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AN EXPLORATION OF SECONDARY SCIENCE GRADE TEACHERS'
WRITTEN ARTIFACTS ABOUT THEIR EXPERIENCES WITH
AN ONLINE PROFESSIONAL DEVELOPMENT IN READING RESEARCH
AND INSTRUCTION: A GROUNDED THEORY STUDY

by

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A dissertation submitted in partial fulfillment of the requirements
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ABSTRACT

Classroom teachers deal with numerous pressures in their classrooms including students' difficulty with reading at the middle and high school levels. Often, teachers can identify the problems, but are often unable to rectify them because of a lack of understanding and support in incorporating reading as part of their content area instruction. This research was conducted to investigate the impact of a sustained, online reading professional development on the teaching practice of middle school and high school science teachers who took the 14-week course.

This grounded theory research used the reflective assignment, a comprehensive, 10-week, job-embedded assignment of 62 science teachers, to generate categories and themes about the reading challenges they perceived in their own classrooms, what strategies and tools they chose to remedy those challenges, and the perceived changes they saw in their students and themselves. The theory that was derived from the data speaks to how effective, job-embedded reading professional development can impact the knowledge, motivation, and instructional practice of science teachers in the classroom.

To the father I never knew and the heirs that he never got to meet. . .

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CHAPTER 1 THE PROBLEM AND ITS CLARIFYING COMPONENTS

Introduction

This chapter provides an overview of the study. It contains the purpose of the study, a statement of the problem, and the background for the study. Terms are defined, and the rationale for the research design is presented. Also included are the theoretical framework, the research questions and a statement as to the significance of the study.

Statement of the Problem

Science text can be obscure and challenging to read for many secondary school students, diminishing comprehension and reducing student engagement in science subject matter (Fang & Schleppegrell, (2008); Pearson, Moje, & Greenleaf, 2010). As technical text is the format of the written science discipline, it is appropriate that science teachers be able to instruct students in the discourse and nuances of their own discipline (McConchie & Petrosky, 2010; Norris & Phillips, 2003; Shanahan & Shanahan, 2008). In support of this, the designers of the Common Core Standards (2010), stated that teachers in all areas of study including science need to be able to use their content expertise to help students comprehend challenging text “because the vast majority of reading in college and workforce training programs will be sophisticated nonfiction” (p. 60). Thus, the question of how to equip science teachers to help students decipher technical writing and construct this science knowledge is an ongoing discussion providing a solid basis for this research study. In addition, one area in secondary science education which has had limited study, is the examination of how science teacher

professional development in reading and literacy may positively influence student learning by facilitating the comprehension of difficult written and spoken science discourse found in the science classroom (Kelly, 2007). Supplementing working secondary science teachers with an extended online professional development in reading is one way to increase teacher knowledge about such challenges that may help mitigate reading issues in their own science classroom. Additionally, an in-depth study of participants of such professional development in their own classroom settings and school environments, may deliver real insights into the role of online professional development in terms of teacher outcomes. With these motivations in mind, the researcher undertook this qualitative, grounded theory study to understand the influences of reading in the content area training delivered through a 14-week, Florida online reading professional development (FOR-PD) on the ongoing teaching practices of a purposive sample of 62 secondary science teachers.

Research Questions

In grounded theory, general concepts about research interests generally lead to particular questions about the research topics (Charmaz, 2006). In this research, the following questions guided the grounded theory study:

1. What types of instructional challenges did middle and high school science teachers report they chose to work on as part of their professional development?

2. In what ways did middle and high school science teachers report they used to facilitate learning from the professional development to resolve their chosen instructional challenges?
3. Based on participating teachers' stated views, what changes did middle and high school science teachers see in their students after the instructional changes were implemented?
4. Based on participating teachers' stated views, in what ways did the professional development help middle and high school science teachers change and improve their instruction?

Purpose of the Study

All science teachers are presented with the challenge of teaching a subject in which learning materials that include a large amount of difficult vocabulary and problematic text structure are utilized. In this study, the researcher investigated science teachers who took a 14-week long online professional development course in reading in an effort to help them develop ways to mitigate these challenges in their classrooms. Interestingly, there have been many types of studies about the effectiveness of professional development, but few have documented its impact on teacher change and student learning (Guskey, 2000).

Additionally, adult learners who in this case were teachers, constructed learning based on their own motivation factors, experience, and view of relevancy (Knowles, 1970). This examination of science teachers' culminating written artifacts about a 14-

week online professional development in reading via grounded theory may enlighten others about the unique challenges of integrating reading into the science classroom. The individual viewpoints of these secondary science teachers are valuable in terms of their students' reading challenges, their plans of action to mitigate those challenges, and their view of the impact of those plans on their students and themselves. They provide personal snap-shots of the ways teachers decide how to implement knowledge from professional development in their classroom instruction and reflect on the results of those actions.

Background of the Study

Research over the past 40 years highlights a number of facts that describe a possible systemic problem that is ingrained in the educational system of the United States. A few of the facts that support this assumption were put forth by the Alliance of Excellent Education (2009): (a) from 1971-2004, the National Assessment of Educational Progress (NAEP) showed no fundamental improvement in reading test scores; (b) approximately eight of 32 students in Grades 4-12, read below the NAEP basic standards; and (c) there was an increase in fourth-grade proficiency from 1998-2007, but a decrease in eighth-grade proficiency. In addition, researchers have found that about 40% of graduating seniors are lacking in the literacy skills necessary for today's employers (Achieve, 2005). These findings support that though literacy and comprehension may be improving at the lower elementary levels, reading skills may be in

fact declining at the secondary levels, indicating a credible education gap in secondary classrooms.

In response to the pervasive problem of reading below the proficiency level in the secondary grades, Biancarosa and Snow (2004) suggested that basic skills and strategies regarding reading comprehension were not being taught. Content area reading has been found to be somewhat unique as to the specific discipline (Shanahan & Shanahan, 2008) and the relationship with science reading and writing can be a somewhat difficult task. Norris and Phillips (1994, 2003) stated that science literacy is fundamentally focused on text, and that it is imperative to be able to understand text structures to enable comprehension of text intentions. Hand and Prain (2006) described science learning as a process of engaging in the organization and logic of the scientific ways of using language (p. 103). McConachie and Petrosky (2010) further defined use of language organization and logic within a discipline as “habits of thinking. . . members of different communities read, inquire, reason, investigate, speak, write, and co-construct their knowledge bases[in their own ways]” (p. 21). Adding to the complexity, Lemke (2003) noted that the language of science also includes the integration of diagrams, pictures, graphs, tables and charts, equations and maps along with words, making this discourse that much more difficult. In light of this, training teachers to integrate reading comprehension in science with the goal of easing the difficulty of written science text for the students may raise students’ comprehension of the subject matter and improve motivation to learn.

Background of Professional Development

The online training, Florida Online Reading Professional Development (FOR-PD), was a state by-product of The No Child Left Behind Act (NCLB) of 2001, which created the need to address the literacy goal of every student reading at or above grade-level by the year 2014. In response to the legislation of this Act and in order to address this need, the then governor of Florida designated “Just Read, Florida!” as a comprehensive reading initiative (Executive Order 01-260). This initiative was responsible for the distribution of a Florida-developed competency-based reading endorsement for PreK-12 educators that encompassed six reading competencies. In response to this, FOR-PD was created by University of Central Florida (UCF) Professors Baumbach (2002-2004) and Zygouris-Coe (2003-2010) to advance Pre K-12 Florida teacher knowledge about effective reading research and instruction. In 2006, the Florida State Legislature drafted and launched House Bill 7087 (F.S. 1003.413) stating that “the Department will emphasize reading instruction professional development for content area teachers, and a package of professional development for content area teachers will be created for the 2006-2007 school year” (Lefsky, 2006, p. 1). This unique initiative called Content Area Reading Professional Development (CAR-PD) defined content area as math, science, social studies, language arts, fine arts, and technical career educators. It called for the completion of a package of 150 in-service points that explores the principles of scientifically based research in reading and incorporates reading endorsement indicators. FOR-PD met Competency 2 for both the Florida Add-on Reading Endorsement and CAR-PD initiatives.

Definition of Terms

Following are definitions of terms relevant to the study. They are offered to increase clarity in subsequent chapters regarding specific terminology applied in this research.

Content area literacy: “the ability to use reading and writing for the acquisition of new content in a given discipline” (McKenna & Robinson, 1990, p. 184).

Disciplinary literacy: learning to read, talk, and write in the specific manner that a certain discipline demands; being able to understand what counts in a specific discipline as a good question, what counts as evidence and the proper procedures to gather that evidence, and how to craft arguments and solutions in ways that the members of that discipline do (McConachie & Petrosky, 2010).

Online Professional Development: professional development that is dispensed via an electronic format (learning management system) that allows long distance learning to take place (etools4Education, 2012).

Professional development: that endeavor that seeks to improve teachers’ skills so as to improve and enhance the quality of teaching (Hart & Lee, 2003).

Reading comprehension: features of reading comprehension that include the brain processing at multiple levels, e.g., interpreting the connotations of word meanings, deriving implication from discourse structures like syntax, and processing whole ideas; the management of working memory, and the generation of inferences (Bruning, Schraw, Norby & Ronning, 2004, p. 267).

Teachers' instructional practices: tools that teachers employ in the classroom that include teacher preparation activities, e.g., planning lessons and designing assessments, and instructional activities. According to the National Academy of Education (2005), examples of these instructional activities include “explaining concepts, holding discussions, designing experiments, developing simulations, planning debates, or organizing writing workshops” (p. 40).

Rationale for Research Design

The grounded theory approach provides a qualitative method that systematically generates a theory that is grounded in the data one is studying (Charmaz, 2006; Glaser & Strauss, 1967). Through the constant comparative method and coding, a researcher can systematically discover and check emerging findings that relate to the data, which culminates in an emergent theory that is rooted in that particular data. In this grounded theory study, the goal was to carefully and intensely examine a comprehensive teacher written artifact known as the reflective assignment of approximately 62 high school and middle school science teachers who completed a 14-week long online reading professional development in reading, hereafter referred to as FOR-PD. The examination of these artifacts through the grounded theory approach allowed for an examination of this phenomenon through the perspective and experiences of participating science teachers as reflected in their instructional artifacts.

The Reflective Assignment

This culminating instructional artifact was the major product of the participating teachers' experience with this professional development project. Teachers identified an instructional challenge they faced in their own classrooms during week three of the 14-week long professional development experience, discussed what they had done to deal with the challenges prior to completing the professional development, and were given nine weeks to select, plan, and implement instructional modifications using learning from the professional development to address that challenge. In addition, teachers discussed their perspectives about the impact their instructional modifications had on student learning and in some cases, next steps in terms of their classroom instructional design. The length of each written artifact ranged from three to five pages per teacher. Analysis of these artifacts may provide a general understanding into insights about (a) the types of instructional challenges secondary teachers identified; (b) how they used learning from the professional development to deal with the instructional challenge; and (c) how this professional experience, in their perspective, helped them to improve their instruction. In their own words, these artifacts reflected on the teaching decisions of the individual science teachers in terms of classroom reading challenges, plans of action to mitigate such challenges, and the outcomes of their plans of action on student learning. The use of grounded theory applied to these teachers' artifacts enabled an analysis culminating in (a) theories about what teachers learned and implemented from the professional development, (b) science teachers' perspectives about the role of reading to support science learning, (c) any themes in the instructional challenges they identified, and (d)

any themes in the ways they used reading to improve science teaching and student learning. In the final interpretative phase, the researcher reported the lessons learned from the analysis.

Theoretical Framework

The use of a theoretical framework in qualitative research can be useful to complement, extend, or justify a methodological approach to research (Corbin & Strauss, 2008). This grounded theory study, in which the influences of a 14-week FOR-PD on the teaching practices of science teachers were examined, employed the integration of three theoretical frameworks that substantially support the point of the research. The first framework was used to structure the research through the lens of Vygotsky's social constructivism, the second through Knowles' paradigm of adult learning, and the third via Guskey's model for evaluating professional development. The integration of these three lenses structured the examination of artifacts through the viewpoint of science teachers constructing and applying their own learning in their classrooms from an extended online professional development. With this in mind, this grounded theory research provides a thematic insight into whether the participation in this professional development resulted in any changes in teacher practice, teacher and/or student attitudes, or improvement in student learning as reflected in teachers' instructional artifact. If so, this would indicate that when science teachers were given authentic and job-embedded opportunities and tools to reflect on their instruction and student learning, as adult

learners in a social setting, these teachers were able integrate constructs from the professional development to positively impact their own classrooms.

The Lens of Social Constructivism

Vygotsky, who has been credited with the origins of constructivism, believed that knowledge is created via the interactions of the learner with the surrounding environment (Vygotsky, 1978). Vygotsky believed that the biggest marker in terms of a learner's intellectual ability was made in conjunction with reasonable learning situations that surround the learner. In Vygotsky's mind, this was an exchange that is done in a culturally derived social setting and, therefore, is a culturally mediated interaction. According to Vygotsky, this interaction was dependent on the motivation of the learner and the relevance of the subject to the learner, thereby affecting the focus of the learning in constructing the newly acquired knowledge. Thematic results from this research indicating changes in student attitudes and/or class-related work could be construed as indicators of instructional change as orchestrated by the teachers highlighting the influences of social constructivism.

