Concordia University St. Paul

DigitalCommons@CSP

CUP Ed.D. Dissertations

Concordia University Portland Graduate Research

Spring 4-15-2020

Science Teachers’ Perceptions of Implementing Literacy Practices in The (Grades 9–12) Science Classroom

Wesley Russ
Concordia University - Portland, wesley_d_russ@mcpsmd.org

Follow this and additional works at: https://digitalcommons.csp.edu/cup_commons_grad_edd

Part of the Science and Mathematics Education Commons

Recommended Citation

Russ, W. (2020). *Science Teachers’ Perceptions of Implementing Literacy Practices in The (Grades 9–12) Science Classroom* (Thesis, Concordia University, St. Paul). Retrieved from https://digitalcommons.csp.edu/cup_commons_grad_edd/466

This Dissertation is brought to you for free and open access by the Concordia University Portland Graduate Research at DigitalCommons@CSP. It has been accepted for inclusion in CUP Ed.D. Dissertations by an authorized administrator of DigitalCommons@CSP. For more information, please contact digitalcommons@csp.edu.

Concordia University - Portland

CU Commons

Ed.D. Dissertations

Graduate Theses & Dissertations

Spring 4-15-2020

Science Teachers’ Perceptions of Implementing Literacy Practices in The (Grades 9–12) Science Classroom

Wesley Russ
Concordia University - Portland

Follow this and additional works at: https://commons.cu-portland.edu/edudissertations

Part of the Science and Mathematics Education Commons

CU Commons Citation

Russ, Wesley, "Science Teachers’ Perceptions of Implementing Literacy Practices in The (Grades 9–12) Science Classroom" (2020). *Ed.D. Dissertations*. 470.
https://commons.cu-portland.edu/edudissertations/470

This Open Access Dissertation is brought to you for free and open access by the Graduate Theses & Dissertations at CU Commons. It has been accepted for inclusion in Ed.D. Dissertations by an authorized administrator of CU Commons. For more information, please contact libraryadmin@cu-portland.edu.

Concordia University–Portland

College of Education

Doctorate of Education Program

WE, THE UNDERSIGNED MEMBERS OF THE DISSERTATION COMMITTEE

CERTIFY THAT WE HAVE READ AND APPROVE THE DISSERTATION OF

Wesley Dale Russ, Sr.

CANDIDATE FOR THE DEGREE OF DOCTOR OF EDUCATION

Christopher Maddox, Ph.D., Faculty Chair Dissertation Committee

Barbra Calabro, Ph.D., Content Specialist

Corey McKenna, Ph.D., Content Reader

Science Teachers’ Perceptions of Implementing Literacy Practices in The (Grades 9–12) Science Classroom

Wesley Dale Russ, Sr.

Concordia University–Portland

College of Education

Dissertation submitted to the Faculty of the College of Education

in partial fulfillment of the requirements for the degree of

Doctor of Education in

Educational Leadership

Christopher Maddox, Ph.D., Faculty Chair Dissertation Committee

Barbra Calabro, Ph.D., Content Specialist

Corey McKenna, Ph.D., Content Reader

Concordia University–Portland

2020

Abstract

Teachers in the (Grades 9–12) science classroom are adjusting to using literacy practices in their pedagogy. This is in response to school systems adopting the Common Core State Standards (CCSS) and the Next Generation Science Standards (NGSS). The purpose of this hermeneutic, phenomenological study was to explore the perceptions of teachers experiencing this change. The research questions of this study were focused on how teachers in the (Grades 9–12) science classroom perceive the implementation of literacy practices and professional development needs. The study site was a large Northeastern public school system that adopted the educational reform measures, at a single high school where 17 of 19 teachers participated. Data were collected through three research instruments: a Qualtrics questionnaire, semistructured interviews, and lesson plan reviews. Data were coded using open, axial and selective coded then triangulated. Four themes emerged from coding of the semistructured interviews. The emergent themes were: (a) proficiency, (b) acceptance, (c) effectiveness and (d) professional development. The results of this study showed an increased use of literacy practices, an acceptance of literacy practices, a perceived effectiveness on student learning in the (Grades 9–12) science classroom and a need for additional teacher professional development. There was also an expressed need for teachers to understand the reasoning behind changes and recognition that additional professional development is needed. The study suggested that future professional development should include information on the reasoning behind the reform measures in addition to training.

Keywords: literacy practices, educational reform measures, pedagogy

Dedication

This dissertation is dedicated to my mother who is the nicest person I have ever known and was completely dedicated to raising her children and also to my middle son, Nathaniel Doyle Russ. Nathaniel inherited the eyes, hair color, and kindness of Margaret Jenelle Russ. During a time of difficulty, Nathaniel chose to risk everything to support me. My first child and oldest child, Wesley Dale Russ Jr., served as my editor and I could not have completed this dissertation without his help. I also dedicate my dissertation to the mother of my children, Rhonda Lorene Russ, my other children, Eric Matthew Russ and my only and beautiful daughter, Emily Marie Russ.

Acknowledgements

I would like to thank Dr. Maddox for his support and guidance in this study. Additionally, I appreciate the insightful insights from Dr. Calabro and Dr. McKenna. I would have never been able to collect the data necessary for this study without the kind help and support of my principal Ms. Brandice Heckert and our staff development person, Ms. Kirsten Sullivan. Through this lengthy study, my family exhibited patience for years, as I reminded them that I needed to work on my dissertation. Thanks to Nathaniel, Rhonda, Emily, Eric and Wesley.

Table of Contents

Abstract ii

Dedication iii

Acknowledgements iv

List of Tables viii

Chapter 1: Introduction 1

Background, Context, History, and Conceptual Framework for the Problem 2

Statement of the Problem 8

Purpose of the Study 9

Research Questions 9

Rationale, Relevance, and Significance of the Study 9

Definition of Terms 11

Assumptions, Limitations, and Delimitations 13

Summary 11

Chapter 2: Literature Review 17

Literature Search Strategy 17

Conceptual Framework 19

Review of the Literature and Methodological Issues 30

Review of Methodological Issues 47

Synthesis of Research 49

Critique of Previous Research 48

Summary 50

Chapter 3: Methodology 52

Research Questions 54
Purpose and Design of the Study 54
Research Population and Sampling Method 54
Instrumentation 58
Data Collection 60
Identification of Attributes 63
Data Analysis Procedures 64
Limitations of the Research Design 64
Validation 67
Expected Findings 70
Ethical Issues 70
Summary 72
Chapter 4: Data Analysis and Results 75
Description of the Sample 76
Methodology and Analysis 77
Summary of the Findings 80
Presentation of the Data and Results 84
Summary 95
Chapter 5: Discussion and Conclusion 101
Summary of the Results 100
Discussion of the Results 106
Discussion of the Results in Relation to the Literature 109
Limitations 110

Implications of the Results for Transformation 111
Recommendations for Further Research 111
Conclusion 117
References 120
Appendix A: Qualtrics Questionnaire of Teacher Literacy Practices in the (Grades 9–12) Science Classroom 132
Appendix B: Interview Questions 138
Appendix C: Lesson Plan Check List 139
Appendix D: Participant Consent Form 140
Appendix E: Participant Recruitment Email 138
Appendix F: Statement of Original Work 142

List of Tables

Table 1. *Lesson Plan Literacy Check List*..96

Chapter 1: Introduction

There are two educational reform measures that have changed the expected pedagogical approaches for teachers in (Grades 9–12) science classrooms (Drew & Thomas, 2018; Nelson & Allen, 2017). The Common Core State Standards (CCSS) and Next Generation Science Standards (NGSS) require the use of literacy practices in science classrooms and were adopted to address both low scores in science and poor literacy skills (Drew & Thomas, 2018; Goldman et al., 2016; Wexler, Mitchell, Clancy, & Silverman, 2017). Scientific literacy contributes to scientific practices creating cross connections between the CCSS and NGSS (Allison & Goldston, 2018). These educational reform measures require formal and deliberate integration of literacy practices to teach science and, in the process, teach students literacy skills in the classroom (Allison & Goldston, 2018; Drew, Olinghouse, Faggella-Luby, & Welsh, 2017; Drew & Thomas, 2018; Goldman et al., 2016; Lee, 2017; McKnight, 2015; Ray, Graham, Houston & Harris, 2016; Soules et al, 2014; Wallace & Coffey, 2016).

Historically, teachers in (Grades 9–12) science classrooms have not received training on using literacy and teaching literacy skills and are therefore reluctant using and teaching them (Drew & Jeffrey, 2018; Nelson & Allen, 2017). Authors have suggested that there are unanswered questions that must be answered in order to develop needed and effective professional development programs to train science teachers in literacy practices (Drew & Thomas, 2017; Gillis, 2014; Roth, Wilson, Taylor, Stuhlsatz, & Hvidsten, 2019; Wexler et al., 2017). Developing a better understanding of science teachers' perceptions of using literacy practices and supporting students in developing literacy skills is critical to designing and developing professional development programs that match the specific needs of the teachers (Lee, 2017). School systems use professional development to educate teachers on educational reform measures, so that they can understand and meet new standards in strategies, curriculum and assessment (Zhang, Parker, Koehler, & Eberhardt, 2017).

A single science department in a high school in a large Northeastern high school was the study site, where I explored the perceptions of teachers in (Grades 9–12) science classrooms implementing literacy practices. The school system, where the high school is located, has recently modified their curriculum requiring teachers to integrate literacy practices in (Grades 9–12) science classrooms. For the purposes of this research, the identity of the school system, the school and participants are kept confidential. To maintain confidentiality pseudonyms were used in place of participants' names. Within this chapter, I introduce the topic of teachers integrating literacy practices to teach science and their role in teaching literacy skills in (Grades 9–12) science classrooms and define the study. The chapter begins by describing the background, context, history and conceptual framework of literacy practices in teaching science, the emergence and requirements of the educational reform measures, followed by a description of literacy practices used to teach science. Next, the problem to be addressed by this study is discussed along with the purpose of the study and each of the research questions. Finally, I discuss the rationale, relevance and significance of developing an understanding of the perspectives of the science teacher as they implement literacy practices, since they are central to the execution of the educational reform measures.

Background, Context, History, and Conceptual Framework for the Problem

Literacy practices are being driven by the CCSS and NGSS educational reform measures to both improve student learning of the content area and student literacy skills (Drew & Jeffrey, 2018; Nelson & Allen, 2017; Wu, Lee, Chen, & Chan, 2018). Historically, teachers in (Grades 9–12) science classrooms have not been trained in using literacy practices and teaching literacy skills to students (Drew & Jeffrey, 2018; Nelson & Allen, 2017). Teachers in (Grades 9–12) science classrooms are now being required to modify pedagogical approaches (Kaldenberg, Watt, & Therrien, 2015; Nelson & Allen, 2017; Siebert et al., 2016; Wexler et al., 2017). Science teachers are now being required to integrate literacy practices into their teaching strategies to meet emerging educational reform measures (Nelson & Allen, 2017; Siebert et al., 2016). The adjustment being made by science teachers is the incorporation of literacy practices into already used approaches. A very common pedagogical approach is the 5E model of instruction. The 5E model of instruction consists of five stages: student engagement, exploration, explaining, extending and evaluating (Manzo, Whent, Liets, de La Torre, & Gomez-Camacho, 2016). Currently, the 5E model of instruction, which uses the inquiry-based learning (IBL) method, is widely used in science classrooms (Akben, & Köseoglu, 2015). Nelson and Allen (2017) discussed imbedding literacy practices into the 5E model to meet NGSS standards for literacy. IBL is a constructivist and student-centered approach, which leverages prior student knowledge in the learning process (Condliffe, Visher, Bangser, Drohojowska & Saco 2016). IBL was developed and adopted to shift from lock-step teaching methods of instruction to active engagement of students in authentic, relevant work (Buchanan, Harlan, Bruce & Edwards, 2016).

Adoption of literacy practices by the science teacher is suggested to help students develop a more holistic understanding of general literacy practices, scientific literacy, and learning science (Wallace & Coffey, 2016). Embedding literacy practices into teaching science changes the way science teachers engage students and promote student learning (Nelson & Allen, 2017). Traditional science education focused on the 5E model with an inquiry-based approach. Inquiry-based approaches provide students with opportunities to investigate, search for solutions, make observation and ask questions (Wallace & Coffey, 2016). The use of literacy practices can be integrated with inquiry-based approaches and is posited to reach a wider range of learners and raise overall learning while also improving literacy skills (Kaldenberg et al., 2015; Wallace & Coffey, 2016; Wexler et al., 2017). The CCSS proposes that teachers use literacy practices in their pedagogical approaches to teach content area subjects such as science (Morabito, 2017). Literacy practices help science teachers meet the principles and requirements of the NGSS (Lee, 2017; Nelson & Allen, 2017). Literacy practices are essential for students to learn to read and write, comprehend, communicate, think critically and develop content knowledge (Froschauer, 2015; Mitton-Kukner & Orr, 2018).

There is a long history going back almost 40 years of using inquiry-based teaching strategies in the science classroom (Crawford, 2014). Literacy practices work very well when integrated with the inquiry-based approach and can help to improve the level of student learning (Putra & Tang, 2016; Spires, Kerkhoff, & Graham, 2016). Literacy practices have been demonstrated to improve the effectiveness of teaching science content and improve scientific literacy, which is an essential 21st-century skill (Bybee, 2014; Drew & Thomas, 2018). Literacy practices are also supported by the curriculum-based approach known as Science, Technology, Engineering and Mathematics (STEM; Soules et al., 2014).

The effectiveness of integrating literacy practices to meet educational reform measures may be influenced by the willingness and abilities of teachers to integrate literacy practices into their pedagogical approaches (Mitton-Kukner & Orr, 2018). The abilities and skills of the science teacher can be addressed through the appropriate professional development and willingness may improve as they develop an understanding of the approach (Mitton-Kukner & Orr, 2018). Implementation of literacy practices in teaching science could be weakened if the (Grades 9–12) science teacher is not confident in the reasoning behind the change and their ability to do this (Koomen, Weaver, Blair, & Oberhausuer, 2016). Presently, there is a lack of information regarding teacher perceptions of their level of preparation and professional development needs to effectively infuse literacy practices in (Grades 9–12) science classrooms (Mitton-Kukner & Orr, 2018). According to Drew and Thomas (2017), there is a need to develop a better understanding of possible synergies between science and literacy in terms of both student learning and teacher professional development needs.

Incorporating literacy practices into teaching pedagogical approaches used in the science classroom requires the science teacher to make changes and adapt to the new practices (Varner, 2016). The science teacher must learn to integrate literacy practices, or reading and writing events, into the lesson planning and scaffolding (Tanner, 2017). While many science teachers have limited experience and training in the use of literacy practices and may seek out help from literacy teachers, the science teacher is the content expert and may be better off seeking professional development (Siebert et al., 2016). Science teachers may be able to enhance their literacy skills and practices through workshops and other training opportunities (Morabito, 2017).

The purpose of the conceptual framework is to guide the research and analysis for a study. Ravitch and Riggan (2012) further describe the conceptual framework as a tool, which enables the researcher to convey what is out there. Then the researcher can develop an understanding of what is to be studied, make connections, and propose a tentatively new theory of the phenomena. Maxwell (2013) characterized the theory developed in the conceptual framework as a tentative explanation of the study. In this dissertation, the theories of three cognitive theorists are identified as having synergy in supporting the suggested learning improvements associated with using literacy practices in the science classroom. Within this dissertation, I discuss the theories of Piaget, Vygotsky, and Marzano and describe how their theories support the benefits of literacy practices in the science classroom. Much of the work by Elkind referred to as Piagetian perspective due to Elkind's practice of the work of Piaget in the United States, so his perspectives on Piaget theory are included in this conceptual framework.

Using the theories of three cognitive theorists, Piaget, Vygotsky, and Marzano, a case is made supporting the advantages of using literacy practices to teach content areas within science classrooms. Piaget (1969) studied the cognitive development of children. Piaget theorized that cognitive development occurs in stages changing over the lifetime of the child and based on how background and situations effects perception and understanding (Mooney, 2013; Piaget & Inhelder, 1969). Contrary to other theories of intrinsic or extrinsic learning, Piaget proposed that students construct their own knowledge, based upon an ensemble of operations, bringing a focus and emphasis on the environment around and experiences of the student (Piaget & Inhelder, 1969). These operations can be viewed as analogous to literacy practices such as reading a writing prompt, formulating an answer, and communicating a response. This could extend into activities such as reading graphs, charts, and data to answer questions of a scientific nature using literacy practices.

In addition to Piaget, the integration of literacy practices by teachers in their pedagogy practices to teach content areas is supported by the theories of Vygotsky. Vygotsky (1978) defined cognitive learning as language-based, in the sense that learning occurs through sociocultural interaction. The theories of Vygotsky make a connection between the processes of cognitive learning and language development, proposing that learning occurs through sociocultural interaction and the distance between prior knowledge and what is being taught. Vygotsky proposed the existence of a Zone of Proximal Development (ZPD), which is the distance between the most difficult task that a student can do alone and the most challenging task they can do with the help of a fellow student or teacher (Vygotsky, 1978). Out of the work done by Vygotsky in proposing the ZPD came the widely accepted concept of scaffolding, which asserts that if students are provided with the appropriate information that they can learn new material (Mooney, 2013; Vygotsky, 1978).

While Piaget and Vygotsky are leading theorists in the field of cogitative development, Robert Marzano is an educational theorist who focused on literacy practices and has developed many widely effective instructional strategies (Marzano et al., 1988). The theories of Marzano led to his development of literacy related strategies such as identifying similarities and differences, summarizing note-taking, and reinforcing effort and providing recognition with, homework and practice and many other approaches to enhance student learning (Marzano et al., 1988). Marzano (2012a) is the theorist who proposed the art of making an argument as associated with literacy practices, which is recommended in the CCSS literature component and NGSS. Marzano's taxonomy of retrieval, comprehension, analysis, and knowledge utilization can be facilitated through the integration of literacy practices and is proposed to help students be able to reach higher-order thinking in scientific subjects such as chemistry (Toeldo & Dubas, 2016).

Common themes within the theories of Piaget, Vygotsky, and Marzano connect with using literacy practices to teach content areas such as science. Classroom practices consisting of science and reading are both interactive-constructive processes where the learner makes connections between prior knowledge and new learning (Wallace & Coffey, 2016). Piaget proposed learning through experiences; Vygotsky saw values in peer collaborations using speech to improve learning and Marzano (2013a) proposed the learner benefits from interacting with knowledge and using simulations to make connections; all of these connect within many literacy practices.

Literacy practices and teaching students to be scientific literate in the science classroom is being incorporated into existing and widely used pedagogical practice called, the inquiry-based approach. Preceding the recent educational reform measures that are currently impacting the science classroom, the common pedagogical practice had been the scientific inquiry-based teaching and learning approach (DiBase & McDonald, 2015; van Aladeren-Smeets et al., 2017). In adopting the emerging educational reform measures of CCSS and NGSS in a STEM environment, to teach (Grades 9–12) sciences, the inquiry-based approach continues to be used and the new practices are integrated into this long-proven strategy (McKnight, 2015).

Statement of the Problem

The implementation of educational reform measures requiring teachers in (Grades 9–12) science classrooms to use literacy practices creates an environment expecting teachers to adapt and shift from traditional pedagogical approaches. This change challenges science teachers since, historically, training programs and professional development for science teachers have not typically included the use of literacy practices. In addition, students often have weak literacy skills and may not be able to apply literacy practices in the context of learning content such as science. As a result, teachers may find themselves teaching literacy skills without having any training in the area. In addition, many school systems do not have the appropriate curriculum and teaching materials. The recently adopted educational reform measures are the CCSS and the NGSS. The use of literacy practices is also supported by STEM; the teaching of science, technology and math in combination with literacy practices. Recent studies provide data on the use of literacy practices in the science classroom; however, there is still a lack of descriptive data on the science teachers' perceptions of implementing literacy practices, specifically professional development needs, for the classroom teacher. The problem is educational training programs do not prepare science teachers to embed literacy practices in the classroom or to teach literacy skills.

Purpose of the Study

The purpose of this hermeneutic, phenomenological study is to explore how teachers perceive the implementation of literacy practices in (Grades 9–12) science classrooms. By collecting teacher's perceptions, it may be possible to identify and describe the needs of teachers to successfully adapt to these changes. Participants provide data that describes their lived experiences of modifying science curriculum to reflect current educational reform measures. By collecting and analyzing the perceptions of science teachers' experiences, it may be possible for administrators to identify commonalities and suggest ways to overcome barriers and to optimize the integration of literacy practices.

Research Questions

The research questions for this study are:

1. How do teachers perceive the implementation of literacy practices in (Grades 9–12) science classrooms?
2. How do teachers in the (Grades 9–12) science classroom perceive professional development needs?

Rationale, Relevance, and Significance of the Study

The rationale for conducting this study was to explore perceptions of teachers in the (Grades 9–12) science classroom. The choice to utilize a hermeneutic, phenomenology approach is because the study focuses on exploring lived experiences through the perceptions of a specific group. Hermeneutic, phenomenology has roots in the work of Husserl (1952/1980) and is proposed by Creswell (2013) to explore the meaning of lived experiences and understand reality through the combined perceptions of a group. A hermeneutic, phenomenological research design is appropriate for exploring the perceptions of teachers' as they implement literacy practices in (Grades 9–12) science classrooms. The need for this study exists because science teachers have not traditionally received training in using or teaching literacy practices in their educational programs.

The relevance of this study is applying the findings to determining and defining professional development and future educational programs. The professional development needs may range from teacher abilities to willingness and confidence levels (Koomen et al., 2016; Mitton-Kukner & Orr, 2018). As a group, teachers in (Grades 9–12) science classrooms do not have the training to integrate literacy practices into their pedagogical approaches and teach literacy practices (Drew & Thomas, 2018). Teachers in the classroom may have a need to be convinced of the value of using practices (Mitton-Kukner & Orr, 2018). There is a need to understand the perceptions of teachers in terms of how well they are implementing literacy practices and their training needs. While there is literature on the use of literacy practices in the science classroom, there is not a clear understanding of the perceptions of teachers as they adapt to implement literacy as a teaching strategy. The experiences of several science teachers can be used to find commonalities in meaning rather than just identifying a single individual as in narrative research (Creswell, 2013). The findings can be used to develop both training and professional development programs. An additional benefit is asking teachers in the (Grades 9–12) science classroom to describe their perceptions of the effectiveness of literacy practices on learning.

The science teacher historically has not received professional development in literacy or how to incorporate literacy practices and has not been provided with curriculum that has integrated literacy practices. However, some school systems are developing new curriculums that have literacy practices and are implementing professional development training programs to support the science teacher. Determining the perceptions of the science teacher lends itself to a qualitative approach since the experiences can vary and possibly not fit into a numerically measurable factor. The research approach selected is a hermeneutic, phenomenological study since the objective is to elicit the perceptions of the lived experiences of the science teacher. While there is literature on the use of literacy practices in the science classroom, there is not a clear understanding of the perceptions of teachers as they adapt to implement literacy as a teaching strategy. The experiences and perceptions of several science teachers can be used to find commonalities in meaning rather than just identifying a single individual as in narrative research (Creswell, 2013).

The finding of this study are significant to administrators and science teachers in the classroom across the country. The information from teacher perceptions can be used to develop appropriate professional development programs. The findings of this study may help in efforts for transformational change, leading to improved best practices in the use of literacy in teaching in the (Grades 9–12) science classroom. The data gathered may also help administrators and classroom teachers appreciate the literacy effort if the perception is that student learning is improved.

Definition of Terms

A list of terms and definitions are provided below to help the reader understand concepts presented in this dissertation. These terms and definitions are used within this dissertation.

Common Core State Standards—Literature Component (CCSS): This term is defined as a set of specific practices for teaching content area subjects through literacy, which promotes students using metacognitive decision-making skills to answer questions as part of the learning process (Griffith, Bauml, & Quebec-Fuentes, 2016; Kamil, 2016).

Direct instruction: This term is defined as the use of straightforward explicit teaching of content through explanations and demonstrations of academic concepts using multiple examples (Davis, 2018).

Disciplinary literacy: The term is defined as a student's ability to comprehend and discuss science information through the practices of listening, speaking, reading, writing and thinking as demonstrated through presentations and group work (Drew & Thomas, 2017; Wright & Gotwals, 2017).

Lived experiences: This term is defined as a representation of experiences and choices that a person, or groups of people have in common from observing a phenomenon (Creswell, 2013).

Models in Literacy Practices: This term is defined as the use by of literacy models by teachers for students, which are suitable for three-dimensional teaching and learning in the science classroom (AASS, 1993; NRC, 1996, 2012).

Next Generation Science Standards (NGSS): This term represents a set of educational requirements that teachers to adopt and use of literacy practices in teaching science and make literacy central to three-dimensional teaching and help students to become scientifically literate (Bybee, 2014; Froschauer, 2015).

Peer review: This term defines a teaching pedagogy where teachers work as peers collaborating following one of many strategies to support classroom learning (Brix, Grainger, & Hill, 2014).

(Grades 9–12) Science Teacher: This term for the purpose of this study, refers to a teacher who is teaching biology, chemistry, or physics in Grades 9 through 12 (Drew & Thomas, 2018).

