficacy of future teachers (Graham et al., 2001). Teacher beliefs can include their efficacy to

teach their subjects, and their attitudes towards their own subjects, and if their self-efficacious

beliefs and teacher self-efficacy has been one personal teaching trait that has been associated

with higher student achievement (Brindle et al., 2016; Tschannen-Moran & Johnson, 2011;

Stevens, Aguirre-Munoz, Harris, Higgins, & Liu, 2013). Bandura (1993) asserted having a

strong sense of self-efficacy enhances personal accomplishment in many ways, and people with

high efficacy approach difficult tasks as challenges to be mastered rather than threats to avoid, and a person's behaviors are motivated and regulated by self-influence (Bandura, 2001). Students who have the same level of cognitive skill development differ in their intellectual performance because of their perceived self-efficacy, and when students acquire new skills, their self-efficacy is influenced (Bandura, 1993). When teachers can find ways to enhance students' belief in their ability to have control over their progress in learning, the better their performance (Eisenberger, Conti-D'Antonio, & Betrando, 2005). Thus, having strong efficacious beliefs has been seen as directly related to one's interest in activities and practices. However, many studies have been conducted on student self-efficacy (Al-Bataineh et al., 2010; Bandura, 1995; McTigue & Liew, 2011; Pajares, 1996), and on examining teachers' writing self-efficacy, pre-service teachers' writing experiences and self-efficacy, including primary teachers (Hall & Grisham-Brown, 2010; Simmerman et al., 2012; Street & Stang, 2009). However, limited studies exist in researching how high school math and science teachers perceive themselves as WTL teachers. Another concept considered was personal teaching efficacy (PTE), a context-specific model in which one evaluates their capabilities such as skills, knowledge, or teaching strategies (Soodak & Podell, 1996; Yoo, 2016). Soodak and Podell (1996) asserted teacher efficacy pertains to a teacher's belief of possessing teaching skills or teaching confidence in the ability to teach in a way that leads to student achievement or positive student learning outcomes. Yoo (2016) asserted that self-analysis and professional development are ways to achieve PTE. Thus, PTE may have a direct positive or negative impact on a teacher's personal belief regarding his or her ability to teach specific content-related skills. Not only does a teacher's belief impact achievement, but also students' self-efficacious beliefs to succeed.

Adolescent self-efficacy. Bandura (1995) suggested self-efficacy has the greatest impact on their educational development and children's sense of self-efficacy enable them to become independent learners who have "self-regulatory capabilities to educate throughout life" (p. 202). The roles self-beliefs and self-efficacy play in how and why students learn in academic settings are important to students' academic achievement. Students expressed ways of thinking, they are learning effective skills and strategies for managing classroom demands, and their learning from others strengthens their beliefs that they can succeed (Bandura, 1991). The major source of self-efficacy has been mastery experience, and according to studies, mastery experiences consistently predicted self-efficacy, making mastery experience predictive of self-efficacy (Bandura, 1995; Usher & Pajares, 2008). Nurturing students' self-beliefs and providing learning experiences that foster self-beliefs or self-efficacy can lead to better academic performance and higher self-esteem. Pajares (1996) explained that self-beliefs or self-efficacy plays a significant role in motivating an individual's self-concept, perceived competence, and academic motivation. Self-efficacy beliefs in academic settings play a critical role in motivating student, and self-beliefs affect academic motivation (Pajares, 1996). Pajares (1996) affirmed that self-efficacy beliefs are strong determinants of academic performance, and schools must be willing to explore educational strategies that encourage and cultivate self-efficacy beliefs among students. Students' perceptions of their confidence to learn, their self-beliefs to complete a task, their confidence to attain a desired level of performance, or their expectancy beliefs have been considered a factors to mediate the outcome of their academic performance (Pajares, 1996), so classroom strategies that enhance self-efficacy are needed to maintain or increase student self-efficacy.

Since self-efficacious beliefs tend to decline at the middle and high school years, McTigue and Liew (2011) suggested promoting self-efficacy during those particular learning years would help adolescents develop a healthy sense of self-esteem while increasing self-efficacy, and what teachers practice will make a difference in whether or not students will build positive self-efficacious beliefs about their learning. Even though writing is often a complex and demanding task, students with high self-efficacy supported academic success or achievement (Al-Bataineh et al., 2010). Plummer, Davis, and Brazier (2011) found that providing students learning opportunities that make them feel excited and comfortable about learning new material afforded them opportunities to construct meaning. Tsai, Ho, Liang, and Lin (2011) upheld, "In a word, self-efficacy mediates people's interpretation of their knowledge, skills, or experiences of prior attainments, and is believed to be an essential factor in positively predicting learner outcomes" (p. 759).

McTigue and Liew (2011) suggested providing a safe and democratic classroom, modeling self-efficacy within the academic environment, promoting self-evaluation, and providing lessons that encouraged students to think creatively and to create a positive sense of self, especially when adolescents are experiencing significant changes socially and emotionally. A way of increasing or strengthening self-efficacy beliefs can occur by providing students vicarious experiences where they see people similar to themselves experience success through perseverance, so, they, too, will believe they can accomplish or master similar tasks (Bandura, 1995)

Studies have shown that students with high self-efficacy have a high academic performance (Austin, 2010; Fife et al., 2011; McDermott & Hand, 2013). Thus, students' self-efficacious beliefs can influence their science and math achievement. "In the twenty-first

century, literacy skills increasingly reflect technology use and the abilities necessary to problem-solve, collaborate, and present information through multi-media" (Pilgrim, & Martinez, 2013).

Cheung (2015) suggested, ". . . one way to foster students' chemistry self-efficacy is to both implement efficacy-enhancing teaching and promote students' use of deep learning strategies" (p. 113). In sum, positive self-efficacy beliefs for students may promote both positive academic learning experiences and high academic performances. Since students' self-efficacious beliefs tend to decline during middle and high schools, teachers' having positive self-efficacious beliefs can foster increasing students' self-efficacy.

Math and science teachers' self-efficacy. The study of teachers' sense of self-efficacy began in the mid-1970s, and researchers found teachers' self-efficacy was related positively to students' achievement, willingness to learn, and motivation (Tschannen-Moran & Johnson, 2011). PTE is a context-specific model in which one evaluates his or her capabilities such as skills, knowledge, or teaching strategies (Soodak & Podell, 1996; Yoo, 2016). Soodak and Podell (1996) asserted that personal teacher efficacy pertains to a teacher's believing he or she possess teaching skills or confidence in their ability to teach in a way that leads to student achievement or positive student learning outcomes. Yoo (2016) claimed individuals could achieve PTE through self-analysis and professional development.

In a study on PTE and the sources of efficacy from student teachers' perceptions, Poulou (2007) claimed self-perceptions of teaching competence, personality traits, and possessing the skills to teach the content dictated to the teachers' efficacy beliefs. Stevens et al. (2013) specified even though math teachers may have the conceptual knowledge for mathematics, they might have difficulty with engaging students in their instruction and recommended professional development to assist teachers with lower self-efficacy. In a study of high school STEM

teachers, Baron (2015) indicated if teachers were empowered to take risks with their lessons, to implement a teaching strategy outside of their comfort zone, or to challenge their beliefs about their own practices, they could become more confident in their teaching methodologies, strengthen their belief systems, and overcome teaching barriers.

Tschannen-Moran, Hoy, and Hoy (2007) claimed there is accumulated and compelling evidence of a direct relationship between teachers' beliefs about their capability to motivate students and to increase student achievement and teacher-self-efficacy beliefs related to students' self-efficacy beliefs. In a study of teachers' sense of self-efficacy, Tschannen-Moran and Johnson (2011) supported the contention teachers' self-efficacious beliefs are related to years of experience, and coaching and mentoring novice teachers, as well as providing them professional development to improve instructional practices, could assure the development of a strong sense of self-efficacy, motivation, and improvement for novice teachers. Riggs and Gholar (2009) proclaimed teachers possess a conative domain, an inner strength compels them to complete a task or to reach a goal, and they are more likely to be intrinsically motivated if they have a high self-efficacy and self-determination.

Al-Bataineh et al. (2010) asserted that positive personal writing experiences, collaborative writing experiences, and teachers' attitudes had a positive impact on student self-efficacy, while negative personal writing experiences, insufficient writing guidelines, and pressure from the learning environment had a negative impact on student self-efficacy. For teachers who provide authentic writing opportunities, WTL can offer a safe and exciting learning environment where students can freely practice WTL activities that will lead to students' having positive learning experiences and positive self-efficacy. Teacher educators, administrators, and

teacher-mentors could have a positive impact on novice teachers if they fostered positive, efficacious beliefs for beginning teachers.

In a qualitative a study of secondary mathematics teachers, Baron (2015) further described math teachers who reflected on their beliefs and practices, took risks in the classroom to apply their individual teaching idea, and discussed their work in a collaborative manner with their colleagues were empowered teachers to trust their ideologies and to maintain their reflective practices. In a meta-analysis, Multon and Brown (1991) found a statistically significant relationship between self-efficacy beliefs and academic performance and suggested further research to evaluate classroom strategies that promote self-efficacy belief. Thus, if teachers believe they can teach effectively using specific strategies, they will have increased self-efficacy.

Summary

There is no current research studying high school math and science teachers' perceptions of themselves as practitioners of WTL and their beliefs about using writing as a tool for learning math and science. Although many schools use WTL, there is no support for on-going professional development for WTL within the school district. The AP and STEM high schools within the district are providing professional development opportunities for Laying the Foundation for AP courses (National Math and Science Initiative, 2016a) to prepare teachers to set high expectations and to encourage students to think at advanced levels, but presently there is no significant professional development on using WTL in math and science.

With writing being a component of math and science state standards, WTL can have a positive impact on learning across grade levels and core courses and can be an essential part of the high school curriculum. Furthermore, high school students in STEM or AP classes will be

expected to use writing to demonstrate their knowledge of science content to meet the writing demands stated in the core standards (Fisher & Frey, 2013).

The literature review outlined self-efficacy, adolescent self-efficacy, and teacher self-efficacy. The literature revealed that teacher beliefs can include their efficacy to teach their subject, and their attitudes towards their subjects, and if their self-efficacious beliefs and teacher self-efficacy has been one teaching trait that has been associated with higher student achievement (Brindle et al., 2016; Tschannen-Moran & Johnson, 2011; Stevens et al., 2013).

The literature reviewed examined current WTL research in the math and science content areas. Studies have shown positive correlations between WTL and test performance (McDermott & Hand, 2013; Whitehead & Murphy, 2014). A critical step to help students become college and career ready is to promote the importance and power of writing in all content areas and understand subject-specific literacy and teachers' beliefs about WTL content.

The literature review showed that WTL could be one of the most powerful tools for learning science and math. Writing can allow students to reason their way with words to help them to find a solution to a problem in science or math and to provide a venue where students' teachers can observe the process of learning (Zinsser, 1988). Science and math classrooms that provide personal WTL opportunities are engaging all students in critical and creative thinking about content knowledge. In this school district, teachers at the AP and magnet high schools are expected to integrate critical thinking into their curriculum either to lay the foundation for students to enter AP courses or to prepare their students to be successful in AP courses (National Math and Science Initiative, 2016a).

Math and science teachers will need to have a clear understanding of the district's expectations if they are expected to prepare students to pass the state-mandated tests and to meet

the school district's educational reform effort for all students to be college and career ready. Math and science teachers themselves should have a positive perception of themselves as WTL teachers. According to Lacina and Block (2012), most studies in the area of writing examine teachers who teach writing in a manner that excels others and suggested educational leaders find ways to increase writing instruction and to increase the use of technology across content areas when writing. Lacina and Block also suggested that educational leaders find ways to foster student motivation and with authentic and meaningful writing experiences. However, the literature review revealed it is necessary to study classrooms where there is a strong need for written forms of mathematical and scientific communication, (Freeman et al., 2016). Increasing technological change is requiring students to know more at a rapid pace, so students must be able to use self-directed learning. School districts should adopt professional development models that promote WTL in the math and science classrooms to keep up with the demands of the 21st Century.

This study provided insight into high school math and science teachers' beliefs about using writing to learn math and science teachers' perceptions of themselves as practitioners of WTL. Understanding NMSI teachers' perceptions of themselves as practitioners of WTL and their beliefs about using writing as a tool for learning math and science also provided insight into professional strategies the participants used that increased their teaching self-efficacy and their students' self-efficacy. This study also provided insight into high school math and science teachers' specific professional development needs. Thus, this case study explored how the implementation of math and science state standards affect teacher efficacies and instructional practices using WTL in the areas of math and science.

CHAPTER THREE: METHODS

Overview

This case study explored how the implementation of math and science state standards affect teacher efficacies and instructional practices and writing across the curriculum in the areas of math and science. This study used a qualitative approach using collective case design to discover high school math and science teachers' beliefs about using writing as a tool for learning content and their perceptions of themselves as WTL teachers. This chapter includes the research design, the research questions, the setting of the research, the data collection process, data analysis procedures, and information supporting the trustworthiness and ethical considerations of the study. This chapter reveals how all the data was collected, analyzed and interpreted.