Knowles' Theory on Andragogy

Adult learners are decidedly different learners than children. According to Knowles (1970), adult learners require a different learning model that better reflects their needs and place in life. This learning theory called "andragogy" was defined by Knowles (1970) as "the art and science of helping adults learn" (p. 38). Knowles ascribed the

following four assumptions to this theory that set it apart from normal pedagogy: (a) self-concept of the adult learner, (b) role of the learner's experience, (c) readiness to learn, (d) orientation to learn. He believed that adult learners are self-directed, mature, self-motivated, and seek relevancy in what they learn. They carry their life experiences as well as their other life roles and responsibilities into their learning. In addition, because adults have built a foundation of life experience and knowledge, they desire to be treated respectfully as learners who can take responsibility for their own learning (Zemke & Zemke, 1984). Thematic outputs of this research that demonstrate the participating teachers' attention to the professional development in terms of internalization and documented use of relevant material in their classrooms situations would be examples of adult learning as depicted by Knowles.

Guskey's Model for Evaluating Professional Development

This study was also theoretically grounded in Guskey's (1985, 2000, 2002) view of professional development and teacher change. Guskey's focus on the outcomes of professional development allows for clarification in terms of teacher beliefs and behaviors in four areas: (a) the participants' reactions to the professional development, (b) the participants' attainment of aspired learning goals, (c) the participants' use of the objectives and artifacts of the professional development, and (d) the evidence of increased student learning within the participants' classrooms. This lens allows a structure for examining the outcomes of FOR-PD in terms of participant behaviors with close attention to the integration of reading for knowledge building in science

classrooms. It was also posited that an understanding of the benefits of this type of FOR-PD for science teachers could shed light on areas of professional development that science teachers in particular need in terms of reading in the content area.

Significance of the Study

This study was conducted to investigate the experience of secondary science teachers participating in professional development focused on content area literacy. The overall significance of these results exists in exploring the participating teachers' perspectives about the role of reading in science instruction, identification of their own challenges, and how they would mitigate these challenges in their own settings. These findings may be of interest to other secondary science teachers who experience the same sorts of challenges with technical text in their science classrooms. Professional developments that provide teacher choice, promote critical reflection of instruction, and facilitate implementation of learning from these professional developments on a continual basis, give the adult learners the ability to choose pertinent activities that augment and promote deep comprehension of the content that they teach (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). In addition, it may be of value to be able to identify what factors facilitate or impede the implementation of knowledge from the FOR-PD to instructional practices. There are so many secondary school level students who struggle in reading and comprehension (Alliance for Excellent Education, 2009). Identification of the needs of the science teachers is important in providing the kind of professional development that is most beneficial to them.

In this chapter, the purpose of the research, the need for the research, and the research design were discussed. The theoretical frameworks that provide the lenses of the research were presented as well as some background information on the situated professional development (FOR-PD). Additionally, definitions of concepts particular to this research were reviewed.

CHAPTER 2 REVIEW OF THE LITERATURE

Introduction

Many educators, scientists, and business leaders agree that there is a literacy gap in the education process that could be a major stumbling block to future technological advancements and the production of a scientifically literate society (Webb, 2010). The literacy gap is more about basic literacy than scientific literacy in that basic literacy is the first necessary step to attainment of scientific literacy (Grant & Fisher, 2010; Klaus-Quinlan & Cazier, 2009; Moje, 2008; Shanahan & Shanahan, 2008). Lee and Spratley (2010) summed up the problem well by commenting that learning to read at the lower levels does not mean that students are fully equipped to now read to learn. Moje (2004) suggested that all disciplines require instruction that necessitates good connection between the readers' background knowledge and ongoing learning. Additionally, Shanahan and Shanahan (2008) forged a convincing two-year study surrounding the issues of disciplinary reading in terms of how the various texts are read differently and how the strategies are varied to achieve comprehension of the disciplinary texts. In an effort to fill this gap and mitigate future educational losses, literacy experts have combined forces with content area experts to delineate disciplinary literacy and help equip teachers with literacy strategies that are unique to the content areas. Literacy training has increased in many ways in discipline areas, and states have mandated literacy coursework. Still, very few studies have been conducted at the secondary level to

examine how teachers have supported their students' engagement in reading in the content area (Dillon, O'Brien, Sato, & Kelly, 2011).

It is important to note that this literature review is summative in nature. Areas of research that are consistent with the topics needed to support the dissertation are presented and discussed. Therefore, in order to further examine the science disciplinary literacy topic and issues surrounding professional development for these teachers, four research areas are addressed in the literature review: (a) the literacy status of U.S. students; (b) how science reading differs from other disciplines; (c) the need for more effective instruction in secondary science in terms of disciplinary literacy; and (d) the role of effective professional development to deliver literacy training to teaching professionals. The first research area sets the stage as to the status of adolescent literacy and how it affects the study of science. The second and third areas establish the uniqueness of science as a discipline, and the fourth area deals with the usefulness of effective professional development.

To guide this discussion, the theoretical framework enabled the four areas of background research to be viewed through the lens of three distinct paradigms: social constructivism as described by Vygotsky (1978), online professional development as defined by Guskey (1985, 2000, 2002), and the adult learner as discussed by Knowles (1970). These three paradigms may contribute to the way the science teachers who participated in the online professional development derived and integrated their own learning into their personal classroom challenges and situations. Figure 1 depicts the

integration of the research topics and the influence of the theoretical framework on the participants' reflective assignments.

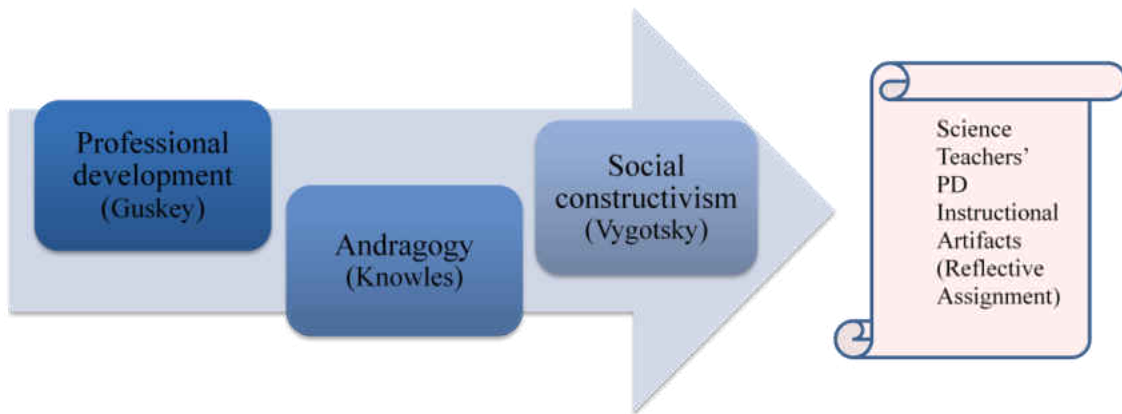


Figure 1. Theoretical framework for background research: Science teachers' reflective assignments.

Literacy and Science Status

The exercise of finding meaning in science involves the use of systematic questioning and the collection of evidence to support the answers to such questions. In terms of such inquiry, according to Krajcik and Sutherland (2010), “fundamental literacy practices such as reading, writing, and oral discourse are essential to developing an understanding of the core ideas of science” (p. 456). The aim of science teaching is to produce students that, based on the National Science Education Standards, have the ability to understand science content, engage in decision making concerning scientific issues, and demonstrate appropriate critical thinking skills that science requires (National Research Council, 1986). With respect to these goals, in 2006, The Programme for

International Student Assessment (PISA) provided insightful information about the problem solving abilities of a random sampling of 15-year-old students representing 57 participating countries. This effort centered on literacy (including reading literacy, mathematics literacy, and science literacy). Trouble-shooting scenarios that showcased students' ability to extrapolate knowledge and focus skills learned throughout their education were presented. The science results revealed that the U.S. ranked 21st among the 30 Organization for Economic Co-operation and Development (OECD) countries. In their report, Bybee and McCrae (2009) wrote:

although the proportion of top performers in the United States was similar to the OECD average, the United States had a comparatively large proportion of poor performers: 24.4% of U.S. 15-year-olds did not reach Level 2, the baseline level of achievement on the PISA science scale at which students begin to demonstrate the science competencies that will enable them to participate in life situations related to science and technology. (p. 181)

Congruent with this less than desired outcome, 25 of the fastest growing professions were reported to demand much higher levels of literacy than the fastest declining professions (Alliance for Excellent Education, 2009). Presenting the U.S. literacy issue in another way, nearly 40% of students who enter college have been required to take remedial courses, and an estimated one-half do not see a degree through to completion (Wagner, 2008). In agreement with Wagner, a 2010 report of the Carnegie Council on Advancing Adolescent Literacy cited studies that showed the skill set that contemporary students need to be able to earn an adequate income has changed radically

and increased in sophistication, but the skills taught in most U.S. schools have not. According to this report, this leaves many students with a likely future of lower incomes and possible future unemployment (Carnegie Council on Advancing Adolescent Literacy, 2010).

Achieve, a report published in 2005 from a non-profit group created by the National Governors Association, examined findings recovered through a survey of 300 instructors about beginning college students at both two-year and four-year institutions. Perhaps the most striking fact was that 70% of the surveyed instructors indicated that their students did not comprehend complex reading material (Achieve, 2005). Maaka and Ward (2012) concurred, citing that community college students reported often experiencing comprehension difficulties in content area reading and, additionally, that instructors felt inadequate to help them. Similarly, ACT, Inc. (2006) reported earlier that only 51% of ACT test takers who planned to go on to post high school education met the college-readiness benchmark that indicated college readiness for college courses. In accordance with these findings, a 2007 report that the Council of Competitiveness compiled for the Alliance for Excellent Education (2009) showed that many employers find recent high school graduates lacking skills in critical thinking, problem solving, and oral and written communications.

In a dissertation study on reading comprehension strategies in the secondary science and social studies classrooms, Ness (2007) found that of 2,400 minutes of direct observation of classrooms, only 82 minutes of reading comprehension instruction were observed, indicating a possible weakness in teaching pedagogy. These facts are situated

atop a growing list of disturbing facts that describe a possible systemic problem that ingrained in the U.S. education system. These statistics imply that although literacy and comprehension may be improving at the lower elementary levels, reading skills may be in fact declining at the secondary levels. The 2010 report of the Carnegie Council on Advancing Adolescent Literacy reminds readers that as grade levels increase, the literacy demands on readers and the textual “landscape” change. These textual “landscape changes are as follows: (i) the text becomes longer, (ii) the word complexity increases, (iii) the sentence complexity increases, (iv) the structural complexity increases, (v) the graphic representations become more important, (vi) the conceptual challenge increases, and (vii) the texts begin to vary widely across content areas” (pp. 10-13). It seems apparent that instructors at the upper grade levels need to assist students in learning how to address these textual changes and use them to their scholarly advantage in each the content areas. As adult learners, science teachers may need well designed learning situations to help equip themselves with knowledge that can help them move their students to a point where students can achieve comprehension of the academic material they are teaching.

The Role of Reading in Science

Making discipline content meaningful and comprehensible is the overall goal of teaching and learning in the educational process. How to accomplish this has been the basis for many educational philosophies and countless educational traditions over time. Science is a unique discipline in that it attempts to explain natural phenomena and events

through rational explanations derived from objective observations (Krajcik & Sutherland, 2010). The structure of science is guided by the nature of science that is seen as skeptical and has a healthy disrespect for authority. In this structure, everyone has the right to bring new ideas to the “table” as long as they follow the same regimented procedure in gathering and presenting data (Matson & Parsons, 2006). At this table, scientist evaluate each other’s data, argue, compare, and substantiate outcomes before arriving at a consensus of what theories can be garnered. In this way, theories can often change depending upon the amount of evidence available at a given moment. It is upon these theories that laws develop over time.

The teaching and learning of science is unique because of the scope of the subject matter, the impact of the philosophy of the nature of science on the discipline, and the variety of technicality that each branch of science contributes. For example, the specialty of biology is based on structure and function (in addition to the basics of physics and chemistry) and encompasses much memorization in order to be learned. In contrast, physical sciences demand much knowledge of mathematical manipulations and the ability to work with concepts in the abstract. The earth sciences draw from both disciplines, capitalizing on both memorization and working in the abstract. This diversity of subject matter and use of distinct cognitive domains makes science teaching and science learning challenging. In addition, because of the technical nature of science and the dense, technical, and complex representation of the subject matter in text, reading comprehension in science remains difficult for many students. As Snow (2010) stated, “The focus on details, the exclusions of ambiguous interpretations, and the complexity of

the vocabulary all present the reader with challenges different than those found in fictional texts.” (p. 450).

Krajcik and Sutherland (2010) related five principles that have reappeared in the science education classrooms they have studied which are consistent with other researchers’ findings. These five aspects reflect features of literacy that they deem important to integrate with inquiry science and are as follows:

(i) linking new ideas to prior knowledge and experiences, (ii) anchoring learning in questions that are meaningful in the lives of students, (iii) connecting multiple representations [e.g. visual elements with text], (iv) providing opportunities for students to use science ideas, and (v) supporting students’ engagement with the discourse of science. (p. 457)

The act of reading and comprehending science text, laboratory manuals, and other materials, in order to attain these five aspects, is a complex and difficult skill to perform for many students. Science texts are written so that prior sources of knowledge are woven together to produce meaningful arrangements eliciting understanding and intellectual capacity surrounding subject matter. This prior knowledge includes “words and word forms, sentence structure or syntax, text structures or genres, and topics” (Lee & Spratley, 2010, p. 3). Heller and Greenleaf (2007) spoke to the uniqueness of this weave in terms of the “hidden literacies--ways of reading, writing, talking, and reasoning” (p. 20), advocating that it should be used to inform the teacher as to how to facilitate increased literacy skill for the students (p. 20).