Science, Technology, Engineering, and Mathematics (STEM): This term defines guidelines that emphasize a switch from the practices of the past where disciplines are taught separately to the integration of all disciplines, including literacy into the teaching of science (Froschauer, 2015).

Scientific literacy: This term is defined as the use of classroom practices associated with developing an understanding of the content of science, how to apply it, how to use it in problem solving and the ability to think critically about it in a variety of contexts (Allison & Goldston, 2018; Fives, Huebner, Birnbaum, & Nicolich, 2014; Wexler et al., 2017).

Assumptions, Limitations, and Delimitations

Assumptions are components of a research study that a researcher may use as a starting point and not try to prove (Simon, 2011). This hermeneutic, phenomenological study included a questionnaire, semistructured interviews and a review of lesson plans. The questionnaire and semistructured interview questions were for the participants to describe their experiences implementing literacy practices. The review of lesson plans was a check for consistency between answers on the first two instruments and actual practice in the classroom. I assumed that all participants answered the questionnaire and semistructured questions as truthfully as possible and provide a lesson plan that accurately represents their teaching in the classroom. I am the only person who knows the identity of the participants and the data was stored in a locked desk in my home office. This maintained confidentiality of the participants.

Assumptions of a judgmental nature could lead to bias of perceptions impacting the answers collected from participants. Participant biases due to differences in individual interpretation of questions could influence the answers to the questionnaire. To circumvent this possibility, the questions were carefully worded with a purpose of an understanding, which is as uniform as possible. In order to reduce basis towards themes or concept, semistructured questions were carefully crafted to include open-ended questions to allow for a degree of depth in the responses from participants.

The study has potential limiting factors such as a small sample size and one primary instrument to collect data, the semistructured interviews. In this study, there are two additional instruments, the Qualtrics questionnaire and a review of lesson plans. The sample size is amplified by the participants all experiencing the same phenomenology and the ability to triangulate data from the three instruments.

Delimitations are restrictions that limit a study such as the location, the participants' demographics, the study design, and the data collection methods (Simon, 2011). I delimited the study by including only teachers in the (Grades 9–12) science classroom. There are 19 potential participants who be asked to be in the study and they all teach in the science department of a single high school. All of the participants teach in a school system that recently adopted the CCSS and the NGSS. Creswell (2013) recommends that a phenomenological study focus on in-depth interviews, interview approximately 10 participants and that the participants be in a single location. The important factor is for the study to be able to describe the meaning of a phenomenon as expressed by a small number of individuals who have gone through the experience (Creswell, 2013).

Summary

In Chapter 1, I start with a discussion of the CCSS and NGSS educational reform measures, which are requiring teachers in (Grades 9–12) science classrooms to integrate literacy practices into their classroom pedagogical approaches. Next, I discuss the historical approaches of how students have engaged in the science classroom through the 5E model and an inquiry-based approach. The three theorists Piaget, Vygotsky, and Marzano support the utility of literacy practices as a teaching tool in science. Next, the research problem, significance of the study, definitions for specialized terms used throughout the study, and the research questions are presented. The problem is educational training programs do not prepare science teachers to embed literacy practices in the classroom or to teach literacy skills. This presents a need to understand licensed teachers' perceptions of adapting to implementing literacy practices in the (Grades 9–12) science classroom and additionally, such as training through professional development, curriculum support and administrative leadership. The purpose of this hermeneutic, phenomenological study was to explore how teachers who are going through the process, perceive the implementation of literacy practices in (Grades 9–12) science classrooms.

The study seeks to collect qualitative data that provides insights from the teachers' perceptions of how they are adapting. Understanding the perceptions of teachers' can be useful in developing support in the form of training and professional development. A conceptual framework is provided to introduce the theories supporting the justification for literacy practices to be used in teaching (Grades 9–12) science classroom. The research questions are focused on the science teachers' perceptions of implementing literacy practices, such as curriculum;

professional development needs, and associated issues impacting implementation. Using an e-mail questionnaire, semistructured one-on-one interviewing and analysis of lesson plans with science teachers, data was collected and analyzed. This introduction presents definitions used in the dissertation, my research assumptions, identified the scope and delimitations, and explained the limitations my study.

In Chapter 2, I discuss the interconnecting conceptual framework in detail supporting and describe the underlying research for using literacy practices in the science classroom. In addition a literature review of literacy practices in the science classroom is provided to inform the reader about the history and practice. The current literature proposing the need for a study to determine the perceptions of teachers in the (Grades 9–12) science classroom is discussed in support of this study.

Chapter 2: Literature Review

In this study, I explored the perceptions of teachers in the (Grades 9–12) science classroom who are adapting to new requirements that literacy practices become central to their pedagogical approaches. As a result of the CCSS and the NGSS, licensed teachers in (Grades 9–12) science classrooms are being required to integrate literacy practices into their teaching pedagogy (Drew & Thomas, 2018; Morabito, 2017; Wallace & Coffey, 2016). The NGSS standards were specifically written to fit with the CCSS (Wexler et al., 2017). The new reform measures are intended to address the poor literacy skills and low scores in science historically observed with students in the U.S. (Kaldenberg et al., 2015; Wexler et al., 2017). The integration of literacy practices into the teaching of science provides opportunities to enhance student learning in science, while also improving literacy skills (Morabito, 2017; Wallace & Coffey, 2016). In most academic content areas, learning has been demonstrated to improve when students use forms of communication such as writing to formulate and share their understanding of the content area (Perrow, 2018).

The CCSS literacy practices are designed to work in content areas, such as scientific fields, to facilitate student engagement through literacy practices and other forms of communication. The CCSS specifies that teachers integrate literacy practices in their pedagogical approaches to teach content area subjects such as science (Morabito, 2017). The expectation is that the use of reading, writing and presentation activities will actively engage students in the science classroom and improve learning outcomes (Morabito, 2017). Literacy practices are considered to be scientific practices as defined by NGSS (Wallace & Coffey, 2016).

The NGSS has direct links to the CCSS literacy practices and when implemented in the science classroom, they can help students learn holistically (Wallace & Coffey, 2016). Writing is a critical element across all eight of the science and engineering practices contained in the NGSS guidelines (Drew & Faggella-Luby, 2017). Embedding the literacy practices within the NGSS principles may present challenges for science teachers since they are not typically trained in this area (Lee, 2017; Nelson & Allen, 2017). The guidelines for literacy practices from the CCSS and NGSS work together enabling students to learn science in a holistic manner (Wallace & Coffey, 2016). A common theme of CCSS and NGSS are literacy practices, which are considered essential for students develop skills in reading and writing, comprehension, communicating, thinking critically and developing content knowledge (Mitton-Kukner & Orr, 2018).

The implementation of educational reform measures are requiring the use of literacy practices in teaching science, and the result is a shift in the pedagogical approaches used by teachers in the science classroom (Wallace & Coffey, 2016). The NGSS standards have been merged with the CCSS standards, bringing about a shift in the pedagogical approaches of the science teacher by requiring the integration of literacy practices with the disciplinary core ideas, an essential component of the NGSS (Drew & Thomas, 2017; Wallace & Coffey, 2016). The integration of literacy into the pedagogy of teaching in the science classroom is considered to offer rewards in the effectiveness of student learning in both science and literacy skills (Enfield, 2015; Ray et al., 2016; Wallace & Coffey, 2016).

Teachers in (Grades 9–12) science classrooms do not typically receive training or have personal experience in literacy practices, or even have an awareness of the value of using literacy practices (Siebert et al., 2016). Recent studies regarding implementation of CCSS and NGSS literacy practices in the science classroom recommend that teachers receive education, professional development, and instructional reform training in the area of incorporating literacy in teaching science and how to support all learners regardless of literacy skills (Drew & Thomas, 2017; Drew et al., 2017; Lee, 2017). Programs have been developed that provide professional development programs that support training for teachers to better teach both science and literacy together (Ippolito, Condie, Blanchette, & Cervoni, 2018).

Following the introduction to Chapter 2, I describe the strategy used to find relevant literature associated with literacy practices and their use by teachers in (Grades 9–12) science classrooms. In the next section, I describe a conceptual framework, discussing how the work of Piaget, Vygotsky and Marzano supports the implied opportunities and benefits of integrating literacy practices into the teaching of science (Wallace & Coffey, 2016). To summarize and show the relationships between the theorists, interrelated connections are made in the conceptual framework. Within the literature review, I explore the emergence of literacy practices, the influence of and common themes between the CCSS and the NCSS. The barriers and potential obstacles related to implementing literacy practices in science education are collectively presented and discussed. While there are numerous literacy practices applicable to the science classroom, some of the more widely used strategies such as writing to learn, the role of questions, and application of models are highlighted in the literature review. Following the discussion of the reasoning behind using literacy practices in content area classrooms, the practices and perceptions of teachers was explored.

Literature Search Strategy

The purpose of a literature review is to support a thesis through evidence (Creswell, 2007). The literature search strategy is essential to understanding current literature, identifying important questions and determining the appropriate direction of the work so that an accurate argument can be developed (Machi & McEvoy, 2016). Information for the literature review was limited to peer-reviewed work published within the past 4 years. Parameters to the literature search included peer-reviewed journals, primary studies, and documents. Databases utilized throughout the literature search were ERIC, ERSCO, Google Scholar, ProQuest, SAGE, and Education Research Complete. I began my search on teachers' perceptions of using literacy practices in the (Grades 9–12) science classroom by focusing on literacy practices in the science classroom regardless of grade level. *Literacy practices in teaching science* yielded nine articles that fell within the parameters of being in the last four years, peer-reviewed, and pertained to the specific topic. The use of educational reform measures in the science classroom was then explored using the following terms: *CCSS and NGSS literacy practices in science education, integrating science and literacy, critical thinking skills and literacy practices.* These three searches yielded five, seven and four articles respectively falling within the parameters. The Concordia librarians, who were available as an online resource, were used multiple times during the search for academic, peer-reviewed work to develop an understanding of the use of literacy practices in the (Grades 9–12) science classroom.

Conceptual Framework

The conceptual framework of a research study, as defined by Creswell and Poth (2017), describes the current state of a research field including assumptions, expectations, beliefs, and theories, the direction it is going along, and the connections that the new study makes with the existing field of work on the topic. In the case of this hermeneutic, phenomenological study insights are sought into teacher perceptions regarding their adapting to implementation of literacy practices in (Grades 9–12) science classrooms. Ravitch and Riggan (2012) proposed that the conceptual or theoretical framework could be used as a tool for the researcher to propose the why and how of the body of work and pull it all together to support a specific position. With this study, the purpose is to understand a phenomenon, which can help school systems optimize their efforts to implement literacy practices in (Grades 9–12) science classrooms. Maxwell (2013) points to the need for careful planning and analysis in order to develop a study that provides answers to the questions. Maxwell (2013) contends the conceptual framework is a conception of the information already available in your field of study and that the theory developed is only a tentative explanation of what you plan to study.

The theorists utilized for this study provide a framework of why the CCSS and NGSS are requiring the use of literacy practices to teach in the (Grades 9–12) science classroom. The theorists proposed to support the use of literacy practices in the science classroom are Piaget, Vygotsky and Marzano. Due to the similarities between the works of Piaget and Elkind, his supportive work is also presented to support literacy practices in science education. Understanding how the theories of Piaget, Vygotsky and Marzano support the use of learning content through literacy practices may prove useful to the science teachers as they select the best literacy practices for specific content to be taught. The cognitive theories of Piaget, Vygotsky and the practices developed by Marzano support the conceptual framework for using literacy practices as an approach to teach content subjects and enhance literacy skills. For the teacher in the (Grades 9–12) science classroom, the acts of using literacy practices are supported by the cognitive theories of Piaget and Vygotsky. The many practices developed by the theorist Marzano align with are ideal as literacy practices in the (Grades 9–12) science classroom.

There are many different approaches to integrating literacy practices into the science classroom to support student learning and enhance literacy skills. The basic approaches can be described as the student listening to instruction; reading texts from various sources, including interpreting graphs and data; followed by constructing and writing a response; discussing their response with peers; and giving presentations. A critical element to literacy practices in terms of the NGSS standards is for the student to have, and the science teacher to provide, the opportunity to redo their work for final submission (Koomen et al., 2016; Putra & Tang, 2016; Tang, 2015; Wright et al., 2016). Central to literacy practices is for students to learn the process of constructing explanations, engaging in arguments from evidence, then evaluating and communicating information. The practices contained in literacy integration are supported by a combination of cognitive theories developed by Piaget, Vygotsky, and the educational theories of Marzano.

The driving reasoning behind the implementation of literacy practices into the science classroom is supported in educational theory through a combination of cognitive theories as descried by the works of Piaget and Vygotsky and supported by the literacy practices described by Marzano. Piaget's definition of the role of schema and constructivism are supportive of the state standards. Piaget (1965) proposed that students learn by doing, rather than by being told. The focus of Piaget's theory is concentrated on the process and art of learning, and the significance of stages that people go through. Vygotsky (1978) discussed the role of language, social interaction and addressing the distant between what the student already knows and is trying to learn. While Vygotsky did not create the practice of scaffolding as a part of the learning process, his theory is used as a basis for the approach. Marzano (2012b) developed many models of effective teaching in the classroom, some of which align with and support the educational reform standards through the use of literacy practices. Integrating literacy strategies in the science classroom is supported by theories described by Piaget (1965), Vygotsky (1978), and models developed by Marzano (2012b). The influences of the theories of Piaget, Vygotsky and Marzano on the emerging reform efforts on (Grades 9–12) science classrooms are presented in the following paragraphs.

Piaget's Role of Schema and Constructivism

Piaget, a Swiss psychologist who worked during the twentieth century, proposed cognitive developmental psychology theories of intelligence proposing that the mind develops in a sequence of stages related to age. His work focused on studying different age groups, starting with children through adults. Piaget's work resulted in the identification and definition of four main stages of cognitive development. As learners pass through these four phases of learning as described by Piaget, he proposed passing from one phase to another is the result of both genetics and sociocultural circumstances (Piaget, 1950).

The first phase as defined by Piaget (1965) is the sensorimotor stage, beginning at birth through the first couple of years of life. This is defined as the time period for the infant to begin constructing their world of permanent objects and to develop conception of things around them in the world. The next phase, preoperational, which typically occurs during the ages of two to six, is the time period where the student learns how to master symbolic function. This time period is where children acquire language skills, discover symbolism and began to dream. As the child reaches age 6 or 7, they enter into what Piaget referees to as the concrete operational phase, which evolves through ages 11 or 12, during which the young person searches for relations. Typically, the final operational phase occurs between ages 12 and 15. During this final phase the young person's major purpose is to take their own thinking as an object and think about thought, contrary fact conditions and ideal situations. Essentially the young person is on a search to develop comprehension.

The theorist Elkind (1972) proposed that Piaget's stages for the development of cognitive skills in children can be related to and applied to the teaching of science. In applying Piaget's theory, Elkind (1972) proposed the stages of scientific learning as having students making observations in the classroom (sensorimotor); then naming and labeling (preoperational period); and culminating with experimentation and theory building (formal operational period and searching for comprehension). If the phases of learning are observation, experimentation and theory building, literacy strategies can be integrated throughout strategies for teaching the science classroom.

While many activities such as direct instruction are passive, Piaget (1965) proposed that learning should be dynamic and children learn through their active experiences such as by listening, making, doing, and sharing. It can be implied that writing is an active process. Piaget was a proponent of students taking information through listening or reading, applying the information to an activity such as proposing an answer and expanding learning through social interaction. In Piaget's terms, taking in the information is referred to as instructionism, making and doing is constructivism and the social aspect is connectivism. By combining instructionism and constructivism teaching starts with teacher focused instruction and concludes with student-centered focus, which makes for a holistic learning process. This means that the teacher is constructing a context for student learning such as with the inquiry based approached which is used with literacy practices.

Elkind (1972) contends that the work of Piaget is likely to have strong implications in the use of literacy strategies in content areas since Piaget's constructivism theory proposed suggests that all knowledge is constructed from the learner's prior knowledge regardless of the type of instruction. Elkind (1972) contends that Piaget's theory supports an approach in (Grades 9–12) science classrooms of following a sequence of science activities, using methods of science instruction such as observation and the content matter.

In the context of this research effort, exploring teacher perceptions of literacy practices in the science classroom in order to enhance student learning and facilitate scientific literacy, Piaget's theoretical framework supports that student learning occurs in a stepwise fashion. Learning in a stepwise fashion can be related to the classroom practice of teacher instruction, students writing a response, discussing it with peer groups the receiving feedback from the teacher. In the sciences, this is commonly associated with the inquiry process. In the inquiry process, students are presented with question, explore possible solutions and develop solutions. This inquiry-based process can easily be integrated with literacy processes. Elkind (1972) describes Piaget's theory of the value of leveraging students' prior knowledge in the learning process and facilitating the student extending their learning as they go through steps prescribed by the teacher within context to guide student learning as they explore possible answers to writing prompts. The concept proposed by Piaget (1965) of engaging student's prior knowledge has synergies with the 5E inquiry-based process currently used in the science classroom.

Vygotsky's Zone of Proximal Development

Vygotsky was a Russian psychologist and the father of social constructivism, a theory based on the idea that learning is benefited from the act of social interaction. As in the case of Jean Piaget, the cognitive theories of Vygotsky (1978) supported the reasoning behind literacy practices required by the new educational reform measures, which are constructivism. Vygotsky (1978) contended a child's intellectual development can be characterized by the role of social interaction where skilled learners can help those at lower levels and socialization strongly impacts cognitive development and student learning. Central to the proposals of Vygotsky (1978) is the theory of the Zone of Proximal Development this is where learning is enhanced and occurs when a student interacts with someone who has a more developed understanding than the student. This can be social interaction with the teacher, or peers. There are many different types of peer-to-peer activities where students learn in grouping strategies. In classroom practices peer-to-peer activities can be linked to and implement through a variety of activities. This form of interaction can be thought of as, projects, study groups and many other forms of peer-to-peer activities, which can incorporate in literacy strategies. As a result, Vygotsky (1978) was a strong proponent of the concept that it is critical for children to process the development of answers to questions and solve calculations both alone, in peer groups and under the guidance of adults, such as teachers. In the science classroom this is typically implemented through the steps of modeling by the teacher; an opportunity for students to synthesize and answer; then receive review in a peer situation; and concluded with guidance from the teacher.

Applying theories by Vygotsky a range of instructional approaches move students' progressively towards a deeper understanding and independence in the learning process. While Vygotsky is sometime mistakenly credited with creating scaffolding he did not. However, socialization activities, such as *peer-to-peer* strategies could be viewed as an approach to implementing scaffolding in the classroom. Scaffolding in the science classroom can be applied by adjusting the support given to students in the classroom or it can take the form of guided participation. Vygotsky (1962) proposed socialization applied to the where students learn through support of social interaction, such as a peer group and from the teacher. The need for scaffolding is supported by an understanding that one does not start out knowing everything that they need to know. Rather, we learn through a process and in the classroom it can be assignment where not all of the students can complete the task on their own, but working with the support of the group they can all find success.

Piaget saw the child as self-centered, independent, and focused on developmental stages of learning. Vygotsky focused on the child as a social being, contending that cognitive development and growth is influenced through social interactions. Vygotsky developed tools and structures to facilitate learning, and to guide the learning steps and take the students through phases and peer-to-peer learning to facilitate initial learning, social learning, and the ability to modify the final product if decided by the student. The theories of Piaget and Vygotsky complement one another and are both insightful into the practice of literature in the science classroom.

Marzano's Instructional Strategies for Effective Teaching

The educational theories of Piaget and Vygotsky support the application of literacy practices enhance student learning by leveraging a student's prior learning and through socialization. Marzano has made contributions to support literacy practices in the classroom through strategies and tools. Marzano is an educational researcher who focuses on the process of cognition and the development of high performing strategies and approaches that can optimize student learning. Marzano (2001) contends that by using specific instructional strategies that the classroom teacher can be more effective in creating student learning. It is his approaches to the process of write and learn that is related to this research effort exploring the teachers' perceptions of literacy practices in the science classroom. Marzano (2004) developed instructional strategies for effective teaching and student learning in the classroom, which has implications for the science classroom; this is because all of these strategies have synergy with the emerging educational reform measures. Literacy practices have been demonstrated to help students frame the learning, demonstrate comprehension, communicate through writing and presentation, think critically, and develop and demonstrate knowledge (Mitton-Kukner & Orr, 2018).

In teaching science and integrating literacy practices students are prompted to explore similarities and differences in an approach to break down complex conceptual points and analyze them in a simpler way as described by Marzano (2012b) applying literacy strategies such as Venn diagrams, charts or in comparing, classifying, and creating metaphors and analogies. These strategies can be combined with other literacy practices or used alone. The selection of a specific strategy, or a combination of strategies depends on the topic to be taught and possibly the specific topic of the lesson plan.

Marzano (2012b) suggested that literacy strategies such as summarizing and note taking promotes a higher level of comprehension in students as they analyze concepts and translate it into their own words to communicate the information to other people. This is also supported by the cognitive theories of Piaget and Vygotsky who proposed, that using prior knowledge and working in structure and socialization would enhance student learning. Marzano (2012b) has conducted research which suggests even simple note taking is better translated into the students on words resulting in deeper learning than verbatim note taking.

Much like the socialization aspects of learning discussed by many cognitive theorists' Marzano (2012b) suggests a need and benefit for effort and recognition speech making the connection between student effort and success in the learning process. Many literacy strategies can facilitate this including story writing, record keeping of efforts and achievement to be reflected upon and even analyzed. This can be a component of cooperative learning where students work in groups of varying sizes with different assignments for the students with both individual and group accountability.

Marzano (2012a) developed the widely used educational teaching strategy of scaffolding lesson plans in the classroom and describes how the process of thinking and the construction of knowledge is facilitated by many different writing applications which can be imbedded in (Grades 9–12) science classrooms (Marzano et al., 1988). Piaget's theories explained the development of learning utilizing prior knowledge and occurring in sequence and Vygotsky defines the benefit of the social aspects of working alone then in groups. Marzano rolls the theories of Piaget and Vygotsky into the strategy of scaffolding and writing to learning practices. The theories and suggestions from Piaget, Vygotsky, and Marzano can be rolled together to support the benefits of embedding literacy practices into the science classroom.

Conceptual Framework Summary

The conceptual framework outlined the developmental stages of learners and the value of prior knowledge, the leveraging of understanding the distance between learned and to be learned material and using socialization strategies and scaffolding materials and strategies. Piaget focuses on the stages of learning and how they occur in a sequence, which is related to cognitive development in children. The theorist Vygotsky explores conditions associated with both the development of learning skills focusing on the role of socialization and conditions around, which learning can be enhanced and optimized in the science classroom. The connections between Piaget and Vygotsky are prior knowledge; social activities and practices, which reflect how children learn and these all, require strategies and practices. This is where the work of Marzano fits in as he identifies strategies and practices to optimize learning in the science classroom.

An approach to viewing the application of Piaget's theories to the science classroom is the association between stages of learning and scaffolding as proposed by Vygotsky. Piaget proposed that learning follows a developmental sequence and Vygotsky suggested learning in stages, starting where the learner is competent and proceeding to take the student further and facilitating their learning new content by applying previously learned material. Since this creates a situation in the classroom where there is active learning, both Piaget and Vygotsky support this in theory.

Educational reform measures driving the integration of literacy in the science classroom, in addition to promoting literacy as a strategy also define specific approaches such as constructing answers, reviewing in groups and the opportunity to rewrite and submit material representing the finality of learning (Bybee, 2014). Therefore, in the emerging science classroom teachers implementing practices and habits to help students develop critical thinking skills increase their understanding of conceptual knowledge and become scientifically literate (Churcher, Downs, & Tewksberry, 2014).

The cognitive developmental theorist Vygotsky (1978) described intellectual development in terms of proximal development, promoting the benefits social interaction. He proposed that a social and collaborative situation positively impacts cognitive development enhancing learning. Therefore, Vygotsky (1978) supported situations in the classroom involving teams working together and dialoguing creating and interactive learning experience. According to Vygotsky (1978), the intellectual development of a child is generated, supported and enhanced when the child imitated models of more advanced learners. The zone of proximal development as proposed by Vygotsky (1978) suggests enhanced learning through a range of internal development processes, which occur only when interacting in communal learning activities. The developer of scaffolding in the classroom, Vygotsky (1978) proposed that ideal learning occurs with a scaffold lesson plan and social interaction. The social interaction according to Vygotsky (1978) is the connection between actual development and potential development.

Review of the Literature and Methodological Issues

The purpose of a literature review is to provide the reader with a clearly defined understanding of the topic as reflected in the current research literature and describe the direction that the work is going and discuss the value of potentially, and including potentially unanswered questions (Creswell, 2017). An in depth understanding of the current research helps to identify potential arguments important to the field of work and the literature review attempts to summarize and interpret the established work and uncover potential gaps for future study which can be used to support the argument (Machi & McEvoy, 2016). In this dissertation, the literature review follows a discussion of the conceptual framework, which is an exploration of the cognitive educational theory supporting the benefits of using literacy practices in (Grades 9–12) science classrooms. The literature review then presents an explanation of the driving factors behind the educational reform measures, the recent history of pedagogical practices, the impact of these educational reform measures requiring implementation of literacy practices in (Grades 9–12) classrooms, the training level of teachers and their perceptions would have significant value in helping school systems optimize and address potential barriers to implementation. The context of my research is a hermeneutic, phenomenological study consisting of investigating the perceptions of teachers in (Grades 9–12) science classrooms and their approaches and needs to meet the requirement to integrate literacy practices in their classrooms.