Design

A qualitative case study approach was used to discover what the math and science teachers' beliefs of their capabilities to teach and to use WTL, and how they perceived themselves as practitioners of WTL. This approach offered multiple sources of evidence from various data collection sources: observations, personal interviews, and a focus group interview (Stake, 1995; Yin 2003). The case study design afforded a better understanding of the case or phenomenon (Stake, 1995). The approach was appropriate to gain a better understanding of the various math and science teachers' beliefs and perceptions towards using WTL, and how they saw themselves as teachers of WTL. This perspective allowed me to look "broadly" at the issues (Stake, 2009). This method also provided a clear understanding of the case "coordination between the individual studies" (Creswell, 2013, p. 98) to maximize the information obtained from both the math and science teachers. This study qualitative case study showed the different perspectives of math and science teachers on the same issues.

Research Questions

1. What are high school math and science teachers' beliefs about their capabilities to teach and use WTL?

2. How do math and science teachers describe themselves as teachers of WTL?

3. What are high school math and science teachers' beliefs of the effectiveness of writing to support learning?

4. What are high school science and math an teachers' beliefs about the support they are given from the state department of education, administration, and the school district for implementing writing in their classrooms?

Setting

The setting for this study was an urban high school in a southeastern state. There are 47 teachers at this site, 13 of which are math and science teachers. The middle and high school population serves approximately 681 students, Grades 6-12, and offers a diverse curriculum, including 10 AP courses with an emphasis on preparation for college and career. The school is designated an AP and magnet school with an emphasis on health sciences and engineering. Students must qualify academically to attend the school. Graduation requirements among the core courses include four credits in English, four credits in math, three credits in science, and three credits in social studies, with United States History, United States Government, and Economics being the required courses in order to receive a high school diploma. Engineering students are required to take five math and five science courses. Health science students must take five science courses.

This school is the only magnet science and math high school in the district, and students receive content-rich lessons, training and resources, and instructional best practices to prepare

them for high school AP courses or college-level courses if students elect to dual-enroll in local

colleges or choose to take online college courses. This setting was appropriate for the case study

because the study involved math and science teachers' beliefs about WTL in an AP magnet high

school. The setting requires the use of writing in the science and math classes to prepare

students to write for the ACT, SAT, ACT, and WorkKeys, to write for free-response questions

on AP exams, and to be College-and-Career Ready. Pseudonyms were used for the school

names, school district name and location, and participants' names and positions to protect the

privacy of information. The study was scheduled to take place over four weeks.

Participants

Participants for this study were limited to five math teachers and five science teachers, at

the same school who participate in the health science, engineering, and STEM program. The

math department offers AP Computer Science, AP Statistics, AP Calculus, Algebra I, Algebra II,

Probability and Statistics, Pre-Calculus Honors, and Geometry Honors. The science department

offers AP Chemistry, AP Physics, AP Biology, AP Environmental Science, Biology, Chemistry,

Physical Science, Forensics, and Anatomy and Physiology. The participants came from varied

backgrounds of teaching experiences and years of experience. Also, the math and science

teachers had no more than two preparations, and the math and science departments had common

planning periods with the math teachers having a professional learning community during second

period, and the math teachers having a professional learning community during sixth period.

Thus, both departments had time set aside for sharing lesson ideas for similar courses.

Additional sampling consisted of a focus group discussion comprised of five math teachers and

five science teachers from the same sample. Participants kept a daily response journal. The

state's department of education had designated each of these participants as a highly qualified teacher. Each participant used a pseudonym to maintain confidentiality at all times.

Procedures

Stake (1995) asserted the qualitative researcher is one "knowing what leads to significant understanding, recognizing good sources of text out of the veracity of their [researchers'] eyes and the robustness of their interpretations" (pp. 49-50). Stake (1995) suggested the essential parts of data gathering are by organizing the data-gathering process, by creating a checklist to review the proposal, by having an efficient and secure data storage plan, by obtaining written permission from the university, school, district, and participants. The Institutional Review Board (IRB) approved my study after all required letters of permission and consent were submitted. Before this study began, I received written permission to conduct the research from the IRB (Appendix A) which included a permission letter from the school district, and a letter of consent (Appendix B) that given to each of the participants. To establish rapport with each participant, they received a consent form including information pertinent to the study as recommended by Creswell (2013): a participant's right to withdraw, the purpose of the study, procedures for data collection, confidentiality, known risks, benefits and the signatures of the participants and researcher. Interviews (Appendix C) were digitally recorded and transcribed into researcher notes, and proper protocol was employed regarding interviews, audio recordings, and response journals, protecting the anonymity of the participants by using pseudonyms, and storing data. The study was bounded by time (four weeks) and by a collective case (math and science teachers).

I conducted member checking, having participants read the rough drafts for accuracy, of the transcriptions (Stake, 1995). After transcription occurred, I analyzed, reviewed, and securely stored the data. I used Atlas.ti to code the data, then, identified and classified prevalent themes.

I selected a focus group (Appendix D) and scheduled a time to meet at the end of the four-week study to obtain a more accurate picture of these participants' self- efficacy. I also discussed insights from the interview process and conducted further discussions. I utilized a digital recording of the focus group for accuracy in dialogue and production of focus group discussion notes. I served as the focus group moderator and facilitated discussion. After transcription occurred, the data was analyzed, reviewed, and securely stored. The data was coded using Atlas.ti where themes were identified and classified.

To increase my understanding of this case, each participant kept a response journal for four weeks (Appendix E). Each participant recorded his or her reflections of each WTL lesson, which concluded the data gathering phase and provided the study with rich insight into high school math and science teachers' perceptions of themselves as WTL practitioners and their beliefs about using WTL. The participants' responses provided critical insight as they were:

- To explain how and why the WTL was put into practice

- To record each WTL practice

- To reflect upon or assess the WTL lesson

- To self-reflect upon or assess personal teaching

- To justify or support my conclusions in the study

- To discuss the results of their WTL practice and its implications of future work

- To express specific areas of need for professional development

Thus, these response journals were used to identify the teachers' needs for professional development to support the state's math and science standards in writing and to explore teachers' beliefs of using writing to learn math and science.

Researcher's Role

I had a strong commitment to the study, and I understood the demands of time and resources this type of study required. Even though there was a personal history as a classroom instructor of the WTL teaching concept, I attempted not to allow personal feelings or biases regarding the ways to use WTL to influence how the individual math and science teachers use WTL. I am an employee of the school district and a teacher at the school where the study took place, and I remained separate from the participants since they were in another department and location/building. Because I was a key instrument and part of the setting where the research occurred, I was aware of any potential biases or pre-conceived ideas that might have existed. I was cognizant that any potential biases or pre-conceived ideas might influence the results of the study. My duties were to gather the information, to serve as the interviewer for all interviews, to serve as the moderator of the focus group, to provide transcribed notes to each interview participant to ensure accuracy of transcriptions and interviewee's intent, and to transcribe accurately and precisely what each relevant data recorded in each participant's response journal. My role was to conduct the research, keep the participants informed, and to provide the participants an opportunity to check the transcriptions for accuracy.

Data Collection

Triangulation of the data occurred by using three types of data collection appropriate for the design: personal interviews with each of the 10 participants, a focus group interview with four math teachers and three science teachers, and participants' response journals. To strengthen

data credibility, triangulation of data sources was consistent with Stake's (1995) and Yin's (2003) recommendations for case study research.

Interviews

Each interview (Appendix D) took place in a private conference area of the school. The interviews were conducted at the participants' school, individually between the interviewee and me, and transcribing was completed following each interview (Creswell, 2013). I created a relaxed climate by thanking each participant for being a part of the study and for their willingness to be open and honest about their experiences and feelings. I obtained individual points of view through face-to-face interviews that lasted from 30 minutes to 45 minutes, and I digitally recorded each interview and transcribed verbatim to ensure proper accountability and exactness of the interview answers. Using the Kvale and Brinkmann (2009) approach to interviewing (as cited in Creswell, 2013) allowed me to change questions during the interview if needed. Each interview was informal and interactive, and the questions and comments were open-ended as suggested by Creswell (2013). The interviews were semi-structured and open-ended in design, which allowed for a discussion with open and varying thoughts during the interview. This semi-structure design provided me the opportunity to venture from the initial question in order to seek additional information discussed by the interviewee. Before conducting individual interviews, I mentally rehearsed the interview questions and revised the questions as needed (Stake, 1995, p. 65). I assured confidentiality and anonymity with each participant during the interview and asked each participant to review the transcription to ensure accuracy.

Yin (2003) suggested that interviews are guided conversations and are usually one of the most important sources of case study evidence. Data collection method of interviews should be targeted and focused on the case study topic, and insightful and provide perceived causal

inferences, and the interviewer should be a good listener. The interview questions should attempt to minimize bias due to poor or misleading questions and help me to be aware of reflexivity or receiving answers the interviewer wants to hear. The purpose of the interview questions was to acquire data on teachers' beliefs about using writing as a tool for learning content in their courses, and to acquire each participant's self- beliefs about their abilities to use WTL, and to gather data on how they see themselves as practitioners of WTL.

Semi-structured Open-Ended Interview Questions

Teacher Beliefs of WTL and Self-Perceptions of Beliefs as WTL Practitioners

1. Why do you feel writing is important in your course, and do you believe you are an effective practitioner of WTL? Why or why not?

2. What kinds of WTL assignments have you used in your course, and how do you feel about the results of using these assignments?

3. Why do you feel WTL activities benefits or hinders students' learning difficult material in your course?

4. How does WTL in your course positively or negatively affect your students' learning content? Explain.

5. Why do think writing is included in the math or science state standards?

6. How do you see yourself as a teacher using WTL in your course? Explain.

7. What feelings come to mind when you are using WTL tasks in your course? Explain.

8. Describe your belief in your ability to use WTL to help students understand content.

9. Describe how offering personal creative writing experiences to your students has affected your belief in your ability to implement WTL in your course.

10. How could you become a more effective teacher of writing or WTL in your course? Explain.

11. Describe your central feelings about using WTL in your course.

12. What suggestions would you make to yourself for improving your self-perception or beliefs about using WTL?

Focus Group

I conducted a 45-minute to one-hour focus group interview (Appendix D) discussion at the end of four weeks to explore the participants' shared beliefs towards WTL and their perceptions of themselves as practitioners of WTL. I digitally recorded and transcribed, verbatim, the focus group interview to ensure proper accountability and exactness of the interview answers. Again, I created a relaxed climate by thanking each participant for being a part of the study and for their willingness to be open and honest about their experiences and feelings while using WTL in their perspective science and math classes and to discuss their self-beliefs about themselves as practitioners of WTL. The relaxed climate afforded teachers to speak freely, openly, and honestly about their feelings regarding using writing in their perspective classrooms. Four math teachers and three science teachers voluntarily accepted the invitation to participate in the focus group discussion, to get a random sampling of writing across the curriculum within each department. This approach provided each teacher with an opportunity to speak openly and freely, promoting a more dynamic open discussion. As suggested by Yin (2003) the focus group was conducted to validate findings from the individual interviews and to capture the interviewees' response from each of the questions (p. 111). Similar questions were used in the focus group interview so that I could clarify or condense previous answers given by participants.

Standardized Open-ended Focus Group Questions

Teachers' Perceptions of WTL and Self-Perceptions of Themselves as WTL Practitioners

1. Why do you feel writing in your content is an important aspect or not important aspect of your course?

2. How do you feel about students' use of the WTL method to explain their understanding difficult scientific or mathematical concepts?

3. What kinds of shared WTL assignments have you done in your courses and do you feel any of these assignments were effective in increasing student understanding of content? These shared assignments can be from within your department or from other sources. Explain.

4. What are your shared beliefs about WTL and if it benefits students' learning difficult material in your course?

5. How does WTL in your courses affect your students' beliefs about learning content? Explain.

6. Why do think writing is a component of both the science and math state standards?

7. What types of professional development does the school or school district provide to help you with writing integration to support college and career standards?

8. How would you describe your shared WTL experiences with your students and other teachers? What feelings come to mind?

9. Express positive feelings about learning science or math when using the WTL method.

10. Express any negative feelings about learning science or math when using the WTL method.

11. Describe what motivates you to use a WTL tasks.

12. Why do you decide not to use a particular WTL task?

13. If you write with your students, describe how sharing your original writing or writings with the class makes you feel.

14. Does writing with your students influence your self-efficacious beliefs about using WTL in your content area? Why or why not?

15. How does working with a peer(s) make you feel when collaborating sharing WTL activities? Describe.

16. Describe how using the WTL approach or supporting the math or science writing standards has affected your self-efficacious beliefs or your belief in yourself to use writing effectively as a tool for learning content or to have students to think critically about the content?

17. What are your sincere beliefs about using WTL in your content area and your personal belief in yourself as a practitioner of WTL?

Participants' Response Journals

Each participant was asked to keep a response journal for four weeks to reflect upon their use of WTL (Appendix E). Participants' responses or reflections provided a rich source of data for gathering key events and for interpreting classroom dynamics among various relationships such as teacher-student, student-student, and individual WTL activity and whole group. Thus, the response journals presented a rich personal set of data to search for meanings, to create categories, and to search for patterns. Throughout the study, the participants included critical reflection pieces that offered insight into of the following:

- To explain how and why the WTL was put into practice

- To record each WTL practice

- To record students' successes or struggles with WTL

- To reflect upon or assess the WTL lesson

- To self-reflect upon or assess personal teaching

- To justify or support my conclusions in the study

- To discuss the results of their WTL practice and its implications of future work

- To express specific areas of need for professional development

The participants' reflection journals served as a place for participants to reflect truthfully on personal biases, frustrations, and fears of the successes or failures of particular WTL lessons and served for participants as a safe place for critical self-reflection on personal understandings of their self-beliefs and perceptions of themselves as WTL practitioners. These response journals provided additional significant meaning and insight to the study in order to aggregate the teachers' beliefs about WTL and how teachers see themselves as WTL practitioners.