When engaging with text, individuals begin with a basic literacy understanding, progressing through an intermediate level of literacy, into a disciplinary literacy at the top of the literacy pyramid, thereby illustrating the uniqueness of each discipline (Shanahan & Shanahan, 2008). Norris and Phillips (2003) further elaborated on the distinction between fundamental (basic) literacy and derived (disciplinary) literacy by stating that if the fundamental sense of literacy is not attended to, the derived sense (in terms of science meaning) is actually inhibited. This lack of comprehension and deep meaning gives rise to complacency and impacts high stakes testing (O'Reilly & McNamara, 2007). In the area of science, several distinct issues come to the surface in terms of deriving text meaning: the specialized vocabulary and grammar structures, the absolute need for background knowledge, and the problematic math components and graph interpretation.

Specialized Vocabulary and Grammar Structures

Vocabulary, basic to science in terms of constructing meaning, can be a monumental impasse to learning. Estimates have shown that students are “required to learn on average 3,000 new words each year in science” (Grant & Fisher, 2010, p. 6), but the average Spanish I class exposes the students to a mere 1,500 words. Vocabulary comprehension and understanding the discursive writing styles that are exhibited in science textbooks are two of the important difficulties in interpreting densely written science texts (McTigue & Slough, 2010).

In addition, students need to be shown that each discipline has its own convention in terms of text structures and style that is very different from other disciplines or the way

language is used in an everyday context. Words in science can take on different meanings depending on the context, can be nominalized (transformation of a verb to a noun), and can have a remarkable amount of content words that are rooted in clauses (Fang & Schleppegrell, 2008; Shanahan & Shanahan, 2008). These linguistic problems present themselves when concentrated in short chunks of text, thereby compounding reading difficulty with comprehension problems. According to Fang (2010), science texts typically feature this type of lexical density, that is, a high number of content-carrying words (nouns, verbs, adverbs, and adjectives) per non-embedded clause. Additionally, the heavy use of modifiers used to describe nouns, often times in long strings, add to the informational density and the difficulty of unraveling the meaning. This type of written text, which is much different than the spoken word, makes the reading highly difficult, technical, and impersonal to readers. In the present educational climate, the teaching of grammar and sentence construction is marginalized in U.S. curricula, making it additionally difficult for students to construct meaning from scientific text. Training for teachers completed with an eye toward helping teachers to mitigate these difficulties in science text and science vocabulary, could possibly lessen student stress and help students comprehend technical material.

The Importance of Background Knowledge

Grant and Fisher (2008) noted that conventional comprehension strategies often cannot be successfully applied to this type of text and that background knowledge is almost always a missing link. Thus, scaffolding knowledge techniques become an

essential tool in terms of textbook and trade book comprehension (Alvermann & Hynd, 1995). According to Brunning et al. (2004), scaffolding can be described as “the teacher, as the more expert person, provides frames of reference and modes of interpretation that students are capable of acquiring but do not yet have” (p. 207). This is a direct reflection of Vygotsky’s Zone of Proximal Development and the underpinning of social constructivism. Science teachers who are aware of the importance of background knowledge for comprehension strive to constantly assess students as to their knowledge with an eye to augmenting it in the future lessons. Teachers can be taught to use certain strategies and tools to activate and build students’ background knowledge via effective professional development and other teacher centered training.

Connecting new words and concepts to previous everyday experiences or hands-on activities builds vocabulary and scaffolds past knowledge to encourage ongoing learning by bridging gaps in concepts and building comprehension. As this process continues, inferences and connectivity between knowledge bases build, and a real understanding of concepts occurs. According to Willingham (2009), critical thinking processes are intertwined with factual knowledge already present in long term memory, not just the stimulus in the present surroundings. Successful thinking is the result of knowing how to rearrange and recombine background knowledge with present situations. Rather than a perfunctory understanding afforded by rote memorization of facts and details, critical thinking requires that a solid base of knowledge is built upon which more knowledge will be added as the lessons in science progress.

Mathematics Concepts and Graphic Information

In addition to the background knowledge and the complexity of vocabulary, science students must also have an underlying understanding of mathematics concepts and an understanding of how to read and interpret a variety of graphics. Graphic information represents the integration of the written word and mathematical symbolic presentation of information and can expose the viewer to difficult upper-level thinking skills.

Lemke (as cited in Kelly, 2007) listed the multimedia tasks involved in a science lesson as follows: “the interpretation of the verbal discourse of the teacher and the other students. . . images from a calculator; overhead transparency and blackboard; writing, diagrams, and mathematical symbols; manipulation of demonstration equipment” (p. 458). Literacy techniques designed to help with comprehension of these discipline specific models raise understanding and further scaffold knowledge (Grant & Fisher, 2008). In addition, according to Slough et al. (2010), more research needs to be conducted to investigate the area of the “analysis of the type and quality of the graphical representations and how they interact with the textual material middle school textbooks” (p. 323). Professional development can provide ways and tools to strengthen students’ comprehension of texts, and content can help teachers understand their students’ challenges and equip them with tools and strategies to repair meaning from text and bolster their comprehension.

The Need for More Effective Science Education

Meta-analyses of education studies have shown that effective teachers have a critical impact on student achievement (Marzano, 2003). Darling-Hammond (2005) stated that effective teachers “engage students in active learning” (p. 3) in addition to “listening to and reading information, watching demonstrations and practicing skills” (p. 3). Engagement and motivation to learn are strongly intertwined and pivotal in the production of real learning (Quate & McDermott, 2009). As well as strong content knowledge, effective science teachers must also be skilled at helping students construct knowledge for themselves, thereby increasing motivation to learn (Banilower, Cohen, Pasley, & Weiss, 2008).

With this in mind, five more areas of research should be briefly discussed to add to the understanding of effective teaching in science and the role of reading and writing in knowledge production in science. These research areas are strongly correlated with the subject of reading in the content areas and are as follows (a) partnering of reading with science content teaching, (b) partnering the science of learning with science instruction, (c) the importance of increased comprehension in science, (d) the role of the Common Core State Standards and science education, and (e) the importance of motivating science students.

Disciplinary Literacy in Science

Perhaps the most glaring literacy misnomer, largely ignored, is that “learning to read” in the lower grades translates to “reading to learn” in the upper grades (Lee &

Spratley, 2010, p.2). It has been shown, however, that early reading skills do not automatically develop into more complex skills that enable students to deal with the specialized and sophisticated reading of the various content areas (Perle & Moran, 2005). As described by Plaut (2009), literacy in the upper grades is more than the basics of decoding and fluency in that it moves into a realm that offers students a certain freedom and the ability to deconstruct the written word with all of its nuances and construct meaning. Although it is true that at the secondary level teachers have the responsibility of teaching content material, it would be well to remember that “strong literacy skills and deep content understanding, are mutually interdependent and mutually reinforcing” (Plaut, 2009, p. 4). Within the constructs of the present educational structure, it is easy to understand why secondary content teachers shy away from the idea of being responsible for advancing literacy skills. Many content area teachers believe that teaching students how to navigate texts in different content areas remains someone else’s task, in part, because over the past century educators have been led to believe that if the right basic reading skills were provided, students could read anything (Dillon et al., 2011).

Additionally, in the present testing climate, new content standard areas are added continuously, adding stress to the already stretched time constraints (Ness, 2007). In a pre-NCLB study, Marzano and Kendall (1998) described a typical K-12 system as dealing with “the knowledge and skills these documents describe represent about 3,500 benchmarks” (p. 5). In addition to the testing pressures, tight budgets, full schedules, absenteeism and discipline problems add to a teacher’s load. Augmenting literacy in the discipline area needs to be addressed as a way to support science teaching and make

comprehension of the subject easier, not as an additional burden to an already overloaded teacher. Pearson et al. (2010) stated that

When science literacy is conceptualized as a form of inquiry, reading and writing activities can be used to advance scientific inquiry, rather than a substitute for it.

When literacy activities are driven by inquiry, students simultaneously learn how to read and write science texts and to do science. (p. 459)

Findings in an experimental design study examining the effects of a 10-day professional development (PD) in reading apprenticeship for biology instructors showed “increased support for science literacy and use of metacognitive inquiry routines, reading comprehension instruction, and collaborative learning structures compared to controls” (Greenleaf et al., 2011, p. 647). Also reported for those students whose teachers received PD was an increase in students’ state assessment scores not only for biology but also language arts and reading comprehension. A quasi-experimental study of randomly assigned middle school students was conducted by Fang and Wei (2010) to investigate the role of integrating explicit reading strategy instruction infused into inquiry-based science curriculum. The results showed that the class that had the infused reading treatment significantly outperformed those without.

Another study by Moje, Sutherland, Cleveland, and Heitzman (2006) illustrated the need for professional developers to focus more attention on the practices of integrated literacy teaching rather than to emphasize literacy strategies or concentrate on reading remediation. Integrated literacy practices were found to be necessary to increase the ability of students to augment learning from science text. In the study, it was also

explained that even though the participant teachers took up the techniques that were taught in the professional development , they “were taken up in ways that reflected the teaching of reading as an act separate from the teaching of science concepts, processes, and practices” (Moje et al., 2006). This indicated that the belief system of the teachers was rooted in seeing the literacy as a remediation tool for students who had lower reading and writing skills rather than a way to increase science comprehension and construct science knowledge for all learners throughout their learning career.

Cognitively, it can be seen that literacy frameworks in terms of activating and constructing meaning in reading are no different than in constructing science knowledge and meaning. Literacy activities that employ elements of effective instruction are derived from learning theory that is based on how people learn and have multiple outcomes such as motivation, eliciting prior knowledge, engagement, use of evidence to critique claims and sense making (Banilower et al., 2008). These learning attributes mirror good science learning strategies and are all moored on an anchor of good reading skills, which need to be modeled for students throughout their learning careers.

Partnering the Science of Learning With Science Instruction

According to Mayer (2011), learning can be described as “a change in what the learner knows caused by the learner’s experience” (p. 14). Learning takes place when applying certain principles like attending to dual channels (verbal and visual), understanding limited capacity and engaging in active processing. When the brain attends to the verbal and visual channels, the sensory memory for the ears and eyes are

engaged, and certain images and sounds are selected and sent on to the working memory. As described by Mayer, these sounds and images are organized into a verbal and pictorial model and are integrated into what is stored in long-term memory as prior knowledge.

This model is consistent with what is known in cognitive psychology to date and provides a working model for teachers to keep in mind as they select strategies to deliver their lessons (Bruning et al., 2004; Hays, 2007). In addition, a classic work by Paivio (1971) showed that an item is better remembered if it is presented as a picture rather than a word and that a concrete word, one that can be easily pictured, is much better remembered than an abstract word that can only be encoded verbally. Prior knowledge also plays an especially important role as it becomes the guiding factor that selects and organizes incoming information, thereby allowing more information to be held in the working memory, by organizing these many knowledge components into one single strand (Mayer, 2011). The engagement of selection, organization, and integration processes defines active learning and allows meaningful learning to take place. This learning is then encoded in long-term memory, and the process of learning continues.

In terms of actuation of this learning process, it is important to remember the role of limited capacity. In light of the previous explanation, it should be understandable that the above system of learning can only process small amounts of information at one time. This limitation has implications for teaching and implies that the learner must be selective in terms of attending to the relevant material, be given time to organize it into coherent depictions, then allow integration with prior knowledge before the sense-making can take place. This complicated procedure is known as active processing and can be

modeled and helped along with competent teaching using good strategies and tools that are suited for these processes.

In regard to this, Mayer (2011) described knowledge construction as “building cognitive representations” (p. 23) by the learner who is the “active sense maker” (p. 23) with the role of the teacher as the “cognitive guide” (p. 23). Willingham (2009) suggested that teachers should pay attention to their lesson plans with a special eye toward the actual cognitive work, making sure that lessons are not just strings of teacher explanation. In his opinion, students need time for real cognitive work and time for cognitive rest in order for the brain to deal with the limited working memory space. Shifting the pace through the use of various learning strategies in the classroom transfers the students’ attention back to the teacher or subject matter and gives time for cognitive rest. When performed correctly, this leads to the birth of self-regulated learners who are motivated to attend to their own metacognition and author their own meaning making.

The Importance of Increasing Comprehension in Science

The strength of these arguments puts tremendous weight on the professional education community to not only derive potent strategies to implement in the classroom but to redirect the minds of the secondary science educators working in 21st century classrooms. Heller and Greenleaf (2007) suggested that a high school diploma should signify at least three things: “the capacity to draw inferences from academic texts, synthesize information from various sources, and follow complicated instructions” (p. 5).