Emergence of Literacy Practices

Students in the U.S. continue to struggle with literacy skills and developing an understanding of content areas, specifically science (Wexler et al., 2017). To address weaknesses in literacy skills, and poor scores in science, educational reform measures have been developed requiring science teachers to implement literacy practices (Wexler et al., 2017). The NGSS and the CCSS have connections requiring science teachers to integrate literacy practices into their pedagogical approaches (Drew et al., 2017; McKnight, 2015; Drew & Thomas, 2018). A common theme of research published in recent peer reviewed journals is that integrating the use of literacy practices into teaching science does in fact, improve the level of student learning and comprehension and improves literacy skills (Morabito, 2017; Perrow, 2018; Wright et al., 2016). Many approaches can be used to integrate literacy practices in the science classroom and several are identified and discussed in the literature review. There is sound educational theory supporting the use of literacy practices to teach content areas suggesting students develop a deeper and more holistic understanding (Wang et al., 2016; Putra & Tang, 2016; Spires et al., 2016). The National Research Council proposed that the historic approach to science education was too general, focused on students memorizing and recalling, rather than developing an understanding of the concepts and applying them in applications (Richmond, Parker & Kaldaras, 2017). Adopting the educational reforms means replacing a teacher centered approach with one that is student centered and requires the student to develop a conceptual way of explaining something new based on patterns and knowledge that they have acquired (Mayer, 2017). The additional benefit of literacy practices in the classroom is that students acquire literacy skills and become scientifically literate. Being scientifically literate means that students are capable of using scientific terms to explain an answer to a question. Reading, writing and communicating with peers are skills, which students can develop and improve when applying to a content area such as science because the content area provides a context for the discussion to take place within (Koomen et al., 2016; Putra & Tang, 2016; Tang, 2015; Wright, Franks, Kuo, McTigue & Serrano, 2016). The educational reform measures are making an assumption that reading scientific articles and materials help students develop a better understanding of the concepts if it enables them to demonstrate and understanding of the material through communication in writing or a presentation, although this is yet to be proven (Soules et al., 2014).

To understand the dynamics of integrating literacy practices into the science classroom, it is helpful to understand the history of science education. Historically, the teaching of science has been evolving from what was primarily direct instruction to the current and widely used inquiry-based approach, integrating many different student engagement strategies and enhancing student learning (Drew et al., 2017; Osborne, 2014). With the adoption of educational reform measures, there is an impetus to change the fundamental pedagogical practices in (Grades 9–12) science classrooms. A central and predominate theme in both reform measures is the use of literacy practices to teach content areas such as science and to develop literacy skills to better prepare the student for the 21st century workplace (Bybee, 2014; Drew et al., 2017; Thomas, 2018). As the educational reform measures are adopted, science teachers are being required to modify their pedagogical practices while maintaining the practice of the inquiry-based approach as the foundation to incorporate literacy practices and teach scientific literacy (Bowman & Govett, 2015; Bybee, 2014; Drew et al., 2017; Thomas, 2018). The idea is that the use of literacy practices optimizes teaching science content and at the same time improve student literacy skills and help them become scientifically literate (Bybee, 2014; Drew et al., 2017; Thomas, 2018). To meet this requirement science teachers are modifying historically used approaches such as direct instruction, peer-to-peer activities and the inquiry process by integrating literacy practices into their classroom practices (Cassidy et al., 2015). The CCSS and the NGSS both propose literacy practices and teaching scientific literacy as a core teaching strategy in the science classroom (Bybee, 2011; Bybee, 2014). The CCSS literacy practices as an approach to teach content area disciplines came out first, followed by the NGSS, which promoted three-dimensional instruction where literacy practices are central to the approach (Bybee, 2014; Froschauer, 2015; Griffith et al., 2016; Kamil, 2016).

The Education Reform Measures

Literacy practices are well established as critical to effective learning across content disciplines such as science (Morabito, 2017; Perrow, 2018). There are two educational reform measures driving the use of literacy practices in teaching science: the CCSS and NGSS (Drew & Thomas, 2017; Wallace & Coffey, 2016). The CCSS proposes that teachers use literacy practices in their pedagogical approaches to teach content area subjects such as science (Morabito, 2017). The purpose behind the CCSS is to simultaneously improve student literacy skills and learning in content areas such as science (Wexler et al., 2017). Some literacy practices help science teachers meet the principles and requirements of the NGSS (Lee, 2017: Nelson & Allen, 2017). Literacy practices from the CCSS and NGSS together change the way students are engaged in the science classroom and enable students to learn science in a holistic manner (Wallace & Coffey, 2016). Embedding literacy practices into the teaching of science is considered to improve student comprehension and learning (Griffith et al., 2016; Kamil, 2016; Soules et al., 2014).

Common Core State Standards (CCSS). Literacy strategies impacting the science classroom first emerged as a component of the CCSS and are considered to be a highly effective classroom practice to teach content areas and promote overall literacy within that content area (Lee, 2017; Novak, Hubbard, Ebeling, & Maher, 2016). While the CCSS literacy practices propose specific practices for teaching content areas, they are only now reaching the science classroom as an expected practice (Lee, 2017; Novak et al., 2016). Studies show that science teachers have minimal training in the use of literacy practices and teaching literacy skills to their students (Ray et al., 2016). The CCSS literacy component proposes the teaching of content area subjects through literacy, which promotes metacognitive decision-making and requires specific teacher education programs such as professional development (Griffith et al., 2016; Kamil, 2016). While CCSS does not promote any specific educational instructional approaches or methodologies, it does promote literacy and the science teacher using instructional levels to increase the level of student understanding (Kamil, 2016). Having the science teacher use approaches to increase the complexity of student reading ability both prepares them for the workforce and elevates the level of student learning in content areas such as science (Allington et al., 2015; Kamil, 2016).

Next Generation Science Standards (NGSS). The NGSS standards are a defined educational approach to learning science which proposes that science educators synthesize lessons combining science and engineering practices (SEPs), crosscutting concepts (CCs) and disciplinary core ideas (DCIs) to facilitate the development of comprehensive scientific knowledge (Lee et al., 2014). The use of practices, crosscutting concepts and disciplinary core ideas is referred to by NGSS as three-dimensional instruction and is considered an approach for aligning the progression of student learning with prior knowledge (Froschauer, 2015). While there is a large set of literature on the integration of literature practices in (K–6) science classroom, there have still been limited studies exploring literacy practices in (Grades 9–12) science classrooms. This is primarily because many school systems began their integration of literature changes by starting with (K–6) science teachers and it is just now reaching the (Grades 9–12) science classrooms. As a result it is not known what (Grades 9–12) science teachers' perceptions of literacy integration are in the science classroom. The problem is educational training programs do not prepare science teachers to embed literacy practices in the classroom or to teach literacy skills. It is proposed that this problem has the result of teachers being concerned that the new approaches might reduce the amount of time available to teach the content; biology, chemistry and physics teachers may not understand how literacy strategies support student learning; teachers do not recognize activities they already practice which incorporate literacy; and teachers do not see existing opportunities to integrate literacy. Additionally, teachers in the (Grades 9–12) science classroom may not have the skills to support their students to be completely literate in science (Drew & Thomas, 2017).

A core component of the NGSS is that scientists should learn how to communicate scientific information through writing (Drew, Faggella-Luby, Olinghouse, & Welsh, 2017). The educational reform measures of CCSS and NGSS are connected through the requirement of students learning through literacy practices. These strategies are proposing the integrating skills and disciplines to develop a deeper understand of the content matter and promote communication skills of writing and speaking (Nelson & Allen, 2017). Literacy directly connects the educational reform measures of CCSS and NGSS; CCSS proposes that students become proficient at writing arguments to support claims and this helps them develop a deeper understanding of content areas, such as science; and NGSS three-dimensional learning framework facilitated by literacy strategies (Lee, 2017; Novak et al., 2016). The use of three-dimensional instruction integrates making claims, which is a statement answering a problem or question; the use of evidence, which can take the form of a range of things such as content, data, or laboratory data; and reasoning where students endeavor to push their understanding further (Lee, 2017; Novak et al., 2016).

Common themes of educational reform measures. The CCSS promotes literacy practices as effective for teaching content areas such as science (Morabito, 2017). It is proposed that literacy practices facilitate the development of a deeper understanding of content knowledge in content areas such as science (Bowman & Govett, 2015; Bybee, 2014; Drew et al., 2017; Thomas, 2018). The NGSS have direct links to the CCSS and are suggested to work together in developing student learning (Wallace & Coffey, 2016). The NGSS proposes the integration of three-dimensional teaching and learning, which has as a central point the use of literacy practices; it also proposes that the development of scientific literacy skills in student learning is a critical element in (Grades 9–12) science classrooms (Drew et al., 2017). Three-dimensional teaching and learning combine science and engineering practices (SEPs), which are behaviors of scientists as they investigate and build models, use crosscutting concepts (CCCs), which have application in multiple areas of science and incorporate disciplinary core (DCCs) ideas, which have broad importance in science (NGSS Website, 2018).

The connection between the CCSS and the NGSS is the integration of literacy practices in teaching content such as science while enabling students to improve literacy skills (Lee, 2017). Literacy is also a critical skill for people to be competent and competitive in the 21st century (Novak et al., 2016). Central to the use and application of literacy practices in the CCSS and NGSS reform measures is the use of arguments. Arguments are components of writing prompts, which require the student to read authentic material and make an evidenced based argument (Drew et al., 2017). It is important that the science teacher understand that implementation of literacy measures requires that students develop skills including communication, problem solving, process, arguments and more (Froschauer, 2015). As these reform measures are implemented in the science classroom one of the primary skills of interest to science teachers is how to facilitate and support their students in the development of arguments (Lee, 2017).

CCSS promotes literacy practices, supported by students constructing an explanation (or explanations) to demonstrate a deeper understanding and making connections between ideas that the student can develop from reading authentic material, practicing and observing (Novak et al., 2016). The application of NGSS practices in the science classroom utilizes three-dimensional instruction, which requires the teacher to develop lesson plans, which uses scientific practices, disciplinary core ideas and crosscutting concepts (Novak et al., 2016). These practices can be used to provide explanations to optimize the understanding of big ideas and explain phenomena through an argument and support it with evidence (Novak et al., 2016). The NGSS framework proposes lessons be designed to help the students develop claims to answer the overall question; support it through evidence and use reasoning to take the argument further, developing a deeper understanding (Novak et al., 2016).

In establishing approaches to integrating literacy in the science classroom, some of the emerging approaches include the use of models as one of the three-dimensional practices (Froschauer, 2015; Novak et al., 2016). Models can take on many different forms including sketches, simulations, diagrams and more, but they should represent what the student observes in nature and allow for the student to make evidenced-based arguments (Froschauer, 2015).

In implementing literacy practices and following the educational reform measures, the amount of scaffolding, defined by Vygotsky (1978) as supporting material, can be adjusted to meet the activities, grade level and the abilities and needs of the student population. One framework is an explanation approach (Novak et al., 2016). When appropriate, the approach can be expanded to include a rebuttal, depending on the content area and level of desired sophistication (Novak et al., 2016). Developing common literacy approaches, which can be used across scientific disciplines, can help students become familiar with formats and approaches (Novak et al., 2016).

Three-dimensional instruction is central to implementation of the NGSS. As described by the National Research Council's (NRC) *Framework for k–12 Science Education* (NRC, 2012) three-dimensional learning is a radical departure from traditional science teaching and facilitates more productive learning of science when teaching activities require students to figure out natural phenomena (Reiser et al., 2017). This suggests that activities for students should engage students in applying all three of the three dimensions of science, which are practices, crosscutting concepts and disciplinary core ideas, to convey their understanding of observable natural phenomena (NRC, 2011). The integration of literacy practices in teaching science is applying the three-dimensional approach as defined by NGSS because students engage in practices to develop and apply disciplinary ideas and crosscutting concepts (Reiser et al., 2017).

The application of literacy in three-dimensional teaching in the science classroom creates the need for science teachers to develop new skills to be able to support their students in building ideas over time, so that they can apply the learned knowledge rather than just memorizing (Reiser et al., 2017). Teachers essentially need to become facilitators of information and lead the overall learning process, rather than providing direct instruction. When three-dimensional approaches are used in the science classroom and compared to the standard direct instruction or an inquiry-based approach, improved scores were observed to be higher on cognitive questions (Lazarowitz & Naim, 2013). This may have been due to the three-dimensional groups having hands on time with the data from the experiment.

Just as three-dimensional teaching requires that science teachers make adjustments in their teaching approaches and materials, assessments must be modified to meet the *Framework* *for K–12 Science Education* component of the NGSS standards (Copper et al., 2017; Underwood et al., 2018). NGSS requires that students demonstrate a solid learning through observation, interpretation and cognition, therefore modifications to assessments can measure student ability to develop an evidentiary argument, elicit evidence of three-dimensional learning.

Literacy Practices in (Grades 9–12) Science Classrooms

The educational reform measures of CCSS and NGSS promote the integration of literacy practices in teaching science, requiring a shift in the pedagogy and curriculum design (Bybee, 2014; Nelson & Allen, 2017). The integration of literacy practices into the science classroom has been demonstrated to improve achievement in both science and literacy (Wallace & Coffey, 2016). When a student practices activities such as listening to a lecture, watching a video, reading authentic material, making observations of scientific phenomenon and using a combination of these to predict and understand a scientific event and conveying it in writing, this is scientific literacy (National Research Council, 2012; NGSS, 2013). Since the educational reform measures of CCSS and NGSS have a common theme of literacy, there are specific elements of the classroom practices that should be observable in (Grades 9–12) science classrooms (Bybee, 2014). In the science classroom literacy practices deepen understanding using language to communicate by applying one or more elements associated with reading, writing, speaking and listening, and language (McKnight, 2015).

Integration of literacy practices and teaching scientific literacy in the science classroom can take on many forms, even as simple as note taking during a lecture or demonstration. The adoption of literacy practices helps the change from direction instruction to the inquiry process and three-dimensional learning by increasing student engagement and interaction with a practice (Al Sultan et al., 2018; Drew et al., 2017; Froschauer, 2015; Moje, 2015). Examples would include reading-to-learn, the students the complete a reading, construct an argument, present it to their peers, then the class, and possibly write a report.

Writing to learn in science. Education continues to place more emphasis on the value and importance of students learning through the process of writing to both improve student reading and writing skills and improve learning in content areas such as science (Perrow, 2018; Rouse, Graham, & Compton, 2016; National Research Council, 2012). Student writing has been identified as an essential skill for 21st century workplace (National Association of State Directors of Career Technical Education Consortium, 2006; National Council of Teachers of English (NCTE, 2009).

The application and integration of writing in (Grades 9–12) science classrooms as a learning approach is supported by educational theory. The implication is that the process of a student writing about their learning involves a higher level of cognitive functions (Emig, 1977). The process of writing and getting feedback also facilitates students' refining of ideas and as a result expanding their learning experience (Emig, 1977).

A component of the writing-to-learn process, are writing prompts typically in a question format, used by the teacher to help students make evidence-based claims (Hand, Norton-Meier, Gunel, & Akkus, 2015). These evidence-based claims may be associated with a specific content area application such as students writing about a phenomena such as balance, or force and motion, or developing models of atomic structures and electric fields, before and after reading, collecting data and having discussions (Hand et al., 2015; Mayer, 2017; Seven, 2017). The process of doing this helps students to internalize, integrate and synthesis explanations, which they present in writing assignments.

Marzano (2012b) suggested that *writing-to-learn* be thought of as occurring in distinctive five phases which are: record, compare, revise, combine and review. *Record* is where students write descriptions of their understandings; *compare* is to share with a partner(s), looking for differences and similarities; *revise* is following the comparison; *combine* functions to explore; and *review* occurs prior to an assessment (Marzano, 2012).

The role of questions. Adapting classroom strategies to meet the reform measures of integrating literacy standards (CCSS) and three-dimensional learning (NGSS, 2013) requires that science learning no longer separate content and process purposes. Learning in the science classroom is defined as applying a combination of knowledge and practice, which makes literacy central to the new approach to learning (NRC, 2011). The application and use of questions at different levels is an effective tool that science teachers can use to both facilitate learning and assess student learning (Marzano, 2013b). In fact, questions can promote comprehension and unlock learning for students (Fisher & Frey, 2018). This is particularly true in the science classroom, where the inquiry process is traditionally used, questions can frame the inquiry, guide student thinking, and help students to think in new ways (Fisher & Frey, 2018). Questions can be used in many ways and by adjusting the level from, for example, details, to characteristics and differences, followed by elaboration and presentation of evidence (Marzano, 2013b).

While there are many literacy practices that can be incorporated into the science classroom, a central approach is to use literacy practices to facilitate the construction of explanations in response to writing prompts, which is a question given to the student (Putra & Tang, 2016; Wang et al., 2016). In the science classroom, literacy strategies include both reading literature and writing answers to questions, both of which require careful planning. The purpose of the planning is to achieve higher-level thinking on the part of the student and to make connections to science concepts (Kracl & Harshbarger, 2017).

Application of models. A critical element to implementing literacy in the science classroom is developing models suitable for three-dimensional teaching and learning, which teachers are often not experienced at doing (AASS, 1993; NRC, 1996, 2012). Models can be used to support learning as the student uses literacy practices in a common writing task to describe and predict data and they support their own claims (Starr & Krajcik, 2013). The requirements out-lined in the NGSS, such as teaching students to build models to explain phenomena are not part of traditional science teacher training (Richmond et al., 2017). One approach is for science teachers to have students construct a claim, which connects a variable or variables and compare them to another grouping of variables (NRC, 2013). It is proposed that students can be taught that scientific phenomena are explanations of causal accounts, which the student can use to describe an event (Kang et al., 2014).

White boarding. Teachers can use white boarding to meet all four areas of the CCSS, which are reading, writing, speaking and listening, and language, and meet the hands-on, lab based requirements of the NGSS (West, Sullivan, & Kirchner, 2016). Students can use white boards to generate ideas, share ideas, and synthesize ideas in the classroom (West et al., 2016). White boarding can facilitate immediate sharing of ideas in the students' own words.

Science notebooks. Science notebooks are a natural way to integrate literacy practices into (Grades 9–12) science classrooms (Fulton, 2017; Morabito, 2017). The use of science notebooks can be used for students to reflect on learning and to make evidence-based claims, meeting both CCSS and NGSS standards and achieve student engagement in an inquiry-based approach (Fulton, 2017; Morabito, 2017). Technology can be a valuable tool to help with science notebooks through the use of e-notebooks and whiteboard applications (Miller & Martin, 2016). The use of digital technology can enable students to incorporate graphs, charts, diagrams, pictures, and videos into their science notebooks (Miller & Martin, 2016).

Quick writes. One of the challenges in implementing literacy practices is that many students have weak literacy skills. Beginning lessons with videos, questions related to the content, or graphic organizers can be used to set students up to do short writings to use and develop their literacy skills (Varner, 2016). The literacy practice may be answering a question, writing a summary, filling in definitions, or writing a question of their own (Varner, 2016).

Training and Professional Development

Changing how teachers in (Grades 9–12) science classrooms engage students is a challenging process that requires specific training and can be addressed through professional development (Nelson & Allen, 2017). Zhang et al. (2017) propose there is little understanding of what science teachers need in terms of professional development to meet educational reform measures such as implementation of literacy practices. The historical approaches currently used by science teachers are established and entrenched in their minds. Asking these professionals with a limited amount of time to make changes to or learn new pedagogy practices presents challenges. There are inherent challenges associated with requiring science teachers to integrate literacy practices into their pedagogical approaches because they need to grasp how, have the ability, have the willingness to change and understand the benefits of literacy practices in the science classroom (Mitton-Kukner & Orr, 2018). The infusion of literacy practices into teaching content areas is still something new to science teachers. Studies of preservice teachers' perceptions of literacy practices are that they are not responsible for, and not skilled at integrating literacy practices, and do not fully grasp what to do (Mitton-Kukner & Orr, 2018).

Gillis (2014) suggests that science teachers are hesitant in regards to justifying the benefits and lack the skills to implement literacy practices into their pedagogical practices. When a professional group is hesitant about a change, to address it often requires selling the concept to them in a convincing manner. There is a lack of descriptive information about the overall process and the extent of the use of literacy practices in the science classroom, leaving unanswered questions, which could be important to the implementation of the educational reform measures (Drew & Thomas, 2018). While there is a wide range of literacy practices that can be combined with the inquiry process in the science classroom, there are indications from prior research that the practice is currently limited due to the need for professional development (Drew, Valentino, Olinghouse, Faggells-Luby, & Welch, 2017).

Science teachers may have many factors affecting their implementation of literacy practices. There is a concern that science teachers are not being provided with the opportunity to develop necessary skills to master how to work their content area into literacy practices (Wright et al., 2016). One study of science teachers had the findings of: (a) juggling curricula to cover time for learning, (b) navigating learner responses to literacy and the manifestation of time nested in classroom routines, and (c) the complexity of investing time into the scaffolding of student learning (Mitton-Kukner & Orr, 2018). Since science teachers are being required to develop skills to use literacy practices in the science classroom, there may be benefits of using literacy instructors in professional development programs (Siebert et al., 2016). Studies into the characteristics of literacy instructors in content areas point to their lack of experience in most of the content areas they are trying to support (Siebert et al., 2016). A lack of experience on the part of the literacy instructor in specific content areas might lessen the value of having them included in professional development programs.

Scientific Literacy and Instructional Practices

Student development of scientific literacy practices is primarily being driven by the Next Generation Science Standards (NGSS) based on the belief that sophisticated language and literacy skills are critical to working in science, technology, engineering and mathematical fields (Drew & Thomas, 2018). In addition to literacy practices in the science classroom enhancing scientific literacy, the improved literacy skills can help the student in literacy practices outside of the science content area and help them to become more successful overall in life (Tang, 2015). In focusing on the science classroom, it is important to start understanding the pedagogical directions that literacy practices are taking us and to determine how the collection of data on the process can contribute to the overall discussion (Tang, 2015). The integration of literacy practices in the science classroom is probably best represented as multiple possibilities with common approaches being broadly classified as reading strategies, writing-to-learn using notebooks, constructing answers to writing prompts, quick write ups and writing-to-communicate and students being allowed to complete multiple drafts to work on their literacy skills (Soules et al., 2014).

Benefits of Literacy Practices

The educational reform measures are grounded in a framework of disciplinary literacy as defined by industry leaders to enhance and optimize learning in the classroom and teach students to be able to communicate in the disciplinary language in the 21st century (Koomen et al., 2016; Zygouris-Coe, 2015). The point of disciplinary literacy is to facilitate learning through the procedural steps of reading the content, thinking about what is being read, writing often in response to a writing prompt, communicating and using learned information within the discipline of study, such as biology, chemistry, earth science, or physics, to present a position in response to a writing prompt (Koomen et al., 2016; Zygouris-Coe, 2015). The processes associated with literacy practices and literacy in the science classroom facilitate the student's developing an understanding of the sources of knowledge and how to form and create a response to answer a question rather than simply learning a series of facts (Koomen et al., 2016; Moje, 2015).

Concerns and Barriers to Educational Reform Measures

While the educational reform measures of CCSS and NGSS are designed to increase learning in the science classroom, there are some concerns associated with the process. In the science classroom, teachers are not trained in literacy practices or teaching literacy and do not typically receive professional development training in this area (Balgopal, Wallace, & Dahlberg, 2017; Drew & Thomas, 2018; Drew et al., 2017; Koomen et al., 2017; Lee, 2017; McKnight, 2015). Other concerns that have been expressed by teachers is that implementation of all of the educational reform measures may distract from teaching the same amount of content historically taught**.** The education and training of science teachers does not include the use of literacy strategies to teach content or how to teach literacy skills (Balgopal et al., 2017; Drew & Thomas, 2018; Drew et al., 2017; Koomen et al., 2017; Lee, 2017). The science teacher is critical to implementation of literacy practices, and the achievement of scientific literacy, as these new standards require a shift in the approach used to teach scientific concepts in the science classroom (Al Sultan et al., 2018; Drew et al., 2017). If science teachers have not already integrated literacy practices into their pedagogical approaches and started teaching literacy skills, they are now being required to by most school systems (Lee, 2017; Novak et al., 2016). While some literacy practices have always been used to teach content areas such as science, it is concerning that science classroom teachers have not been trained in literacy practices and scientific literacy, do not receive professional development in this area, and students in the classroom have a wide range of literacy skills (Al Sultan et al., 2018; Drew et al., 2017; Gillespie Graham, Kiuhara, & Hebert, 2014; Moje, 2015). Many school systems have recently started programs to train science teachers in literacy practices and teaching scientific literacy (Koomen et al., 2016; Siffrinn & Lew, 2018).