Data Analysis

Since this study was a case study, categorical aggregation was used for analysis and interpretation to establish themes or patterns. Stake (1995) proposed a "search for meaning often is a search for patterns, consistency within certain conditions, which we call 'correspondence'" (p. 78). I created and organized files, and read transcriptions gathered from the personal and focus group interviews and journal responses "to understand behavior, issues, and contexts with regard to the particular case" (Stake, 1995, p. 78) to classify data into codes and themes using categorical aggregation and to establish themes and patterns, and to make generalizations of what was learned from this study. The triangulation of data collection of interviews, the focus group, and participants' response journals allowed me to analyze the data by classifying the data into

codes and themes using categorical aggregation to establish themes or patterns. Analyzing the data through a thick description of the case, developing themes from interviews, a focus group, and teacher response journals to reveal teachers' beliefs about using WTL and their perceptions of themselves as a practitioner of WTL, I developed naturalistic generalizations to produce a recommendation of findings. I utilized four forms of data analysis and interpretation as suggested by Stake (1995): categorical interpretation, direct interpretation, and naturalistic generalizations. Thus, for data analysis, I used categorical interpretation to examine the collection of instances from the data and used direct interpretation to draw meaning from several instances. I looked for similarities and differences from the data, and I "develop[ed] naturalistic generalizations from analyzing the data, generalizations people can learn from the case either for themselves or to apply to a population" (Creswell, 2013, p. 200). The entire picture of the findings using detailed descriptions about the case, I presented in the narrative, and the interpreted data I used to develop recommendations through the use of coding the data and creating narratives.

Trustworthiness

In this study, I incorporated Lincoln and Guba's (1985) suggested four criteria for establishing trustworthiness: (a) credibility (internal validity), (b) dependability (reliability), (c) transferability (generalizability), and (d) confirmability (objectivity). I further established trustworthiness through transferability and dependability through rich and in-depth participant interview and journal responses (Lincoln and Guba, 1985).

Credibility

Creswell (2013) suggested the use of member checks to ensure the credibility of a qualitative study. I established credibility by member checking for accuracy of transcriptions of

data. I used triangulation—personal interviews, focus group interviews, and observations using observational protocol using descriptive and reflective notes—in order to corroborate the findings from the varied sources. Before conducting individual interviews, I mentally rehearsed the interview questions and revised the questions as needed (Stake, 1995). I had participants to member check the transcriptions of the interviews to validate the research report as recommended by Stake (1995) so that participants could provide a critical interpretation of the transcriptions for accuracy and specific wording. The participants and I checked and rechecked the transcriptions to ensure accuracy and reliability of the data, in order to describe the participants' beliefs about WTL and their perceptions of themselves as practitioners of WTL. I maintained credibility through triangulation, member checks, and peer reviews. An individual who held a doctorate in education conducted a peer review.

Dependability and Confirmability

Lincoln and Guba (1985) described dependability as a confirmation of external validity. Thick textural and structural descriptions supported the dependability of the data (Creswell, 2013). Member checks supported confirmability of the transcriptions of the individual and focus group interviews. To ensure confirmability, an external auditor conducted external checks and rechecks of the research. (Creswell, 2013). I used reflexivity in order to reveal the process of thinking critically about my role during the research process. I kept a reflection or description journal to aid the validation of the study, but the information within my journal will not be a part of the research data. Robust descriptions presented a realistic assessment of the case.

Transferability

To achieve external validity, I presented detailed descriptions and narratives concerning the phenomenon so that the conclusions drawn were transferable to other settings and situations.

Stake (1995) offered a thorough checklist for critiquing the case study to ensure a good case study report. In order to enhance transferability, the research was described thoroughly, providing thick descriptions of the participants, the setting, and the collection methods. Triangulation of the data revealed common themes that could be applicable in other contexts. Although the understanding of a phenomena is gained gradually through several studies by presenting a well-organized case study that included thick descriptions and narratives to provide applicable context for future studies on math and science teachers' beliefs about WTL and how they perceive themselves as practitioners of WTL in AP or magnet high school math and science classes. As suggested by Creswell (2013) the study should contribute to our understanding of the phenomena, invite interpretation and be aesthetically pleasing, reveal self-awareness within the study, and lead me to new questions or a call to action. To ensure a good case study with transferability as suggested by Creswell (2013), I clearly identified the case and the research problem, included thick descriptions of the case, identified the significant themes, made clear assertions or generalizations about the case, and was reflexive and self-disclosing about my personal position in the study. I conducted this study so that the results will be useful, relevant, and adding to the existing literature on the phenomenon.

Ethical Considerations

Before conducting the research, I submitted a research proposal to the IRB at Liberty University for approval (Appendix A). I acquired approval from the school district and the building level principal before beginning the study. Also, each participant received an IRB-approved participant letter of consent (Appendix B). I identified all personal biases and pre-conceived ideas of result findings. I maintained confidentiality and security for all participants at

all times and stored all information on a secured password-protected external hard-drive, and I will destroy all data within three years after this study.

Before the study, the participants completed and signed consent forms. I respected the privacy and rights of the participants by assigning pseudonyms, and I was conscious not to place any participant at risk or in harm's way. I provided a statement of confidentially for interviewees and focus group members. I honored the right of the participants to withdraw from the study at any time and provided gift cards to all participants for their time and effort for participating in the study.

Summary

In this chapter, I presented the methods used in this study. A qualitative case study was the best approach for this study. Data collection methods included a triangulation of personal interviews, focus group interview, and participants' response journals. I utilized case study recommendations from Stake (1995), Yin (2003), and Creswell (2013) to conduct this research. I safeguarded participants' confidentiality, and I employed research methods of dependability, credibility, transferability, and confirmability to ensure trustworthiness.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this qualitative case study was to document and explore high school math and science teachers' beliefs and instructional practices concerning Writing-to-learn (WTL), or students learning content through writing. The problem was there is a lack of current research on high school math and science teachers' self-efficacious beliefs concerning the use of writing in their content areas or how they are being prepared to implement best practices for using writing in their content areas. With the emphasis placed on writing across the curriculum, research suggested all stakeholders—colleges, universities, schools, school districts, and state departments of education—need to do a better job of adequately preparing teachers across subject areas to use writing in instruction rather than relying on teachers' personal efforts to do so (Amber et al., 2015; Gillespie et al. 2014;). Participants for this study were five high school science teachers and five high school math teachers who teach in a science, technology, engineering, and math magnet school in the southeastern part of the country. Interviews, a focus group interview, and participants' response journal notes served as the data collection methods. An analysis of the data occurred using Atlas.ti for coding and categorical aggregation. The process identified patterns and recurring themes that emerged in an attempt to discover how these math and science teachers perceived themselves as teachers using writing as a tool for learning and their self-efficacious beliefs about their ability to use writing as a tool for learning. Included in this chapter are the themes and patterns that emerged from the data collected and a detailed description of each participant. Also included are theme development, research question responses from each of the participants from each of the data collection methods, and a summary.

Participants

Each of the participants in this study was assigned a pseudonym to protect their identities. The sample size was 10 participants, five high school math teachers and five high school science teachers from the same school in the southeastern region of the United States. Seven of the participants in the study were part of the focus group. The focus group consisted of three science teachers and four math teachers. Two of the science teachers and one math teacher were called to participate in a curriculum meeting at the district level the day of the assigned focus group meeting. The focus group responded to 17 opened-ended questions. Each participant responded to the same 12 open-ended questions during individual interviews. Each participant kept a response journal for four weeks to record his or her thoughts and feelings regarding their use of WTL in their respective courses and their self-efficacious beliefs about their abilities to use WTL effectively. Each of the participants is described in detail in the following:

Mary

Mary was a 40-year-old Caucasian female who had taught for five years. Her certification was in secondary math, Grades 6-12, and she had an endorsement in gifted and talented. She taught pre-calculus to mixed classes of honors level and gifted and talented students. Most of her students were juniors and seniors. She felt that writing does not come naturally to math educators like herself, but she desired to know more about how she could improve the use of writing in her classroom. She felt that she was prepared to teach content, but she did not feel as adequate using WTL activities.

Linda

Linda was a 59-year-old African-American female who had taught for 33 years. She was certified to teach math Grades 6-12 and had a gifted and talented endorsement. She taught AP

Statistics and Algebra 2. Most of her students were juniors and seniors. Linda felt her AP

Statistics class was more of a writing class than her Algebra 2 class even though WTL was a

vital part of both courses. She felt that she was not the best practitioner of WTL but believed

that she was "getting there" (personal communication, November 14, 2018). Linda loved to use

WTL because her students could "tell" her what they knew about the lesson. She felt that

writing was important because it is a needed skill for the real world. Linda believed writing was

critical thinking and having good critical thinking skills helped students to be college and career

ready. She felt she needed help with improving the use of writing as a tool for learning

mathematics**.**

Brenda

Brenda was a 44-year-old African-American female who had been teaching for 15 years.

She taught Algebra I. Her certification was in middle Grades 6-8 math, and secondary math

Grades 6-12. Her students were either in ninth or tenth grades. She felt that any time students

had the opportunity to write about what they understand not only helps them, but also helps her

to see their strengths and weaknesses in the content. WTL also allowed students to see and hear

what their peers were thinking, and WTL pushed them to think deeper about math concepts.

Also, WTL allowed her to see what misconceptions students might have had about the lesson,

and it showed her what concepts she might need to reteach.

Tracy

Tracy was a 55-year-old African-American male who was in his first year of teaching.

He taught AP Chemistry, Scientific Research, and Honors Chemistry. Tracy came from the

public sector and was working on his certification. His students were a mixture of 10th, 11th,

and 12th graders. He said that most of the writing in chemistry was related to lab notebooks,

documenting the students' interpretation of what they performed during the lab, and explaining their results. Word problems on assessments allowed students the opportunity to communicate their thoughts through writing, which best evaluated their level of understanding. He felt that students seemed to have a problem with the interpretation of basic communication based on procedural instructions on the entries for their lab notebook that they consistently failed to do properly. Another area of student weakness was their failure to describe a well-thought-out conclusion to accurately describe laboratory results. In some instances, students insisted on step-by-step directions and acted as if they were afraid to think on their own. Coming from the industrial world with a lot of field knowledge, Tracy knew the value of writing because writing was used daily for communication and documentation.

Erin

Erin was a 69-year-old African-American female who had taught for 43 years. At the time of this study, she taught Anatomy and Physiology. Her certification was in advanced science. Erin believed that writing was imperative for all subject areas. Even though free responses or WTL assignments might take longer to grade or to check for understanding, the writing tasks could reveal understanding and mastery of the subject matter. She believed that writing was both creative and critical thinking that prepared students for summative assessments

Ryan

Ryan was a 48-year-old Caucasian male who had taught for 22 years. He taught Physics, AP Physics, and AP Environmental Science, and held certification in broad-field science. He felt that writing could be important in his course because it allowed him to identify if students truly knew the content in their explanations. He was a proponent of WTL. "I think communication across the board should be emphasized. It doesn't matter if it's in a gym class or

an AP Physics class. They need to know how to communicate" (Ryan, personal communication, November 15, 2018).   Before teaching in this school, he participated in a writing-across-the-curriculum program in his previous school in another state. He understood the value in WTL, but he also valued the support needed to use WTL effectively.

Cameron

Cameron was a 32-year-old Caucasian male who had taught for seven years. He taught Algebra 2, Calculus, and AP Calculus. He held certification in secondary mathematics, Grades 6-12. Cameron found it helpful for students to write down their thought process or to look at somebody else's thought process and try to work through that. He said, "It's helpful for identifying common errors and working through the thoughts" (Cameron, personal communication, November 30, 2018). He felt writing is a helpful learning tool that increases rigor in the class, but he also felt he would benefit by learning new ways to implement WTL.

Evan

Evan was a 34-year-old Caucasian male who had taught for 12 years. He taught AP Biology and Honors Biology. He was certified in broad field science, grades 6-12. He felt literacy was important across the curriculum, and that it had to be "intentional." Evan stressed that writing was an essential part of the science department's curriculum map. His WTL philosophy was as follows: "You don't get better at something by not doing it. You get better at it by doing it. And that's a real personal belief" (E. Barton, personal communication, December 20, 2018). He said that his philosophy stems from the English teachers in his family, so there was an "ingrained emphasis" on writing (Evan, personal communication, December 20, 2018).

Glen

Glen was a 47-year-old Caucasian female who had taught for 23 years. She taught ninth grade Algebra I. Glen held certifications in Pre-K -Grade 12 math and Pre-K- Grade 12 science, social studies, and English. She also held certification in secondary administration. Glen knew the positive impact of writing across the curriculum. She believed it was beneficial but time-consuming to grade and to analyze students' writings. Glen thought that WTL needed to occur more often with all teachers, not just those who are passionate about it. She said, "Because not all the time, do I have the opportunity to have a one-on-one conversation with them [the students]. But sometimes when they are able to write it [the assignment], I'm able to take it home, and then I can see their own personal reflections" (Glen, personal communication, December 17, 2018).