Although numerous studies have shown that generic reading comprehension strategies have value, researchers have conceded that competence in reading also requires the knowledge, proficiency, and reasoning ability to comprehend texts in the various disciplines (Heller & Greenleaf, 2007). Difficulty in comprehending science text can be directly related to the readers' inability to deal with the syntactic structure, the content and context, and/or the technical style (National Institute for Literacy, 2007). Good comprehension in science means that the student has been explicitly taught how to integrate meaning across grammatically difficult text interwoven with mathematical and graphical representations of information. "Good comprehension in science" infers that science teachers must be skilled not only in content area but must possess a repertoire of explicit instructional strategies that can move students of different skill levels through science content and teach them how to monitor their own comprehension.

Wellington and Osborne (2001) discussed the necessity to teach students to interact with a text in a structured and scaffolding manner, making use of strategies that activate and build upon prior knowledge. Mayer (2011) succinctly described instruction as manipulation that causes the student to have experiences that cause knowledge. Teaching disciplinary content knowledge and reading strategies concurrently narrows the comprehension gap and allows student to see the relevance of reading in conjunction with the learning process of the individual disciplines (Zygouris-Coe, 2010).

Science and the Common Core State Standards (CCSS)

The Common Core State Standards (CCSS) (2010) are a set of common standards that were drafted by individual states with the goal of giving all students the tools necessary to succeed and providing a consistent set of high standards for all across the United States. The CCSS were intended for English language arts and literacy in history/social studies, science, and technical subjects. In this way, literacy has been woven into each discipline, and the clear set of expectations outlined in these standards has been established to help ensure that all students are prepared to the same high level. The development of the core standards has been an attempt to measure all students across the country with an equal assessment system and encourage textbook developers to become more standard. Implementation of these standards will be complete by 2014.

The Common Core State Standards are dependent on high literacy skills. Some examples of skills that are included in the science area at the Grade 12 level are:

comprise citing specific textual evidence to support analysis of science and technical text. . . paraphrasing them in simpler, but still accurate terms. . . analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text. . . identifying important issues that remain unresolved. (Common Core Standards, 2010, p. 62)

As can be seen by these examples, the standards demand a high skill level in terms of comprehension and are not reflective of the rote memorization type of learning. This type of competency standard will require teachers to teach at a higher level and use various techniques and strategies to prepare all students to be able to engage at this level.

The Common Core Standards have been accepted by all but six states. It can be seen that training all content teachers in disciplinary literacy will only contribute to the success of the implementation of these standards and more importantly, to the success of the students.

The Importance of Motivating Science Students

Motivation is a baseline ingredient that must be present in order to engage in any mentally difficult activity. According to Willingham (2009), cognitive science shows that the human “brain is not designed for thinking” (p. 4). Much of the brain is designed for efficient control of the body functions and this it does very well. The action of thinking in terms of reasoning, problem solving, and dissecting difficult text passages, is much harder and slower for the brain. In regard to this, humans need to be motivated to engage in exercises such as these. This activity is further complicated by the need for the activity to be at a proper level of difficulty. Findings about how people learn compiled by the National Research Council (2000) illustrate that undertakings that are too difficult cause the learner to become frustrated, and tasks that are too easy quickly become boring and dull. To increase motivation, it is important that learners see that they can use the new information and apply it to other situations.

Increasing motivation is a complicated and individual process. Brunning et al. (2004) separated motivation into intrinsic (motivated by the activity itself and the satisfaction it gives) and extrinsic (motivated by an external reward). Classroom situations with multiple numbers of individual students make motivation of any student a

tricky task. The assignment of grades or marks of any sort to student work automatically attaches extrinsic rewards to work. For some students, this sort of reward is not enough to motivate, especially if these students have struggled with academics throughout their educational careers. For some students, this experience drives a student into thinking that they will never succeed. Dweck (2010) reminded educators that the mind is fluid and can change throughout life and that both teacher and student mindsets have a direct effect on student motivation and grades. Therefore, it is imperative that teachers promote a growth mind-set to students that encourages academic success, provides students with a classroom environment that promotes autonomous learning and well organized, meaningful instruction that contributes to self-efficacy (Brunning et al., 2004; Dweck, 2010).

Mayer (2011) relayed four components that support instructional motivation: (a) personal, (b) activating, (c) energizing, and (d) directed. The first component deals with motivation at a personal level internal to the student, and the second deals with activating a student's interest. When student interest is activated, the student can be energized into the third phase, thereby promoting an intensity and persistence to maintain a goal-directed aim to complete cognitive processes otherwise known as learning. This is the point of instructional strategies and tools. When a strategy or tool is used that is seen as personal, that can activate and energize a student to direct his learning, instruction can happen. When learning happens, cognition occurs that contributes to self-efficacy and an improved belief system and supports ongoing goal setting and attributions that contribute to continual learning (Brunning et al., 2004; Mayer, 2011). In this continuum, the teacher

plays an important partnership role with the student as they work together to achieve the learning goals and instructional objectives set forth by the teacher. Motivated students see that effort leads to success (Quate & McDermott, 2009). In this way, motivation serves to move students from the inactive learners that frustrate teachers to the actively learning students that teachers' desire.

Professional Development and Teacher Instruction

If content area teachers are going to be convinced to integrate literacy strategies into their instruction, "they must be extremely clear as to whom they are asking to take on which responsibilities for which aspects of literacy instruction" (Heller & Greenleaf, 2007, p. 16). It should be understood that these secondary teachers will not be responsible for basic reading skills. This aspect of learning should be left to reading specialists who are expert in that area. According to Zygouris-Coe (2010), "disciplinary literacy highlights the complexity, literacy demands, and differentiated thinking, skills and strategies that characterize each discipline" (p. 5). It can be argued that content area teachers are in need of good quality professional training that builds an ongoing content knowledge base. With this knowledge base, they can infuse a variety of literacy strategies that can be applied to their different discipline areas and reflect their self-imposed analysis of what is needed in their own teaching (Dillon et al., 2010). Well-planned and administered professional development can build confident and well-equipped teachers who can blend literacy instruction with their unique content area (Heller & Greenleaf, 2007).

A study involving 1,027 science and mathematics teachers rendered a large scale look at the effectiveness of certain professional development characteristics on teachers' learning (Garet, Porter, Desimone, Birman, & Yoon, 2001). Self-reported results showed that PD's focus on content knowledge, on giving teachers opportunities for active learning, and on making the learning activities coherent with one another and with standards, increases knowledge and skills, including classroom practices. Furthermore, Garet et al. (2001) considered the importance of structural features including the type of activity such as workshops and institutes, etc., the duration, and the collective participation. Results of this study showed that "sustained and intensive professional development" (p. 935), PD that focuses on "academic subject matter" (p. 935) that gives teachers "hands-on opportunities" (p. 935), and that is "integrated into the daily life of the school (coherence), is more likely to produce enhanced knowledge and skills" (Garet et. al., 2001, p. 935).

Moje (2008) took a firmer stand on this suggesting that "disciplinary literacy instructional programs" need to build into the discipline teaching structure rather than just encouraging content area teachers to apply literacy strategies to their various disciplines. Moje (2008), in company with Shanahan and Shanahan (2008), argue that applying strategies without taking the uniqueness of the various disciplines into consideration, are not deeply penetrating enough and do not adequately equip teachers with literacy tools. Because of the distinctive manner in which science learners arrive at constructing knowledge, literacy itself is shown to be indispensable to the learning process and can be

supported by a set of ‘tools’ that improve reading and writing in the content area (Moje, 2008).

The multiple dimensions of science teaching in terms of content knowledge use an interpretation of mathematical and graphical data, and may involve inquiry methods. This makes science professionals especially good candidates for opportunities to deepen pedagogical knowledge. Banilower et al. (2008) suggested that effective professional development is a vehicle for providing science teachers with opportunities to deepen understanding of how students think about concepts and ways to help students advance and improve their own instruction. Closing the science discipline literacy gap calls for high quality ongoing professional development which, by proxy, necessitates teaching professionals to view themselves as learning professionals (Heller & Greenleaf, 2007). This change in professional attitude about science specific reading instruction and the delivery of high quality training in some form could be the change factor that could alter perfunctory science education into making science more comprehensible to students.

High quality professional development for mathematics and science teachers should contain among its goals a tight link with contemporary learning standards and a vision for student learning in concert with a connection to the analysis of student learning (Loucks-Horsley et al., 2003). The framework for planning the professional development should include the beliefs and knowledge that support it: the critical issues associated with the design, the influential contextual factors, the different strategies that will be included in it, and the processes used to implement the professional development. According to Dillon et al. (2010), effective professional development provides an

evidence-based learning platform that is reflective of relevant research, is consistent with the needs of the teachers and the students, and is grounded in research that considers the adult learning process. Zemke and Zemke (1995) explained that adult learners who are presented with learning opportunities that are problem centered, relevant, realistic, contain feedback, and have transfer strategies built into them, are motivated to follow through with the professional development. These attributes of professional development help promote re-evaluation of learners' current information and patterns and promote the integration of information presented for future use.

Benefits and Challenges of Online Professional Development

The ideal professional development is intensive, job-embedded, and conducted primarily on-site (Wagner, 2003). According to Biancarosa and Snow (2004), when certain characteristics are built into professional development, it is the most long lasting in its effect. It needs to be built into the school schedule and use an adult learning format incorporating the newest research into contemporary practices. It should offer consistency in terms of opportunities for teachers to implement new learning in their own classroom, and it should contain a reflective component.

Online professional development has many advantages in that it (a) presents materials in a non-fragmented way, (b) fits with professional busy schedules, (c) offers work-embedded opportunities and support, (d) provides opportunity for immersion into subject matter, (e) improves ability of teachers to draw on a wide variety of resources and (f) gives participants the chance to reflect because of the asynchronous interactions

(Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009). It was with these advantages in mind and the goal of finding an effective delivery method to provide all teachers with an effective and comprehensive research based reading course that online professional development was constructed.

The challenges of online professional development can range from students working in “isolation” in their own environments to the constant pressure of time constraints connected with managing work, family, and continual training. Online professional development does allow adult learners to work at their own pace at their training while continuing to work on the job. However, a professional training that has a long term assignment, as did this reflective assignment, requires the adult learner to stay close to the schedule so as to not only be able to make the appropriate teaching changes, but also see the results of these changes in students. Also, because of the constraints of the online professional development, learners could feel alone and isolated in their work environments. Even though, there was access to online discussion boards and chat rooms, the learners had to make the effort to connect to these attributes. Connection to others is, therefore, a construct of available learner time and effort, which may or may not be followed up upon. One major time constraint in terms of learner understanding is the wait time connected to learner questions. Wait time can add frustration to the learner’s already full plate in terms of work and family life balance, thereby possibly undermining the online professional development’s purposes. It is possible that if teachers were provided with online professional development training in effective reading research and instruction, they could improve their instruction and by extension, student achievement.

These strategies have been tested and validated in various experimental comparative studies and found to be effective in the classroom (Robinson, McKenna, & Wedman, 2004).

Summary

In the present study, the researcher sought to find further support for providing science content area teachers with adequate training, tools, and time in the area of reading and effective reading instruction in the content areas. By doing so, they would continue to learn, reflect on their instruction and student learning, implement new insights about promoting student reading, comprehension, and learning, and would refine their classroom instruction. Perhaps, learning how to read and comprehend in science, can be shown to be a missing link in the broad landscape of developing scientifically literate students, and relevant integration of reading and science can be infused into middle school and high school classrooms to educate a new generation of scientifically literate citizens. As expressed by Metz (2012), “In this information age, the emerging synergy between science and language arts can only help prepare students to become better producers and more critical consumers of ideas” (p. 6).

Multiple topics have been presented in this chapter in an effort to contribute to the background understanding and validation of effective professional development activities and experiences that promote teacher reflection and instructional improvements from the Florida Online Reading Professional Development (FOR-PD) course for purposes of this research. Three possible lenses through which to view this research were introduced

using Vygotsky's lens of social constructivism, Knowles' theory on how adults learn, and Guskey's model for evaluating professional development. Research was reviewed regarding the present status of science reading and the upcoming demands that the Common Core State Standards will impose on teaching. High quality professional development was defined and discussed with specific emphasis on the benefits of online professional development. In the next chapter, the details of the methodology employed in this research are presented along with participant information related to the reflective assignments.

CHAPTER 3 RESEARCH METHODOLOGY

Introduction

This chapter contains a description of the methods and procedures that were used in conducting the study. The research design and research questions are presented, and the population and sample are described. The Florida Online Reading Professional Development (FOR-PD) program and teacher artifacts (i.e., the reflective assignments) are also detailed.

Research Design

According to Johnson and Onwuegbuzie (2004), qualitative data represents the participants “own categories of meaning” (p. 20) and instructional situations, thereby describing research in its particular contextual realm derived via a process of inquiry. Patton (1990) highlighted an overarching rationale for using inquiry design to inductively understand human experiences and holistically describe them in their unique context. Glesne (2006) described this inquiry paradigm as contributing to “ways of knowing” (p. 4) because it allows for the contextualization of issues “in their particular socio-cultural-political milieu, and sometimes to transform or change social conditions” (p. 4). These foundational comments about qualitative research form the basis of the rationale for the use of grounded theory that were employed in conducting this qualitative research study.