Review of Methodological Issues

According to Nelson and Smith (2015), qualitative research is considered to lack scientific rigor because the findings are based on opinions and lack credibility. Findings in qualitative research are based on judgments made both by the participants and the researcher, which has the potential for biases. In qualitative research, the researcher must consistently check the data for inclusion of any biases. Nobel and Smith (2015) believed in order for qualitative research to be valid, the researcher should create generalizability, reliability, and validity throughout the study. When using qualitative research, the research must keep in mind that multiple realities may exist, while personal biases may result in issues within the methodological results. Applicability, confirmability, and consistency are criteria that should be used throughout the process of evaluation in qualitative research (Nobel & Smith, 2015).

In order for qualitative research to be accurate and creditable, the results of the study should be detailed. Qualitative simply requires a broader and less restrictive concept of "design" than some of the other traditional research designs (Maxwell, 2013). Since qualitative research using the hermeneutic approach is based on interrupting rich descriptions, the data must be organized and reviewed multiple times to gain meaning from participants' descriptions (Creswell, 2014).

Synthesis of Research

Themes emerged in the research related to the use of literacy practices in the (Grades 9–12) science classrooms, suggesting that the teachers need support to integrate literacy practices. The literature review provided findings regarding the dynamics behind the educational reform measures and the classroom situation with teachers in (Grades 9–12) science classrooms. A concern has been that science teachers may be reluctant to teach literacy skills, which are required in the process (Drew & Thomas, 2017; Wexler et al., 2017). Studies investigating integration of literacy practices in content area classrooms have reported that students improve their literacy skills while gaining more access to learning science (Wexler et al., 2017). The lack of training and experience in following the CCSS and NGSS literacy practices are likely to make science teachers reluctant to attempt using literacy practices in (Grades 9–12) science classrooms (Drew & Thomas, 2017: Wexler et al., 2017).

Critique of Previous Research

There is a lack of scholarly research about what science teachers need for improvement in the context of educational reforms and curriculum changes. (Zhang et al., 2017). CCSS and NGSS are in the forefront of science educational reform since literacy is a natural fit with teaching science (Fulton, 2017). Previous studies have focused on areas such as the implementation of CCSS and NGSS literacy practices (Drew & Thomas, 2017); literacy practices in science (Wexler et al., 2017); and supporting and bridging learning science and literacy together (Ippolito et al., 2018; Nelson & Allen, 2017; Varner, 2016; Wexler et al., 2017). Some studies explored implementation of CCSS and NGSS in terms of the extent to which they have been implemented in (Grades 9–12) science classrooms (Drew & Thomas, 2017). Many of the studies investigated the need for professional development (Ippoliti et al., 2017).

When looking specifically for research on literacy practices in the (Grades 9–12) science classroom, the focus has been on implementation of the CCSS and NGSS, but not perceptions of the teachers (Drew & Thomas, 2017; Wexler et al., 2017). The study conducted by Drew and Thomas (2017) examined the extent to which (Grades 9–12) science teachers were implementing literacy practices. Previous studies suggested that a better understanding of the synergy between science and literacy is essential to enhanced teacher professional development (Drew & Thomas, 2017; Wexler et al., 2017). The study by Wexler et al. (2017) reported on teacher perceptions of literacy practices in terms of the types of texts they used and the amount of vocabulary and comprehension instruction that was used. The research by Wexler et al. (2017) suggested a need for more professional development for teachers to help clarify the requirements of CCSS and NGSS and strategies to implement literacy practices.

Summary

As a result of the CCSS and the NGSS, teachers in (Grades 9–12) science classrooms are modifying their pedagogical practices by incorporating literacy practices. The central theme of CCSS and NGSS is the adoption of multiple literacy practices in teaching science (Bybee, 2014; Lee, 2017). Within the context of these educational reform measures, three-dimensional teaching and learning, which is a component of NGSS, is important because this approach is facilitated by literacy practices (Bybee, 2014; Lee, 2017). The literature component of the NGSS was designed to fit with the CCSS (Wexler et al., 2017). This common component in all of the educational reform measures, which is the integration of literacy, entails using literacy to teach science content and to enable students to become scientifically literate (Bybee, 2014). These educational reform measures are now resulting in changes to pedagogical practices in science classrooms, creating the requirement of literacy practices and teaching scientific literacy (Bybee, 2011; Drew et al., 2017; Lee, 2017; Moje, 2015). Applying literacy practices in teaching content area disciplines, such as the sciences, is known as disciplinary literacy instruction and is proposed in the educational reform measures (Moje, 2015). The purpose of literacy practices in the science classroom as defined by the standards is to facilitate the student in communicating information in terms of constructing explanations, engaging in arguments from evidence and obtaining, evaluating and communicating information so that they develop a deeper understanding and become scientifically literate (Drew et al., 2015; Moje, 2015). Literacy practices and developing scientific literacy skills have the ultimate purpose of helping students develop a deeper and longer lasting learning of knowledge in the science class and the new reform measures accomplish this through infusing the way scientists think and work (Moje, 2015; Drew et al., 2017).

This broad literature review addresses the drivers behind the adoption of literacy practices into the pedagogical practices of the science teacher, presents the practices which are literacy practices, and discusses the supporting reasons for this change and potential barriers faced by the science teachers. As Machi and McEvoy (2016) contend, this in-depth understanding is important but in addition they point to the value of the literature review uncovering potential gaps for further research and analysis. The following chapter describes the research methodology that was used to explore the perceptions of science teachers, including the current and future amount of literacy practices they are adopting, the approaches to literacy practices that they plan to use the most and their perception of the effectiveness of literacy practices on student learning. Purposeful selection was used in this study and the qualitative approach used was a hermeneutic, phenomenological design.

Chapter 3: Methodology

While teachers in (Grades 9–12) science classrooms do not typically receive literacy training they are being required to implement literacy practices in their pedagogy (Drew & Jeffrey, 2018). Prior studies propose a need to develop effective professional development programs to train science teachers in literacy practices (Drew et al., 2017; Drew & Thomas, 2018; Gillis, 2014; Mitton-Kukner & Orr, 2018; Roth et al., 2019; Wexler et al., 2017). A better understanding of science teachers' perceptions is critical to designing and developing professional development programs that match the specific needs of the teachers (Lee, 2017). School systems use professional development to educate teachers on educational reform measures so that they can understand and meet new standards in strategies, curriculum, and assessment (Zhang et al., 2017).

According to Creswell (2013), individuals seek to develop understandings by considering their own experiences. Qualitative research studies are ideal for collecting data, which can be useful in making something of interest visible and available for discussion and to be addressed through an increased understanding (Creswell, 2013). Qualitative research is a common research study approach used to explore the perceptions of individuals and expose trends in the field of education (Merriam, 2009). In qualitative research, questionnaires and interviews are appropriate and useful tools to inquire about the participants' perceptions of their experiences (Creswell, 2013). The results of a qualitative research study can identify practices and strategies useful to teachers for more effective professional development programs (Merriam, 2009). Creswell (2013) defined the research methodology section of a study as the definition and explanation of the theoretical lens of the study, which provides the context of the research work to the reader.

The methods section is an epicenter, where theory merges with an explanation of how collected and analyzed data is to be used and interpreted (Smagorinsky, 2008).

Teachers are being required to modify their pedagogical approaches in the (Grades 9–12) science classroom by integrating literacy practices; this is to meet the requirements of the CCSS, and the NGSS (NGSS; Drew et al., 2017; Drew & Thomas, 2017; Nelson & Allen, 2017; Siebert et al., 2016; Wexler et al., 2017; Wright et al., 2015). The use of literacy practices is supported by data showing, that when students construct sentences, they develop and deepen their understanding of the material being studied, and a wider range of students can be reached (Tanner, 2017). Historically, educational preparatory programs and professional development for science teachers have not included training in literacy practices (Varner, 2016). While there have been studies of literacy practices in the science classroom, there is limited research describing the perceptions of the science teacher (Drew & Thomas, 2017; Wexler et al., 2017). Exploring teachers' perceptions is a way to explore possible trends and commonalities, which may be useful to develop educational programs and professional development for teachers in the (Grades 9–12) common classroom. The common perceptions may include things such as their understanding of what literacy practices look like, their comfort level, the extent to which and how they are using literacy practices, and their perceptions of professional development needs. Within this hermeneutic, phenomenological study, I explored how teachers perceived the implementation of literacy practices in the (Grades 9–12) science classroom through a Qualtrics questionnaire, semistructured interviews and a review of lesson plans. In this chapter, I present the research questions, research design, and methodology that were used to guide this study. My role as a researcher was explained as well as the participant selection logic. Ethical considerations and protection of the identities of the participants were addressed.

Research Questions

The research questions for this study were:

1. How do teachers perceive the implementation of literacy practices in (Grades 9–12) science classrooms?
2. How do teachers in the (Grades 9–12) science classroom perceive professional development needs?

Purpose and Design of the Study

The purpose of this hermeneutic, phenomenological study was to explore how teachers who are going through the process, perceive the implementation of literacy practices in (Grades 9–12) science classrooms. Participants provided data that described their lived experiences of modifying science curriculum and pedagogy to reflect current educational reform measures. The exploration of the perceptions of teachers is important to identify the needs for developing effective training and professional development programs. Creswell (2013), based on the work of Husserl (1952/1980), proposed exploring the lived experiences through the combined perceptions of a group. A hermeneutic, phenomenological research design is appropriate for exploring the perceptions of teachers' as they implement literacy practices in (Grades 9–12) science classrooms.

A qualitative approach is appropriate for a study to explore lived experiences of a specific population (Creswell, 2013). Information rich populations can be found by using purposeful selection (Creswell, 2013). In this study the target population was purposefully selected to be licensed teachers in (Grades 9–12) science classrooms. The research instruments used were a Qualtrics questionnaire, a semistructured interviews and a review of lesson plans, which is supported as a phenomenological approach to explore participants' experiences (Moustakas, 1994).

Research Population and Sampling Method

This hermeneutic, phenomenological study focused on collecting the perceptions of licensed teachers in (Grades 9–12) science classrooms who are making adjustments in their pedagogical approaches to integrate literacy into their instructional practices. The study site was located in a large suburban school system in the Northeastern U.S.; it was a single large public high school. In this study, there were 17 participants, who are all licensed in (Grades 9–12) sciences. Qualitative studies are characterized as presenting information rich phenomena of defined groups, making purposeful selection an ideal approach to gain useful and meaningful insights (Creswell, 2013). Purposeful selection of participants in a research study is a foundational step to a strong qualitative study (Patton, 2002). The review and accountability office in the school system approved that I as a researcher could contact participants with the questionnaire, recruit participants for semistructured interviews and share their lesson plans for review. Participation in the e-mail questionnaire, the semistructured interview, and review of lesson plans was all done on a voluntary basis. The first part of the Qualtrics questionnaire enabled the participants to identify their demographics such as years of experience, race and sex.

The selection of science teachers who are gaining lived experiences of the phenomenon being studied is supported as an effective approach (Creswell, 2013). Creswell (2013) contended that a sample size should be large enough to collect sufficient data to enable the researcher to collect the essences of the participants' experience. The high school where the study took place had 19 science teachers. This sample size should be large enough to capture the essence of the phenomenon. The teachers represented a diverse range of experience in terms of years of teaching, sexes, and races.

Participant Selection Logic

The purpose of this hermeneutic, phenomenological study was to explore how teachers perceive the implementation of literacy practices in (Grades 9–12) science classrooms. In order to explore perceptions of a specific population of licensed teachers in (Grades 9–12) science classrooms who are integrating literacy practices into their pedagogical approach, purposeful selection was used. Purposeful selection is appropriate for qualitative research where the goal is to explore information-rich insights, where there are limited resources (Patton, 2002), and is useful for selecting groups especially knowledgeable and or experienced with a phenomenon of interest (Creswell & Plano Clark, 2011). The selected participants are a homogenous population within the science department of one large suburban high school. They are all licensed teachers in (Grades 9–12) science classrooms and are teaching biology, chemistry, or physics, or a combination of these disciplines. The participants are in a school system where they recently were required to integrate literacy practices into their pedagogy approaches.

The criterion for selection of a school system was to find a large suburban school district serving a range of socioeconomic levels. Criteria for selection of participants was:

- Licensed teachers: Only science teachers who had passed recognized content licensing exams required by the state and school system where the study is being conducted were identified through purposefully selection.
- Science disciplines represented: Science teachers licensed to teach biology, chemistry, or physics and currently teaching in the state and school system. Some (Grades 9–12) science teachers were licensed in more than one content area.

- Academic level: Science teachers were asked to volunteer answer questions for their classes, which are on-level and honors but not advanced placement. The exclusion of teachers' experiences in advanced placement is because they are likely very different from on-level and advanced placement classes in terms of student abilities and motivation. For interviewing purposes and review of lesson plans, teachers of on level and honors were selected.
- Grade level: The sequence of biology, chemistry and physics is taken by the student during Grades nine, 10, and 11, respectively. This was a data component in the questionnaire.
- Years of experience: The perceptions of science teachers with different years of experience were collected to look for specific reportable trends.

Procedures for Recruitment

For this study, participants were identified initially as being within a school system in a large Northeastern city currently requiring the use of literacy practices, in the science department of one high school. The names and e-mails of the teachers are public knowledge, but were kept confidential for the purposes of this study. There were two levels of participation: those who volunteered to take the Qualtrics questionnaire and from that group, volunteers who participated in a semistructure interview and a review of lesson plans. The participants were recruited by an e-mail containing a link to the Qualtrics questionnaire. The e-mail included an explanation of the purpose of the study, that the estimated for completion time would be 5 to 10 minutes, and that only the researcher would know the identity of the participants. The Qualtrics questionnaire had a link where participants were able to volunteer to participate for the second part of the study, which was a semistructured interview and a review of lesson plans.

The participant pool were biology, chemistry, and, or physic teachers' in (Grades 9–12) classrooms of a public high school. The internal review board of the school system where the study took place approved the study and identified one high school in their system to be used as the study site. Participants were recruited through school e-mail and a letter to introduce the study and gain interest in participating. An introduction to the study of teachers in the science classroom was designed to explain the reason for the collection, how it will be used and the potential benefits to them as teachers. Participation in the study was strictly voluntary.

The study site is located in a school system that recently launched new curriculums for (Grades 9–12) biology, chemistry, and physics and provided training in literature practices. The first curriculum to be launched was biology, and this is the third year of use. Chemistry and physics are in their second year of use by the school system. To address the educational reform measures, literacy practices are integrated into a newly designed curriculum. The new curriculum contains practices that are used on a regular basis. The literacy practices of argumentative writing, cause and effect graphic organizers, construction of scientific explanations, are among the types of literacy practices expected by the school system. In the questionnaire, the participants were asked about the frequency of use of these specific practices during this and last school year.

Instrumentation

Instrumentation in a study refers to the tools or means used to collect and measure data variables of interest to the research study (Creswell, 2007; Rubin & Rubin, 2005). Questionnaires, semistructured interviews and review of lesson plans are common instruments in qualitative studies of participants (Creswell, 2013). The forms of data, which were collected was a Qualtrics questionnaire, semistructured interviews and a review of teacher lesson plans using a checklist (see Appendix C). The results from the questionnaire were written into a narrative form, which is appropriate for a qualitative study.

According to Todres and Galvin (2005) a phenomena-based study should yield information-rich descriptions about the targeted phenomenon and enable the participants to create specific descriptions of the situation, which sheds light on the area of investigations. In order to expand on the questionnaire responses, interviewing can be used to provide participants an opportunity to contribute information that may not be found from results of the questionnaire (Denzin & Lincoln, 2005). A researcher-created tool (see Appendix B) was be used to conduct the semistructured interviews, which facilitates flexibility in questioning and answering (Merriam & Tisdell, 2016). The semistructured interviews were limited to four questions in order to keep the process focused. Three of the questions had two parts and the participants were asked if things have changed since their school system has adopted the educational reform measures. The teachers volunteering for the interview also agreed to a review of their lesson plans. As the researcher, I compared the results of the questionnaire to the findings of the review of lesson plans using a checklist. Since the purpose of the data collection is to collect the perceptions of the science teachers on the integration of literacy practices into their pedagogical approaches and elicit information rich data, it is essential to allow broad answers to questions (Johnson & Christensen, 2017). All interview data and lesson plans collected had participants' names replaced with pseudonyms using numbers. An Excel spreadsheet was used to maintain the number assignment with the associated participant. The Excel spreadsheet, saved on a thumb drive, was kept in a locked filing cabinet at my home. I am the sole owner of the key to the file cabinet. The computer is password protected so that no one other than the researcher can view the files.

The questionnaire was designed with a clear explanation of the objective of the research study and how the results are to be used. Since the county school system is currently emphasizing literacy processes and it is a component of the school system's school improvement plan, there was motivation for the teachers to participate. The study design included comparing results of the answers to the questionnaire to the checklist used for the review of lesson plans. To make the comparison possible, the participants were asked to identify themselves in the questionnaire. Participant number to protect their identity to everyone except the researcher is used to describe their identity in the narrative. The initial block of questions had a request for informed consent and collected demographics of the participants. Participants had the option of opting out of the demographics.

The consent form (see Appendix D) was reviewed with the individual at the start of the interview and review of lesson plan session, and the signature of the participant documented that they had an understanding of the research project and guidelines. In a private setting within the school, a semistructured interview took place with the teacher using the research questions found in Appendix A. The interview was for the researcher to carefully record the experiences and perceptions of participants concerning implementation of literacy practices in the (Grades 9–12) science classroom. I recorded the interviews with a digital recorder. As the primary researcher, I wrote notes during the interviews and transcribed the recordings afterwards. Following the semistructured interview (see Appendix B), a checklist (see Appendix C) was used to review the teacher's lesson plans.

Data Collection

The collection of data is an essential step in developing answers to central questions in a research study (Machi & McEvoy, 2016). The data was collected in a single science department at a high school in a large school system in the Northeastern U.S. The collection of data started during the last week of instruction of Semester A of the 2019 school year and concluded after two weeks. The research study was based on using three instruments for data collection. Collection of data started with e-mail Qualtrics questionnaire, which were sent to all of the teachers in the school who are in (Grades 9–12) science classrooms in the science department of a single high school. The participants were asked to volunteer for a second phase of data collection, which was a semistructured interview, and a review of lesson plans. The first nine who volunteered through the Qualtrics questionnaire were interviewed and their lesson plans reviewed with a checklist. Merriam (2015) proposes that interviews with participants facilitate their being able to share their perspectives and the way reality is seen through their eyes. Patton (2002) suggests that reflection of the participant can be found and presented in the research through the use of interviews.

The proposal for the hermeneutic, phenomenological study was presented to the Concordia University–Portland Institutional Review Board (IRB) and approved. The school system's research review and accountability office, where the study took place then reviewed the request to collect data. During the IRB review, the questions were evaluated to determine if they were specific and straight forward in order to elicit the appropriate information, and that vagueness was reduced as much as possible. The committee for the school system's research review and accountability office meets bimonthly to review proposals for the collection of data. A cover letter explained the purpose of the study, the data collection method, potential benefits, confidentiality, potential risks, incentives and the informed consent process. The respondents to the questionnaire provided identification, which is only known to me and is maintained confidential. Collecting the participants' identity enabled comparison of data from the three instruments.

Following approval of the questions by the review and accountability office, the Qualtrics questionnaire along with an introduction was sent by e-mail to 19 (Grades 9–12) science teachers at the study site, which is a single high school. The study site was designated by the school system. All of the teachers were licensed and teach biology, chemistry, or physics in the (Grades 9–12) science classroom. The responses were collected and analyzed. One of the questions on the Qualtrics questionnaire was used to recruit volunteers to participate further in the study. The first nine who volunteered were chosen to participate in one-on-one semistructured interviews and a review of their lesson plans with a checklist. Interviews were done in person at the teacher's school location. As each interview was conducted, a recording was made of the session using a digital recorder. I created field notes and recorded observations within 24 hours of completion of each interview (Creswell, 2013; Merriam & Tisdell, 2016). A semistructured approach was used to facilitate some guidance but also promoting, which Merriam (2015) proposed is the opportunity for the participant to openly describe their experience. Therefore, questions provided for some flexibility so as not to confine the participant in their descriptions of the situation in the science classroom. The purpose of reviewing the lesson plans was to identify the extent and types of literacy practices being used. Lessons plans included a list of the activities or anything that outlined the instructional activities used in one typical lesson sequence.

Since I am a science teacher and also making adjustments to use literacy practices, I put aside any preconceptions while examining the data making sure the data is through the eyes of the participants only (Creswell, 2013). As each interview was conducted, I made an audio recording to assist in the transcription process (Creswell, 2013). I created field notes and recorded all observations within 24 hours of the interview (Creswell, 2013: Merriam & Tisdell, 2016). Following the recommendations of Creswell (2013) and Moustakes (1994),

1. All 19 teachers in (Grades 9–12) science classrooms in a single school received an invitation through their school e-mail to participate in the study. There were 17 teachers completed the questionnaire.
2. The first nine teachers who volunteered to participate in the semistructured interviews and review one of their typical lesson plans using a checklist were selected.
3. At the beginning of each interview, I reviewed the consent to participate form to allow the participant to ask questions prior to the interview beginning.
4. All interviews occurred in the teacher's classroom following the conclusion of the school day and in private after students have left.
5. I recorded the interviews with a digital recorder.
6. I transcribed the semistructured interviews verbatim in my private home office. All of the volunteers received a copy of the interview notes to confirm that they were represented accurately and to provide the opportunity to make changes.
7. To establish that the data collection had integrity, all participants performed a transcript review within one week of data collection. Participants were asked to identify any part of their transcripts that did not seem accurate.
8. During the study and completion of the dissertation, I am keeping all recordings on a digital recorder and in a locked desk at my private residence.
9. Three years after publication, all of the data collected will be destroyed as required by the IRB and school system where the study took place.

Identification of Attributes

The main attributes of this study stem from the conceptual framework that the use of literacy practices to teach content area subjects can address both low scores in science and poor literacy skills (Drew & Thomas, 2018; Goldman et al., 2016; Wexler et al., 2017). The identified attributes for this study are adapting pedagogy to use literacy practices to teach in the (Grades 9–12) science classroom. This study explored the perceptions of teachers in the (Grades 9–12) science classroom, their skill and confidence level, the perceived effectiveness in study learning and professional development needs for teachers. The perceptions and experiences shared by the (Grades 9–12) science teachers provided rich data to answers the research questions of the study.

The focus on exploring the perceptions of the teachers is to understand the impact of scientific literacy contributions to scientific practices creating cross connections between the CCSS and NGSS (Allison & Goldson, 2018). The purposefully selected population under study are applying educational reform measures integrating literacy practices to teach science and in the process, teaching students literacy skills in the classroom (Allison & Goldston, 2018; Drew et al., 2017; Drew & Thomas, 2018; Goldman et al., 2016; Lee, 2017; McKnight, 2015; Ray et al., 2016; Soules et al, 2014; Wallace & Coffey, 2016). Bases on these educational reform measures, the use of these attributes in this study informed the exploration of the teacher population on their implementation of literacy practices.

Data Analysis Procedures

Three research instruments, a Qualtrics questionnaire, semistructured interview, and a review of lesson plans was used. Each of these instruments is based on different approaches to derive meaning from the data. Participants’ responses to the questionnaire provide demographics of the population, their perceptions of use, confidence level, effectiveness on study learning and professional development training needs for teachers. The semistructured interviews provided rich information valuable to developing answers to the research question. Data analysis in qualitative research, such as interviews, commonly involves determining meaning from the data by reducing it into themes through a process of coding (Creswell, 2013). Creswell (2013) proposed that for qualitative studies the collection and analysis of data should go hand-in-hand. Therefore, the analysis of each form of data began in a timely manner, right as the data is collected. This section describes how I performed analysis of the data.

A critical component of the data analysis is to be able to perform triangulation of the data. In qualitative studies, triangulation of information from different sources of data has been recognized as an effective practice to address validity. Triangulation is the use of different reference points to measure something. According to Creswell (2013), rigor can be demonstrated in a qualitative study attempting to develop an understanding of a phenomenon by contrasting, comparing, replicating, cataloging and classifying data. In order to assess the validity of data, the practice of triangulation is often employed and is considered by Merriam (2015) to be critically important to the confidence of the study. If triangulation of different data points and types of data demonstrates the same outcome, it is viewed as being important to look at when the research is presented. In this study, the responses to the questionnaire, interviews and review of materials was reviewed and common themes identified by connecting different forms of data.

The questions in the questionnaire, the semistructured interviews, and the review of lesson plans with a checklist focused on how the participants' perceived integrating literacy practices into their pedagogical approaches. I used Moustakas' (1994) phenomenological reduction method of data analysis. The data analysis steps were as follows:

1. Important statements were identified and coded through a process referred to as horizontalization by Moustakas (1994) and Creswell (2013).
2. Keeping the purpose of this research in mind of determining the perceptions of (Grades 9–12) science teachers adapting to literacy practices, the data was compared. A procedure of reduction and elimination of the data was used to isolate the repetitions and cluster the essential parts and divide them into themes called measuring units (Moustakas, 1994; Creswell, 2013).
3. The next step, defined by Moustakas (1994) as textual descriptions, which is a detailed description of what happened through the eyes, and words of the participants.
4. Subsequently, a description of the perceptions' of the participants was written of how the phenomenon was experienced including the where and when of the experience. Moustakas (1994) defines this as a structural description.