Ken

Ken was a 62-year-old Caucasian male who had taught for 15 years. He taught high school Physical Science. Ken held certification in middle school math and science, high school science, gifted and talented, and reading. Ken had always used writing in his science classes, and he enjoyed teaching this subject. Most of his WTL assignments came from writing descriptive answers to lab questions or textbook questions for review. He was fond of a WTL device that he created when he first started teaching called a SQUID which was a Science Question of the Day. He contended that rote learning was not as effective as a student's ability to communicate knowledge accurately through writing.

Results

The purpose of this qualitative case study was to discover high school math and science teachers' beliefs and instructional practices concerning WTL, or students learning content

through writing. Data analysis of the interviews, the focus-group interview, and the individual response journals was used to identify codes and patterns to develop broad categories. Assigning a word or phrase to each category completed the coding of each data collection source. See Appendix F for the codes with the frequency of occurrence for the interview transcriptions, the focus group interview transcription, and transcriptions from the individual response journals.

The results of this qualitative case study included an analysis of the interviews, a focus group interview, and the participants' response or reflection journals. I used Stake's (1995) method of categorical aggregation for the study. Included in the following sections are theme development, research question responses, and a summary.

Theme Development

After I transcribed the data, each participant was asked to review the transcriptions of their remarks from the interviews and the journal for accuracy. I coded each interview and journal transcription using Atlas.ti, a program that allowed me to interact with the data intuitively. For qualitative analysis, Atlas.ti afforded me a way to code each quotation, to create a code document table (Appendix F) where 39 codes emerged and to aggregate all of the data in an Excel table. I placed each of the phrases and words used for coding into categories for each of the four research questions. Because the list of codes was extensive, the code list was narrowed down.

After listening to and transcribing the interviews, reading the transcripts of the data sources, and reviewing each of the participants' response journals, I analyzed the data through coding in Atlas.ti. Many of the codes were synonymous since the interview and focus group questions were the same questions, or the questions were loosely related. As a result of combining similar patterns and grouping these patterns categorically under the most appropriate

code, five themes were then identified to reveal the participants' beliefs in their effectiveness, beliefs regarding WTL, their self-perception, their ability, and their need for support (See Table 1). The goal of interview and focus group questions and response journals was to discover the participants' efficacious beliefs regarding WTL and how they perceive themselves as WTL practitioners. I concentrated on formulating individual interview and focus group questions that had the potential to produce thick descriptions of the participants' beliefs about WTL. I also formulated the questions to elicit their capabilities of using WTL, their effectiveness with using WTL, their descriptions themselves as WTL practitioners, and the support they were given to improve their use of WTL. Subsequently, the dominant themes identified were directly in line with the overarching research questions.

The themes were consistent with the relevant literature regarding teacher self-efficacy, math and science teachers perceived self-efficacy using WTL, and the benefits of WTL, all of which helped to provide answers to the research questions. Teacher beliefs can include their efficacy to teach their subjects, and their attitudes towards their own subjects, and if their self-efficacious beliefs and teacher self-efficacy has been one personal teaching trait that has been associated with higher student achievement (Brindle et al., 2016; Tschannen-Moran & Johnson, 2011; Stevens et al., 2013). I identified the theme of their beliefs regarding the effectiveness of WTL and their ability to use WTL as an instructional tool to support student learning from the verbatim statements of the participants' feelings or personal responses that came from the interview and focus group transcriptions and the participants' personal journal response notes. The codes that supported or defined this theme of effectiveness were as follows:

- Consistency: Using WTL must be consistent.

- Creative and critical thinking: WTL promoted creative and critical thinking.

- Types or kinds of writing: The type of WTL could support learning.

- Feeling effective: Using WTL could make the participant feel effective.

- Feeling ineffective: Participants sometimes felt ineffective as practitioners of WTL.

- Become more effective: Participants desired to become more effective practitioners of WTL.

Of these codes, the frequency revealed that most participants felt that WTL was a useful teaching tool, and the participants felt they were effective practitioners of WTL. However, some practitioners indicated that they sometimes felt ineffective for several reasons: time constraints, handling the paper load, lack of personal confidence, and the need for ongoing professional development (See Table 1).

Another theme identified from the coding was the participants' general beliefs about WTL. Participants felt that WTL helped students to understand content, benefitted the students' understanding and retention of the content or concepts being taught, needed to be required in all courses, and posed challenges like time constraints, getting timely feedback to the students, and dealing with students who were reluctant to write (See Table 1). All participants agreed WTL was beneficial, and all participants felt since writing takes time to complete in class and often takes time to grade outside of class, time management was a major challenge.

Another theme identified from the codes was self-perception as a WTL practitioner. The participants' self-perceptions of themselves as practitioners of WTL supported the codes that defined or identified this particular theme. The codes that related to the participants' self-perception were as follows: (See Table 1)

- Proponent of writing: The participants saw themselves as a proponent of writing.

- Positive results: The participants' perceived themselves as teachers who are able to produce positive learning results from using WTL.

- Improve self-perception: The participants desired to ways to improve their self-perception to sustain their teaching stamina with using WTL.

- Intimidating: Some participants perceived themselves as being intimidated by writing since they did not feel adequate as writers themselves.

The teachers perceived themselves as advocates of WTL who could produce positive results using this teaching tool, but they desired ways to improve their self-perception with the aim of their teaching enthusiasm and endurance. Some participants felt intimidated by the act of writing since they did not feel confident as writers themselves.

The last theme identified from the codes was a need for support, a core belief among the participants. The participants expressed they desired ongoing professional development and support in order to improve their ability to use WTL, to improve their self-perception of themselves as practitioners of WTL, and to improve their writing skills as well as their students' writing skills.

Table 1

Theme Identification Chart

Themes	Codes	Code Frequency Total
Belief in effectiveness	Consistency	36
	Critical and creative thinking	24
	Type or kinds of writing	44
	Feeling effective	197
	Feeling ineffective	110
	Be more effective	120
Beliefs about WTL	Understanding content	43
	Benefits	88

Themes	Codes	Code Frequency Total
	Writing in all courses	73
	Challenges	71
Self-perception as WTL practitioner	Proponent of writing	54
	Positive results	67
	Improve self-perception	70
	Intimidating	51
Belief in ability to use WTL	Good practitioner	82
	Positive results	169
	Challenge to motivate students	31
	Frustrations (teacher)	139
Need for support	Improve ability to use WTL	89
	Improve self-perception	102
	Improve writing	132
	Core beliefs and feelings	139
	Professional development	39

Research Question Responses

Using an analysis of the data from interviews, the focus group interview, and the response journals, I answered each of the research questions. In order to get a rich description of the data and answers to each of the research questions, I matched the questions to the specific themes that emerged from the data.

RQ1. What are high school math and science teachers' beliefs about their capabilities to teach and use WTL?

Belief in effectiveness. The participants saw themselves as teachers who were willing to use WTL to enhance instruction, who thought WTL made them stronger teachers, but some of the teachers had some reservations about their capabilities to use WTL in their classes. Most of the participants felt they were skilled teachers and could employ best practices for using WTL. Even though this is Tracy's first year teaching, he believed he was capable, but he did face some

opposition when using WTL in Chemistry. "I feel effective using it [WTL]. I guess my challenge is encouraging them or motivating the students to do it [write]" (T. Stroud, personal communication, November 13, 2018). The math and science teachers believed they could use WTL, but they each desired to improve upon their effectiveness using WTL. Both Mary, a math teacher, and Ryan, a science teacher, believed that using WTL was an effective teaching tool, but did not always see themselves as strong practitioners. Mary expressed,

It [writing] makes them think about the concepts more than the computations. I get a lot of positive energy from the kids when I try to get them to use their brains more. I just don't feel confident as a writer myself. I sometimes feel frustrated because when I ask students to use writing in an assignment, they ask me why I am wanting them to write in math class. I really wish I had more help with using WTL effectively in high school math . . . ongoing professional development so that I can be more effective using WTL because I know it's beneficial. (personal communication, November 16, 2018).

Ryan also expressed,

Using writing to learn content works. I think communication across the board should be emphasized. It doesn't matter if it's in a gym class or an AP Physics class. They need to know how to communicate . . . I sometimes avoid it [writing] because I do not feel that I am a good writer. I wish I had the magic answer to what WTL activities work best for my courses. (personal interview, December 2018)

Tracy expressed additional feelings of confidence and inadequacy. Tracy's self-efficacious beliefs were shaped by his feeling confident about his students' attitudes towards WTL and his personal feelings about WTL. Tracy said about using WTL in his chemistry class:

I believe it is important because, in science, effectively communicating is vital to getting

correct data, especially when you are dealing with other scientists when you get into the

real world. So, although we have oral communication, written communication is also

very important. I feel I push or encourage or support that in most of our writings,

especially in the activities that we do in our course. I feel hopeful and confident when

students do complete WTL assignments. My personal self-efficacious beliefs about my

ability to use WTL effectively is somewhat confident, but it [using WTL] is often time-

consuming—there are too many time constraints in teaching. Reading all of the

assignments frustrates me because of the amount of time it takes to read each student's

writing. I sometimes feel intimidated because I do not always feel positive about his own

writing skills. (personal communication, November 13, 2018).

In her response journal, Erin revealed the following about her beliefs about WTL:

I believe in writing. Writing is imperative. It shows understanding. Grades are important

during assessment—it is easy to correct multiple choice, T/F, even fill in the blank. Free

response takes even longer to grade, but it shows understanding and mastery of the

material. Writing is directive. It gives information to perform the task or it can tell me

how the task was complete. Writing can force the students to prepare for the assessment.

They know you can guess and get lucky with an answer—it is all objective. When

writing, you need to know your subject/content. Writing causes you to think about

material. Writing helps you to explain what you are learning, and it lets you know what

you don't know. (personal communication, November 13, 2018)

Overall, most of the teachers felt WTL was beneficial to their students' learning content, but they desired more support and ongoing professional development and direction for using WTL in their courses.

   Belief in ability to use WTL. Most participants believed they could execute WTL assignments or activities through a variety of methods. Linda, Glen, Brenda, Cameron (all math teachers), Erin, Evan, Ken, and Tracy (all science teachers) described themselves in positive ways as practitioners of WTL. Brenda expressed,

   I think I'm definitely able to execute [WTL assignments], but I would definitely be open

   to and welcome more writing ideas within the classroom. I think that to be more

   effective, it's just something that I would have to implement or be a part of my lesson

   plan. (personal communication, December 14, 2018).

Tracy expressed that he believed that WTL was a valuable aspect of his teaching and that writing was one of the most important skills that students would need to be college and career ready. Tracy divulged his feelings based on workplace experiences. Tracy came to the classroom from the public sector. Before becoming an educator, Tracy's workplace experiences were with other scientists because he is a nuclear engineer. Tracy shared the following:

   I believe it [writing] is important because, in science, effectively communicating is vital

   to getting correct data, especially when you are dealing with other scientists when you get

   into the real world. So, although we have oral communication, written communication is

   also very important. I feel I push or encourage or support that in most of our writings,

   especially in the activities that we do in our course. (personal communication, November

   13, 2018)

Erin stated,

It [WTL] allows me to know that I am not only meeting the state standards, but I'm

taking them above the basic learning process and that's my goal, just to make them

stronger than they were when they came. I think it's foundational, it's fundamental, it's

monumental. (personal communication, November 13, 2018)

All of the participants believed they felt competent in using WTL within their perspective subject

areas and WTL benefited their students' learning the content and thinking more deeply about the

content.

RQ2. How do math and science teachers describe themselves as teachers of WTL?

In the focus group interview, the participants were asked, "How would you describe your

shared WTL experiences with your students and other teachers? What feelings come to mind?"

They were also asked, "Describe how using the WTL approach or supporting the math or science

writing standards has affected your self-efficacious beliefs or your belief in yourself to use

writing effectively as a tool for learning content or to have students to think critically about the

content?" In the focus group interview the participants were asked, "What are your sincere

beliefs about using WTL in your content area and your personal belief in yourself as a

practitioner of WTL?"

Self-perception as a WTL practitioner. The teachers had varied self-perception of

themselves as WTL practitioners when asked, "Describe how using the WTL approach or

supporting the math or science writing standards has affected your self-efficacious beliefs or

your belief in yourself to use writing effectively as a tool for learning content or to have students

to think critically about the content?" This perception could be because each of them taught a

different course with different age groups. Frequency of use or the number of times the teachers

used WTL, whether weekly or daily, suggested that their self-perception appeared more positive

when they used WTL practices more frequently than teachers who did not consistently employ WTL activities. Erin, a science teacher who frequently uses writing in her science classroom, described herself as a practitioner:

> I think by doing it [WTL], it takes them out of their comfort zone. I see me as using it as a means to take them higher, as a means to make them critically think, to assess, and so, for me, it lets me know that I am giving them an instrument or a pathway in life that they are going to be able to, when they study or prepare for an assessment. And because I'm doing that, if you want to have that success from me, you are going to have to go beyond surface and writing does that. They think I'm over the top. So, I don't know anything else I can really do that I don't already do, but if I found something that would enhance more. (personal communication, November 13, 2018)

Glen, a math teacher who frequently uses WTL, explained,

> I find it [WTL] easy for me to do. So, I implement it as much as possible so that the kids have to write to be able to explain things. Because not all the time do I have the opportunity to have a one-on-one conversation with them. But sometimes when they are able to write it, I'm able to take it home and then I can see their own personal reflections . . . I get excited. Because it shows that I can integrate the writing and the math and when the kids are able to produce a writing piece, even though I'm just a math class, it shows the kids that we are actually all intertwined and how writing can be done in math. So, I like that. (personal communication, December 17, 2018)

On the other hand, even though he believed in the overall benefits of WTL and writing was important in his class, Ryan, a science teacher, felt that time was the main deterrent to his using WTL consistently:

Using writing to learn content works. I think communication across the board should be

emphasized. It doesn't matter if it's in a gym class or an AP Physics class. They need to

know how to communicate . . . I don't do enough of it. And a lot of it comes down to

time to grade. I mean, that's the honest thing. But with the curriculum that we have, we

have lots of stuff that we have to squeeze in, so I question if we ever truly master what

we cover. (personal communication, November 15, 2018)

Ryan saw himself as a mediocre WTL practitioner because he felt hindered by time. He desired

to know ways to manage his class time more effectively, especially with using writing as a tool

for learning. Thus, making time for using WTL influenced the frequency of use. Mary, a math

teacher, also believes expressed,

I try [to use WTL], but I don't do it nearly as often as I could be doing it. It takes a lot of

time and personally I don't like grading writing assignments . . . My ability? It's not that

great. Because writing is my weakest point as far as academia goes. (personal

communication, November 16, 2018).