Rationale for Grounded Theory

Grounded theory is a qualitative method of research that allows emergent theories to be drawn directly from a researcher's data. More specifically, grounded theory is a methodological, dynamic, and systematic technique that progressively draws out nascent findings that eventually, via structured procedures, ends in theories grounded in the documents that are being studied (Charmaz, 2006). In their seminal work, Glaser and Strauss (1967) posited "that generating grounded theory is a way of arriving at a theory suited to its supposed uses" (p. 3) and was very much dissimilar to arriving at a theory via "logical deductions from *a priori* assumptions" (p. 3). Corbin and Strauss (2008) described the use of grounded theory as a way of "entering into the world of participants" (p. 16). In Strauss and Corbins' viewpoint, it was important to understand (a) how participants view an event and (b) that these events would be incomplete without being embedded in the context, emotions, and interactions that are experienced. In this way, grounded theory can be seen as a creative and reflective strategy that is rooted in a series of investigative tools that produce a representative theory.

Glaser (2001) further portrayed grounded theory as resolving a main concern. For this reason, it was viewed as an appropriate method to use to relate teachers' experiences with the online professional development and the effects of online professional development on their teaching. In addition, grounded theory, which is constructivist in nature, fit the paradigm of participant science teachers engaged in an online professional development who subsequently constructed meaning for themselves in terms of identifying and mitigating their own classroom challenges.

According to Stake (1995), most incidents of interest in education concern people or the programs in which people participate. In this qualitative grounded theory study, the online professional development program was of interest in terms of its ability to impact teachers' instructional practices. The teachers, themselves, were of interest in terms of how they implemented what they learned.

The core course assignment, the Reflective Assignment, served to capture participating teachers' instructional challenges, reflections about their instruction and student learning, and ensuing changes in their classrooms. This assignment represented the culminating project for a 14-week reading course that was steeped in research-based readings, discussion activities, and many reflective assignments. In addition, this final assignment involved an ongoing reflective process that integrated what the course was teaching into the participant teachers' own classrooms and the challenges found therein. The reflective assignment was an ideal document for which to use the grounded theory method to deduce participants' thoughts about the course, their own classroom challenges, and the ways in which the participants could address their challenges in terms of science reading.

Research Questions

The following questions were used to guide the researcher in this qualitative study. The researcher conducted a document analysis of the nine-week long instructional reflective assignments of online professional development participants in her search for answers to the following three questions:

1. What types of instructional challenges did middle and high school science teachers report they chose to work on as part of their professional development?
2. In what ways did middle and high school science teachers report they used to facilitate learning from the professional development to resolve their chosen instructional challenges?
3. Based on participating teachers' stated views, what changes did middle and high school science teachers see in their students after the instructional changes were implemented?
4. Based on participating teachers' stated views, in what ways did the professional development help middle and high school science teachers change and improve their instruction?

Since the fall of 2006, a reading in the content area course has been available through the State of Florida and could be completed by any teacher desiring to do so. This study targeted those science teachers who took and completed that course, thereby completing reflective assignments. Science teachers who completed reflective assignments as part of the requirement for the spring and summer of 2010 online professional development comprised the population from whom the sample was drawn. Of importance in regard to the population and sample is that this research involved a secondary data analysis. Though the science teachers took the course and completed the overarching work in the form of the reflective assignment, it was the reflective

assignments, not the online professional development participants, that were being investigated.

Sample

Using the 2010 timeframe as a criterion, a sample of 62 science teachers' reflective assignments were conveniently selected. There were several reasons for the selection of the sample. First, there was a need to study science teachers' needs and responses to this type of online professional development in order to determine what role reading might play in their everyday science instruction. Second, better understanding about how science teachers in the secondary grades interacted with the online professional development content, what their specific challenges were in terms of reading, and how they would implement discipline-specific strategies in their instruction, could be helpful in the modification or redesign of future similar types of professional development. Finally, because of the choice participation of only two semesters in 2010 from school districts that were spread throughout the Florida, this sample of science teachers was chosen from a possible large population representing many school districts across the state. It was possible, therefore, that this sample would represent a diversity in types of schools including middle, high, urban, magnet, and urban fringe schools and would reflect a microcosm of Florida schools.

Demographic Characteristics of Participating Science Teachers

The 62 teacher participants in this study taught only science. All teachers who taught multiple subjects or had multiple duties (such as instructional coaching) were removed to protect the perspective of science teaching in terms of training and delivery of instruction.

A total of 16 of the state's 67 counties were represented in the sample of science teachers who had completed the spring and summer 2010 online professional development course. Of the 62 teachers, 47 shared their resident counties with other teachers involved in the study. The number of teachers within those counties was tabulated for purposes of illustrating the distribution of participant teachers in this convenience sample across the state. Figure 2 shows that this convenience sample provided for a somewhat diverse sampling across the state in terms of school locations, environments, and cultural pressures, including diversity. It is interesting to note that the two largest groups of teachers come from the Orlando area and the Miami-Dade areas. These two areas represent large school districts with highly diverse populations in which English is not the primary language spoken at home. The only broad area in the state that was not represented in this study sample was the panhandle area of the state.

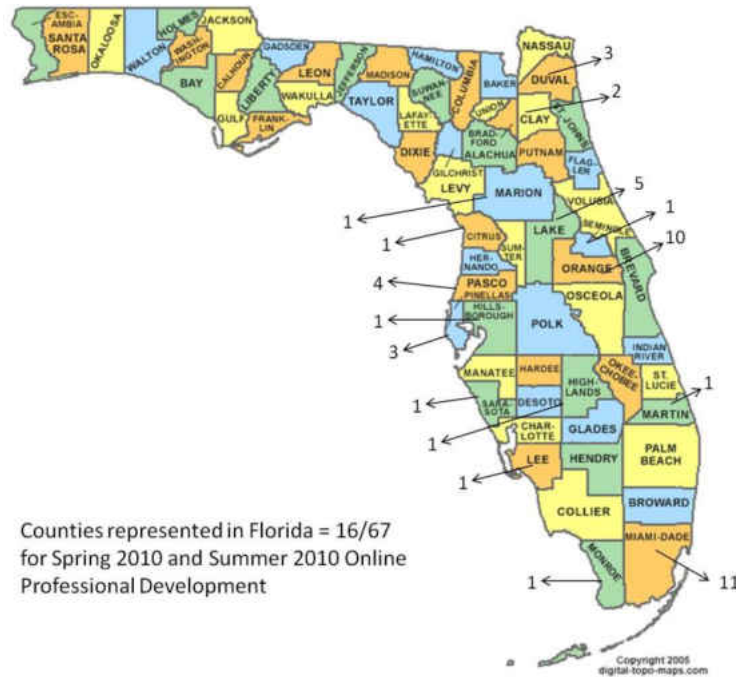


Figure 2. County representation of 42 participants' reflective assignments (N = 67)

Demographic characteristics for participants (i.e., gender, school level, and years of experience) are reported in Table 1. Of the 62 participants reporting, 22 (35.5%) were males and 40 (64.5%) were females. In regard to school level, 25 (40.3%) taught at the middle school level, and 37 (59.7%) taught at the high school level. Only 37 of the 62 teachers shared their years of experience. There were 27 (73.0%) teachers who had 1-3 years of experience, four (10.8%) teachers with 4-10 years of experience, three (8.1%) teachers with 11-20 years of experience, and three (8.1%) with 21 or more years of experience.

Table 1

Demographic Characteristics of Participants (N = 62)

Characteristic	Frequency	Percentage
Gender		
Male	22	35.5
Female	40	64.5
Total	62	100.0
School Level		
Middle School	25	40.3
High School	37	59.7
Total	62	100.0
Years of Experience		
1-3 years	27	73.0
4-10 years	4	10.8
11-20 years	3	8.1
21+ years	3	8.1
Total	37	100.0

Table 2 shows the science subjects taught by the 62 participants. A total of 15 (24.2%) indicated that they taught Science, the general name for many of the middle school science courses. The next largest number of teachers (10, 16.1%) indicated that they taught multiple sciences in their teaching schedule. Aside from those, the percentages were those one might expect to find in a typical high school for Grades 9, 10, and 11 with Integrated Science (this includes Levels 1, 2, and 3), Biology, and Chemistry evenly divided at eight teachers (12.9%) each.

Table 2

Subjects Taught by Participating Teachers

Subject	Frequency	Percentage
Science	15	24.2
Multiple Science	10	16.1
Integrated Science	8	12.9
Chemistry	8	12.9
Biology	8	12.9
Earth Science	4	6.5
Physics/Physical Science	3	4.8
Agri-Science	1	1.6
Anatomy/Physiology	1	1.6
No response	4	6.5
Total	62	100.0

Florida Online Reading Professional Development (FOR-PD)

The FOR-PD program was developed as a result of The No Child Left Behind Act (NCLB) of 2001, which created the need to address the literacy goal that would have every student reading at or above grade level by the year 2014. In response to this goal, FOR-PD was founded by the “Just Read, Florida!” office of the Florida Department of Education for the purpose of advancing the knowledge about effective reading research and instruction of Florida’s preK-12 teachers. By 2006, this course work extended into all content disciplines. This course provided an immersion in the relevant reading research and effective strategies that all discipline area teachers, including science, could integrate in their teaching. As previously discussed, the 14-week online learning module context was a good fit for professionals already working in their field in terms of sustained time on topic, relevance and integration to professional work, and conformation to professionals’ personal schedules. Additionally, FOR-PD helped to address the

literacy needs of teaching professionals that were inherent in the Common Core Standards that will eventually affect every course area.

Reflective Assignment Description

Qualitative research regularly uses text as part of data analysis. Charmaz (2006) defined two types of textual analysis that may be used as primary or secondary analysis: extant text and elicited text. Extant text is text that was not produced by researchers but is often used as a supplemental informational source in regard to the research questions. On the other hand, elicited text is text that a researcher requests from participants and can be in the form of interviews, journals, logs, or questionnaires. Murphy and Dingwall (2003) likened elicited text to interview data and by extension suggested that this type of data works best when the respondents have a stake in the topic and consider it relevant. In this grounded theory study, the reflective assignments represented an elicited response to a major assignment related to the participants' involvement in the online professional development. Therefore, this elicited assignment reflected the cultural and situational constraints and contexts of each individual science teacher participant and was appropriate for this study.

Rationale for the Reflective Assignment

Teaching reading well while meeting the reading needs of all students is no small feat. Reading is a complex process, and unfortunately, most students do not come to school with the adequate skills, preparation, or motivation to read. There has been much research conducted since 2000 showing that the teacher can be the catalyst for student

reading success and achievement (McConachie & Petrosky, 2010, Schmoker, 2011). For the online professional development final, culminating assignment, the participant science teachers were asked to think of an instructional challenge that they faced in their classroom and to use what they had learned from the course to address their own classroom challenges. According to Marzano (2003), effective teachers constantly examine what they do and how they impact student learning. Clearly, educators can gain from tangible and relevant experiences. Thus, applying what teachers learned through the online professional development to their own classrooms and school settings hopefully enhances the learning experience (Dillion et al., 2010).

Participant Artifacts.

Approximately 62 reflective assignments were analyzed from secondary science teachers who completed the FOR-PD course in spring and summer of 2010. The use of these self-reported artifacts, as determined by the University of Central Florida's Institutional Review Board was in compliance with the standards of study participant safety and privacy. This convenient selection of participants and their documents, as noted by Creswell (2009) could best inform the researcher so as to better understand the three research questions which guided this study.

Description of the Reflective Assignment (Artifact)

This core course assignment was developed by Dr. Zygoris-Coe (2009) as a means of providing participating teachers the FOR-PD with relevant implementation

experiences and time to reflect on their instruction and student learning. The assignment began in Week 3 of the course and ended in Week 12, allowing the development of the assignment to coincide with the learning and practice of the participants as they moved through the course. The professional development activities invited teachers to identify reading and comprehension challenges in their own classrooms, plan mitigation for these challenges, implement their plan, and reflect as to how the implementation worked. The assignment was divided into two parts as follows:

Part I: Identification and Description of an Instructional Challenge.

- Instructional challenge pertaining to reading.
- Current state of reading instruction in my classroom and/or school.
- Description of challenge and steps taken so far to produce desired results.

Part II: Implementation of a Plan of Action, Reflection, and Next Steps.

- Development of plan of action (including rationale).
- Results of the plan of action (lesson plan, thoughts, observations, and questions).
- Reflection of decisions made during implementation of the plan of action.
- Impact of the plan of action on students, school, classroom, or teacher.
- Next steps and unanswered questions.

Specifically, as part of the reflective learning assignment, participants had to assess what they had learned in the online professional development in terms of the

research readings and discussions that followed, and concentrate on what was happening in their own classrooms. What were the challenges that were specific to their students in their specific subject matter? How could they take what they had learned about literacy and apply it directly to their discipline in their unique school and classroom environment? How did those specific things help or hinder learning and what was the effect on the students? This specificity provided an opportunity for the teachers to adjust and apply what they learned to their own learning environment, enabling them to give direction, specific meaning, and value to their own learning. The specific instructions that were given to the teachers during the online professional development are contained in Appendix A.

Researcher Bias

Researcher bias is an unavoidable phenomenon that affects all research. This researcher's background contains 10 years of teaching in the classroom at the high school level. Six years were spent with ninth graders, four with juniors who were largely disenfranchised from school, and 10 years were spent with higher level physics students. The difficulty with reading technical text became apparent during the first year of teaching; however, I had no idea how to remedy the situation, nor did I have resources with which to address the situation. Frustration with students' inability to extract information while reading from the text and during laboratory tasks, was a continual theme in my teaching experience.