According to Creswell (2013), most methodological approaches in qualitative research require only that the researcher be careful to document, code and report in an organized manner. The researcher must keep in mind that the collection and consolidation of data are essential steps in the analysis and use of data in a research study (Creswell, 2013). The triangulation of data is to ascertain consistencies in responses across the three methods of data collection (Yin, 2014).

Limitations of the Research Design

Simon and Goes (2013) define limitation in research studies as potential incidents, situations, or issues that can enter a study and are outside of the researcher's control. The collection of data in phenomenological research can be limited since the target population is sharing their opinions on the topic. Primary limitations in phenomenological research can be the research instrument(s) and small sample sizes. To address the limitations of a small amount of data, Creswell (2013) suggest that the population be purposefully selected from individuals sharing a common experience or phenomenon. In addition to purposeful selection, to address and reduce the influence of this limitation, three instruments were used. Teachers sharing the experience of adapting to the requirements of using more literacy practices to teach in the (Grades 9–12) science classroom were chosen. Additionally, they are all in the same school system and same high school. There were 17 participants who completed the Qualtrics questionnaire and nine completed the semistructured interviews. This small sample size for the semistructured interviews allowed for the collection of rich descriptions of their perceptions of the experiences.

The honesty and wiliness to provide detailed information by the participant can be a limitation. To support participants' honesty and full participation, I assured confidentiality of their identity. Within 3 days of the semistructured interviews being completed, I carried a typed copy of their transcript and offered the opportunity to make edits prior to initialing that the transcript was accurate. Another limitation of the study was my reliance that the perceptions recorded in the research are those of the participants and not influenced by the researcher (Patton, 2002). As the researcher, I maintained objectivity and trustworthiness, which must be established by qualitative researchers. Establishing truthfulness assures that the conclusions of the study are the opinions of the participants and not the researcher's beliefs (Shenton, 2004; Patton, 2002).

Transferability of the data may be limited by the small sample size, so the focus is on a well-defined population at a single study site. To make transferability more likely, I provided descriptions of the participants, and information rich descriptions of the study results in Chapter 4. The goal of qualitative research is not to try fitting the results into another situation. While the data may not be transferable, the results of the rich descriptions of the study may be of value to others. To allow for other researchers to consider the data, the rich descriptions are included in Chapter 4.

Validation

It can be challenging to collect data that is trustworthy for researchers using a qualitative approach. While there may be challenges collecting trustworthy data, it is important to maintain the integrity of the results. Collecting data that is trustworthy means that the purpose is for the outcome to be valid and reliable. Creswell (2013) described accuracy, dependability, and credibility of a study as being directly related to validity and reliability. There are various approaches which may be used to address validity and reliability of a study. In order to improve the validity, triangulation was used to determine if there was agreement between data found in the three research vehicles. For example, the checklist review of lesson plans was used to identify the extent to which literacy practices are used to match the answers from the e-mail questionnaire and the interviews.

Credibility

The triangulation of the data collected through the Qualtrics questionnaire, semistructured interviews, and review of lesson plans is an approach to ensure credibility. The Qualtrics questionnaire was created to obtain the demographics of the participants, their perceptions of their degree of use of literacy practices, confidence and skill level and need for professional development. The semistructured interviews used four questions to access the same themes as the questionnaire but to obtain more detailed information from the participants. The review of lesson plans provided a way for the researcher to verify the answers about the degree that literacy practices were used in this school year. Semistructured interviews were conducted in the participants' classroom at the end of the school day with the classroom door closed for privacy. The interviews were recorded with a digital recorder.

Member check was utilized to ensure the credibility of the data collected through interviews. Notes were taken during the interviews, the recordings were transcribed, and the participants were provided the transcripts for review and the opportunity to make changes or ask questions. Once all of the data was collected and analyzed, participants were invited to review and discuss the results. This was done through e-mail and phone discussions.

Dependability

Dependability in qualitative research is important to trustworthiness as it establishes the study findings as consistent and repeatable (Gerring, 2001). The process that I followed in my research is described in detail so that other researchers can replicate the study. Gerring (2001) considered research conducted in a reproducible manner to be essential to establishing dependability. Therefore, dependability is required to be established by the researcher in order to create trust in the study.

To achieve dependability in my research, all of the procedures, questions and steps taken in the analysis phase were transparent (Creswell, 2013). While there is subjectively in both the researcher and participants, it should not present a problem if the researcher makes it transparent during the research (Silverman, 2016). If the research takes steps to ensure dependability, it allows the final product of the research to be viewed as authentic while allowing participants to be authentically with the researcher during data collection.

Creswell (2013) proposed that reflection should occur at every step of the research phase. This is an opportunity for the researcher to admit involvement with the research, potentially being partial and questions that they may have. Lincoln and Guba (1985) describe a conformability audit where an outside researcher reviews the findings looking for potential concerns. In this research, which are qualitative rich descriptions of perceptions, the better approach is to have some of the participants have an opportunity to review the findings and provide feedback to the researcher. This can reduce the possibility of mistakes in the interpretation of the data.

Expected Findings

I expected the participants to be engaged in adjusting to using literacy practices. As a result, I expected a reported increased use of literacy practices, confidence and possibly a perception that the practices are effective. This is a natural expectation since the school system where the study site is located is requiring the use of literacy practices in the (Grades 9–12) science classrooms. Considering the large amount of emphasis and resources being placed on integrating literacy practices into teaching in the (Grades 9–12) science classroom, I expected the participants to be enthusiastic about participating in the research effort. I believed that the participants would express that they were increasing their use of literacy practices, finding it somewhat challenging, and desiring additional professional development.

Ethical Issues

The methodology of this research was submitted to the Internal Review Board (IRB) at Concordia University–Portland. The approval from the IRB was submitted along with the appropriate forms to solicit approval from the large northeastern school district's review and accountability office to collect research data for external purposes. This hermeneutic, phenomenological study was designed to obtain the perceptions of the science teachers focused on their implementation of literacy practices and teaching scientific literacy. The participants in the questionnaire were informed of the purpose of the study and had the option of volunteering or opting out. Teachers who volunteered to participate in a semistructured interview and review of lesson plans were informed of that additional role in the research study. The answers are the personal opinions of the science teachers and their identity was not collected by the data collecting software. Since the data from the questionnaire was collected blindly, the results did not need to be shared prior to publication to the participants. While bias can influence the results in any data collection, it was made clear in the instructions that this study was collecting perceptions, and the importance of honest and accurate answers was stated clearly in the instructions.

Storage and Destruction of Data

Participants were informed that there were no risks to participating in this study other than providing their information, which was protected. Personal information provided was coded so it could not be traced back to the participant. Any name or identifying information was kept securely via electronic encryption or locked inside my office desk at home. None of the data had names or identifying information. A secret code was used to analyze the data. There was nothing that could identify a participant in any publication or report. The information is kept private at all times, locked inside the my office desk at home and then all study documents will be destroyed 3 years after the conclusion of the study.

Conflict of Interest Assessment

While I am a (Grades 9–12) chemistry teacher I am not employed at, or professionally associated with the high school where the study took place. A foreseeable issue was the possible inclination to express my feelings and beliefs about answers to the questions during the semistructured interviews. Something as simple as sharing agreement or disagreement with the participant might skew the results. It was necessary to keep myself removed from offering any indications or discussions about the topic being discussed. My role as the researcher was to serve as an active listener to the participants, solely focusing on their lived experiences and not my own.

Researcher's Position

There were common characteristics that I shared with the participants of this research. As a (Grades 9–12) chemistry teacher, I am going through the same changes as the participants. My role as researcher in this study consisted of obtaining approval from Concordia University–Portland and the school system where the study site is located, primary data collector, conductor of interviews, reviewer of lesson plans, and data evaluator and analyzer of all data collected. The study site selected in a school system in a single large public high school in the Northeastern region of the U.S., where perceptions were explored of teachers' in (Grades 9–12) science classrooms currently adapting to the use of literacy practices. I am a chemistry teacher in the school system, but I have no role, relationship, or connection to the school at the study. I was entirely responsible for recruiting participants, sending and collecting of data using a Qualtrics questionnaire, conducting semistructured interviews and reviewing lesson plans. I received authorization from the school system's review and accountability office through an external research request. I received Institutional Review Board approval from Concordia-University–Portland to conduct the study. As outlined in the written agreement, the study site remains confidential in the published dissertation.

It should be noted that I am a teacher in a (Grades 9–12) science classroom and currently being required to modify my own pedagogical approaches by integrating literacy practices. It is through my experiences of adapting to the changes associated with using literacy practices to meet the CCSS and the NGSS that I realized the challenges and need for more understanding to develop appropriate training and professional development programs. To avoid personal bias I disregarded my own experiences. The study site is a single high school that I have no connections with in any regards. Hence, as the researcher, I have no influence at the study site and my opinions are not reflected in the data. There is no conflict of interest in my role as the researcher in this study.

Summary

The research rationale, participants and methodology, which is planned to be used in this descriptive phenomenology study of teachers' perceptions of the implementation of literacy practices in the science classroom is described. A questionnaire administered by e-mail using a Qualtrics program initiated the collection of data followed by semistructured interviews and a review of the lesson plans used by the teacher's is described in this chapter. Developing an understanding of the current experience level, the approaches for using literacy practices in the classroom and barriers such as professional development would be useful to science teachers, school systems and others. By obtaining a snapshot of the current situation through the eyes of the science teachers, steps can be taken to optimize the support, such as professional development, to the teachers.

The wording of the questions in the questionnaire and answers was carefully done order to maintain externality and internal validity. The first block of questions, "Informed Consent and Demographics," makes the participants aware of their rights and breaks down the demographics. The second block of questions, "Experience level and training needs to use literacy practices," measures the science teacher's degree of self-perceived level of training and ability in using literacy practices in teaching their content area. The third block of question, "Use of instructional approaches related to literacy practices," is designed to determine the level of applying literacy practices this year in the science classroom. The fourth and final block of questions, “Barriers on the use of literacy practices in my classroom,” seeks out information on any potential barriers to the science teacher implementing and using literacy practices in the classroom.

In phenomenological research, the purpose is to find commonalities that a group has and shares regarding a common experience (Merriam & Tisdell, 2016). After gathering the data, I organized it by identifying common themes to describe the experiences of the participants (Creswell, 2013). Inductive coding began with a review of the results of the questionnaire and immediately following each semistructured interview and analysis of lesson plans to identify essential terms within the data (Johnson & Christensen, 2017). The data was organized around the research questions. Categories were developed using the words of the participants.

Chapter 4: Data Analysis and Results

In this study I explored the perceptions of teachers integrating literacy practices in (Grades 9–12) science classrooms. These perceptions were explored using three research instruments: a Qualtrics questionnaire, semistructured interviews, and a review of a typical lesson plan for one unit of study. The research instruments had the participants compare last year to this school year while probing the concepts of experience, amount of literacy practice use, teacher confidence level, effectiveness on student learning and professional development needs. During this school year, the school system started requiring teachers in the (Grades 9–12) science classroom to integrate literacy practices into their classroom pedagogy. The CCSS and the NGSS (NGSS; Morabito, 2017) drive the integration of literacy practices in the (Grades 9–12) science classroom. These educational reform measures are intended to improve both student literacy skills and learning in content areas such as science (Wallace & Coffey, 2016). Prior research has revealed that science teachers receive minimal training in literacy practices as they acquire their degrees and through traditional professional development training (Ray et al., 2016). Some studies indicate that the lack of teacher training may be resulting in their not being able to appropriately support student learning (Drew & Thomas, 2017; Wexler et al., 2017). On the part of teachers, the literature reports a possible lack of confidence, willing and abilities necessary to make the change (Koomen et al, 2018; Mitton-Kukner& Orr, 2018).

The purpose of this study was to explore how teachers perceive the implementation of literacy practices in the (Grades 9–12) science classroom. The resulting information would benefit schools making decisions associated with designing professional development and other support. I selected a hermeneutic, phenomenological approach to elicit new knowledge from the participants' experiences based on the concept that reality exists as how things are perceived

(Husserl, 1952/1980). Purposeful selection was used to focus on the perceptions of a group of individuals sharing a common experience.

Within Chapter 4, I provide a description of the sample used for data collection, which includes the target population and the participants included in the study, as well as the study site. A summary of the methodology and analysis is also included, followed by a summary of the findings. Chapter 4 concludes with a presentation and analysis of the data and results. The 9 participants in the semistructured interviews and review of lesson plans also participated in taking the Qualtrics survey. A process of open, axial and selective coding was used. In this chapter, the emergent themes arising from direct participant quotes from semistructured interviews are presented. Triangulation between responses on the Qualtrics questionnaire, semistructured interviews and the review of lesson plans was used for the nine teachers who participated in all three data collection activities. The results of my data are presented in three sections. The first section includes emergent themes from the semistructured interviews; the second section includes participants' results from the online Qualtrics questionnaire; and the third section presents results from reviewing the lesson plans.

Description of the Sample

Participants in this study were selected based on meeting the requirements of being a licensed teacher in a (Grades 9–12) science classroom and in a school system that recently adopted the CCSS and the NGSS. The hermeneutic, phenomenological study was conducted in a high school of a large northeastern school system in the third year of implementing the CCSS and the NGSS. The school system approved the study and identified one of their high schools for the study to take place. All of the 19 teachers in the (Grades 9–12) science classroom at the high school where the study took place were invited to participate on a voluntary basis. This sample size falls within the participant range suggested by Creswell (2014) for a phenomenological study in order to reach data saturation. All of the invited participants taught one or more of the disciplines of biology, chemistry, or physics. During the recruitment process, 17 of 19 (Grades 9–12) science teachers agreed to participate in a Qualtrics questionnaire and 9 of the 17 participated in individual semistructured interviews and a review of lesson plans. There were enough volunteers for the sample size to meet the participant range for a phenomenological study in order to reach data saturation, as suggested by Creswell (2014). Since all of the participants completed the Qualtrics questionnaire and a subgroup took part in a semistructured interview and a review of lesson plans, the demographics are described in two groups.

Of the 17 respondents who voluntarily participated in taking the Qualtrics questionnaire, three were Asian, one participant was Latino, one was mixed race and 12 were White. Eleven participants were female and six male. There were three who taught only in the ninth grade, three in the ninth and 10th grades, and 11 taught students in Grades 10 to 12. In terms of experience, none of the teachers were first year teachers. There were five who have been teaching 5 years and 12 have taught more than 5 years. There were three who taught a combination of chemistry and physics, five were teaching biology and chemistry, and three each taught biology, chemistry, and physics alone as classes. There were five of the 17 teachers who have their teaching assignment changed from year to year. In terms of years in following the new curriculum, one teacher was in their first year; nine in their second year, and seven were in their third year.

The participants who took the Qualtrics questionnaire were invited to be in a semistructured interview and a review of their lesson plans. Nine of the 17 participants who complete the Qualtrics questionnaire volunteered to take part in the interviews and review of lesson plans. I assigned all participants a pseudonym of #1, #2, #3, #4, #5, #6, #7, #8, or #9.

Methodology and Analysis

A hermeneutic, phenomenological research design was selected for this study because it explored the perceptions of teachers' implementing literacy practices in the (Grades 9–12) science classroom. The phenomenological approach, largely developed by Edmund Husserl, was selected based on the premise that reality is based on how it is perceived by those who are going through the experience. Husserl (1952/1980) contended that human experiences in the world are a source for knowledge and meaningful perspectives. Purposeful selection was used to provide information-rich descriptions from those who are experiencing the phenomenon. I utilized three research instruments as sources of data for collection and analysis.

Multiple data collection instruments were utilized to provide a rich understanding of how teachers in the (Grades 9–12) science classroom perceive using literacy practices in their classroom pedagogy. The initial data was obtained from 17 participants who completed a Qualtrics questionnaire. At the end of the Qualtrics questionnaire, participants were invited to volunteer to participate in semistructured interviews and a review of lesson plans. Semistructured interviews using open-ended questions enable participants more freedom to express their own ideas than a questionnaire (Creswell, 2012). Next, semistructured interviews were conducted with nine participants to better understand perceptions of the participants on their use of literacy practices in the (Grades 9–12) science classroom. Lastly, for triangulation of the data, lesson materials representing a typical unit of study were reviewed with the nine participants who took part in the interviews, to see if the participants' responses matched between the data collection methods. The data collected from the Qualtrics questionnaire, semistructured interviews and the review of lesson plans, were triangulated to improve validity of the data. The school system granted permission for the data to be collected at the study site and the principal gave his approval.

The Qualtrics Questionnaire (see Appendix A) was sent by school e-mail to all 19 of teachers at the study site. Of the 17 participants who completed the questionnaire, nine from this group participated in the semistructured interviews (see Appendix B) and a review of lesson plans (see Appendix C). Qualtrics is an online survey tool for which Concordia University had a license to use. With Qualtrics questionnaires can be constructed, sent to participants and the data received, stored and analyzed. The Qualtrics questionnaire was used to collect teachers' perceptions of implementing literacy practices in the (Grades 9–12) science classroom and how it has changed during this school year. The data was collected for the study during the last two weeks of Semester A. This school system has two semesters. Semester A represents one half of the typical school year. Questions were grouped into the following blocks: (a) informed consent and demographics, (b) experience level and training needs to use literacy practices, (c) use of instructional approaches related to literacy practices and (d) barriers to the use of literacy practices in my classroom. The answer options were designed to collect information from the participants to answer the research questions discussed in Chapters 1 and 3. Over a 2-week period, during the last 2 weeks of the semester, the questionnaire was sent as directed by the school research office using the school system e-mail three times.

The semistructured interview questions were developed to align with the Qualtrics questionnaire. The semistructured interviews and review of lesson plans were started after the first week of the questionnaire being sent out. All of the data was collected within three weeks from the first recruitment e-mail. The semistructured interviews were all conducted in the participant's classroom, with the door closed for privacy. The interviews were recorded with a digital recorder. During the interview process, there were some disruptions of other teachers coming in and phones ringing. The recording was paused during these interruptions. After the participants addressed the disruption, the recorder was turned back on and the interview continued. All of the participants in the semistructured interviews were asked the same questions (see Appendix B). I reviewed the lesson plans with the participants, during the same meeting.

The data from the semistructured interviews were analyzed through open, axial, and selective coding. The first step used in the process of analysis was open coding. During the process of opening coding, I read through the data multiple times and created labels for chunks of data, which summarized the participants' responses to the confidential Qualtrics questionnaire. Throughout the process of coding, I used the participants' responses to Qualtrics questionnaire and the semistructured interviews to chunk the data.

The themes of the study were derived through open, axial, and selective coding of the semistructured interviews and they were: (a) proficiency, (b) acceptance, (c) effectiveness and (d) professional development needs. The predefined answer responses selected by the participants from the Qualtrics questionnaire were carefully aligned with the emergent themes from the semistructured interviews.

Methodological triangulation was utilized to establish and verify meaning from the data (Yin, 2014). Utilizing multiple data collection methods strengthened the validity of the findings and maintained the results based on discovery in objectivity rather than perception and bias. Utilizing multiple data collection instruments was also included in an effort to compensate for the small number of questions in the semistructured interviews. The review of lesson plans was intended to be a method where the teacher's reporting of their use of literacy practices could be verified. During the review of typical lesson plans, it was found that all of the teachers were using the same lesson plans for each unit, with the same number of lesson plans, because they were being required to by the school system.

Summary of the Findings

The findings of this study are the experiences described by the participants as their perceptions of the explored phenomenon. The participants responded to questions exploring their experiences integrating literacy practices into their pedagogy in the (Grades 9–12) science classroom. The school system where the participants teach recently adopted the CCSS and the NGSS for teaching biology, chemistry and physics in the (Grades 9–12) science classroom. Three research instruments were used: a Qualtrics questionnaire, semistructured interviews, and a review of lesson plans. The use of three research instruments allowed for triangulation of the data in order to increase data reliability.

Through their responses to the Qualtrics questionnaire, the participants provided their demographics along with insightful information and answers to the central research questions. Responses from participants to the questionnaire fall into three emergent themes. The themes relate to the use of literacy practices, their level of experience and confidence, professional development needs and the impact on student learning. During this school year, the participants have become more comfortable with using literacy practices. The participants reported that most feel they have received support, but the majority report still needing more training. They are beginning to understand the reasoning behind the educational reform efforts, the CCSS and the NGSS. The majority of the participants did not start the school year with much experience using literacy practices in the (Grades 9–12) science classroom. The study was conducted mid school year and by that time the participants expressed that they had gained more experience. All of the participants reported receiving professional development training supporting the use of literacy practices. The combination of the training and the experiences in the classroom during this school year has resulted in their expressing more confidence in their skills using literacy practices. There were positive feelings in the answers from the participants. Participants expressed the perception that students were learning more and developing a deeper understanding of the classroom content.

The themes of the semistructured interviews were derived through open, axial and selective coding of the semistructured interviews and they are: (a) proficiency, (b) acceptance, (c) effectiveness and (d) professional development needs. All of these themes align with the responses to the questionnaire (see Table 1). Additionally, the amount of use of literacy practices was confirmed by a review of the lesson plans. The results of the questionnaire administered via Qualtrics (see Appendix A), the semistructured interviews (see Appendix B) and the review of lesson plans (see Appendix C), were used to answer the research questions discussed in Chapters 1 and 3.

Question #1: How do teachers perceive the implementation of literacy practices in (Grades 9–12) science classrooms? In the questionnaire, the data collected regarding this question yielded some definitive findings and trends as participants gained more experience during the current school year with literacy practices. Initially, teachers in the (Grades 9–12) science classroom were skeptical about the benefits of literacy practices. During this school year, the participants have become more comfortable with using literacy practices. They are beginning to understand the reasoning behind the educational reform efforts, the CCSS and the NGSS. The theme of proficiency from the interviews correlates with the responses on the questionnaire of an increased use of literacy practices this year as compared to last year and the expressed growth in confidence level of the teacher.

Participants expressed the perception that students were learning more and developing a deeper understanding of the classroom content. In the interviews, participants referenced their teaching teams having discussions about student learning improving, resulting in a group perception that literacy practices were helping students improve their learning and retain the information.

The combination of the training and the experiences in the classroom during this school year has resulted in their expressing more confidence in their skills using literacy practices. This correlated with the theme of acceptance in response to experience, training, and seeing the results. Many teachers were initially skeptical about literacy practices. In the interviews the majority of participants reported the need for additional professional development.

Question #2: How do teachers in the (Grades 9–12) science classroom perceive professional development needs? The majority of the participants did not start the school year with much experience using literacy practices in the (Grades 9–12) science classroom. The study was conducted mid school year and by that time the participants expressed that they had gained more experience. It should be noted that this school year, the use of literature practices was being required by the school system.

All but one of the participants reported the need for additional professional development training supporting the use of literacy practices. Responses from the participants indicated that some aspects of professional development needs were not addressed in prior sessions. Several teachers expressed a desire to have the educational reform measures explained and justified.

The review of the lesson plans was intended to determine if participants were using literacy practices in their class room pedagogical approaches as reported in the questionnaire and semistructured interviews. During the collection of data phase, it was learned that the teaching teams were following the guidelines of the school system that is “teach-a-like” teams. In this (and many school systems), “teach-a-like” means that all teachers in a discipline team, such as chemistry, were teaching the same topics and using the same strategies and materials daily. When lesson plans were checked, all except one teacher was abiding by this. As a result of the review of lesson plans, it was determined that literacy practices were being used more this school year than last. These findings clearly demonstrate an increased use of literacy practices, which are gaining acceptance by teachers in the (Grades 9–12) science classroom. Additionally, teachers perceive the use of literacy practices to improve student learning in the classroom. Possibly as a result of seeing the value in using literacy practices, teachers are responding that they need more training in the use and preparation of materials. This goes along with acceptance, which was a theme from the interviews. Finally, participants perceive that there is a need for them to be able to teach literacy skills to students. The emergent themes from the Qualtrics questionnaire and semistructured interviews and the review of lesson plans all align in this study.

Presentation of the Data and Results

By organizing, reviewing and analyzing the data collected, I was able to gather the information necessary to answer the research questions and develop an understanding of the perceptions of (Grades 9–12) science teachers implementing literacy practices. In this section, I present the questions and responses of the participants to the Qualtrics questionnaire, the semistructured interviews, and report on reviewing the lesson plans. The data from the questionnaire is presented in in terms of the number of participants who selected specific responses. The semistructured interview data is reported in a narrative format. Creswell (2013) suggested that writing and composing a narrative for interview data in a qualitative study brings all of the research together. Open, axial, and selective coding was used to explore the themes, which emerged from the interviews. The review of lesson plans was used to determine the amount of literacy practices being used in the classroom and triangulate the results with the perceptions of the teachers elicited from the other two

Qualtrics Questionnaire

The Qualtrics questionnaire study participants were asked to complete consisted of a total of 38 questions. The Qualtrics questions were grouped into four blocks: (a) informed consent and demographics, (b) experience level and training needs to use literacy practices, (c) use of instructional approaches related to literacy practices and (d) barriers to the use of literacy practices in my classroom. The first block of questions, numbered 1 through 7, informed potential participants about the study, required their consent and asked about their demographics. The next block represented experience level, confidence using literacy practices, and training needs; these were questions 8 through 37. The last question, number 38, allowed participants to volunteer to participate in the semistructured interviews and review of lesson plans. Results of the demographics are presented in the Sample Demographics section of this chapter. The questionnaire administered via Qualtrics consisted of the following questions (see Appendix B):

Question #8: Have you participated in training on literacy practices to teach in the (Grades 9–12) science classroom within the past two years? All 17 of the participants responded that they had received training on using literacy practices through professional development provided by the school system.