In the focus group interview Mary also revealed that she would use WTL more, but she desired

more in-service on using WTL [in math].

As Cameron expressed, "I could definitely use more tools to use WTL more effectively"

(Cameron, personal communication, November 30, 2018). Both the math and science teachers

believed that WTL was an effective tool for learning their subjects, but they all felt a need for

ongoing professional development (focus group interview, January 4, 2019).

RQ3. What are high school math and science teachers' beliefs of the effectiveness of

writing to support learning?

In the individual interview, the participants were asked the following questions: "Why do

you feel writing is important in your course, and do you believe you are an effective practitioner of WTL? Why or why not?" and "Describe your central feelings about using WTL in your course." In the focus group interview the participants were asked, "What are your shared beliefs about WTL and if it benefits students' learning difficult material in your course." They were also asked, "Why do you feel WTL activities benefits or hinders students' learning difficult material?

Beliefs about WTL. All participants agreed that WTL is beneficial to both the students and the teachers. When students are learning through writing, they are learning to think critically and intentionally about the content. For teachers, the assignments provide both summative and formative assessments; it provides a depth of knowledge and insight into what the students truly know. Erin said,

> I think it's foundational, it's fundamental, it's monumental. Because without writing, they don't completely understand. Because they can guess [at the answers] all the time . . . if I give them a truly thought-provoking discussion question or analytical question, it's something they just can't look through and plug in answers. They've got to know the information, and I can tell by their writing whether they know the content or not. (personal communication, November 13, 2018)

Each of the math and science teachers expressed that WTL should be taking place in all classrooms. Ken, a 62-year-old science teacher who has taught for 15 years believed,

> Any teacher in any subject that doesn't use writing, and this includes PE [physical education], or any other topic you want to put it in, I feel you are doing a disservice to your students. That's probably it [his strongest belief] in a nutshell. If you don't have your students write, you are not fulfilling your contract with whatever state you have a

contract with. I can't say it any clearer than that. (personal communication, December

18, 2018)

Also, the math and science teachers believed that using writing in a variety of ways increased

rigor and prepared students to be college and career ready which is a goal of the school district.

Several of the math and science teachers came to this magnet school from the public sector to

teach. These teachers believed that students' having good writing skills was directly related to

their success in the real world of work. Tracy, who came from a chemical engineering job to

teach high school chemistry, expressed,

> I believe it [writing] is important because, in science, effectively communicating is vital
>
> to getting correct data, especially when you are dealing with other scientists when you
>
> into the real world. This why I push or encourage or support WTL in many ways.
>
> (personal communication, November 13, 2018).

Brenda added, "So, as our state testing goes now, they have added constructed responses, and so,

the students still have to be able to explain what their answer means" (personal communication,

December 14, 2018). The participants also believed that increasing knowledge retention,

improving communication skills, increasing creative and critical thinking skills, and showing a

certain level of academic maturity is what WTL does for high school students. Because

participants faced giving students benchmark assessments or end-of-course assessments, they

understood the importance of their students being able to respond to writing prompts effectively

on these assessments.

Although Mary saw herself as a weak practitioner of WTL, she saw the benefits: "It gives

those students who have more artistic and creative tendencies a way to showcase their abilities

and shine more, especially those students who are shy" (personal communication, November 16,

2018). All of the participants believed that WTL should occur frequently, consistently, and intentionally for WTL to be beneficial.

While the teachers had positive beliefs about the benefits of WTL, they also found negative aspects of its use in their perspective classrooms. A central concern among the participants was the time that WTL takes within the classroom, and the time it takes for teachers to read outside of the classroom. In his response journal Tracy revealed, "Reading all of the WTL assignments is time-consuming—there are too many time constraints in teaching" (personal communication, November 13, 2018). Linda also expressed in her response journal that time was a constraint: "The drawbacks to assessing WTL is that it takes longer to read/grade . . . subjective" (personal communication, November 14, 2018).   Because teachers feel that they have to cover the curriculum and include the writing component, they feel stressed and frustrated to cover all of standards into for each grading period. Ryan expressed the feeling he sometime gets when he is using WTL: "Oh, crap, I have to grade something! I mean, when am I going to do that? I'd rather do less of something . . . it's the time piece that's always the issue" (personal communication, November 15, 2018). Frustrating to some of the participants was motivating the students to write or to participate in WTL assignments. Either some students feel excited about the writing, or some students do not. Again, having time to conduct WTL activities was the participants' greatest concern. Glen explained in the focus group interview,

> It all sounds great in theory. Time is one of the elements that's most against us. As has been said numerous times, it takes time to grade these, to look at them and to reflect on them. If we have that time and if we can figure out how to utilize all that because we have to do data analysis reports all the time. But it's hard to pull a data report from a paragraph. The child understands it? Check. The child doesn't understand it? Let's go

back and remediate with them. And unless you can show how that paragraph reflects on

their numeric grade, then we are focused on that numeric grade. Whereas we need to

look at our priorities with these children and what is critical thinking and what is helping

these students to be able to do, not just to know, but to be able to do. And

communication is critical and like you said it's in all our standards, state standards, but

they get lost as we go down. (focus group interview, January 4, 2019)

Another drawback was having negative feelings about WTL due to feeling inadequate as a writer

or having student feeling frustrated with a particular writing assignment.

RQ4. What are high school science and math teachers' beliefs about the support they are

given from the state department of education, school administration, and the school district for

implementing writing in their classrooms?

In a personal interview, each teacher was asked, "How could you become a more

effective teacher of writing or WTL in your course?" and "What types of professional

development does the school or school district provide to help you with writing integration to

support college and career standards?"

Need for support. All of the teachers believed they needed more support and

professional development that focused on writing in math and science courses. In the focus

group interview, Glen expressed,

I'd like to see more examples of it being used. Just some, in ELA, you can buy books . . .

journal starts . . . those kind of things. But to find a journal start or something like that

that is just kind of a thought-provoking thing because sometimes I'm not witty enough to

think of something to get them sparked in it as far as the writing component, and I'm just

looking for content area. But like Erin says, it will eventually lead to the final

celebration, but it's the beginning, the sparks that you need . . . the thought process that needs to get started . . . and sometimes I'm not even sure where I'm starting, so to have some examples of thought-provoking questions not just yes/no answer that they could actually write. (focus group interview, January 4, 2019).

All of the teachers expressed a strong desire to learn more about implementing WTL more effectively in their classrooms. The school district, as well as the state math and science standards, expects them to use writing in their courses, but the district has not provided any real professional development for math and science teachers for using WTL.

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Summary

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Chapter Four included a detailed description of each participant and the findings from the research data collection from which the five major themes emerged. Data analysis of the interview transcriptions, the focus group interview transcription and the response journals were used to identify patterns and codes to develop broader categories. Using Atlas.ti to aggregate the codes into broader categories or classifications, the five major themes emerged from the data.

The five major themes were consistent with the relevant literature regarding teacher self-efficacy, math and science teachers perceived self-efficacy using WTL, and the benefits of WTL, all of which helped to provide answers to the research questions. The final part of the chapter included responses to the four research questions, including narrative responses and quotes from the participants that were relevant to the predominant themes.

CHAPTER FIVE: CONCLUSION

Overview

The purpose of this qualitative case study was to discover high school math and science teachers' self-efficacious beliefs and instructional practices concerning Writing-to-learn (WTL), or students learning content through writing. I conducted the research in an urban science and engineering AP and magnet school in a southeastern section of the United States. Chapter Five presents (a) a summary of findings, (b) a discussion of the findings, (c) implications of the study, (d) delimitations and limitations, and (e) recommendations for future research.

Summary of Findings

To answer the research questions, I collected data from 10 high school math and science teachers, five science teachers, and five math teachers. Data sources included 10 individual interviews, a focus group interview, and the participants' response journals to facilitate triangulation. The individual interviews and the focus group interview occurred from October 2018 to January 2019. The participants' kept response journals over four weeks. Seven of the participants in the study were part of the focus group. The focus group consisted of three science teachers and four math teachers. Two of the science teachers and one of the math teachers were called to participate in a curriculum meeting at the district level the day of the assigned focus group meeting. Each participant responded to the same 12 open-ended questions, and the focus group responded to 17 opened-ended questions. Each participant kept a response journal for four weeks to record his or her thoughts and feelings regarding their use of WTL in their perspective courses. The focus of this study was to discover how high school math and science teachers' individual experiences and beliefs of the instructional value of using

writing-to-learn (WTL) strategies with their students may shape the research. As a result of the data analysis, five recurring themes emerged from the data analysis:

- belief about effectiveness of using WTL,

- general beliefs about WTL,

- self-perception as a WTL teacher,

- belief in the ability to use WTL, and

- need for support to use WTL

The first research question attempted to understand high school math and science teacher's beliefs about their capabilities to teach using WTL activities. Analysis of the data revealed that high school math and science teachers believed that writing in all subject areas is important for learning content, and that most teachers desired to learn ways to improve using writing-to-learn in the classroom. Most participants believed they could execute WTL assignments or activities through a variety of methods. The participants saw themselves as teachers who were willing to use WTL to enhance instruction, who thought WTL made them stronger teachers, but some of the participants had reservations about their capabilities to use WTL in their classes since they lacked confidence in their ability to write well. Most of the participants felt they were skilled teachers and could employ WTL best practices.

The second research question attempted to discover how high school math and science teachers described themselves as teachers of writing-to-learn. The teachers had varied self-perceptions of themselves as WTL practitioners. Frequency of use or the number of times the teachers used WTL, whether weekly or daily, suggested that their self-perception appeared more positive when they used WTL in their courses than those teachers who did not consistently employ WTL activities such as reports, exit slips, explanations, or creative writing activities.

While most of the teachers described themselves in a positive light, six teachers had feelings of inadequacy, frustration, intimidation, and stress when using WTL because they did not feel they could write well themselves, and these negative feelings often hindered them from using WTL. Their frustration with using WTL stemmed from their not having enough time to conduct as many writing assignments as they wanted and reading the students' WTL assignments often required a considerable amount of time outside of class. Glen expressed in her response journal, "Time is a negative factor. Time always frustrates me--giving timely feedback to the students when given a writing prompt because math moves quickly and builds, so time is of the essence."

The third research question attempted to discover what high school math and science teachers' beliefs of the effectiveness of writing to support learning content in their perspective math and science courses. Both the math and science teachers believed that using writing in a variety of ways increased rigor and prepared students to be college and career ready which is a goal of the school's district and the state's department of education. Several of the math and science teachers came to this magnet school from the public sector to teach, enforcing their belief that students' having good writing skills was directly related to their success in the real world of work. All participants agreed that WTL is beneficial to both the students and the teachers. The participants agreed that when students are learning through writing, they are learning to think critically and intentionally about the content. The participants believed that the assignments provided both summative and formative assessments and depth of knowledge and insight into what students truly know about the content. The participants also believed that increasing knowledge retention, improving communication skills, increasing creative and critical thinking skills, and showing a certain level of academic maturity is what WTL does for high school students. Mary felt that using writing as a tool to learn math concepts is beneficial because the

writing allows students to understand what they are doing and the writing builds students' confidence in learning math and that writing makes them [her students] think outside of the simple computations of mathematics.

While the teachers had positive beliefs about the benefits of WTL, they also found negative aspects of its use in their perspective classrooms. A central concern among the participants was that WTL takes time within the classroom as well as time outside of the classroom for teachers to read the students' writings and to provide feedback on the writings to the students. Some of the math and science teachers' negative feelings resulted in their feeling inadequate as writers or having students feeling frustrated with a particular writing assignment.

Because the teachers felt that they had to cover the curriculum and include the writing component, they felt stressed and frustrated to cover all of the standards and grade all of the work each grading period. They desired support and direction to help with time management, and they also desired to have exemplars for using WTL in math or science. Brenda expressed that she would like to do more WTL activities than what she currently does, but time constraints did not permit her to employ these activities daily. She desired to know how to manage the time when using WTL, how to incorporate best practices in WTL in math daily, and how to improve her ability to use WTL. Thus, students benefit from using this learning tool, but ongoing professional development is needed and desired among participants.