In terms of this background, I came to this topic ready to seek answers. At the beginning point of the research process, I had already read much about reading and the difficulties that are seen, particularly in science. These factors may have already biased me in terms of reading into the teachers' own frustrations when describing their own difficulties with students. Because of this background and because of the change to the role of researcher, there was an attempt on my part to step back and try to read only the words that the teachers used in their own writing. In that process, categories very often turned into common phrases or words that the participants used. The same process was used to describe themes. An attempt was made to use words or phrases that the participants used but that would define all the categories that could be gathered into that particular theme. It is also useful to note that this thinking and use of words and phrases may be particular to the enterprise of teaching and/or even to science teaching.

Additionally, much of the professional development that I received as a teacher was short and never revisited again. This has biased my viewpoint of professional development in general. However, I never participated in an online, sustained, and job-embedded 14-week long professional development such as the one I researched. Therefore, my viewpoint was fairly open to receiving and recording what the participants experienced. A real attempt was made to only record the words that the participants used to describe their experiences. Most of these can be found in the viewpoints discussed in response to Research Question 4.

Data Collection

This research was supported through the Institutional Review Board (IRB) coverage that served the online professional development course and extended itself to all research documents that resulted from the online professional development. This coverage ensured that this research project was in compliance with the standards of study participant safety and privacy. Appendix B contains documentation regarding both recorded and written data that encompasses this human factors research.

The science participants' RAs were extracted from informational spreadsheets from spring and summer of 2010 that contained each semester's participants and coursework in the online professional development. Individual self-reported demographic data for the participants were compiled and coded on a separate spreadsheet, after which time any identifying participant information was destroyed. The researcher then completed a preliminary read of all of the 62 reflective assignments to gain a basic insight into the participant thoughts before any reflective assignment coding began (Creswell, 2009).

Data Analysis

The process of conducting grounded theory can vary widely. This research study followed the data analysis process proposed by Charmaz (2006) and the researchers, Corbin and Struss (2008). According to Charmaz, this type of analysis is generally accomplished by treating the data in the manner explained in the following paragraphs.

The Process of Conducting Grounded Theory

The first element of Charmaz' process of conducting grounded theory involved constant comparative analysis, a method that sorts and synthesizes data. Through an inductive process that compares data to data, data to categories, and categories to categories, abstract concepts and theories emerge. Glaser and Strauss (1967) defined the basic rule for constant comparative method as "while coding an incident for a category, compare it with the previous incidents in the same and different groups coded in the same category" (p. 106). Constant comparison of the data allows the researcher to attach codes, e.g., labels, to segments or chunks of the data. More specifically, coding means putting segments of data under short headings that allow the researcher to separate data into an analytical accounting of that data. This coding process self sorts and distills the data, while still allowing comparisons to other data. These comparisons, which lead to themes that the data produce, slowly allow the emergence of clearly defined categories.

Coding, according to Charmaz (2006), is divided into at least two stages. An initial coding or open coding remains very close to the data, coding it closely with what the data actually states. The researcher's mindset should remain open to what the data is saying. A more focused phase "uses the most significant or frequent initial codes to sort, synthesize, integrate, and organize large amounts of data" (Charmaz, 2006, p. 46). This phase allows the researcher to identify categories and move toward thematic outputs of the data (sometimes called axial coding).

A subsequent important step in the coding process is memo-writing or memoing. Glaser and Strauss (1967), viewed memo-writing as an important tool in tracking passing

thoughts about the data that were being collected and coded, as the researcher moved through the stages of grounded theory. Corbin and Strauss (2008) further describes this process as a necessary tool that allows the researcher to step back and look at the larger picture of what the data are saying to the researcher before proceeding to the next steps. According to Charmaz (2006), memo-writing is a critical step performed frequently between the data gathering step and the writing of the draft.

Memo-writing is a constant analysis completed by the author in an attempt to critically analyze the codes and categories that emerge as to how they best represent the work that has been reviewed. This allows another important step, the emergence of categories early in the work which forces the researcher to pay constant attention to the persistent production of intangible ideas that guide the direction of the research, develop categories, and eventually yield themes.

Another step is saturation of the data in terms of sampling that occurs when the researcher is satisfied that no more information is emerging. At that point, the “major categories show depth and variation in terms of their development” (Corbin & Strauss, 2008, p. 149).

Finally, although true total development may never really occur, there will come a point at which the researcher will feel assured that enough data were sampled to ensure a deep understanding of the phenomena and a well-defined connection between the categories. It is at this point that an analysis of the representative categories will climax in a grounded theory or theories about the research questions.

It is important to mention the freedom and flexibility that grounded theory can bring to research. Corbin and Strauss (2008) emphasized that the primary goal of qualitative researcher is to enter the participants' world and to represent that world as accurately as possible. Performed correctly, meaning is attributed to the participants' experiences, and new knowledge can be extracted from these experiences for the benefit of others. It was with the guidance of this framework that this research was conducted.

Theoretical Sampling

In many cases a point of saturation is not reached with the data at hand, and this necessitates the need for more data. To Glaser & Strauss (1967) this meant that the researcher must ask certain questions about where to turn next for data appropriate for collection. To Charmaz (2006), theoretical sampling meant "seeking pertinent data to develop your emerging theory" (p. 96). Theoretical sampling in grounded theory is based on two conditions: (a) what it is that the researcher is looking for; and (b) the purpose of the research which, in turn, affects the way the research is conducted (Charmaz, 2006). Theoretical sampling is consistent with the goal of grounded theory in that continuously emerging data portends the direction of the study. Theoretical sampling is not a random selection process or a sampling of a representative population. It is driven by what emerges from the data, and its ultimate goal is to develop each category to saturation. Because of this, researchers may be required to seek other avenues of data in order to fully define the boundaries of their research questions. In this research, however,

saturation was achieved after all 62 reflective assignments were completely examined and all researched questions were completely addressed.

Evaluation: Quality and Verification Issues in Grounded Theory

Issues surrounding the quality of grounded theory are immersed in the concept of validity and verification in grounded theory research. Basic use of a series of methods provides a framework that promotes a quality study including synchronized data collections with constant comparative analysis, the use of theoretical sampling, and routine memoing in conjunction with the coding process to extract themes (Elliott & Lazenbatt, 2004). Grounded theory is progressive in nature, always moving on to new data or data sources to test the accuracy of the findings. This process is constructivist in nature and can be differentiated from the objectivist's verification process. The objectivist's view is rationalistic and demands rigor, whereas the constructivist's viewpoint values trustworthiness as its' standard (Creswell & Miller, 2009; Morse, Barrett, Mayan, Olson, & Spiers 2002). Rigor for an objectivist can be described in terms of internal and external validity, reliability, and objectivity. In Glaser's viewpoint, this objectivity is exemplified by a researcher's distance that keeps the data separate and largely untouched by the researcher's viewpoint and interpretation (Glaser, 2001). Others have found this kind of objectivity realistically impossible and have suggested that the focus should instead be on sensitivity (Corbin & Strauss, 2008).

In the constructivist viewpoint, qualitative research is guided by the trustworthiness of the research, that is the extent to which the research results are fit,

auditable, and confirmable (Guba & Lincoln, 1981). Guba and Lincoln further defined trustworthiness as being accomplished by certain activities that include peer debriefing, member checking, prolonged engagement, persistent observations, and audit trails. Yin (1994) concurred, defining trustworthiness as the criterion to enable a research design to be tested. In this regard, the most significant ways to uphold trustworthiness is to be a knowledgeable researcher, listen to the data, work deductively, and use research directives strategically to drive decision making in the process (Morse et al., 2002). Furthermore, according to Morse et al., verification strategies that authorize both the validity and reliability of data must be built into the research process. These researchers believed that “investigator responsiveness, methodological coherence, theoretical sampling and sampling adequacy, an active analytical stance, and saturation” (p. 17). In this case, attention to and listening to the data, working deductively, and attending closely in terms of the participants’ input for each separate question, allowed categories and themes to emerge naturally. Attention to methodological procedures and a large participant base allowing saturation helped build in validity and reliability. In addition, rigor was established through the use of an internal auditor (the writer) and an external auditor (dissertation chair). This was accomplished through frequent meetings during the coding and category separation process and again when the focus was on theme construction. During these meetings, data were reviewed, categories were mutually agreed upon, and themes were constructed based on the participants’ comments as reported in their reflective assignments.

Corbin and Strauss (2008) expanded on personal researcher conditions that ensure the development of “quality” research. The first condition was methodological consistency, which demands that the researcher be trained in conducting research, have a clear goal as to the purpose of the research, and maintain self-awareness to keep biases in check. Other qualities of researchers that enable them to do quality work include a sensitivity to the work, an openness to the creativity and decision-making that the work demands, and a willingness to work hard. Corbin and Strauss (2008) also stressed the criteria that determine the quality of grounded theory research. These criteria include: (a) the fit or the extent to which the research fits the participants or situation, (b) the applicability of the results of the research, (c) the substance of the findings, (d) the contextualization of the findings, (e) the logical flow of ideas, (f) the depth of the findings, (g) variation in the findings that demonstrates complexity, (h) presentation of the findings in a creative and/or innovative manner, (i) presentation of sensitivity to the participants and data, and (j) support of findings via evidence of memos. In regard to these criteria, the methods employed to gather category data that later became themes logically flowed out of the participants’ comments. These comments were organized into logical tables that allowed a more meaningful presentation of what the participants talked about. Accompanying each table, narratives explaining the participants experiences and comments, allow participant ideas to be fully expressed.

Charmaz’ (2006) list of quality grounded theory criteria was more concise but still corroborated the terms of Corban and Strauss (2008). For Charmaz, “credibility, originality, resonance and usefulness” (p. 182) described the conditions that the research

must attain in order for the highest value of it to be attained. Accordingly, for Charmaz, the addition of original research to credible research increased the resonance of the research, thereby increasing its value and scholarly contribution.

Data Development and Analysis Overview

From the beginning of this research, the data were organized using separate spreadsheets delineated as middle school (MS) and high school (HS). In this data set, there were 37 middle school and 25 high school participants who produced 62 reflective assignments (or teacher artifacts) encompassing approximately 256 pages. Demographic data were collected from each participant, and all names and other identifying information were removed. The participating teachers' responses to Part I of the reflective assignment were separated from their Part II responses and transferred to their own middle and high school word documents. An Excel spreadsheet was initiated and designed to have four pages, one page per research question. These pages, eight in total, were separated as was the high school and middle school participant information. The pages were structured to bring together all the categorical and thematic information gathered from the grounded theory analysis. Whole phrases were color coded (as per grounded theory protocol) and later copied from the word documents containing the participants' reflective assignment responses. These phrases were then pasted into the Excel spread sheets using the appropriate research question-response page underneath the category names as they emerged. This Excel information was then analyzed (column additions) and graphically displayed using the available Excel features. Percentages were

calculated independently and added to the appropriate tables and figures. This provides a better picture of how many teachers behaved in the same ways or had the same feelings about certain events. This can be interesting in the discussions that compare and contrast the results of middle school teachers to high school teachers.

Part I of the reflective assignment addressed Research Question 1 dealing with the challenges that teachers experience in their classrooms. Part II addressed Research Question 2 as to how middle and high school science teachers used learning from the professional development to resolve their chosen instructional challenges; Research Question 3 focused on the changes middle and high school science teachers saw in their students after the instructional changes were implemented; and Research Question 4 sought information on the ways professional development helped middle and high school science teachers to change and improve their instruction. The word documents facilitated easier reading and color-coding according to the reflective assignment question responses.

In the interest of making the analysis easier to comprehend, three divisions of the analysis are described. Before any coding began, a quick overview of the reflective assignment responses, by way of independent word searches, was conducted to provide insight as to important key words and concepts in the teachers' thinking. For this research, this was referred to as a Level I analysis. To complete the Level II analysis, the reflective assignments were read and coded to identify categories as specified in grounded theory practice. A third level of analysis, Level III, permitted the emergence of

themes from the categories. Figures and tables have been used throughout Chapter 4 to graphically display and support accompanying narratives.

Throughout the Level II analysis, reading and coding of the documents went hand in hand, analyzing one research question at a time, moving from one participant to the next, and comparing their comments, one to another as much as possible. The reading and coding were performed in long stretches of time so as to better support comparative analysis. Because the categories were many, saturation was satisfactorily reached for each question upon arriving at the end of each of the high school and middle school groups. Combining these groups' data yielded a realistic saturation result in terms of the numbers of participants. Later these color-coded sections of text were transferred to spreadsheets in the categories as they arose from the text. After all the coding was transferred into the appropriate categories and numeric data pertaining to the categories were tabulated, figures were created within the Excel program to display the results of the analysis for each for each research question and for middle and high school reflective assignments separately.

Having established the categories, Level III of the analysis was initiated to determine themes. For Research Question 1, challenges naturally fell together into themes based on the major areas that teachers identified as challenge areas, e.g., reading difficulty and vocabulary. For Research Question 2, categories were combined into themes based on the teachers' use of instructional categories as these naturally fall into certain themes, e.g., vocabulary development, instruction, comprehension development. For Research Question 3, themes were based on teachers' perceptions of changes

observed in students. For Research Question 4, themes were based on changes the teachers saw in themselves. Tables and figures were constructed to show how the categories were used to identify themes. Individual middle and high school thematic figures were also combined to illustrate the overall effect for the two groups. This display of separate and combined figures allowed for a more complete comparison and picture of middle and high school education as it was impacted by professional develop.