Question #9: How skilled do you consider yourself in implementing literacy into your pedagogical practices in the (Grades 9–12) science classroom? While responses ranged from novice to experience, there were two who selected novice and 12 of the participants identified as beginners, while only three considered themselves experienced.

Question #10: Prior to beginning the NGSS curriculum, to what degree did you use literacy practices? The study participants' answers clearly indicated a wide range of experience using literacy practices prior to this school year. Responses provided by the participants were varied, with eight sometimes (once or twice a month), seven selecting often (once or twice a week) and two reporting using literacy practices daily.

Question #11: How would you describe your confidence level using literacy practices in the (Grades 9–12) science classroom? The participants' confidence varied similar to their reported experience level prior to this school year. There were four participants who reported a low level of confidence, nine reported a moderate level of confidence and four reported a high level.

Question #12: Do you believe you are in need of additional professional development training in the area of implementing literacy practices in the (Grades 9–12) science classroom? The responses to this question are aligned with the responses asking about identifying as novice or experienced. There were 13 who reported that they are in need of professional development with two reported probably, one might not, or one definitely not.

Question #13: To what degree do you use literacy practices in your (Grades 9–12) science classroom this school year? The majority of participants, 15, identified as using literacy practices often (once, or twice a week) with only one selecting sometimes (once, or twice a month) and 1 daily. This is probably being influenced by the push in the school system where the study taking place.

Question #14: Prior to the school system implementing an NGSS curriculum, did you have students propose and answer and or make a prediction from a writing prompt, to explain their understanding of a concept such or real world phenomena? The answers were eight selecting rarely (a few times a year), six selecting sometimes (once, or twice a month), two reporting often and one reporting daily.

Question #15: In the current school year, how often do you have students propose and answer and or make a prediction from a writing prompt, to explain a real world phenomenon? 15 participants selected often (once or twice a week) and two identified with sometimes (once or twice a month).

Question #16: During previously school years, how often did you have students respond to a writing-prompt to assess their learning? There were eight of the participants reporting sometimes (once or twice a month), five rarely (a few times a year) and four often (once or twice a week).

Question #17: During this school year, how often did you have students respond to a writing-prompt to assess their learning? There were two participants responding rarely (a few times a year), one answered daily and 14 responded often (once or twice a week).

Question #18: During previous school years, how often did you have students write an observation and develop an explanation? There were 13 participants who selected rarely (a few times a year) and four sometimes (once or twice a month).

Question #19: During this school year, how often will you have students write about an observation and develop an explanation? There were 16 teachers reporting often and one reported daily.

Question #20: During previous school years, how often did you use mixed work sheet containing some questions where would write out responses to reinforce practices or content? In the responses, 14 participants reported never and three participants selected sometimes (once or twice a week).

Question #21: During this school year, how often did you use mixed work sheet containing some questions where the student will write out responses to reinforce practices or content? There were two selecting sometimes (once or twice a month) and 15 selected often (once or twice a week).

Question #22: Prior to the NGSS curriculum to what degree did you use direct instruction to explain science concepts? There was one participant selecting daily and 16 selected sometimes (once or twice a month).

Question #23: During this school year, how often did you use direct instruction to explain science concepts? All 17 of the participants responded that they rarely (a few times a year) used direct instruction any more.

Question #24: During previous school years, how often did you use vocabulary words before a lesson was taught? There were 16 participants who reported sometimes (once or twice a month) and one reported often (once or twice a week).

Question #25: During this school year, how often did you use vocabulary words before a lesson was taught? There were two who responded rarely (a few times a year), one answered sometimes (once, or twice a month), one responded daily, and 13 selected often (once or twice a week).

Question #26: During previously school years, how often did you have students explain science concepts to one another in groups? There was one respondent who selected often (once or twice a week) and 16 reported sometimes (once or twice a month).

Question #27: During this school year, how often did you plan to have student explain science concepts to one another in groups? There were two teachers who selected sometimes (once or twice a month), one selected daily, and 14 participants selected often (once or twice a week).

Question #28: How often do you use the county's NGSS school curriculum? There were eight of who responded as often (once or twice a week), six reporting sometimes (once, or twice a month), and one reporting daily.

Question #29: To what degree are you using science and engineering practices to teach science? The responses were nine reporting sometimes (once or twice a month) and seven reporting often (once, or twice a week) with one reporting daily.

Question #30: To what degree do you use evidence, and reasoning model to generate scientific explanations? The answers were split between nine reporting sometimes (once or twice a month) and eight reporting often (once or twice a week).

Start of Block: Barriers on the use of literacy practices in my classroom

Question #31: In terms of learning and implementing literacy practices, what is the level of support that you receive, or have received from the administration? There were three participants who reported a high level of support, 13 participants reported a medium level of support, and one reported a low level of support.

Question #32: In terms of learning and implementing literacy practices, what is the level of support from your Professional Learning Community? There was one participant who reported a high level of support, 11 reported medium, and five identified as receiving a low level of support.

Question #33: How is your access to appropriate instructional materials to teach using literacy practices? There were 100% of the participants selecting that materials are accessible to them.

Question #34: How would you characterize your level of understanding of literacy practices? There were four who reported a high level, 10 a medium level, and three reported a medium amount of support was needed.

Question #35: When using literacy practices, to what degree do you need to teach literacy skills to students? A majority of the participants perceived a need for them to teach literacy practices to students. A high level of support was reported by 15 of the participants and two reported that a medium amount of support was needed.

Question #36: Do you feel the need to have training specifically on literacy skills so that you can better support students? The majority of the participants reported as needing professional development. There were 14 of the teachers who reported that they perceive a need for additional training, one selected probably, one might not and one definitely not.

Question #37: How would you describe the professional development opportunities provided to you related to teaching students literacy skills? There were 14 teachers who selected the answer that they had not received enough professional development opportunities, compared to a three of participants who selected that they had received enough professional developing training in the use of literacy practices.

Interviews

Semistructured interviews were conducted to explore the perceptions participants have regarding adapting to literacy practices in the (Grades 9–12) science classroom. Additionally, through the interviews, I sought to gain rich descriptions, which are possible through purposeful selection. Due to varying availability of the participants, it took 2 weeks to complete all semistructured interviews. The semistructured interviews were recorded using a digital recording device. Each recording was transcribed on my home computer within 24 hours and e-mailed to the participant for their review and approval. As requested, all of the participants replied, and all confirmed that the transcription represented their answers accurately. Following the response from the participant that the interview was transcribed accurately, the recording was permanently deleted from the digital recording device.

Question #1: Describe your experience level with literacy practices in the (Grades 9–12) science classroom? Has it changed over the past three years? The participants of this study noted the NGSS curriculum and the school system requiring that they follow the new curriculum as a driver to their adapting to using literacy practices:

The response from Participant #3 was typical:

> I am becoming proficient with using literacy practices in teaching science as a result of the requirements of the NGSS curriculum and since we started using the new curriculum, I am increasing the use of literacy practices each year.

A representation of the reluctance to adopt literacy practices was expressed by Participant #5 who reported:

> I was very hesitant to adopt literacy practices until we were required to make the change. This school year it was mandatory to implement literacy practices into our teaching approaches and scaffolding.

An answer to the question that describes the level of change during this school year is given by the response of Participant #4:

> I stuck with the old worksheets as long as I could and only this year start following and using the new materials. Since it was a requirement this year, I was forced to adapt my materials to more of a literacy approach.

The recent training was mentioned as helpful and some noted an increase in using literacy practices:

> Participant #2 responded, the recent training has helped me recognize what literacy practices are and how they can be used. Participant #1 replied, I did reading on literacy practices, studied the school systems curriculum and consider myself moderately an expert.

Question #2: What are your perceptions of using literacy practice(s) in the (Grades 9–12) science classroom? Has this changed over time and if so, how? Participants displayed a growth in appreciation and understanding of literacy practices. The following passage from Participant #6 was typical:

> While I was skeptical initially, thinking literacy practices were too time consuming, I am both recognizing the different types of literacy practices, which can be used and the utility. It takes a lot of time to handout, collect, grade and return them, and they engage the students on the specific content being taught. Students find the activities useful for review. Overtime, I am finding more value in literacy practices.

All of the participants except one expected a negative result from using literacy practices. An example of the concern was expressed by Participant #2 who stated:

> I resisted literacy practices as long as I could. I did not realize that I was already using some of them. I find it time consuming to use literacy practices. What impacted me was feedback from my professional learning community and hearing from them about positive results.

During this school year their perceptions changed, and they now see them as valuable. Once they gained experience using literacy practices, they were reporting them as useful. An example from Participant #5 was stated in the following passage:

> My perceptions changed this year. I did not realize until this year how many effective that literacy practices can be used in teaching science. I was concerned that students would have poor literacy skills. Now, I realize students are taking English classes where they are writing well enough to also be able to do it in my science class.

Another good representative response was from Participant #4 as stated in the following:

> Learning more about the format that literacy practices take in the science classroom has made me understand their utility and value. I first thought literacy practices to be time consuming. There was no explanation of how they would be more effective. Simply saying they are central to NGSS practices was not enough. This year I am finding them very effective and routinely work them into my lesson plans.

Question #3: To what extent do you find literacy practices to be effective in terms of student engagement, and learning? Do you find differences in effectiveness? Participants reported positive results in terms of student learning when they starting using more literacy practices in the (Grades 9–12) science classroom. Typical of the responses was one from Participant #1 who responded:

> This year, students seem to be developing a better and more complete understanding of the content. Literacy practices are more effective than I originally expected. Students must engage in the learning process in order to complete literacy practices. I find the effectiveness of "big idea" unit summaries to be the least effective. Students have a tendency to cut and paste directly from the Internet on these activities. The most effective

> practices are short and easy to review and return to students for immediate feedback. These would include summaries, graphic organizers and writing in response to questions.

All of the participants responded similar as demonstrated by Participant #5:

> Literacy practices are more effective that traditional approaches. It is a holistic approach to learning. The students engage and as a result my test scores remained flat while those of other teachers increased. I changed to using literacy practices and had the improved results in higher-grade averages.

Participant #2 replied:

> I find literacy practices to be highly effective. Students are actively working when they are using a graphic organizer, or writing argumentatively. Placing the content into terms where the student must write, or communicate and answer clearly improves test results reflecting learning.

Participant #4 replied:

> This year I am seeing that literacy practices are highly effectives in terms of student learning and engagement. This year I am seeing the positive results reported by my PLC members.

Question #4: Do you have professional development needs using literacy practices? All of the participants identify as needing professional development in many areas of literacy practices. Needs ranged from training on how to prepare different activities to strategies for using literacy practices. While (Grades 9–12) science teachers are not literacy teachers, some participants expressed a need for training in teaching students literacy practices. Participant #8 gave the typical reply:

> I find it necessary to create many of the literacy practices myself. It would be helpful to have training on how to prepare different activities such as graphic organizers, argumentative writing and writing from reading texts, and interrupting graphs. Within my professional learning community, some teachers are behind in understanding and using literacy practices.

Participant #7 replied:

> We need training on how to teach literacy practices to students. There needs to be more of an understanding of where our students are in terms of literacy skills. As science teachers, we do not know students writing abilities.

Lesson Plan Review

Of the 17 participants who completed the Qualtrics questionnaire, there were nine who volunteered to participate in the semistructured interviews and a review of their lesson plans for one unit of study. The lesson plans were reviewed and checked using the lesson plan review document (see Appendix C). A checklist was used to check off the frequency of commonly used literacy practices. These included activators, or warm-up activities which use literacy practices, constructing scientific explanations based on an observation or article, summarizers requiring a literacy practice, graphic organizers, laboratory write up, or "big idea" unit summaries. Since the school system where the high school study site was located requires curriculum alignment through a professional learning community, the frequency of use in the lesson plans were the same for all of the teachers. A review of the lesson plans supported the responses for the current year in terms of the use of literacy practices in the (Grades 9–12) science classroom. Within each discipline, such as biology, chemistry, or physics, the teachers were following the same pedagogy in their lesson plans. Literacy practices were being used in the following formats and frequency: (a) activator, or warm-up, daily, (b) constructing scientific explanations, weekly, (c) summarizer, daily, (d) cause and effect graphic organizer, daily, (e) close reading (analyzing text), weekly, (f) laboratory write-up, weekly and (g) big idea unit summarizers, quarterly.

Table 1

Themes From Data Analysis

Research questions	How do teachers perceive the implementation of literacy practices in (Grades 9–12) science classrooms?	How do teachers in the (Grades 9–12) science classroom perceive professional development needs?
Themes determined from questionnaire	Proficiency Acceptance Effectiveness	Professional development
Themes determined from interviews	Proficiency Acceptance Effectiveness	Professional development

Summary

In Chapter 4, I provided an overview of this qualitative study of teachers' perceptions of using literacy practices in the (Grades 9–12) science classroom. Previous research on the implementation of literacy practices pointed to a lack of willingness and ability in the teachers being required to implement the change (Mitton-Kukner & Orr, 2018). Additionally, the lack of perceived experience resulted in a lack of confidence (Koomen et al., 2018). When teachers are in need of professional development, there needs to be an understanding of what teachers need for improvement in the context of the educational reform and pedagogy (Zhang et al., 2017).

Overall, it is difficult to determine the actual differences occurring in the implementation of literacy practices in the (Grades 9–12) science classroom. However, it is possible to use perceptions and observe trends that can be used to determine the need for and best approaches to developing professional development programs. The conceptual framework was developed to explain the reasoning behind and intentions of the educational reform measures to use literacy practices. Through this study, trends were collected from the data that is useful to school systems in supporting and designing professional development programs.

In this chapter, the demographics of the study sample are described as licensed teachers in (Grades 9–12) science classrooms in a school system and the science department of a single high school. The methodology I used in this study was described in this chapter, in addition to a discussion of the research instruments utilized in collecting the data and a description of the data analysis process. I provided a summary of the findings, which were used to answer the research questions: (a) how do teachers perceive the implementation of literacy practices in (Grades 9–12) science classrooms, (b) what is the experience level of teachers' use of literacy practices in the (Grades 9–12) science classroom, has it changed during this school year, and are there professional development needs, and how do teachers perceive the effects of literacy practices on student learning? In order to answer the research questions, I conducted a review of the Qualtrics questionnaire, performed analysis and coding on the semistructured interview questions, and triangulated the results with a review of the lesson plans.

The Qualtrics questionnaire consisted of 38 scaling questions, which participants completed through a link provided by e-mail and the data was collected using Qualtrics software. Responses to the first block of questions, informed consent and demographics, were used to complete the description of sample. The next group of questions focused on experience level and training needs to use literacy practices. While all reported receiving training, roughly 50% characterized their skill level to be at the beginner level, have a moderate level of confidence and all reported to be in need of further training. The next block of questions addressed the use of instructional approaches related to literacy practices. Questions asked about the use of literacy practices this year compared to last year. The questions asked about different types of literacy practices to not only determine if there was an increased use, but across a range of practices. The responses for last school year were rarely to sometime and this year almost all selected often. Participants were asked about the amount of direct instruction during this year compared to previous years. The responses reflected a change from sometimes using direct instruction to rarely. The final group of questions asked about barriers to the use of literacy practices, and focused on support, accessibility of materials and teaching literacy skills to students. All but one participant reported a high level of support from the administration and access to materials. All reported a high level of support from their teaching team. Still, all reported not receiving enough training and specifically training in how to teach literacy practices to students.

Responses to the questions indicated that while all of the participants received training, they started out without much experience or confidence with using literacy practices. The data from the study shows that during this school year there is an increase in experience and confidence level. Most study participants also reported a need for additional professional development training in literacy practices.

The interviews conducted with the study participants were semistructured with open-ended questions. This allowed the interviewee to share their perceptions in depth, allowing for freedom of expression. During the interviews, participants were asked a series of four questions designed to explore the perceptions they have on literacy practices in the (Grades 9–12) science classroom pedagogy. Three of the four questions had two parts, so the participant could discuss if there had been a change this school year compared to last year. Responses to the interview questions confirmed what had been reported in the Qualtrics questionnaire and expanded the context through the freedom to use their own words in answering the questions. This is observed in the themes, which emerged through coding of the interviews. The emerging themes of proficiency, acceptance, effectiveness and professional development align with, but are more specific, than the trends from the questionnaire. In the interviews the participants were able to discuss how they initially were concerned about using literacy practices, but as they used them recognized the value in improved student learning. During the first half of the school year they increased confidence in their ability to use literacy practices as them more. In addition, they became more proficient. In their classrooms and in their professional learning communities, the teachers and their peers observed improvements in student learning. In terms of professional development, the participants identified training needs in developing and using literacy practices and strategies on how to teach literacy skills to their students.

The review of lesson plans was intended for triangulation of the data collected. Reviewing the lesson plans was an approach to confirm the frequency of literacy practices being used in the (Grades 9–12) science classroom. During the review of lesson plans, it was observed that all of the teachers were using the same literacy practices at the same frequency. The participants reported that their school system had recommended specific literacy practices and a suggestion for frequency of use. This high school was following the school system’s suggestion. While there was variation in how and when each teacher used the strategy, they planned everything out as professional learning communities.

The findings indicated that teachers in the (Grades 9–12) science classroom have increased their use of literacy practices during this school year as a result of the requirements placed on them by the school system. During this school year, the teachers have become more proficient using literacy practices, are more accepting of them, and find them effective in enhancing student learning, but teachers still need professional development training. In Chapter 5, I discuss the findings of this study in detail, in addition to discussing the results and how they relate to the current literature. I also outline the limitations of this study, as well as the implications of the results for transformation, including implications on policy, practice, and theory. I conclude Chapter 5 with recommendations for further research.

Chapter 5: Discussion and Conclusion

The need to understand perceptions of teachers implementing literacy practices in the (Grades 9–12) science classroom is well documented (Drew et al., 2017; Drew & Thomas, 2018; Gillis, 2014; Mitton-Kukner & Orr, 2018; Roth et al., 2019; Wexler et al., 2017). School systems recently adopted educational reform measures, which have changed the expected pedagogical approaches for teachers in (Grades 9–12) science classrooms (Nelson & Allen, 2017). The CCSS and NGSS require the use of literacy practices in science classrooms and were adopted to address both low scores in science and poor literacy skills (Drew & Thomas, 2018; Goldman et al., 2016; Wexler et al., 2017).

Using purposeful selection, a study site was selected where the school system is requiring the use of literacy practices by teachers in the (Grades 9–12) science classroom. A science department at one high school was identified by the school system as the study site based on my request to conduct research within the district according to defined study parameters. Three research instruments were used: a Qualtrics questionnaire, semistructured interviews and a review of lesson plans. All 19 teachers in the science department received a Qualtrics questionnaire through their school e-mail. After receiving the e-mail, 17 participants volunteered to complete the questionnaire and 9 of the participants volunteered to participate in a semistructure interview and a review of their lesson plans. All 17 of the participants completed the entire questionnaire. Purposeful selection was used because I wished to focus on a group of teachers who were sharing a common experience. Data were collected through the three research instruments. Common themes of the study were identified through a comprehensive data analysis process.

The results of this study may provide information that is supportive of an investment in teacher professional development and details about the design to meet the needs of teachers in the (Grades 9–12) science classroom. In this chapter, I describe a summary of the results of the data collected in this study and outline significant elements identified in the research. Additionally, I provide my interpretation of these results, in relation to the participants' descriptions of their experiences. Furthermore, I outline the limitations of this study and the implications of the results for transformation, specifically discussing the implication on policy, practice, and theory. Lastly, I conclude Chapter 5 with recommendations for further research.

Summary of the Results

There has been a lack of understanding about what teachers need for improvement in the context of educational reforms (Zhang et al., 2017). Additionally, the literature reports that teachers in the (Grades 9–12) science classroom do not currently have the willingness, abilities and confidence to use literacy practices in their pedagogy (Koomen et al., 2018; Mitton-Kukner & Orr, 2018). As a result, teachers are hesitant to introduce the change in their classroom instruction (Gillis, 2014). How public school teachers can effectively implement literacy practices into the pedagogy of the (Grades 9–12) science classroom is not well known.

The findings of this qualitative study were revealed through a hermeneutic, phenomenological approach used to explore the perceptions of teachers in the (Grades 9–12) science classroom adapting to literacy practices in the pedagogy. Procedures for data collection and analysis were used to extract meaning from the study participants' perceptions of integrating literacy practices into the pedagogy of the (Grades 9–12) science classroom. The three research instruments used in the study were a Qualtrics questionnaire, semistructured interviews, and a review of lesson plans. As directed by the school systems research committee, the school e-mail was used and all teachers in (Grades 9–12) science classrooms at the study site received a recruitment letter with a link to take a Qualtrics questionnaire. Of the 19 who received the questionnaire, 17 participated by taking the questionnaire, and nine volunteered to participate in semistructured interviews and a review of lesson plans. All of the data from the three research instruments are aligned with the central research questions. Through data analysis, common themes were identified from the Qualtrics questionnaire, from coding of the semistructured interviews and the review of lesson plans.

Qualtrics Questionnaire

The Qualtrics questionnaire (see Appendix A) contained 38 scaling questions segmented into four blocks. The first 8 questions related to informed consent and demographics, the next 30 questions probed the perceptions of the participants. The final question provided contact with me to volunteer for further participation in the semistructured interview and a review of lesson plans. The invitation to participate in the Qualtrics questionnaire was sent by school e-mail to the entire science department, which included 19 teachers. There were 17 of the 19 teachers who participated and completed answers to all of the questions. Of the 17 participates completing the questionnaire, nine also volunteered to participate in the semistructured interviews and a review of their lesson plans. There were eight other Qualtrics survey participants who, while completing the survey, did not volunteer for the semistructured interview and review of lesson plans.

Following collecting demographics of the participants, the data from the Qualtrics questionnaire (see Appendix A) were grouped into important areas, which are asked in the research questions: (a) prior use of literacy practices, (b) this year’s use of literacy practices, (c) confidence, skill level, need for professional development and support, and (d) barriers to using literacy practices. Responses to the questionnaire clearly indicate an increase in the use of literacy practices during this over the previous year. While confidence and skill levels using literacy practices have grown during this school year, the participants expressed a need for more professional development and support to better prepare them for creating and using literacy practices in the science classroom.

Semistructured Interviews

Four themes emerged from coding of the semistructured interviews. The emerging themes were: (a) proficiency, (b) acceptance, (c) effectiveness and (d) professional development.

Theme 1: Proficiency. The first semistructured interview question focused on participant's experience level with literacy practices in the (Grades 9–12) science classroom. The purpose of this question was to gauge teachers' perception of their experience implementing literacy practices into their pedagogy. Participants #1, #6, and #8 considered themselves to be proficient; #1 stated, "Becoming proficient, since we starting using the new curriculum, I am increasing the use of literacy practices each year." The perceptions of Participants #2 and #4 answered as beginners and recently bought into the practices; the response of Participant #4 was, "I had postponed thinking about literacy practices until this year, entry level." One respondent, Participant #6, conveyed, "Experienced, struggle with teaching literacy skills to students." The possible reason for the participants' answers suggests that making a commitment to learning to integrate literacy practices is key to becoming proficient. This may be best shown in the response of the answer by Participant #9; they answered, "Last year novice, this year expert level."

Theme 2: Acceptance. Another question asked during the semistructured interviews centered on the participant's perception of using literacy practices and how it has changed over time. The question was designed to see if teachers changed their opinions about literacy practices as they used them more in the classroom. Participants #1, #2, #4, and #5 provided answers conveying resistance and a lack of confidence, which changed with practice; #2 stated "Resisted literacy practices; Time consuming to use literacy practices; impacted by feedback from my PLC and hearing about positive results." Participant #3 always had confidence in literacy practices, as conveyed by the statement, "expected them to be useful and find that to be true; opinion has not changed." There was a concern expressed by Participant #4: "concerned students would have poor literacy skills; realize students are taking English classes where they are writing well enough to also be able to do it in my science class."

Theme 3: Effectiveness. Another question asked during the interview focused on the participant's perceptions of the effectiveness of literacy practices and differences. The purpose of this semistructured interview question was to determine if teachers were finding literacy to be more or less effective compared to traditional approaches. All of the participants believed that literacy practices are highly effective. Participant #1 expressed the typical response, "students seem to develop a better and more complete understanding of content; literacy practices are more effective than originally expected; students must engage in the learning process in order to complete literacy practices." This is further supported by Participant #2; "literacy practices are more effective than traditional approaches; changed to using literacy practices; improved results of higher-grade averages."