The fourth question attempted to discover what high school math and science teachers' beliefs about professional development and support provided from the state department of education, administration, and the school district for implementing writing activities in their classrooms. All of the teachers expressed a strong desire to learn more about implementing WTL more effectively in their classrooms. The teachers expressed the state math and science

standards expects them to use writing in their courses, but the district has not provided any real professional development for math and science teachers for using WTL. The teachers believed that if they had the much-needed support and on-going professional development for using writing in their classrooms, they could be more effective practitioners of WTL. Even though the participants believed that they could implement WTL, they felt the need to learn how to be more effective using writing in their math and science classrooms. The teachers especially desired support with time-management, with handling the paper load, with best practices in WTL for math and science as Tracy revealed in his response journal,

> WTL has not made me feel as successful as I would like to feel as a first-year teacher; however, there has been a small percentage of students who have felt successful which I turn makes me feel like I have accomplished the tasks. I truly would like help with WTL best practices, teacher demonstrations, knowing what to expect from a particular age group, and see more assignment(s) that stand out: scientific reports which include excellent and skilled research—detailed explanations of a reaction.

Discussion

The section includes a discussion of the finding through the lens of the theoretical framework and empirical literature. Bandura's (1993) theory of self-efficacy, and Vygotsky's (1978, 1986) sociocultural theory, which operated on the premise people gain knowledge from their lived experiences and learn by doing rather than simply observing, supported this study. These theories as well as, the concept of WTL (Zinsser, 1988) are explored in greater depth in Chapter Two.

Theoretical Literature

The theories that guided this study were self-efficacy and the sociocultural theory. The first was Bandura's (1977) theory of self-efficacy that deals with one's concern with how well one can execute the course of action required to deal with prospective situations. Self-efficacy is grounded in social cognitive theory. Bandura's (2001) theory of self-efficacy supported the idea of personal agency, "to personally make things happen by one's action" (p. 2), embodies the idea of the self-being an influence on one's behavior within a social environment. Vygotsky's (1978) sociocultural theory operated on the premise that people gain knowledge from their lived experiences, and they learn by doing rather than simply observing. Vygotsky (1978) emphasized the collaborative nature of learning and the importance of cultural and social interactions. Vygotsky (1978) stressed that writing assignments should be meaningful in order to arouse an intrinsic need in students, and writing should be a part of a task relevant to life. This mode of learning allowed students to use their imaginations to create a poem relating to the content, a summary, a personal opinion, or a lab report to enhance their social experiences through reading and listening. To reveal their content knowledge to others, students can share their original writings, reinforcing and responding to each other's critical and creative thinking about the content in the safe zone of the classroom. The findings suggested that even though most of the teachers believed that they could implement WTL, they felt the need to learn how to be more effective using writing in their math and science classrooms. All 10 participants used WTL activities within their perspective classrooms and felt they could execute WTL activities when needed and that using writing activities to reinforce students' learning made them better teachers. These WTL activities related to Vygotsky's (1978) sociocultural theory since writing is a cultural and social interaction, and this interaction leads to cognitive development. The students

were learning content through the writing which is a socially mediated activity and is a reflection of one's social cognitive development. Vygotsky (1986) claimed that the process of writing involves social and cultural interaction, giving an individual an inner voice, internalized thoughts, and an outward voice in the form of the written word. Vygotsky (1978) stressed that writing assignments should be meaningful in order to arouse an intrinsic need in students, and writing should be a part of a task relevant to life. By incorporating WTL activities into their classrooms, the participants provided the kinds of socially mediated activities that Vygotsky (1978) claimed would help students to learn through making generalizations or by thinking in concepts, a higher order of thinking skills. Approaching this study from a sociocultural point of view revealed how the implementation of math and science writing standards affect high school math and science teachers' efficacies and instructional practices. If the WTL assignments had a positive impact on the students' learning, it affirmed the teachers' self-efficacy regarding WTL.

Bandura (2011) defined self-efficacy as one's belief in the ability to accomplish tasks. Bandura (1995) asserted self-efficacy is the belief in one's own ability to complete tasks and to succeed in a particular situation, both of which influence how people think, feel, act, or how they motivate themselves. Bandura (1982) defined "perceived self-efficacy [as] concerned with judgments of how well one can execute courses of action required to deal with prospective situations. Initially called observational learning theory, Bandura's (2001) self-efficacy theory supported the idea of personal agency, "to personally make things happen by one's action" (p. 2), embodied the idea of self-being an influence on one's behavior within a social environment. Bandura (1991) supported the idea people have a lasting interest in activities they feel self-efficacious, especially if they have mastered a task at hand, and self-efficacy can influence the choices people make and how they persevere to accomplish a given task. Bandura (2001)

asserted unless people believe they could create the desired or positive results and prevent those results with their actions that might have negative consequences; they will not have the personal incentive to persist through their struggles.

The findings from this study revealed that the participants had positive self-perceptions of their ability to teach their respective subjects, and they could produce positive results from using WTL activities to teach content to their students. These findings supported Bandura's (1995) self-efficacy theory that if people believed they could accomplish a task, then they felt self-efficacious about the accomplishment and future choices. Even though two participants, one math teacher and one science teacher, expressed they did not feel adequate as writers themselves, they still believed in the importance of using writing as a tool for learning content, thus supporting the state's standards for secondary math and science and supporting the academic rigor in this particular magnet school for math and science.

Empirical Literature

WTL can be beneficial to students' academic achievement, and there is a need for professional development for math and science teachers in an AP high school. WTL has been defined as a pedagogical approach using writing to facilitate learning (Zinsser 1988) and described as students learning content through writing (Emig 1977; Fry & Villagomez, 2012; McDermott & Hand, 2013; Whitehead & Murphy, 2014), or the act of making a subject or topic clear to oneself by reasoning through it in writing. Emig (1977) supported WTL as a unique mode of learning since it has the power to connect the learner to learning through writing, listening, reading, performing, and talking through and about the process. Thus, the use of writing as a tool for learning has the potential to increase student achievement, thus increasing teacher and student self-efficacy (Austin, 2010; Fife et al., 2011; Kincaid & Yin, 2011;

McDermott & Hand, 2013), affording students to read more extensively and carefully, to think more deeply about the content, and to be engaged in class discussions about the content WTL strategies had a positive impact on high-stakes student test scores (Fisher & Frey, 2008). Romano (1987) further claimed students who readily and habitually use their language for learning possess a most powerful educational tool, and teachers should have them write to discover, create, and explore knowledge and to use writing to help them overcome difficult concepts (p. 34). Thus, the students take full ownership of their writing Brenda expressed,

> I think the results are always good because you can clearly understand what the students are understanding. You are able to see what they understand or what their viewpoint is and it gives me a lot of insight as far as if there is anything that I need to revisit or if they completely have that standard and we can move on. So, I think it is important for them to be able to translate what they are thinking to writing. (personal interview, December 14, 2018).

When students can convey their conceptual understanding of scientific or mathematical knowledge through creative WTL means, then students are more apt to retain the knowledge they have constructed, and they have a sense of ownership and self-belief about their ability to learn new information. The participants agreed that students who write within their perspective classes have the potential to retain what they are learning and to convey a deeper understanding of the content. Tracy stated,

> I believe it is important because, in science, effectively communicating is vital to getting correct data, especially when you are dealing with other scientists when you get into the real world. So, although we have oral communication, written communication is also very important. I feel I push or encourage or support that in most of our writings,

especially in the activities that we do in our course. (personal interview, November 13, 2018)

Young (2006) believed reflective writing is critical to the learners' gaining a deeper understanding of their learning and thinking, and reflective writing affords students to apply what they have learned in all areas of their lives, making the learning evening meaningful, and providing teachers insight into what their students are actually learning (pp. 45-46). The findings from this study revealed that participants in this study believed that WTL benefited their students academically. The participants agreed that students were able to think analytically, critically, and creatively about the content or particular math and science concepts and that WTL activities reinforced students' learning the content.

Math and Science Teachers' Self-efficacy

The study of teachers' sense of self-efficacy began in the mid-1970s, and researchers found teachers' self-efficacy was related positively to students' achievement, willingness to learn, and motivation (Tschannen-Moran & Johnson, 2011). Poulou (2007) claimed self-perceptions of teaching competence, personality traits, and possessing the skills to teach the content dictated to the teachers' efficacy beliefs. Stevens et al. (2013) specified that even though math teachers may have the conceptual knowledge for mathematics, they might have difficulty with engaging students in their instruction and recommended professional development to assist teachers with lower self-efficacy. Bandura (1977) asserted that having a strong sense of self-efficacy enhanced personal accomplishments in many ways. The participants concurred that WTL validated their students' understanding of course material and that writing was an essential component to their students being to communicate their knowledge and understanding of course content, thus giving them self-confidence in using WTL and increasing their belief that they

could accomplish positive learning results with using WTL. The participants believed they could use WTL effectively, but they desired ongoing professional development and collaboration among their peers in order to increase their positive self-efficacious beliefs about their ability to use WTL and to improve ways to implement WTL best practices. Glen stated,

> My belief in writing in all content areas . . . I think it's critical. I think it's very important, but there's a gap. I'm trying to make up that gap in the curriculum piece and I feel rushed. So, I don't feel I am adequately prepared to be able to do as many writing pieces as I would like because I have to get the math skills in. And I want to become more efficient that I can do them more hand-in-hand. (focus group interview, January 4, 2019)

In a study of high school STEM teachers, Baron (2015) indicated if teachers were empowered to take risks with their lessons, to implement a teaching strategy outside of their comfort zone, or to challenge their beliefs about their practices, they could become more confident in their teaching methodologies, strengthen their belief systems, and overcome teaching barriers. The participants in this study agreed that using writing as an instrument to reinforce learning or to reveal students' understanding of content was academically beneficial for their students, using WTL activities often gave them a greater sense of teaching success. They agreed that their students' writings gave them more information about their understanding of science and math content than what a multiple-choice test could reveal since writing conveyed a deeper understanding of the students' knowledge of the course content. However, all participants desired more ongoing professional development in order to support and enhance their current teaching methodologies and having the time to implement the writing activities and to grade or to check for student understanding [in the writing] was time-consuming. Glen expressed,

As has been said numerous times, it takes time to grade these, to look at them and to reflect on them. If we have that time and if we can figure out how to utilize all of the students' WTL activities . . . because we have to do data analysis reports all the time. But it's hard to pull a data report from a paragraph. The child understands it? Check. The child doesn't understand it? Let's go back and remediate with them. And unless you can show how that paragraph reflects on their numeric grade, then we are focused on that numeric grade. Whereas we need to look at our priorities with these children and what is critical thinking and what is helping these students to be able to do, not just to know, but to be able to do, and communication [writing] is critical. It's in all our standards, state standards, but these standards sometimes get lost as we check off what we are to teach each quarter. (focus group interview, January 4, 2019)

Implications

Research has shown that teacher beliefs can include their efficacy to teach their subjects, and their attitudes towards their own subjects, and if their self-efficacious beliefs and teacher self-efficacy has been one personal teaching trait that has been associated with higher student achievement (Brindle et al., 2016; Tschannen-Moran & Johnson, 2011; Stevens et al., 2013). Bandura (1993) asserted that having a strong sense of self-efficacy enhances personal accomplishment in many ways, and people with high efficacy approach difficult tasks as challenges to be mastered rather than threats to be avoided, and a person's behaviors are motivated and regulated by self-influence (Bandura, 2001). Students who have the same level of cognitive skill development differ in their intellectual performance because of their perceived self-efficacy, and when students acquire new skills, their self-efficacy is influenced (Bandura, 1993). When teachers can find ways to enhance students' belief in their ability to have control

over their progress in learning, the better their performance (Eisenberger et al., 2005). Thus, having strong efficacious beliefs has been seen as directly related to one's interest in activities and practices and students' positive academic performance.

Results from the research revealed that math and science demonstrated that current high school science and math teachers' self-efficacious beliefs and instructional practices concerning Writing-to-learn (WTL) are that they have positive self-beliefs regarding their ability to use WTL in their courses. The study also revealed that these math and science teachers desired ongoing professional development and support for implementing best practices using WTL in high school math and science and how to manage the time constraints. Also, this study revealed that all participants believed that writing should be a major component of all subject areas to increase rigor, to promote critical thinking, and to prepare students to be college and career ready.

Teachers this study believed in the positive academic benefits WTL had on their students. They also believed that their attitudes could greatly improve towards the ability to use WTL more effectively by ongoing professional development from district-level support. The participants also indicated a desire for ongoing collaboration among their peers in order to increase their positive self-efficacious beliefs about their ability to use WTL and to improve ways to implement WTL best practices. Those who support Bandura's (1977) and Vygotsky's (1978) sociocultural theory such as teacher educators, administrators, and teacher-mentors could have a positive impact on novice teachers if they would foster positive, efficacious beliefs for beginning teachers, and teachers who have a strong understanding of how to implement WTL will have positive self-efficacy about their ability to use WTL effectively. Students learn by doing rather than simply observing. Vygotsky (1978) emphasized the collaborative nature of

learning and the importance of cultural and social interactions. The act of writing is giving an individual an inner voice, internalized thoughts, and an outward voice in the form of the written word which Vygotsky (1978) claimed would help students to learn through making generalizations or by thinking in concepts, a higher order of thinking skills.