Limitations

The limitations in this study range from the chosen mode of research to issues associated with the sample and difficulties with online professional development in general. Limitations in grounded theory have much to do with the methods that the researcher uses and how stringently the researcher adheres to the direction that memo-writing stipulates. Researcher attention to analysis, in terms of side-by-side comparison, accurate coding, organization of the coding into relevant categories and eventual themes, is the foundation of grounded theory (Charmaz, 2006; Corbin & Strauss, 2008). The researchers' previous knowledge of and bias regarding the subject matter may impact the coding and influence the production of the themes. The extent to which the researcher can apply theoretical sampling can minimize this bias, but extensive theoretical sampling cannot always be applied. In this research, the document analysis of the elicited reflective assignment during a specific two-semester period could have been limiting. However, the researcher was prepared to add more data from other semesters if the need arose. The fact that the document analysis was completed through the comparative

analysis of 62 documents of science teacher participants was anticipated to generate rich data with sufficient depth to produce good representative theories.

As previously mentioned, sample selection was limited to science teachers enrolled in only two sections of online classes. This limited the enrollees in terms of number and geographical spread across the state. It follows, therefore, that the artifact analysis was limited to the artifacts alone for this group of teachers. Also, because this group of participants was drawn from the spring and summer sessions, the parts of the analysis that dealt with the impact of mitigations on students or teachers could only be answered by the spring group who could actually implement their plans fully. In addition, the online professional development and the reflective arena in which the individual science teachers took up their work could be construed to be work completed in isolation. Discussion with others about teachers' work within the same school building and environment was limited to those who were taking the same online professional development. How well these segregated and insulated teaching situations apply to the whole of secondary education across the district or even state could be considered to be over-reaching by some individuals (Dillon et al., 2010).

Another limitation to consider is that there were not student artifacts to tie to the teachers' reflective assignment. The articles were teacher-reported descriptions of their own teaching challenges and choices they made to remedy their own classroom instructional difficulties. In addition, no participant interviews, surveys, or focus groups were conducted with which to triangulate information. The grounded theory produced emerged from the analysis of the reflective assignments alone.

Summary

This chapter has provided a description of the methods and procedures used to conduct the study. The population and sample have been detailed, and the data collection and analysis procedures have been explained. Chapter 4 contains a summary of the results of the analysis.

CHAPTER 4 DATA ANALYSIS

Introduction

Using the grounded theory process and the three levels of analysis described in the previous chapter led to the identification of various categories and themes. The grounded theory process that was used flowed naturally from the capture of the participants' comments into spreadsheets to a more formal assignment into categories via open coding (Charmaz, 2006; Corbin & Strauss, 2008). Like categories were then gathered into themes that best described the participants' thoughts and experiences. There was a real attempt to withhold researcher bias and place the data into categories and themes according to the mindset of the participant. The coding work was completed in fairly long continuous sessions so as to minimize loss of the train of thought. An attempt was made to capture the comments of the participants within the narrative of the results.

This chapter contains the results of the data analysis for each level. The chapter has been organized around the three levels of analysis: (a) Level 1, word search; (b) Level II, identification of categories, and (c) Level III, emergent themes. Tables and quotations from the participants supplement the narratives in response to each research question. In addition, Appendix C contains visual displays of the data to further a deeper understanding of the data. Both separate and combined thematic results are presented for middle school and high school. This gives insight into the specifics for each education

level as well as a general view overall for the secondary level. A comprehensive summary of the findings of the study concludes the chapter.

Level I Analysis: Overview of Words/Phrases

Teachers' Instructional Challenges

The Level I analysis was completed with an eye towards the overall feelings and mindset that the teachers possessed when they thought about their classrooms and wrote their reflective assignments. It was conducted after a cursory reading of approximately 30 of the 62 reflective assignments via the application of a tool in NVivo (under Query/Explore/Text Search). Eleven words and/or phrases that were thought to be apropos for this research were searched through both sections of the reflective assignments (Parts I and II). Table 3 displays the results of this search. See also Appendix C, Figure 4.

Table 3

Teacher Challenges Found by Word Search

Searched Words/Phrases	Frequencies of Searched Words in Reflective Assignments (RA)	
	RA I	RA II
FCAT	69	34
Lack of time	97	203
Wasted time	74	181
Lack of vocabulary	217	352
Reading problems	577	971
Lack of comprehension	76	187
Lack of prior knowledge	67	191
Lack of print-rich environment	39	93
Increase incentive to read	250	424
Adapt lesson plans	41	92
Discipline problems	9	16

It is interesting to note that the largest instructional challenge that was repeatedly mentioned and discussed by teachers was the category, “reading problems” which registered 1,548 mentions. The fact that it was mentioned 394 more times in the second part of the reflective assignment was significant, because it was this part of the reflective assignment that related to how teachers dealt with their classroom challenges. The reality that “reading problems” were the biggest problem for teachers in this study underlies many of the other problems. As shown in the figure, the second largest phrase mentioned was to “increase incentive to read.” This goes hand in hand with the previously discussed “reading problems” and with the next most mentioned problem, “lack of vocabulary.” It is worthwhile to note that the fourth most mentioned challenge dealt with teachers’ “lack of time.” In the reflective assignment readings, this was often talked about in concert

with “wasted time” and “High Stakes Assessments,” which in these cases were the Florida Comprehensive Assessment Test (FCAT). The fact that those pressures can often drive how the time is spent in the classroom explains why these things were sometimes mentioned with the underlying emotion of frustration. Another interesting finding was the last challenge listed: “discipline problems.” This is interesting because it was a lesser concern. “Discipline problems” registered only 25 mentions in comparison to the 1,548 “reading problems” and 569 “vocabulary” declarations. This means that the teachers in this study found the other 10 challenges to be much more problematic than discipline.

Teachers’ Feelings About Teaching

The other word and phrase search that was executed before the grounded theory methodology commenced concerned the teachers’ feelings about teaching. As shown in Table 4, only two words and one phrase were proposed for this search. See also Appendix C, Figure 5.

Table 4

Teachers' Feelings About Teaching

Searched Words/Phrase	Frequencies of Searched Words in Reflective Assignments (RA)	
	RA I	RA II
Stress	2	4
Frustration	4	5
Students don't know what to do	876	2,297

The results showed a very low count for two words that are occasionally heard in discussions about the teaching profession, but as evidenced in these teachers' reflections, they were not often addressed. These two related words, "stress" and "frustration" were counted only six and nine times, respectively. More taxing to the teachers than these words was the phrase "students don't know what to do." This phrase was counted 876 times in Part I and 2,297 times in Part II for a total of 3,173 mentions. This is significant and trenchant in terms of how these teachers perceived their classrooms, instructional issues, and school culture. Students who "don't know what to do" in the classroom, and more specifically in terms of reading and comprehension within their science classrooms, cause a breakdown in the relationship between text, laboratory procedures, and general learning. This phrase can be quite illuminating in terms of the level of critical thinking skills that these teachers saw in their students and could explain much in terms of the gap between student skills and teacher expectations.

Level II Analysis: Categories

Categorical Analysis of Instructional Challenges

The next step in the data analysis concerned applying grounded theory analysis to the reflective assignments in order to group the instructional challenges teachers reported having experienced in their classroom environments. This information was used in responding to Research Question 1, "What types of instructional challenges did middle and high school grade science teachers choose to work on as part of their professional development?" Data were divided for middle school (MS) teacher group of

25 teachers and the high school (HS) teacher group of 37 teachers. As shown in Table 5, the categories registered were varied but also quite similar for this grade range of six to seven years. (See also Appendix C, Figures 6 and 7.)

Table 5

Instructional Challenges in Categories

Instructional Challenges	HS <i>f</i>	Instructional Challenges	MS <i>f</i>
Comprehension	18	Comprehension	11
Vocabulary	15	Vocabulary	11
Read below level	11	Increase incentive to read	8
How to motivate to read	10	Difficulty reading	7
Text above reading level	2	High stakes assessment	3
More effective use of text	2	Issues-technological text	2
Connect to world	2	Reduce wasted time	2
How teach both?	1	Lack of prior knowledge	1
Do not care about school	1	Lack of time	1
Time	1	Struggle to make print-rich	1
Frequent absence	1	Adapt lesson plans	1

Note. HS = High School; MS = Middle School

It is interesting to note that in both the middle school and high school levels, comprehension and vocabulary were the two highest ranking categories. For high school teachers, comprehension ranked as the greatest challenge and vocabulary was the second greatest challenge. In the middle school classrooms, however, they were equal challenges. Equally notable was the third highest category, the “Read below level” category, on the high school figure, which supports the higher ranking comprehension problem. It is interesting that these teachers knew that their students actually read below the level that they should or that the text they were using was too difficult, as indicated in

the first category of the chart. “Difficulty reading” falls to the fourth problem on the middle school figure, surpassed by the problem of “Increase incentive to read.”

The difficulty in reading as discussed by the teachers in their reflective assignments show two sides of the problem that could be tied to the age difference of the students. In middle school, some of the students are still receiving reading instruction in classes, but this is not the usual case at the high school level. One middle school teacher highlighted her problem in this way:

. . . getting them to implement the reading strategies they are learning in their reading classes into my science class. The students do not stop at punctuation marks, they read as if they are running a race (50 yard dash), they stumble over big words or they just simple skip the word.

Another middle school teacher put his problem like this: “Challenges I have been facing with my students is they don't know how to read their textbook and pick out the main ideas and details to write in their notes.” Yet another described the reading difficulty issue in terms of the vocabulary issue that inhabits the same challenge by saying, “Challenges that I face is that my student[s] shy away from reading cause their thought is ‘Science is difficult to read with all the “big” words.’” This middle school teacher related textbook problems by saying, “Sometimes I go insane trying to find creative ways to keep them from being intimidated by the text book.” This quotation from a high school teacher shares similar thoughts of their students, “Students feel very overwhelmed by their text and show great disdain for it entirely.” One high school teacher stated that the book that had been purchased was written at a higher level than the

students were capable of reading. Far more prevalent in the high school teachers' comments was the fact that students just read below the level at which they should be reading. For example, another teacher connected all the dots in his teaching experience in this manner:

. . . [Students] that are not on grade level or have received low reading scores on the last FCAT test that they have taken. I find that most of the ones that are at low reading levels cannot connect the words to comprehend the ideas or topics.”

These high school science teachers represented all areas of sciences taught, not just the lower level courses. This Chemistry teacher shared insights as to the challenges he deals with as follows: “Contrary to what I thought I was going to do, I was not just going to teach chemistry, but I had to teach these students how to read and write English.”

Another high school teacher related the reading challenges she saw, “I was shocked at the number of students--even in my honors classes--that cannot read at grade level.” These quotations lend a certain understanding to what was happening in these teachers' classrooms and prompt the question as to how teachers can teach an already difficult subject in terms of content when engagement of their students in the textbook is already very much hampered.

High school teachers fared no better in terms of their struggles with comprehension and vocabulary. One high school science teacher found that “Many times students know the answer but do not understand what is being asked of them; many times students do not understand what they read” Another high school teacher highlighted his students' problems with comprehension by stating that “What I quickly discovered

was that even though they can read the words, they really don't comprehend very much of it at all." This high school teacher described a common frustration into the difficulties of teaching to the various levels of reading ability in his classroom stating that ". . . higher level students who are quick with their reading but get caught up with the memorizing of the new vocabulary; lower level students who struggle with some basic vocabulary due to either low motivation or language issues."

Vocabulary at the high school science level was also shown to be a big issue. In most high school science courses, teachers try to present students with the vocabulary they need to know to be able to get them ready for technical school or college courses. As one physics teacher noted, "Many terms in physics and science in general have very specific meanings that do not translate to outside world use." Overall, perhaps the best quotation to represent how high school teachers felt about the vocabulary and comprehension issue was as follows:

My challenge is that although the students are learning the vocabulary, it is not necessarily helping them in reading the text book. I have a really hard time getting my students to find answers to questions in the text that requires them to put several ideas together.

This motivation to read challenge was also a major challenge for high school teachers, showing up in a close fourth position behind students reading below the anticipated education level. One high school teacher reported his challenge this way: "What I find challenging pertaining to reading is the lack of motivation from some of my students--who no matter what I do to encourage, motivate, and even threaten with

consequences, will do absolutely nothing.” Another reported, “I have an issue with students even opening their textbooks let alone reading them. They are just not motivated to do so.” Yet a third stated, “There just doesn’t seem to be enough time to motivate each student about their reading.” All of the rest of the challenges of high school teachers were seldom reported and were definitely subordinate to the four top-ranked major challenges. This was also true for the middle school data, as the rest of the challenges were only reported between one and three times each. Thus, these two educational levels were very much in agreement with each other in terms of the greater and lesser challenges that were found in each of the 62 classrooms represented in the reflective assignments.