Theme 4: Professional development. The final question asked during the semistructured interviews focused on teachers' perceptions regarding professional development needs. The purpose of this interview question was to determine teacher perception of professional development needs in creating and using literacy practices. Participant #1 suggested, "within my professional learning community, some teachers are behind in understanding and using literacy practices; they need training." Participants #8 and #9 stated that they need specific training on scaffolding with literacy practices. Participant #8 stated, “I would like to learn more about scaffolding with literacy practices and modifications for students who require more support.” Participant #9 stated, “I could benefit from training on creating literacy practices specifically on how to scaffold a lesson sequence.”

Perceptions of the use of literacy practices in the (Grades 9–12) science classroom changed through the first half of this school year. Confidence in and the use of literacy practices increased as reported by the participants. Participants report observing positive results in student learning. Additionally, participants perceive a need for additional professional development.

Discussion of the Results

The research explored the perceptions of teachers in the (Grades 9–12) science classroom. Careful analysis of the data collected resulted in identifying four overall themes. These themes represent the perceptions of this purposefully selected population. There is no relative order of these themes, so they are discussed in the order in which they appeared in the research instruments. The four themes were teachers becoming proficient in using literacy practices, teacher acceptance of literacy practices, and perceived effectiveness of literacy practices on student learning and the need and desire for professional development.

The study instruments started with questions probing into the frequency literacy practices were used this year compared to last year. Participants reported gaining experience during this school year. This correlates with the school system requiring science teachers to increase their use of literacy practices. One participant even reported, “last year a novice, this year an expert.”

The theme of becoming more proficient at using literacy practices goes along with the theme of acceptance. Using questions designed to determine if the perception of participants changed, they reported starting out questioning the value of literacy practices. Literacy practices were initially perceived as time consuming compared to the value they would offer. As participants gained more experience using literacy practices, they were more accepting of the value in using them in the classroom.

The perception that literacy practices are effective in student learning was a theme that was said to have changed over time. Participants described discussions in teaching teams regarding the use of literacy practices and being motivated by feedback from their peers. In the questionnaire and interviews, participants reported observing improved student learning. Some participants reported that incorporating literacy practices into their pedagogy was highly effective. These themes reiterated the idea that teachers may lack the willingness, abilities and confidence until it is demonstrated to them regarding the implementation of something new such as literacy practices (Koomen et al., 2018; Mitton-Kukner & Orr, 2018).

Proficiency

A classroom teacher's proficiency, or ability to create, incorporate into lesson plans and implement in a teaching environment, is influenced by training, including professional development for current teachers and experience putting it into practice (Ippolito et al., 2018). While responses in to the questionnaire ranged from novice to experience, slightly more than half of the participants identified as beginners, with only two considering themselves to be experienced. During the interviews, participants noted the NGSS curriculum as a driver to their adapting to using literacy practices. Recent training was mentioned as helpful and some noted the increase in using literacy practices as helping develop their skill level. This conveys that there has been a change in recent years due to requirements place upon the teachers.

Acceptance

To implement a change in the expectations placed on classroom teachers, an understanding of why and how it can improve outcomes is needed. Findings support the current research that teachers in the (Grades 9–12) science classroom need to be willing to make the change and have the abilities to implement new requirements (Mitton-Kukner & Orr, 2018). They also need to have confidence that the change is useful (Koomen et al., 2016). Some of the answers in the interviews reflect that prior to using them, teachers lacked an understanding of why literacy practices should to be used. The only reason they were using them was in response to being required. One consistency in the different forms of data collection was growing acceptance this year of the use of literacy practices. In the questionnaire, slightly more than 50% reported a moderate level of confidence. One reported a high level and two reported low level of confidence. In the interviews, participants displayed a growth in appreciation and understanding of literacy practices. All of the participants except one expected a negative result from using literacy practices. During this school year, their perceptions changed. Once they gained experience using literacy practices, they were reporting them as useful.

Effectiveness

An important aspect of this research is to determine if teachers perceive their effort to use literacy practices to be benefiting student learning and retention. In the interviews, participants reported positive results in terms of student learning when more literacy practices were used. They reported holistic learning through the use of literacy practices. Some participants reported an increase in students' scores.

Professional Development

All of the participants responded that they had received training on using literacy practices through professional development provided by the school system. The majority reported that they are in need of professional development, with few reporting probably, might not, or definitely not. All of the participants identify as needing professional development in many areas of literacy practices. Needs ranged from training on how to prepare different activities to strategies for using literacy practices. While (Grades 9–12) science teachers are not literacy teachers, some participants expressed a need for training in teaching students literacy practices. All but one respondent, who reported a low level of support, reported that they had received a high level of support in terms of materials and professional development.

Discussion of the Results in Relation to the Literature

In this study, the participants were all teachers in the (Grades 9–12) science classroom. Historically, teachers in (Grades 9–12) science classrooms have not received training on using literacy and teaching literacy skills and are therefore reluctant using and teaching them (Drew & Jeffrey, 2018). Authors suggested that there are unanswered questions to develop needed and effective professional development programs to train science teachers in literacy practices (Drew & Thomas, 2017; Gillis, 2014; Wexler et al., 2017). Additionally, a lack of willingness and abilities to use literacy practices has been reported (Mitton-Kukner & Orr, 2018). Developing a better understanding of science teachers' perceptions of using literacy practices and supporting students in developing literacy skills is critical to design and develop professional development programs that match the specific needs of the teachers (Lee, 2017). School systems utilize professional development to educate teachers on educational reform measures, so that they can understand and meet new standards in strategies, curriculum, and assessment (Zhang et al., 2017).

The conceptual framework for this study centered on common themes within the theories of Piaget, Vygotsky, and Marzano. Their theories connect with the use of literacy practices to teaching in the (Grades 9–12) science classroom. Classroom practices consisting of science and reading are both interactive-constructive processes where the learner makes connections between prior knowledge and new learning (Wallace & Coffey, 2016). Piaget proposed learning through experiences; Vygotsky saw value in peer collaborations using speech to improve learning; and Marzano proposed the learner benefits from interacting with knowledge and using simulations to make connections; all of these connect within many literacy practices. Furthermore, in the review of literature I identified themes that permeate through the current body of literature, including: (a) proficiency, (b) acceptance, (c) effectiveness and (d) professional development. These themes emerged in the perceptions of teachers in the (Grades 9–12) science classroom.

Limitations

The researcher recognizes the limitations of using a purposive, homogenous sampling method and a single case study design. Nonprobability methods have limitations, but it can be useful when the population is large (Etikan, Musa, & Alkassium, 2016, p. 4, Yin, 2009). The sample in this study consisted of teachers in the (Grades 9–12) science classroom. All of this population was impacted by implementation of the CCSS and the NGSS. Primary limitations in phenomenological research can be the research instrument(s) and small sample sizes. To address the limitations of a small amount of data, Creswell (2013) suggests that the population be purposefully selected from individuals sharing a common experience of a phenomenon. Teachers sharing the experience of adapting to the requirements of using more literacy practices to teach in the (Grades 9–12) science classroom were chosen. Additionally, they are all in the same school system and same high school. There were 17 participants and nine in the semistructured interviews. This small sample size for the semistructured interviews allowed for the collection of rich descriptions of their perceptions of the experiences.

The honesty and wiliness to provide detailed information by the participant can be a limitation. To support participants' honesty and full participation, I assured confidentiality of their identity. Within 3 days of the semistructured interviews being completed, participants received a typed copy of their transcript and offered an opportunity to make edits.

The use of a single site to perform the study is limiting. This study explored the experiences of teachers in the (Grades 9–12) science classroom of one science department at a single high school. The study did not include data collected from (Grades 9–12) science classrooms at other schools. Limitations are associated with a small sample size.

As the primary researcher, my personal background as a teacher in a (Grades 9–12) science classroom could be considered a limitation. I have personal experience adapting to the requirements related to integrating literacy practices into my classroom pedagogy. To limit potential bias and maintain confirmability, my personal experiences and thoughts were not communicated. To preserve objectivity, my role as the researcher was to be an active listener to the participants and focus on their experiences and not mine.

Implications of the Results for Transformation

The results of this hermeneutic, phenomenological study can guide decisions regarding the implementation of literacy practices, as well as contribute to the literature concerning the use of literacy practices in the (Grades 9–12) science classroom. This section presents the relationship of the findings of this study to the potential implications on policy, practice and theory. The implications are presented with the assumption that a school system is introducing requirements for their (Grades 9–12) science teachers to use literacy practices.

Implications on Policy

Improving student learning and literacy skills in (Grades 9–12) science classrooms is a focus for public school administration, but how to do so in an optimal manner is a conundrum. School systems are in a situation where science teachers do not understand the reasoning behind, or the value in making the change (Nelson & Allen, 2017). Without justification for the change, teachers may not have the willingness and therefore are not developing the abilities that they need in the classroom (Koomen et al., 2018; Mitton-Kuker & Orr, 2018). The implementation of any new policy can be challenging. In terms of this study, teachers in the (Grades 9–12) science classroom find themselves reacting to policy change. The participants in the study are increasing their use of literacy practices because it is required by the school system. They are integrating literacy practices into their pedagogy based on policy change. Their situation arises from school systems adopting the CCSS and NGSS without completely addressing the need for the teachers to add their buy in to the change.

When a policy change shifts the way students are engaged in the classroom, there is a high impact on the classroom teacher. To persuade a group of classroom teachers to implement such a major change in their pedagogy, something is needed to justify the changes. Data collected in this study illustrate a growth in the use of all literacy practices required by the school system. The teachers are implementing the change largely because they are being told that they must. Making a change under pressure, without agreeing with it is not ideal. One facet of the result of this study, the perception that student learning improved when using literacy practices, is an example of information that can be used by the administration to gain acceptance for the change with the classroom teacher.

Implications on Practice

Integrating literacy practices into the pedagogy of teaching in the (Grades 9–12) science classroom is a focus of public school systems (Kaldenberg et al., 2015; Wexler et al., 2017). This impact on the classroom is a change or a shift in the way students become engaged by the classroom teacher (Drew & Thomas, 2018). To accomplish this, the classroom teacher must modify their scaffolding of lesson plans. In addition, the use of literacy practices may require that some students be taught literacy skills in their science class.

Data collected from this study indicates an increase in the use of literacy practices since being required to by their school system. The results of the study also illustrated that the confidence level of the teachers increased this year and that they observed improved learning in their students. Some of the participants mentioned the resistance to the change and the perception was a lack of understanding why they were being required to change their pedagogy. This is valuable information for school administrators. School administrators can use the perceptions of teachers in the (Grades 9–12) science classroom to understand their needs for justifying the change and professional development.

Data was collected on the use of literacy practices during this school year compared to last school year. Participants in this study noted a growing comfort level and increased confidence level this year as they used literacy practices. Participants also noted improved student learning and the elimination of some concerns such as needing to teach literacy skills to students. To combat teacher misconceptions of using literacy practices to teach science, teachers need training and exposure to data, such as what is in this study. Proactively providing this exposure as early as possible in the process might facilitate the change and reduce initial skepticism and unwillingness.

Role of the administration. The administration would provide an explanation, preferably using data, to illustrate the reason for and value of using literacy practices in the (Grades 9–12) science classroom (Ippolito et al., 2018). The use of literacy practices would be incorporated into the expectations placed on the classroom teacher that the administrators would expect to see during classroom observations. The administrators would provide feedback and guidance to the classroom teacher and help them develop the necessary skills to successfully use literacy practices.

Role of staff development. Traditionally, school systems have specific school improvement plans including those for the teachers. The staff development teachers create professional development programs to train teachers to deliver what the administrator is looking for in the classroom. If the administration created an expectation of teachers using literacy practices in the (Grades 9–12) science classroom, the staff development teacher would create and implement professional development.

Role of the classroom teacher. Classroom teachers would be expected to participate in training and learn how to create and use literacy practices in the (Grades 9–12) science classroom. This would include how to scaffold the learning with literacy practices. Regular participating in the training sessions, practicing in the classroom and working to optimize the new pedagogy would be expected. The CCSS literacy component and the NGSS practices, propose the teaching of content area subjects through literacy, which promotes metacognitive decision-making and requires specific teacher education programs such as professional development (Griffith et al., 2016; Kamil, 2016).

Implications on Theory

This hermeneutic, phenomenological study was constructed using the work of multiple theorists: Piaget (1965), Vygotsky (1978) and Marano (1988). With his cognitive development theory, Piaget (1965) proposed students learn by doing, such as writing, presentations and discussions with teachers and peers. In the zone of proximal development theory, Vygotsky (1978) connected cognitive learning with the distance between prior knowledge and what is being taught. By applying his theories, Marzano (1988) developed many literacy related practices with make connections with the theories of Piaget and Vygotsky.

A population of teachers currently being required was the sample population in order to gain their perceptions of experiencing a change in requirements on their pedagogy. The majority of the participants were reluctant to use literacy practices. The use of all types of literacy practices increased during this school year because they were being required by the school system. The adoption of literacy practices was illustrated in the questionnaire and confirmed in the interviews. The increase in use of literacy practices was associated with a perception that their proficiency using literacy practices and confidence level increased. The study results indicate participants began to accept and see the literacy practices as being effective in promoting student learning. In the interviews, participants reported being motivated by the positive results discussed in their teaching teams. Responses to the questionnaires indicated that their experience level increased during this school year only because they were being required to implement literacy practices. The interviews yielded the same factor, an increase in use due to the requirement.

This present study focused on perceptions of teachers in the (Grades 9–12) science classroom adapting to integrating literacy into their pedagogy. This is a result of the adopting of the CCSS and the NGSS by school systems requiring the literacy practices in science pedagogy

(Drew & Thomas, 2018; Morabito, 2017; Wallace & Coffey, 2016). The literature highlighted that the new reform measures were designed to address poor student literacy skills and the low scores in science courses (Kaldenberg et al., 2015; Wexler et al., 2017). The results of this current study highlight that teachers perceive their students learning better through literacy practices. It was a contention of Wallace and Coffey (2016) that literacy practices help students learn in a holistic manner. This would support both the CCSS use of literacy practices to support learning content subjects (Morabito, 2017) and the NGSS promoting them as being central to teaching science (Mitton-Kukner & Orr, 2018; Wallace & Coffey, 2016).

Measures, such as professional development needs in literacy practices for teachers were highlighted in the literature as being needed. It has been reported that teachers in the (Grades 9–12) science classrooms do not typically receive training, or have personal experience in literacy practices, or even have an awareness of the value of using literacy practices (Siebert et al., 2016). The present study points to an increased comfort level using literacy practices and a growing perception that they are effective in terms of student learning when teachers were asked about this year, compared to last year. This indicated a potential need for professional development and that it could bring promising results.

Recommendations for Further Research

During this study a number of ideas emerged regarding unanswered questions that could be pursued in future research. The first recommendation is that more information is needed to confirm how much literacy practices are being used in the (Grades 9–12) classroom. A qualitative study using observations as a research instrument could accurately confirm that teachers are using literacy practices to the degree reported in the questionnaire, interviews and document review. Using observations of the classroom as a research instrument could also be used to explore the techniques and specific types of literacy practices being used by the classroom teachers. The first part of the data collected from this project would be more convincing and persuasive than a review of lesson plans. The second part of the data could be very useful in developing professional development training.

For this specific study, there are two further research projects that would provide a greater understanding of teachers' perceptions of literacy practices in the (Grades 9–12) science classroom. The first project would be similar to this hermeneutic, phenomenological study. There were statements by the participants on the topic of their desire to receive justification prior to the changes to their pedagogy. Zang (2015) proposed, "there is a lack of understanding about what teachers need for improvement in the context of educational reforms and curriculum changes." A study of how teachers perceived the implementation of the educational reforms would be valuable in developing professional development programs when future educational reforms are being implemented.

The second research project would to determine if being an English as a second language (ESL), or English as a foreign language (EFL) learner impacts the use of literacy practices in the (Grades 9–12) science classroom in terms of student learning. The study was performed at a school that has a large ESL and EFL program for their students. There would be value in finding out if there were a variation in perceptions and specific needs associated for ESL and EFL students. A study for this would require a sample population from more than one school.

Conclusion

The purpose of this hermeneutic, phenomenological study was to explore how teachers perceive the implementation of literacy practices in (Grades 9–12) science classrooms. The participants answered a Qualtrics questionnaire, provided vivid descriptions to open-ended questions in semistructured interviews and agreed to a review of their lesson plans. By sharing their perceptions, the participants of this study provided valuable insights into factors related to their adapting to literacy practices in their pedagogy. Data was collected which answers the research questions:

1. How do teachers perceive the implementation of literacy practices in (Grades 9–12) science classrooms?
2. What is the experience level of teachers' use of literacy practices in the (Grades 9–12) science classroom has it changed during this school year, and are there professional development needs?

Four themes emerged from coding of the Qualtrics questionnaire and semistructured interviews. The emergent themes were: (a) proficiency, (b) acceptance, (c) effectiveness, and (d) professional development.

The findings of this study showed an increased use of literacy practices this year over last year. The degree of confidence using literacy practices increased. There was an emergence of considering literacy practices being effective in student learning. This was true for all types of literacy practices. Through coding, the theme of proficiency emerged associated with use of and confidence associated with literacy practice.

This study showed that as the teachers implemented the change during the school year that they began to accept the requirement of using literacy practices. Indications of the study point to an administration that did not have a group of teachers willing to make the change to using literacy practices. Teachers were only using them because the school system was requiring the change. As a result, the teachers started the school year lacking wiliness, abilities and confidence, as has been previously reported in the literature by other studies (Koomen et al., 2018; Mitton-Kukner & Orr, 2018). This study showed through use of literacy practices, gaining confidence, and starting to become proficient that the theme of acceptance emerged. Acceptance of literacy practices as an approach to teaching in the (Grades 9–12) science classroom was an important outcome of this study.

Participants in this study reported literacy practices as effective in teaching in the (Grades 9–12) science classroom. Some participants reported successful results in terms of test results being shared in their teaching teams and motivating them to use literacy practices. Since the ultimate desired outcome is improved student learning, it is very important that effectiveness emerged as a theme of this study.

All of the participants reported that they had received training in literacy prior to this school year through professional development required for all teachers in the (Grades 9–12) science classroom. Even with the professional development experience, the teachers began the year viewing their experience, skills and confidence as lacking. The study showed that during this school year, teachers gained experience, there confidence was evaluated, but they all report needing more professional development, and this emerged as a theme of the study.

The findings of this study are expected to add to the current literature on the perceptions of teachers in the (Grades 9–12) science classroom integrating literacy practices into their pedagogy. These findings provide valuable information on how the teachers are adjusting in terms of accepting and implementing the pedagogy and developing appropriate training. Future efforts taken to better understand literacy practices pedagogical impact in the (Grades 9–12) science classroom and practice as a result of this research may help develop improved professional development programs.

References

Akben, N., & Köseoglu, F. (2015). Inquiry-based learning and 5E model in laboratory practices: A professional development program for prospective classroom teachers *. *Egitim Bilimleri Fakultesi Dergisi, 48*(1), 161–197. Retrieved from http://search.proquest.com/docview/1787752026/

Allington, R. L., McCuiston, K., & Billen, M. (2015). What research says about text complexity and learning to read. *The Reading Teacher, 68*(7), 491–501. https://doi.org/10.1002/trtr.1280

Allison, E., & Goldston, M. J. (2018). Modern scientific literacy: A case study of multiliteracies and scientific practices in a fifth grade classroom. *Journal of Science Education and Technology, 27*(3), 270–283. https://doi.org/10.1007/s10956-017-9723

Balgopal, M. M., Wallace, A. M., & Dahlberg, S. (2017). Writing from different cultural contexts: How college students frame an environmental SSI through written arguments. *Journal of Research in Science Teaching, 54*(2), 195–218. https://doi.org/10.1002/tea.21342

Bowman, L. L., Jr, & Govett, A. L. (2015). Becoming the change: A critical evaluation of the changing face of life science, as reflected in the NGSS. *Science Educator, 24*(1), 51–61.

Bybee, R. W., & National Science Teachers Association. (2010). *The teaching of science: 21st Century Perspectives*. Arlington, VA: National Science Teachers Association Press.

Bybee, R. W. (*2011*). *Scientific and engineering practices in K–12 classrooms: Understanding a framework for K–12 science education. The Science Teacher, 78*(9), 34–40.

Bybee, R. W. (2013). *Translating the NGSS for classroom instruction*. Arlington, VA: National Science Teachers Association Press.

Bybee, R. W. (2014). NGSS and the next generation of science teachers. *Journal of Science Teacher Education*, *25*(2), 211–221. doi:http://dx.doi.org.cupdx.idm.oclc.org/10.1007/s10972-014-9381-4

Bybee, R. W. (2015). *The BSCE 5E Instructional Model: Creating Teachable Moments*. Arlington, VA: National Science Teachers Association Press.

Buchanan, S., Harlan, M., Bruce, C., & Edwards, S. (2016). Inquiry based learning models, information literacy, and student engagement: A literature review. *School Libraries Worldwide*, *22*(2), 23–39. https://doi.org/10.14265.22.2.03

Creswell, J. W. (2008). *Research design: Qualitative, quantitative, and mixed methods approaches: Quantitative, and mixed methods approaches*. Thousand Oaks, CA: SAGE.

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among the five approaches.* Thousand Oaks, CA: SAGE.

Creswell, J. W., & Poth, C. N. (2017). *Qualitative inquiry & research design: Choosing among five approaches* (4th ed.). Thousand Oaks, CA: SAGE.

Davis, A. (2018). Evidence-based approaches to education: Direct instruction, anyone? *Management in Education*, *32*(3), 135–138. https://doi.org/10.1177/0892020618765421

Drew, S., & Thomas, V. (2018). Secondary science teachers' implementation of CCSS and NGSS literacy practices: a survey study. *Reading and Writing*, *31*(2), 267–291. https://doi.org/10.1007/s11145-017-9784-7

Drew, S. V., Olinghouse, N. G., Faggella-Luby, M., & Welsh, M. E. (2017). Framework for disciplinary writing in science grades 6–12: A national survey. *Journal of Educational Psychology*, *109*(7), 935–955. https://doi.org/10.1037/edu0000186

Elkind, D. (1979). *The child and society: Essays in applied child development*. New York, NY: Oxford University Press.

Elkind, D. (1972). Piaget and Science Education. *Science and Children, 10*(3), 9–12.

Emig, J. (1977). Writing as a mode of learning. *College Composition and Communication, 28*, 122–128.

Enfield, M. (2014). Reading scientifically: Practices supporting intertextual reading using science knowledge. *Journal of Science Teacher Education, 25*(4), 395–412.

Etikan, I., Musa, S., & Alkassium, R. (2016). Comparison of convenience and purposive sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1–4.

Fisher, D., & Frey, N. (2018). Using questions to drive content area learning: Revising old favorites. *Reading Teacher*, *72*(3), 406–411.

Fives, H., Huebner, W., Birnbaum, A. S., & Nicolich, M. (2014). Developing a Measure of Scientific Literacy for Middle School Students. *Science Education*, *98*(4), 549–580. https://doi.org/10.1002/sce.21115

Fulton, L. (2017). Science notebooks as learning tools: Lessons from a multi-year professional study group offer insights on getting the most out of science notebooks. *Science and Children*, *54*(6), 80–85.

Gillespie, A., Graham, S., Kiuhara, S., & Hebert, M. (2014). High school teachers' use of writing to support students' learning: A national survey. *Reading and Writing, 27,* 1043–1072.

Gillis, V. (2014). Disciplinary literacy. *Journal of Adolescent & Adult Literacy*, *57*(8), 614–623. https://doi.org/10.1002/jaal.301

Goldman, S., Britt, A., Brown, W., Cribb, G., Marianne, G., Greenleaf, C., Lee, C., & Shanahan, C. (2016). Disciplinary Literacies and Learning to Read for Understanding: A Conceptual

Framework for Disciplinary Literacy. *Educational Psychologist*, *51*(2), 219–246. https://doi.org/10.1080/00461520.2016.1168741

Griffith, R., Bauml, M., & Quebec-Fuentes, S. (2016). Promoting metacognitive decision-making in teacher education. *Theory Into Practice*, *55*(3), 242–249. https://doi.org/10.1080/00405841.2016.1173997

Hand, B., Norton-Meier, L. A., Gunel, M., & Akkus, R. (2015). Aligning teaching to learning: A 3-year study examining the embedding of language and argumentation into elementary science classrooms. *International Journal of Science and Mathematics Education*, *14*(5), 847–863. https://doi.org/10.1007/s10763-015-9622-9

Johnson, R. B., & Christensen, L. B. (2017). *Educational research: Quantitative, Qualitative, and Mixed approaches 4th edition*. Thousand Oaks, CS: SAGE.

Husserl, E. (1952/1980). Phenomenology and the foundations of the sciences. Boston: Martinus Hijhoff Publishers. (Original work published 1952.)

Kaldenberg, E., Watt, S., & Therrien, W. (2015). Reading instruction in science for students with learning disabilities: A meta-analysis. *Learning Disability Quarterly, 38*(3), 160–173. https://doi.org/10.1177/0731948714550204

Kamil, M. L. (2016). Common core state standards and adaptive teaching. *Theory Into Practice: Adaptive Teaching: Theoretical Implications for Practice, 55*(3), 234–241. https://doi.org/10.1080/00405841.2016.1173991

Koomen, M., Weaver, S., Blair, R., & Oberhausuer, K. (2016). Disciplinary literacy in the science classroom; Using adaptive primary literature. *Journal of Research in Science Teaching, 53*(6), 847–894. https://doi.org/10.1002/tea.213117

Kracl, C., & Harshbarger, D. (2017). Ask the right question. *Science and Children, 54*(9), 78–82.