Theoretical Implications

The theories that guided this study were Bandura's (1977) theory of self-efficacy and Vygotsky's (1978) sociocultural theory. This study focused on math and science self-efficacious beliefs about their ability to use WTL as a tool for learning. The findings suggested that even though most of the teachers believed that could implement WTL, they felt the need to learn how to be more effective using writing in their math and science classrooms. All 10 participants used WTL activities within their respective classrooms and felt they could execute WTL activities when needed. Another paradigm guiding this study is Vygotsky's (1978) sociocultural theory. Vygotsky's (1978) sociocultural theory asserted that social interaction leads to cognitive development; the social interaction can lead students to develop a sense of identity and self-efficacious beliefs about their ability to learn new material. For students to be able to think critically about what they are learning leads to their having a deeper understanding of the content.

Approaching this study from a sociocultural point of view revealed how the implementation of math and science writing standards affect high school math and science teachers' efficacies and instructional practices. This approach allowed for a study of the complexity of the participants' beliefs to be interpreted rather than to categorize the meanings of the participants. The participants expressed that they believed that using writing activities to reinforce students' learning made them better teachers since they saw positive results in their

students' learning content through writing. Some of the types of WTL assignments the participants used were as follows: summaries, exits slips, lab reports, original poetry, narratives, composing short answers, collaborative writing, short-answer quizzes, research reports, journals, observation reports, annotated bibliographies, and expressive writing. These writings demonstrated students' knowledge of content. These assignments fostered critical thinking, requiring analysis, application and other higher-level thinking skills. The WTL assignments were often impromptu, short informal assignments or tasks designed by the teacher to help students think about key concepts and ideas. Participants provided a safe and supportive environment for their students to write, to share, and to respond to each other's writings.

The findings from this study revealed that the participants had positive self-perceptions of their ability to teach their respective subjects, and they could produce positive results from using WTL activities to teach content to their students. Even though two participants, one math teacher and one science teacher, expressed they did not feel adequate as writers themselves, they still believed in the importance of using writing as a tool for learning content, thus supporting the state's standards for secondary math and science and supporting the academic rigor in this particular magnet school for math and science. Bandura (2001) asserted unless people believe they could create the desired or positive results and prevent those results with their actions that might have negative consequences; they will not have the personal incentive to persist through their struggles. The two participants who did not feel confident about their writing abilities felt they did not have the expertise to grade the grammar and mechanics in their students' writings. Mary expressed in her response journal,

Writing does not come naturally to math education. I always include explain-type

questions on tests to promote critical thinking and to increase rigor. However, I check for

[students'] understanding of the concept rather than for grammar and punctuation because I don't feel confident correcting those kinds of errors and even finding those kinds of errors in my students' writings. I know some teachers do, but I don't. (personal communication, November 16, 2018)

Tracy also had feelings of inadequacy. He revealed in his response journal the following:

My position on using writing in my classroom is strong because I am fresh out of a graduate course, and we had to write a good bit. I have a low confidence level in creating WTL assignments because my exposure to using it or facilitating this concept has been limited. I feel hopeful and confident when students do complete WTL assignments accurately. Specific needs of professional development might be ways to create or generate best practice ideas for chemistry—being creative is my weakness since I am so analytical. Personal self-efficacious beliefs about my ability to use WTL is somewhat confident, but it is often time-consuming because overthink how you can make an assignment academically beneficial to the students. I feel intimidated because I do not always feel positive about my own writing skills; I don't think that I am truly qualified to accurately correct grammar and mechanics even when I know I should be focusing on content. (personal communication, November 13, 2018).

The results of this study supported Bandura's (1977) theory of self-efficacy and Vygotsky's (1978) sociocultural theory. The participants in this study indicated positive self-beliefs regarding their ability to use WTL, and they said that WTL had a positive impact on their students' achievement. Writing is a social action and has the potential to increase students' cognitive abilities and their self-efficacy. Teacher educators, administrators, and teacher-mentors could have a positive impact on teachers if they fostered positive, efficacious beliefs for

beginning teachers. Teachers who have a strong understanding of how to implement WTL will have positive self-efficacy about their ability to use WTL effectively. School districts should look to experienced and knowledgeable high school math and science teachers whose efficacious beliefs regarding WTL are positive and supportive, and who have a wealth of knowledge regarding WTL best practices they could share with fellow teachers.

Empirical Implications

The findings from this study suggested WTL can be beneficial to students' academic achievement, and there was a need for professional development for math and science teachers in this health science and engineering magnet high school. WTL activities afford students to read more extensively and carefully, to think more deeply about the content, and to be engaged in class discussions about the content (Jordan, 2014), and WTL strategies had a positive impact on high-stakes student test scores (Fisher & Frey, 2008). When students can convey their conceptual understanding of scientific or mathematical knowledge through creative WTL means, then students are more apt to retain knowledge they have constructed, and they have a sense of ownership and self-belief about their ability to learn new information. Young (2006) believed reflective writing is critical to the learners' gaining a deeper understanding of their learning and thinking, and reflective writing affords students to apply what they have learned in all areas of their lives, making the learning evening meaningful and providing teachers insight into what their students are actually learning. The findings from this study revealed that participants in this study believed that WTL benefited their students academically since their students' writings revealed a deeper understanding of the content or subject matter. The participants agreed that students were able to think analytically, critically, and creatively about math and science

concepts, and that WTL activities reinforced students' learning the content. The participants also concurred that writing should be an integral part of every teacher's course.

The research revealed the teachers' self-efficacy was related positively to students' achievement, willingness to learn, and motivation (Tschannen-Moran & Johnson, 2011). In a study of high school STEM teachers, Baron (2015) indicated if teachers were empowered to take risks with their lessons, to implement a teaching strategy outside of their comfort zone, or to challenge their beliefs about their practices, they could become more confident in their teaching methodologies, strengthen their belief systems, and overcome teaching barriers. The participants in this study agreed that using writing as an instrument to reinforce learning or to reveal students' understanding of content was academically beneficial for their students, using WTL activities often gave them a greater sense of teaching success. However, all participants desired more ongoing professional development in order to support and enhance their current teaching methodologies. Poulou (2007) claimed self-perceptions of teaching competence, personality traits, and possessing the skills to teach the content dictated to the teachers' efficacy beliefs. The participants in this study were highly qualified teachers who were hired to teach in this magnet school because they knew their content or were considered experts in their field. They were willing to try various WTL strategies, and they felt that WTL benefited and reinforced their students' understanding of content. However, the participants expressed that they desired ongoing professional development, collaboration, and support with using writing in science and math. Stevens et al. (2013) specified that even though math teachers may have the conceptual knowledge for mathematics, they might have difficulty with engaging students in their instruction and recommended professional development to assist teachers with lower self-efficacy. School districts and teacher mentors should consider providing on-going professional

development for all teachers in using WTL best practices. Teacher educators, administrators, and teacher-mentors could have a positive impact on teachers if they fostered positive, efficacious beliefs for teachers. Teachers who have a strong understanding of how to implement WTL will have positive self-efficacy about their ability to use WTL effectively. school districts and teacher mentors should consider providing on-going professional development for all teachers, novice and experienced, in using WTL best practices. According to the National Writing Project (2017), there is no single right approach to teach writing or to use writing as a tool for learning in any classroom. There are some practices that can be more effective than others. Having an informed community of teachers on best practices in WTL could strengthen teachers' teaching efficacy and improve academic achievement. Teachers who have been well informed and effective with their WTL practices can be successful teachers of teachers (The National Writing Project, 2017).

Practical Implications

Practical implications resulted from this study. The findings suggest that the participants see and understand the benefits of using WTL, and they desire to acquire more practical ways to employ WTL in their perspective classrooms. The participants agreed that time was one of the major hindrances to using writing and that ongoing professional development and support within their departments would serve to increase their stamina and desire to use writing more frequently within their perspective high school math and science courses. Having ongoing professional support, having time to read the students' writings, and having time to collaborate were central concerns among the participants.

Teachers must build a community of writers within their classrooms where they and their students not only feel efficacious with their writing, but teachers and students also feel safe and

comfortable with each other's writings. This study revealed that teachers want to build a sense community and support among themselves and their students; however, time is a constraining factor with the ongoing pressures to cover the required curriculum within the school district.

Also, WTL activities must be meaningful to the students so that they feel a sense of ownership. This feeling of ownership increases student's self-efficacious beliefs about their ability to learn new content. For teachers who provide authentic writing opportunities, WTL can offer, and a safe and exciting learning environment where students can freely practice WTL activities will lead to students' having positive learning experiences and positive self-efficacy. The participants revealed that they experienced more positive learning outcomes using WTL since these types of writing activities reinforced content knowledge. Teacher educators, administrators, and teacher-mentors could have a positive impact on novice teachers if they would foster positive, efficacious beliefs for beginning teachers, and teachers who have a strong understanding of how to implement WTL will have positive self-efficacy about their ability to use WTL effectively. School districts and teacher mentors and leaders should consider supporting all teachers with the implementation of WTL best practices and with ongoing professional development. Also, school districts and administrators should consider having teachers who have had successes with WTL share their best practices with high school teachers who might be struggling or hesitant to implement writing activities within their perspective courses. As secondary science and math teachers prepare their students to become college and career ready, they must focus their instruction on using writing as a learning tool. This preparation includes having students analyze, interpret, make conjectures, construct arguments, and communicate their findings or answers through writing in order to prepare students to be college-and-career ready. Teacher educators, administrators, and teacher-mentors could have a

positive impact on education if they fostered positive, efficacious beliefs for teachers. Teachers who have a strong understanding of how to implement WTL will have positive self-efficacy about their ability to use WTL effectively. School districts and administrators should consider having teachers who have had successes with WTL share their best practices with high school teachers who might be struggling or hesitant to implement writing activities within their perspective courses. The National Writing Project (2017) suggests that teachers teaching teachers can play a vital role in sustaining a positive, collaborative learning environment among teachers. Teachers can work together to design lessons for high school math and science courses that have been deemed effective practices in WTL for teaching content. Experienced math and science teachers can be transformative leaders within their own school by contributing successful WTL strategies. Ongoing peer collaboration of ideas and resources can sustain teacher efficacy and energy.

Delimitations and Limitations

This study was delimited to high school math and science teachers who use writing as a tool for learning math and science content. The rationale for using high school math and science teachers who use writing in their courses was because there is limited research on high school math and science teachers' self-efficacious beliefs about using WTL and because I have used WTL in high school English.

The first limitation of this study was that time, location, and money were constrained. The second limitation was that a convenience sample is not representative of a larger group. The limitation of this study was that I selected the participants from one school district, and the inclusion of other school districts within the region would have increased the validity of the study. Other limitations I considered were science and math teachers may not use writing daily,

their response journals may be biased, they may have a negative predisposition towards writing in general, and they may not have had any professional development on using writing in their subjects even though the state standards require the use of writing in their courses.

Recommendations for Future Research

In consideration of the study's findings, delimitations, and the limitations placed on the study, I provided several recommendations in this section. For a future study of this topic, completing a collective case study of three to four different magnet math and science schools is recommended. By including more schools and more participants, the researcher could obtain a larger sample population. The school district in this study had only one math and science magnet school and expanding this study to include more math and science magnet schools, including middle schools, would possibly provide more insight into math and science efficacious beliefs regarding the use of WTL in math and science.

There are increased demands in secondary math and science Common Core State Standards to use writing in these content areas. With state and national tests requiring writing components on these assessments, a longitudinal study of math and science teachers' efficacious beliefs about their ability to use writing as a tool for learning content could reveal specific professional development needs that could directly impact student achievement and teacher efficacy. In a meta-analysis, Multon and Brown (1991) found a statistically significant relationship between teacher self-efficacy beliefs and student academic performance. They suggested further research to evaluate classroom strategies that promote teacher self-efficacy belief. A study that revealed the types of WTL activities, strategies, and professional development needs that promote teacher self-efficacy would benefit all teachers who use or plan to use writing as a tool for learning.

For future research, completing a collective case study with more schools within the district where high school science and math teachers are implementing WTL could reveal a more accurate picture of high school science and math teachers' efficacious beliefs. This future study could result in discovering the specific professional development and support needs of high school math and science teachers for using writing in their subjects effectively.

Within the past decade, high schools have increased the number of AP courses being offer to students as college credit courses—math, science, English, and social studies—with AP teachers being expected to use writing consistently within those courses. Although WTL is an effective method for increasing student learning of content, little research has been conducted at the high school level to discover science and math teachers' beliefs about using WTL. Thus, high school math and science teachers need a clear understanding of what WTL activities can be most effective in their classrooms, and what needs exist in the types of professional development seminars to become self-efficacious practitioners of writing. Professional development opportunities for teachers that will strengthen their self-beliefs regarding the use of writing as an instructional tool could have the potential to have a positive impact on student achievement. Districts should consider creating an informed and reflective community of confident and successful teachers who consistently use WTL best practices in order to teach and to support other teachers either within a school or district. Teachers themselves are the greatest resources schools, and school districts have.

Summary

The purpose of this qualitative case study was to document and explore high school math and science teachers' beliefs and instructional practices concerning WTL. Chapter Five presented (a) an overview of the study, (b) a summary of findings, (c) a discussion of the

findings, (d) theoretical, empirical, and practical implications, (e) limitations and delimitations of the study, and (f) recommendations for future research. Having multiple sources of data supported triangulation. Five themes emerged from the data analysis: belief about the effectiveness of using WTL, general beliefs about WTL, self-perception as a WTL teacher, belief in the ability to use WTL, and need for support to use WTL.