Lazarowitz, R., & Naim, R. (2013). Learning the cell structures with three-dimensional models: Students' achievement by methods, type of school and questions' cognitive level. *Journal of Science Education and Technology*, *22*(4), 500–508. https://doi.org/10.1007/s10956-012-9409-5.

Lee, O. (2017). Common core state standards for ELA/literacy and next generation science standards: Convergences and discrepancies using argument as an example. *Educational Researcher, 46*(2), 90–102. https://doi.org/10.3102/0013189x17699172

Machi, L. A., & McEvoy, B. T. (2016). *The literature review: Six steps to success* (3rd ed.). Thousand Oaks, CA: Corwin Press.

Manzo, R. D., Whent, L., Liets, L., de La Torre, A., & Gomez-Camacho, R. (2016). The impact of the 5E teaching model on changes in neuroscience, drug addiction, and research methods knowledge of science teachers attending california's ARISE professional development workshops. *Journal of Education and Learning, 5*(2), 109–120.

Marzano, R. J., Brandt, R. S., Hughes. C. S., Jones, B. F., Presseisen, B. Z., Rankin, S. C, & Suhor, C. (1988). *Dimensions of thinking: A framework for curriculum and instruction*. Alexandria, VA: ASCD.

Marzano, R. J., Frontier, T., & Livingston, D. (2011). *Effective supervision: Supporting the art and science of teaching*. Alexandria, VA: ASCD.

Marzano, R. J. (2012a). Teaching argument. *Educational Leadership, 70*(1), 80–81.

Marzano, R. J. (2012b). Writing to learn. *Educational Leadership*, *69*(5), 82–83.

Marzano, R. J. (2013a). Cognitive verbs and the common core. *Educational Leadership, 71*(1), 78–79.

Marzano, R. J. (2013b). Asking questions -- At four different levels. *Educational Leadership*, *70*(5), 76–77

Maxwell, J. A. (2013). *Qualitative research design: An interactive approach* (3rd ed.). Thousand Oaks, CA: Sage.

Mayer, K. E. (2017). *Students' development and use of models to explain electrostatic interactions* (Order No. 10286778). Available from ProQuest Dissertations & Theses Global: The Humanities and Social Sciences Collection. (1971888322).

McKnight, K. S. (2015). *Common core literacy strategies for math, science, and technical subjects, grades 6–12: Strategies to deepen content knowledge (grades 6–12)* (1st ed.). San Francisco, CA: Jossey-Bass.

Miller, B., & Martin, C. (2016). Digital notebooks for digital natives: Supporting early childhood science and engineering practices with e- notebooks and whiteboard applications. *Science and Children*, *53*(5), 84–89.

Mitton-Kükner, J., & Murray Orr, A. (2018). A multi-year study of pre-service teachers' literacy practices in the content areas: Time epistemologies and indicators of stasis and growth. *Pedagogies: An International Journal*, *13*(1), 19–35. https://doi.org/10.1080/1554480x.2017.1376670.

Moje, E. B. (2015). Doing and teaching disciplinary literacy with adolescent learners: A social and cultural enterprise. *Harvard Educational Review*, *85*(2), 254–278, 301. https://doi.org/10.17763/0017-8055.85.2.254.

Morabito, N. P. (2017). Science in writing workshop: Enhancing students’ Science and literacy learning. *Reading Teacher*, *70*(4), 469–472. https://doi.org/10.1002/trtr.1506

National Research Council. (2012). *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: The National Academies Press.

Nelson, S., & Allen, P. (2017). Time to change. *Science and Children, 55*(3), 80–83.

Novak, A. M., Hubbard, P., Ebeling, B., & Maher, B. (2016). Explanations across the curricula: Integrating common core state standards in literacy with the next generation science standards. *Science Scope*, *39*(8), 54–60.

Osborne, J. (2014). Teaching scientific practices: Meeting the challenge of change. *Journal of Science Teacher Education*, *25*(2), 177–196. https://doi.org/10.1007/s10972-014-9384-1.

Piaget, J., & Inhelder, B. (1969). *The psychology of the child*. New York, NY: Basic Books.

Piaget, J., & Gabain, M. (1965). *Judgment and reasoning in the child*. London, England: Routledge & Kegan Paul.

Posavac, E. (2015). *Program evaluation: Methods and case studies*. New York, NY: Routledge Publishing.

Putra, G., & Tang, K. (2016). Disciplinary literacy instructions on writing scientific explanations: A case study from a chemistry classroom in an all-girls school. *Chemistry Education Research and Practice, 17*(3), 569–579.

Ravitch, S. M., & Riggan, M. S. (2011). *Reason & rigor: How conceptual frameworks guide research*. Thousand Oaks, CA: SAGE

Ray, A. B., Graham, S., Houston, J. D., & Harris, K. R. (2016). Teachers' use of writing to support students' learning in middle school: A national survey in the United States. *Reading and Writing, 29*(5), 1039–1068. https://doi.org/10.1007/s11145-015-9602-z

Reiser, B. J., Michaels, S., Moon, J., Bell, T., Dyer, E., Edwards, K. D., Mcgill, T. A., Novak, M., & Park, A. (2017). Scaling up three-dimensional dcience learning through teacher-led study groups across a state. *Journal of Teacher Education, 68*(3), 280–298.

Richmond, G., Parker, J. M., & Kaldaras, L., (2017). Supporting reform-oriented secondary science teaching through the use of a framework to analyze construction of scientific explanations. *Journal of Science Teacher Education, 27*(5), 477–493. https://doi/org/10.1007/s10972-016-9470-7

Roth, K. J., Wilson, C. D., Taylor, J. A., Stuhlsatz, M. A. M., & Hvidsten, C. (2019). Comparing the effects of analysis-of-practice and content-based professional development on teacher and student outcomes in science. *American Educational Research Journal, 56*(4), 1217–1253. https://doi.org/10.3102/0002831218814759

Rouse, A. G., Graham, S., & Compton, D. (2016). Writing to learn in science: Effects on grade 4 students' understanding of balance. *The Journal of Educational Research, 110*(4), 366–379. https://doi.org./10.1080/00220671.2015.1103688

Rubin, H. J., & Rubin, I. (2005) *Qualitative interviewing: The art of hearing data* (2nd Ed.) Thousand Oaks, CA: Sage Publications

Siebert, D. K., Draper, R. J., Barney, D., Broomhead, P., Grierson, S., Jensen, A. P., … & Wimmer, J. (2016). Characteristics of literacy instruction that support reform in content area classrooms. *Journal of Adolescent & Adult Literacy*, *60*(1), 25–33. https://doi.org/10.1002/jaal.526

Siffrinn, N. E., & Lew, S. (2018). Building disciplinary language and literacy in elementary teacher training. *Reading Teacher*, *72*(3), 325–341. https://doi.org/10.1002/trtr.1723

Smagorinsky, P. (2008). The method section as conceptual epicenter in constructing social science research reports. *Written Communication*, *25*, 389–411. https://doi.org/10.1177/0741088308317815

Soules, A., Nielsen, S., LeDuc, D., Inouye, C., Singley, J., Wildy, E., & Seitz, J. (2014). Embedding multiple literacies into STEM curricula. *College Teaching*, *62*(4), 121–128. https://doi.org/10.1080/87567555.2014.935699

Spires, H., Kerkhoff, S., & Graham, A. (2016). Disciplinary literacy and inquiry: Teaching for deeper content learning. International Literacy Association, *60*(2), 151–161. https://doi.org/10.1002/jaal.577

Starr, M., & Krajcik, J. (2013). Developing and using models to align with NGSS. *Science Scope*, *37*(1), 31–35.

Tang, K. S. (2015). Reconceptualising science education practices from new literacies research. *Science Education International*, *26*(3), 307–324.

Tanner, M. (2017). Taking interaction in literacy events seriously: A conversation analysis approach to evolving literacy practices in the classroom. *Language and Education, 31*(5), 400–417. https://doi.org/10.1080/09500782.2017.1305398

Underwood, S. M., Posey, L. A., Herrington, D. G., Carmel, J. H., & Cooper, M. M. (2018). Adapting assessment tasks to support three-dimensional learning**.** *Journal of Chemical Education*, *95*(2), 207–217. https://doi.org/10.1021/acs.j

Varner, T. (2016). Bridging the literacy gap in science. *AMLE Magazine*, *4*(1), 25–27.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* Cambridge, MA: Harvard University Press.

Vygotskiĭ, L. S., Hanfmann, E., & Vakar, G. (1962). *Thought and language*. Cambridge, MA: M.I.T. Press, Massachusetts Institute of Technology.

Wallace, C. S., & Coffey, D. (2016). Science in Sync. *Science and Children, 53*(8), 36–41.

Wexler, J., Mitchell, M., Clancy, E., & Silverman, R. (2017). An investigation of literacy practices in high school science classrooms. *Reading & Writing Quarterly, 33*(3), 258–277. https://doi.org/10.1080/10573569.2016.1193832

Wright, K. L., Franks, A. D., Kuo, L. J., McTigue, E. M., & Serrano, J. (2016). Both theory and practice: Science literacy instruction and theories of reading. *International Journal of Science and Mathematics Education, 14*(7), 1275–1292. https://doi.org/10.1007/s10763-015-9661-2

Wright, T., & Gotwals, A. (2017). Supporting kindergartners' science talk in the context of an integrated science and disciplinary literacy curriculum. *The Elementary School Journal, 117*(3), 513–537. https://doi.org/10.1086/690273

Wu, S. M., Lee, S. H., Chun, E., & Chan, Y. (2018). Teaching academic literacy using popular science texts: A case study. *Teaching & Learning Inquiry, 6*(2), 29–49.

Zhang, M., Parker, J., Koehler, M. J., & Eberhardt, J. (2017). Understanding in-service science teacher's needs for professional development. *Journal of Science Teacher Education, 26*(5), 471–496. https://doi.org/10.1007/s10972-015-9433-4

Zygouris-Coe, V. I. (2015). Teaching discipline-specific literacies in grades 6–12: Preparing students for college, career, and workforce demands. New York City, NY: Routledge. http://search.proquest.com/docview/1655505599/

Appendix A: Qualtrics Questionnaire of Teacher Literacy Practices in the (Grades 9–12) Science Classroom

Study: Science Teachers' Perceptions of Implementing Literacy Practices in The (Grades 9–12)

Science Classroom

Principal Investigator: Wesley Dale Russ, Sr.

Faculty Advisor: Christopher Maddox, Ph.D.

Start of Block: Informed Consent and Demographics

1. Participation in this questionnaire is strictly voluntarily. You may chose not to participate, or chose to stop at any time. I have read, and understood the above consent form and of my own free will, plan to:
    a. Voluntarily participate in this questionnaire
    b. Not participate in this questionnaire
2. What is your gender?
    a. Female
    b. Male
    c. Chose not to identify
3. What is your race?
    a. Asian/Pacific Islander
    b. Black/African American
    c. Hispanic/Latino
    d. White/Caucasian
    e. Mixed Race
    f. Chose not to identify
4. Which grade level(s) of the student you teach are primarily (i.e., a 10th grade class may have some 11th graders) in your classes?
    a. 9th
    b. 10th
    c. 11th
    d. 12th
5. Overall years of teaching experience
    a. New to teaching
    b. 1–2 years
    c. 3–5 years
    d. 6–10 years
    e. > 10 years
6. The specific course(s) you are teaching in a (Grades 9–12) science class (check all which apply):
    a. Honors, or On-level Biology
    b. AP or AB Biology
    c. Honors, or On-level Chemistry
    d. AP or AB Chemistry
    e. Honors or On-level Physics
    f. AP or AB Physics

g. AP or AB Environmental Science

7. As a (Grades 9–12) science teacher, your year in which you are following the new NGSS science curriculum?
    a. First year
    b. Second year
    c. Third year

Start of Block: Experience level and training needs to use literacy practices

8. Have you participated in training on literacy practices to teach in the (Grades 9–12) science classroom within the past two years?
    a. Yes
    b. No
9. How skilled do you consider yourself in implementing literacy into your pedagogical practices in the (Grades 9–12) science classroom?
    a. Novice – Needs assistance to utilize practices in the science curriculum
    b. Beginner – Comfortable using literacy practices in the science curriculum
    c. Experienced – Comfortable, teaches others how to utilize literacy practices in the science curriculum
10. Prior to beginning the NGSS curriculum, to what degree did you use literacy practices?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
11. How would you describe your confidence level using literacy practices in the (9 –12) science classroom?
    a. Highly confident
    b. Moderate level of confidence
    c. Low level of confidence
12. Do you believe you are in need of additional professional development training in the area of implementing literacy practices in the (Grades 9–12) science classroom?
    a. Yes
    b. No

Start of Block: Use of instructional approaches related to literacy practices

.

13. To what degree do are you using literacy practices in your (Grades 9–12) science classroom this school year?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily

14. Prior to the school system implementing an NGSS curriculum, did you have students propose and answer and or make a prediction from a writing prompt, to explain their understanding of a concept such or real world phenomena?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
15. In the current school year, how often do you have students propose and answer and or make a prediction from a writing prompt, to explain a real world phenomenon?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
16. During previously school years, how often did you have students respond to a writing prompt to assess their learning?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
17. During this school year, how often do you plan to have students respond to a writing prompt to assess their learning?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
18. During previous school years, how often did you have students write an observation and develop an explanation?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
19. During this school year, how often will you have students write about an observation and develop an explanation?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
20. During previous school years, how often did you use mixed work sheet containing some questions where would write out responses to reinforce practices or content?
    a. Never

b. Rarely - a few times a year
c. Sometimes - one or twice a month
d. Often - once or twice a week
e. Daily or almost daily

21. During this school year, how often did you use mixed work sheet containing some questions where the student will write out responses to reinforce practices or content?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
22. Prior to the NGSS curriculum to what degree did you use direct instruction to explain science concepts?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
23. During this school year, how often did you use direct instruction to explain science concepts?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily or almost daily
24. During previous school years, how often did you use vocabulary words before a lesson was taught?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
25. During this school year, how often did you use vocabulary words before a lesson was taught?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
26. During previously school years, how often did you have students explain science concepts to one another in groups?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily

27. During this school year, how often did you have student explain science concepts to one another in groups?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
28. How often do you use the county's NGSS school curriculum?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - once or twice a month
    d. Often - once or twice a week
    e. Daily
29. To what degree are you using science and engineering practices to teach science?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes - one or twice a month
    d. Often - once or twice a week
    e. Daily
30. To what degree do you use evidence, and reasoning model to generate scientific explanations?
    a. Never
    b. Rarely - a few times a year
    c. Sometimes (one or twice a month)
    d. Often (once or twice a week)
    e. Daily or almost daily

Start of Block: Barriers on the use of literacy practices in my classroom

31. In terms of learning and implementing literacy practices, what is the level of support that you receive, or have received from the administration?
    a. High
    b. Medium
    c. Low
32. In terms of learning and implementing literacy practices, what is the level of support from your Professional Learning Community?
    a. High
    b. Medium
    c. Low
33. How is your access to appropriate instructional materials to teach using literacy practices?
    a. Accessible
    b. Not Accessible
34. How would you characterize your level of understand of literacy practices?
    a. High
    b. Medium

    c. Low

35. When using literacy practices, to what degree do you need to teach literacy skills to students?
    a. High
    b. Medium
    c. Low
36. Do you feel the need to have training specifically on literacy skills so that you can better support students?
    a. Yes
    b. No
37. How would you describe the professional development opportunities provided to you related to using literacy practices?
    a. Enough
    b. Not Enough
38. I am looking for volunteers to participate further by taking part in a semistructured interview and a review of the lesson plans for one typical unit of study. If you would like to volunteer, please let me know through my school e-mail and I will schedule an appointment after school, in your classroom. The meeting will be recorded, you will have the opportunity to review my transcription of the interview.

Appendix B: Interview Questions

Study: Science Teachers' Perceptions of Implementing Literacy Practices in The (Grades 9–12) Science Classroom

Principal Investigator: Wesley Dale Russ, Sr.

Faculty Advisor: Christopher Maddox, Ph.D.

Interview Questions:

1. Describe your experience level with literacy practices in the (Grades 9–12) science classroom? Has it changed over the past three years?
2. What are your perceptions of using literacy practice(s) in the (Grades 9–12) science classroom? Has this changed over time and if so, how?
3. To what extent do you find literacy practices to be effective in terms of student engagement and learning? Do you find differences in effectiveness?
4. Do you have professional development needs using literacy practices?

Appendix C: Lesson Plan Checklist

Study: Science Teachers' Perceptions of Implementing Literacy Practices in The (Grades 9–12) Science Classroom

Principal Investigator: Wesley Dale Russ, Sr.

Faculty Advisor: Christopher Maddox, Ph.D.

The school system study site requires daily use of the five E's, which are engage, explore, explain, extend and evaluate. Lesson plans for a unit were reviewed for each of the five parts of the lesson plan to determine the extent and types of literacy practices being used.

1. Engage activator, or warm-up
   a. _____Writing prompt and short answer
   b. _____Calculation
   c. _____Other_____
2. Explore
   a. _____Reading
   b. _____Cause and effect graphic organizers
   c. _____Writing prompt
   d. _____Laboratory write up
   e. _____Other
3. Explain & extend
   a. _____Literacy practice
4. Evaluate
   a. _____Exit card (written response)
   b. _____Literacy practice

Appendix D: Participant Consent Form

Research Study Title: Science Teachers' Perceptions of Implementing Literacy Practices in the (Grades 9–12) Science Classroom
Principal Investigator: Wesley Dale Russ, Sr.
Research Institution: Concordia University–Portland
Faculty Advisor: Christopher Maddox, Ph.D.

Purpose and what you will be doing:
The purpose of this hermeneutic, phenomenological study is to explore how (Grades 9–12) science teachers perceive literacy practices in the science classroom. The requirement is that participants are biology, chemistry, or physics teachers in (Grades 9–12) science classrooms at [site name redacted] High School. The course level can be on level, honors, AP, or IB. Approximately 10 to 19 purposely selection volunteers are expected to complete the questionnaire and seven to nine volunteers for a semistructured interview and review of lesson teaching materials. No one will be paid to be in the study. We will begin enrollment during November and end enrollment the last day of January. Participants can volunteer to participate in an online questionnaire and stop at that point. Volunteers can also chose, if they would like to, for participation in a semistructured interview and review of teaching materials such as syllabuses, or a time line for one unit of study. There will be not viewing of any actual work of students. Semistructured interviews will be recorded to make transfer to typed notes reliable. The recording will be deleted following transferring to types notes. No names will be recorded. Completing the questionnaire should take no more than 10 minutes. The semistructured interview and review of lesson material should take no more than 15 minutes.

Risks:
There are no risks to participating in this study other than providing your information. However, we will protect your information. Any personal information you provide will be coded so it cannot be traced back to you. Any name or identifying information you give will be kept securely via electronic encryption or locked inside the researcher's office desk. When we, or any of our investigators look at the data, none of the data will have your name or identifying information. We will only use a secret code to analyze the data. We will not identify you in any publication or report. Your information will be kept private at all times and then all study documents will be destroyed 3 years after we conclude this study.

Benefits:
The information you provide will help development an understanding of (Grades 9–12) teachers adapting to literacy practices in the science classroom. You could benefit this by contributing to information, which may be useful identifying ways to improve teacher training and professional development programs.

Confidentiality:
This information will not be distributed to any other agency and will be kept private and confidential. The only exception to this is if you tell us abuse or neglect that makes us seriously concerned for your immediate health and safety. Interview sessions may be recorded, or notes taken. Please make your choice: (1) yes, to recording, or (2) no to recording, but yes to notes. If recordings are made, they will be deleted immediately following transcription and checking by the participant. All study-related materials will be destroyed at the conclusion of the study.

Right to Withdraw:
Your participation is greatly appreciated, but we acknowledge that the questions we are asking are personal in nature. You are free at any point to choose not to engage with or stop the study. You may skip any questions you do not wish to answer. This study is not required and there is no penalty for not participating. If at any time you experience a negative emotion from answering the questions, we will stop asking you questions.

Contact Information:
You will receive a copy of this consent form. If you have questions you can talk to or write the principal investigator, Wesley D. Russ, Sr., at [redacted] or call [redacted]. If you want to talk with a participant advocate other than the investigator, you can write or call the director of our institutional review board, Dr. OraLee Branch (email obranch@cu-portland.edu or call 503-493-6390).

Your Statement of Consent:
I have read the above information. I asked questions if I had them, and my questions were answered. I volunteer my consent for this study.

Please circle the appropriate response:

Option A: I agree to participate in the questionnaire and not the interview and review of materials.

Option B: I agree to participate in the questionnaire, the interview and review of materials.

______________________________ ___________
Participant Name Date

______________________________ ___________
Participant Signature Date

______________________________ ___________
Investigator Name Date

______________________________ ___________
Investigator Signature Date

Investigator: Wesley Dale Russ, Sr.; email: [redacted]
c/o: Professor Christopher Maddox, Ph.D.
Concordia University–Portland
2811 NE Holman Street
Portland, Oregon 97221

Appendix E: Participant Recruitment Email

My name is Wesley Russ; I am a doctoral candidate at Concordia University–Portland and have been an [redacted] classroom teacher for over 18 years. As the final phase of my doctoral dissertation, I am required to collect data from biology, chemistry and physics teachers in the (Grades 9–12) science classroom, within one high school science department. Participants may teach any level, i.e., on level, honors, AP, or IB. I am inviting you to volunteer to participate in my research study. Agreeing to participate in the study is strictly voluntarily. This recruitment e-mail is being sent to all (Grades 9–12) science classroom teachers at [site name redacted] High School [location redacted]. Permission to collect this data has been received from the [site name redacted] principal and the [district name redacted], [research review board name redacted]. My receiving approval is only to clarify that I have permission, it should not influence volunteering. Participation is strictly on a volunteer basis.

The title of the study is "Science Teachers' Perceptions of Literacy Practices in the (Grades 9–12) Science Classrooms". The purpose of this hermeneutic, phenomenological study will be to explore how teachers perceive the implementation of literacy practices in (Grades 9–12) science classrooms. Participants will provide data that describes their lived experiences of modifying science curriculum to reflect current educational reform measures. By collecting and analyzing the perceptions of science teachers' experiences, it may be possible for administrators to identify commonalities and suggest ways to overcome barriers that optimize the integration of literacy practices.

If you chose to volunteer to participate in the study, you will answer a 10-minute online questionnaire regarding your experiences and perceptions of implementing literacy practices in your science classroom. If you are willing to participate, you can volunteer to a 30-minute face-to-face semistructured interview and a review of a lesson sequence for one typical unit of study. If you choose to participate there is a questionnaire, which will take approximately five minutes to complete on line. If interested, you can volunteer to participate further by agreeing to a ten-minute semistructured interview, which includes a review of a syllabus, or schedule of activities for one unit of study. This would take place at your school, or a local coffee shop convenient for you. There will be no collection of student work, in fact, this is not allowed.

Sincerely,

Wesley Dale Russ
Doctoral Candidate

Appendix F: Statement of Original Work

The Concordia University Doctorate of Education Program is a collaborative community of scholar-practitioners, who seek to transform society by pursuing ethically informed, rigorously-researched, inquiry-based projects that benefit professional, institutional, and local educational contexts. Each member of the community affirms throughout their program of study, adherence to the principles and standards outlined in the Concordia University Academic Integrity Policy. This policy states the following:

Statement of academic integrity.

> As a member of the Concordia University community, I will neither engage in fraudulent or unauthorized behaviors in the presentation and completion of my work, nor will I provide unauthorized assistance to others.

Explanations:

What does “fraudulent” mean?

> “Fraudulent” work is any material submitted for evaluation that is falsely or improperly presented as one’s own. This includes, but is not limited to texts, graphics and other multimedia files appropriated from any source, including another individual, that are intentionally presented as all or part of a candidate’s final work without full and complete documentation.

What is “unauthorized” assistance?

> “Unauthorized assistance” refers to any support candidates solicit in the completion of their work, that has not been either explicitly specified as appropriate by the instructor, or any assistance that is understood in the class context as inappropriate. This can include, but is not limited to:

- Use of unauthorized notes or another’s work during an online test
- Use of unauthorized notes or personal assistance in an online exam setting
- Inappropriate collaboration in preparation and/or completion of a project
- Unauthorized solicitation of professional resources for the completion of the work.

Statement of Original Work (Continued)

I attest that:

1. I have read, understood, and complied with all aspects of the Concordia University–Portland Academic Integrity Policy during the development and writing of this dissertation.

2. Where information and/or materials from outside sources has been used in the production of this dissertation, all information and/or materials from outside sources has been properly referenced and all permissions required for use of the information and/or materials have been obtained, in accordance with research standards outlined in the *Publication Manual of The American Psychological Association*.

Wesley Russ

Digital Signature

Wesley Dale Russ, Sr.

Name (Typed)

April 18, 2020

Date