This research demonstrated that high school math and science teachers' self-efficacious beliefs were influenced by negative factors such as time, handling the paper load, and the need for support and professional development. There were also positive influences such as students' increasing knowledge of content, using writing as formative or summative assessments, and having positive learning and teaching experiences using WTL. This study found that teachers who had successes using WTL felt positive about using writing as a tool for learning content, and the math and science teachers who used WTL more frequently had more positive self-efficacious beliefs regarding the use of WTL in their respective subjects, and they saw favorable and valuable academic results among their students. The findings from this study revealed that the participants had positive self-perceptions of their ability to teach their perspective subjects, and they could produce positive results from using WTL activities to teach content to their students. Even though two participants, one math teacher and one science teacher, expressed they did not feel adequate as writers themselves, they still believed in the importance of using writing as a tool for learning content, thus supporting the state's standards for secondary math and science and supporting the academic rigor in this particular magnet school for math and science.

In this chapter, I discussed the results from the theoretical and empirical literature and suggested practical implications. I provided the delimitations and limitations of the study and

gave recommendations for future research. This study demonstrated that current high school science and math teachers' self-efficacious beliefs and instructional practices concerning WTL are that they have positive self-beliefs regarding their ability to use WTL in their courses. The study also revealed that these math and science teachers desired ongoing professional development and support for implementing best practices using WTL in high school math and science and how to manage the time constraints. Also, this study revealed that all participants believed that writing should be a major component of all subject areas to increase rigor, to promote critical thinking, and to prepare students to be college and career ready. Ken summed up most of the participants' feelings with the following remarks:

> Hopefully to reinforce the fact that it's [learning science or math] not just rote learning of facts and figures and formulas, but to be able to communicate knowledge of that content to whatever audience you need to communicate it to. I look back at what worked for me and my friends and people that I grew up with and it was all writing. It was description. It was look at the microscope, describe what you see, draw it. We don't do that as much anymore in science and it's a huge mistake. So, I want to get back to that. That's why I've always stressed that. I think that any teacher in any subject that doesn't use writing, and this includes PE [physical education] or any other course, I feel you [teachers] are doing your students a disservice. That's probably it [my beliefs] in a nutshell. If you don't have your kids write, you are not fulfilling your contract with whatever state you have a contract with. I can't say it any clearer than that. I don't know that my perception about using writing-to-learn needs to be improved. I believe in it. Again, I do believe that writing-to- learn is necessary and important, and I would do it even if I were not required. I think that my core belief is that if you don't write, you don't learn. So that's

why I've always used it. Even when I was an inclusion teacher, I required my SPED kids

to write. (personal interview, December 2018)

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APPENDICES

Appendix A: IRB Approval Document

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

September 28, 2018

Virginia Dunker
IRB Approval 3461.092818: Case Study of High School Math and Science Teachers' Beliefs About Using Writing-to-Learn and Their Beliefs About Themselves as Writing-to-Learn Practitioners

Dear Virginia Dunker,

We are pleased to inform you that your study has been approved by the Liberty University IRB. This approval is extended to you for one year from the date provided above with your protocol number. If data collection proceeds past one year or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Your study falls under the expedited review category (45 CFR 46.110), which is applicable to specific, minimal risk studies and minor changes to approved studies for the following reason(s):

   6. Collection of data from voice, video, digital, or image recordings made for research purposes.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
The Graduate School

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Appendix B: Letter of Consent

INFORMED CONSENT

CASE STUDY OF HIGH SCHOOL MATH AND SCIENCE TEACHERS' BELIEFS ABOUT

USING WRITING-TO-LEARN AND THEIR BELIEFS ABOUT THEMSELVES AS

WRITING-TO-LEARN PRACTITIONERS

Virginia Dunker

Liberty University

School of Education

You are invited to participate in a research study on math and science teachers' beliefs about using

writing as a tool to learn content. You were selected as a possible participant because you are a high

school math / science teacher and you use writing in your classroom. Please read this form and ask

any questions you may have before agreeing to this study.

Virginia Dunker, a doctoral candidate at Liberty University in the School of Education at Liberty

University is conducting this study.

Background Information: The purpose of this study is to understand high school math and science teachers' beliefs about using writing-to-learn (WTL) course content and their perceptions of themselves as WTL practitioners.

Procedures: If you agree to this study, I would ask you to do the following things:

1. Incorporate Writing-to-Learn activities at least three times weekly in your lessons.

2. Participate in a 45-minute personal interview that I plan to audio record. This interview will take place during the third week of the study either during the one-hour lunch period or after school. The interview will be conducted in secure a place on campus.

3. Participate in a 45-minute focus-group interview that I plan to audio record. This interview will take place during the fourth week of the study either during the one-hour lunch period or after school. Other math/science teachers participating in this study will be present. The focus-group interview will be conducted in a secure a place on campus.

4. Participate in keeping a daily response journal for a period of four weeks. Spend no more than 15 minutes to reflect each day. Your refection journal will serve as a place for you to reflect truthfully on personal successes, biases, frustrations, fears, and the successes/failures of particular WTL lessons and to provide a safe place for critical self-reflection on personal understandings of your self-beliefs and self-perceptions as a WTL practitioner. All information written in this journal will be kept confidential. You will be able to review and approve any data used from your journal.

5. Review the transcriptions of your interviews to check for accuracy. The transcriptions will be made available within two weeks after the interviews and the review should take approximately 30 minutes for you to complete.

Risks: The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

Benefits: No direct benefits are expected for each participant. However, there are possible benefits to society. Students who can analyze, synthesize, and critique information are developing skills for the 21st century, and these critical thinking/writing skills can allow these students to make connections across disciplines and to carry these critical thinking skills with them in everyday life and the workplace. Using writing as a tool for learning math and science increases one's understanding of content, and writing-to-learn provides teachers with a clear formative or summative assessment of students' depth of understanding of a subject. The findings of this research study have the potential of informing pre-service, novice, and experienced teachers as to how educators are using writing in science and math in an era of a narrowing curriculum, and the findings may reveal these educators' self-efficacious beliefs about using writing-to-learn, underscoring the potential direction for professional development needs.

Compensation: Participants will be compensated for participating in this study. Each participant will be given a $50 Visa gift card if he or she completes all study procedures. If a participant does not complete all aspects of the study, he or she will be given a gift card of one-fourth ($12.50) for each completed aspect of the study.

Confidentiality: The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only I will have access to the records. I may share the data I collect from you for use in future research studies or with other researchers. If I share the data that I collect about you, I will remove any information that could identify you, if applicable, before I share the data.

• Participants will be assigned a pseudonym. I will conduct interviews in a location where others will not easily overhear the conversation.

• The data will be stored on a password-protected hard drive and kept in the school's secured vault. The data may be used in future presentations. After a period of three years, all electronic records will be deleted.

• All interviews and the focus group will be audio recorded and transcribed. Audio recordings will be stored on password locked computer for three years and then erased. Only I will have access to the audio recordings.

• I cannot assure participants that other members of the focus group will not share what was discussed with persons outside of the group.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University or your school district. If you decide to participate, you are free not to answer any question or withdraw at any time.

How to Withdraw from the Study: If you choose to withdraw from the study, please contact I via email address/phone number included in the next paragraph. Should you choose to withdraw, data collected from you, apart from the focus group data, will be destroyed immediately and will not be included in this study. Focus group data will not be destroyed, but your contributions to the focus group will not be included in the study if you choose to withdraw without affecting those relationships. **Contacts and Questions:** I conducting this study is Virginia Dunker. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at ███████████ You may also contact I's faculty chair, Dr. David Benders, If you have any questions or concerns regarding this study and would like to talk to someone other than I, **you are**

encouraged to contact the Institutional Review Board, 1971 University BLVD. Green Hall Ste.

2845, Lynchburg, VA 24515. ***Please notify I if you would like a copy of this information for your***

records.

Statement of Consent: I have read and understand the above information. I have asked questions

and have received answers. I consent to participate in the study. ☐ The research has my permission

to audio record me as part of my participation in this study.

_____

Signature of Participant Date

_____

Signature of Investigator Date

Appendix C: Interview Form and Questions

Richmond County School District

Date of interview: _____   Name of interviewer:_____

Name of interviewee:_____   Teaching position:_____

1. Why do you feel writing is important in your course, and do you believe you are an effective practitioner of WTL? Why or why not?

2. What kinds of WTL assignments have you used in your course, and how do you feel about the results of using these assignments?

3. Why do you feel WTL activities benefits or hinders students' learning difficult material in your course?

4. How does WTL in your course positively or negatively affect your students' learning content? Explain.

5. Why do you think writing is included in the math or science state standards?

6. How do you see yourself as a teacher using WTL in your course? Explain.

7. What feelings come to mind when you are using WTL tasks in your course? Explain.

8. Describe your belief in your ability to use WTL to help students understand content.

9. Describe how offering personal creative writing experiences to your students has affected your belief in your ability to implement WTL in your course.

10. How could you become a more effective teacher of writing or WTL in your course? Explain.

11. Describe your central feelings about using WTL in your course.

12. What suggestions would you make to yourself for improving your self-perception or beliefs about using WT?

Appendix D: Focus Group Interview Form and Questions

Richmond County School District

Date of interview: _____ Name of interviewer:_____

Name of interviewee:_____ Teaching position:_____

1. Why do you feel writing in your content is an important aspect or not important aspect of your course?

2. How do you feel about students' use of the WTL method to explain their understanding a difficult scientific or mathematical concepts?

3. What kinds of shared WTL assignments have you done in your courses and do you feel any of these assignments were effective in increasing student understanding of content? These shared assignments can be from within your department or from other sources. Explain.

4. What are your shared beliefs about WTL and if it benefits students' learning difficult material in your course?

5. How does WTL in your courses affect your students' beliefs about learning content? Explain.

6. Why do think writing is a component of both the science and math state standards?

7. What types of professional development does the school or school district provide to help you with writing integration to support college and career standards?

8. How would you describe your shared WTL experiences with your students and other teachers? What feelings come to mind?

9. Express positive feelings about learning science or math when using the WTL method.

10. Express any negative feelings about learning science or math when using the WTL method.

11. Describe what motivates you to use a WTL tasks.

12. Why do you decide not to use a particular WTL task?

13. If you write with your students, describe how sharing your original writing or writings with the class makes you feel.

14. Does writing with your students influence your self-efficacious beliefs about using WTL in your content area? Why or why not?

15. How does working with a peer(s) make you feel when collaborating sharing WTL activities? Describe.

16. Describe how using the WTL approach or supporting the math or science writing standards has affected your self-efficacious beliefs or your belief in yourself to use writing effectively as a tool for learning content or to have students to think critically about the content?

17. What are your sincere beliefs about using WTL in your content area and your personal belief in yourself as a practitioner of WTL?

Appendix E: Participant Response Journal Instructions

Richmond County School District

Dates of reflections _____ Name of participant _____

Teaching position: _____

From _____ to _____ (dates), keep a daily response journal on your WTL practices. A journal notebook will be provided. Your response journal will serve as place for you to reflect truthfully on personal successes, biases, frustrations, and fears of the successes / failures of particular WTL lessons, and to provide you a safe place for critical self-reflection on personal understanding of your self-beliefs and perceptions of yourself as WTL practitioners. All information written in this journal will be kept confidential. You will be able to review and approve any data used from your journal. Your journal may include daily critical reflection pieces to provide insight into of the following:

- Explain how and why the WTL was put into practice.

- Record / identify each WTL practice.

- Reflect upon or assess the WTL lesson.

- Self-reflect upon or assess your personal teaching during the WTL lesson

- Express specific areas of need for professional development

Always feel free to add any additional information that you feel would be pertinent to your use of WTL and your beliefs about using WTL. You are not obligated to complete each of the above bulleted item, only what you feel is a true self-reflection of your WTL experiences.

Appendix F: Code Frequency Chart

Table 1

Code Frequency Chart

Codes	Frequency from Interviews	Frequency from Focus Group	Frequency from Response Journal	Frequency Totals
Be more effective	26	17	4	47
Belief in ability to use writing	50	27	5	82
Central feelings	38	14	9	61
Challenge to motivate students	8	3	0	11
College and career ready	11	6	3	20
Communication	10	3	0	13
Consistency	3	0	0	3
Core belief in WTL	39	14	7	60
Creative expression	8	0	1	9
Critical and creative thinking	13	0	2	15
Feelings	27	0	4	31
Frustrating to students	12	7	1	20

Frustration	26	12	4	42
Good practitioner	17	5	0	22
Importance of writing in content	39	12	4	55
Improving ability to use WTL	31	8	3	42
Improving self-perception	23	7	2	32
Improving writing	7	7	0	14
Ineffective practitioner	7	0	0	7
Intentional	3	0	0	3
Intimidation	3	2	1	6
Kinds or types of writing	21	2	0	23
Mediocre practitioner	3	0	0	3
Negative effects of WTL	21	6	5	32
Positive experiences with WTL	39	9	2	50
Positive results	23	8	6	37
Practical experience in writing	15	4	2	21

Practical results	7	2	0	9
Proponent of writing	36	18	0	54
Risk-taking	2	0	5	7
Self-perception	40	19	4	63
Support and professional development	25	14	0	39
Understanding content	9	0	1	10
Writing in all courses	10	2	6	18
WTL benefits	56	26	6	88
WTL challenges	29	20	6	55
Totals	737	257	93	1,087