Some of the lesser challenges may be more tightly tied to the grade and student maturity issues. For example, at the middle school level, “Lack of prior knowledge” was listed as a challenge but was not mentioned at the high school level. This may be because of the lack of emphasis on science in the lower grades. Additionally, after three years of middle school science, background knowledge may not be as much of an issue for higher grade levels of science as it relates to the high school challenges reported. Other lesser challenges noted from the middle school teachers were issues that centered on making the classroom environment more print-rich and learning how to better adapt lesson plans. At the high school level, trying to connect the subject matter to the real world was mentioned as a challenge along with issues dealing with effective use of the text. In addition, two issues mentioned by high school teachers were “Frequent absences” by their students and some students “who do not seem to care about school.” One high

school teacher was concerned with how to teach literacy skills to students in addition to their subject matter. Teachers at both levels indicated issues with time. One middle school teacher put it this way: “I want to learn more about how to manage groups working together, to reduce the amount of time they spend off topic. . . .” Another stated, “First, I am unable to compensate for time of each class. This is due primarily to deadlines set in the form of FCAT administration.” It is obvious that the additional pressure of high stakes testing impacts all middle school teachers. Thus, the use of time is an issue teachers live with on a daily basis.

Categorical Analysis of Instructional Challenge Mitigations

Research Question 2, “In what ways did middle and high school science teachers use learning from the professional development to resolve their chosen instructional challenges?” was designed to elicit data on the ways teachers chose to alleviate the challenges and issues that were presented to them. Interestingly, the number of mitigation categories chosen for each data set was almost equal with 27 categories for middle school teachers and 24 categories for high school teachers. As displayed in Table 6, this indicates that a wide variety of instructional tools were chosen to help teachers resolve their challenges throughout the secondary level. (See also Appendix C, Figures 8 and 9).

Table 6

Mitigations of Instructional Challenges

Mitigations of Challenges	HS <i>f</i>	Mitigations of Challenges	MS <i>f</i>
Modeling (Think-Alouds)	19	Modeling (Think-alouds)	13
Vocabulary development	18	Vocabulary development	13
Utilize word walls	18	Graphic Organizers	11
Graphic organizers	18	Use/create word walls	10
Collaborative learning	14	Read-alouds	8
Journals	12	Build prior knowledge	8
Activating prior knowledge	11	Etymology	8
Read-alouds	10	Increased classroom library	8
Class library	8	KWL	8
Print-rich environment	8	Adding articles about topic	8
Etymology	7	Differentiation (Learning communities)	8
Questioning	7	Summarize text	6
Silent sustained reading	7	Extra for lower level readers	6
KWL	7	Formative assessment use	5
Adding articles	7	questioning/clarifying techniques	4
Summarization activities	7	Science word a day	3
Current events related to study topics	6	Vocabulary bookmarks	3
Explicit instruction	5	Sustained quiet reading	3
Art connection to vocabulary	4	Think-alouds	2
Formative assessments	4	Illustrations with words	2
Word games	2	Use of journals/notebooks	2
Making reading guides for text	2	Relationship to text	2
T.H.I.E.V.E.S.	1	Students develop Powerpoints	1
Scaffold exams	1	Calculated readability of text	1
		Directed reading questions	1
		Scaffolding	1
		Increase print-rich environment	1

Note. HS = High School; MS = Middle School

As can be seen in Table 6, two areas were equal with the highest number: “Modeling (Think-alouds)” and “Vocabulary development” for both middle school and high school. For middle school teachers, the third area was “Graphic organizers” followed closely by “Use/create word walls.” Following was a string of seven different instructional tools that were mentioned equally: read-alouds, build prior knowledge, etymology, increased classroom library, KWL, add articles about topic, and

differentiation (learning communities). For high school teachers, the third and fourth place mitigations were similar--“Utilize Word walls” followed by “Graphic organizers.”

The fact that of all the instructional tools that could have been chosen, both middle school and high school teachers chose the same top four strategies was interesting and notable. Collaborative learning was mentioned next most frequently for high school teachers followed by journal use, activating prior knowledge, and the use of read-alouds. After these, the methods chosen varied considerably.

Teachers used modeling in a variety of ways. One high school teacher described his use of the “think-aloud” in this manner: “I want students to see how I organize and assimilate the information in the text,” and another reported that he would “model questions that they should be thinking about while performing the lab.” A third said, “I will model several ways of taking notes.” For middle school teachers, vocabulary development meant that they would use “highlighting and underlining headers and important vocabulary” and “force kids to use the words in our discussions and make them feel comfortable using these new words” as well as a concentrating on the “ten most important words.” Words walls became more important to high school teachers as they reported that they “now have an active word wall,” that “Word walls have been expanded to hang these new vocabulary words on clotheslines,” and that “a student generated word wall where scientific vocabulary is grouped together” was created. Middle school teachers described their use of graphic organizers in terms of “word chains, concept maps, models,” “SQ3R organizers,” “anticipation guide graphic organizer.” and “present the ideas in using a schematic map.” This short rendition of teacher-implemented

strategies makes it apparent that the professional development did provide teachers with plenty of tools and strategies that they could implement into their classroom routines in an attempt to impact their students' reading difficulties.

Categorical Analysis of Observed Student Changes

Research Question 3 asked, "What changes did middle and high school science teachers see in their students after the instructional changes were implemented?" Responding to this question required a categorical analysis of the changes participant teachers identified. Teachers listed the changes they saw in their students after applying and using the techniques and tools learned in the extended professional development conducted for teachers. There were 58 responses from the middle school teachers in 16 categories and 59 responses from the high school teachers in 11 categories. The responses of middle school and high school teachers are displayed in Table 7. (See also Appendix C, Figures 10 and 11).

Table 7

Changes Teachers Saw in Their Students

Changes in Students	HS	Changes in Students	MS
	<i>f</i>		<i>f</i>
Overall comprehension improved	15	More questions/more discussions	7
Less frustrated/more engaged	9	Increased motivation/more engaged	6
Grades improved	7	Will read in class now	6
Feel supported/successful	6	Raise comprehension	5
Increased confidence/self-esteem	6	Reading more	5
Vocabulary use has increased	5	Vocabulary improving	4
Instructional decisions improved	3	Grades improved	4
Classroom management improved	3	Less behavior issues	4
More questions/discuss more	3	Increased BK	3
Used BK to decipher models/examples	1	Overcome fear of mistakes	3
Have become active readers	1	Feel more successful	3
		Feel like in control of learning	3
		Class is more enjoyable	2
		Complaining has decreased	1
		Receptive to new learning strategies	1
		Are using word wall	1

Note. HS = High School; MS = Middle School

The greatest reported response in terms of middle school student change was in the area of students “answering more questions and involving themselves in more discussions.” One middle school teacher described her students, saying that they “couldn’t wait to tell me what they had learned as well as answer the questions. . . .” Another teacher reported this change: “Students are able to express themselves more often and in more ways than they did before I took this course.” This observed change was followed closely by an “increased level of motivation/engaged” and “Will read in class now.” One middle school teacher shared that she noticed in her students an “increased level of motivation and self-esteem from developing and nurturing these lessons on their own.” Another shared, “I saw a sense of responsibility in my students

and a reading culture gradually developing in my students.” This teacher found that her students became more engaged after implementing vocabulary strategies saying, “I have found an increase in participation and just seemly more well-rounded science students since implementing these vocabulary building strategies”. Middle school teachers also reported that “Raising comprehension” and “Reading more.” were very important, ranking in a third place of importance as they related to middle school students. In the words of one teacher, “I have found that the plan showed an improvement of comprehension levels on classroom assignments because of understanding the vocabulary.” Following close behind these at equal rank were “Vocabulary improving,” “Grades improved,” and “Less behavior issues.” Representative comments included “My classroom is blooming with new vocabulary. . . .”, “I am not having some of the behavior issues that I have had in the past. . . .” and “The informal assessments I used to give them before are now coming back with a better grade.” Beyond this, at lower listed levels were other important categories like “Increased background knowledge,” “Overcoming fear of mistakes,” and “Feel more successful.” Middle school teachers reflected on their students changes about how they (the students) felt about themselves, reporting that “confidence that they now have within themselves challenges them to think about other concepts. . . .” and that “Students feel that they are in charge of their learning: they tend to be more successful”.

As shown in Table 7, high school teachers listed fewer categories and overwhelmingly reported “Overall comprehension improved” to be the most important change seen in their students. High school teachers reported that “Students often made

comments that demonstrated they were connecting the new material to previous knowledge,” and that strategies they employed “. . . proved very effective in my class. I used some of these when reviewing for the final exam and the majority of my students were able to make connections and remember information when I used these strategies.” One high school teacher remarked, “I feel like my plan is going to have a huge impact on the reading and comprehension challenges my students face.” This high school teacher saw changes in his lower level readers and reported the following: “Student comprehension has benefitted greatly; lower level readers now are working with less help and have the motivation to stick with it.”

The second largest category that high school teachers reported was that the students were “Less frustrated/more engaged,” and the third was listed as “Grades improved.” High school teachers said that their students “. . . seem less frustrated and more willing to complete the activities assigned. . .”, “. . . are more invested in the word wall because they are the ones that come up with the words to put on it. . .” and that “. . . students have improved in their engagement in classroom discussions and notes as a direct result of the strategies I have used.” Importantly and equally cited, was that students “Feel supported/successful” and that they experienced “increased confidence/self-esteem” while doing their class work. One high school teacher may have best summarized this by reporting that student “resistance to reading aloud is declining and the students’ defensive behavior during ‘fine-tuning’ or correcting has become minimal.” Also mentioned was “Vocabulary use has increased.” Perhaps even more important, at least for some teachers, “Classroom management improved.” One teacher

described this change by explaining that “more students are motivated to do better for themselves and this harbors a much more positive environment than what it was”.

Categorical Analysis of Observed Teacher Changes

Research Question 4, “What ways did the professional development help middle and high school science teachers to change and improve their instruction?” dealt with how the teachers who participated in the online professional development saw themselves and their own teaching behavior and attitudes after implementing the instructional tools and strategies for a period of time. Middle school and high school teachers’ responses are displayed in Table 8. (See also Appendix C, Figures 12 and 13).

Table 8

Changes Teachers Saw in Themselves

Changes in Teachers	HS <i>f</i>	Changes in Teachers	MS <i>f</i>
Attitude change to teaching	12	Can motivate students	10
Feel like a better teacher	7	It is my responsibility	7
Reading/vocabulary is my responsibility	4	ID difficulties	4
Learned to slow down	2	Differentiate needs	4
Saved teaching time in the end	2	I am more excited about teaching	4
Give strugglers more attention	1	I can support reading in many ways	3
I took skills for granted	1	I learned to communicate with students	3
I do not have to grade everything	1	Lessons run more smoothly	2
I am sharing my experiences	1	I had taken things for granted	2
Made it easier to differentiate	1	I must constantly monitor	2
		Need to be comfortable with strategies	1
		Students need to feel in control	1

Note. HS = High School; MS = Middle School

Middle school teachers saw a wide variety of changes within themselves after mitigating classroom challenges with the tools and strategies learned in the professional development. The largest change they saw in themselves was that they could “motivate students” by their change in instruction, which was insightfully followed by the fact that it was their “responsibility” to help their students with reading issues. In her own words, one teacher reported that, “I learnt a lot in terms of how to motivate students to read and understand especially in science.” Another middle school teacher testified to her changes in instruction by saying that the “changes I made in instruction include a drastic modification in the way vocabulary is taught and it was a complete success.” One participant alluded to her change in attitude about responsibility by sharing: “I am aware of the obligations as it relates to reading instruction that every educator regardless to their subject area must fulfill to ensure the reading success of our students.” An equal number of teachers expressed the discovery that they could identify difficulties with reading, differentiate their students’ needs, and that they were more excited about teaching. One middle school teacher shared, “I think the most exciting part is that it has given me a renewed excitement and reason to keep teaching. . . “while another stated, “I feel more accomplished and well-rounded as a teacher after having implemented the activities in my plan.” Less significant comments from the middle school teachers included that they were learning to communicate with their students, that they could support reading in their classrooms in many ways, that their lessons were running more smoothly, and that teachers needed to monitor their students consistently. One comment mentioned only a few times was that the teachers had taken “things for granted” in their classrooms. For

example, one middle school teacher shared, “I noticed I assumed the students know more than they did. I took simply background knowledge, word parts, etc. for granted.” These statements indicated that prompted by professional development dealing with literacy issues in science teaching, a fair amount of thinking went into their teaching.

Table 8 also displays the changes high school teachers saw in themselves. The change that was reported most frequently was teachers’ attitudinal change to teaching itself. Of the 32 responses, 12 fell into this category. One high school teacher reported, “I like what I am doing. I like what I am seeing in my students.” Another teacher noted, “I was disenchanted with teaching and my role as an educator. I no longer see reading inabilities as a ‘road block’ but an opportunity to use a diverse array of strategies.” A third high school teacher summed it up in this way: “I now realize that if I use good strategies that I learned from this course, I won’t need to set aside 15 minutes a day just for reading.”

The next most common response to this question from respondents was “feel like a better teacher.” This comment garnered approximately seven of the 32 responses. One high school science teacher stated this change for herself in this way: “I can teach reading during my content area class while managing to stay on track with my content area pacing guide. Teaching reading actually makes my job of teaching science easier.” Another teacher described the change in the following way: “By learning these techniques, it helped me be more confident in teaching reading. By being more confident, I can better facilitate my students.”

The third largest change reflected by high school teachers was the admission that “Reading/vocabulary is my responsibility.” This quotation from a high school participant accounted for that by saying,

However, I did feel that it was primarily up to the reading teachers to actually facilitate students in reading. Now that I have seen the data and strategies provided through this class I do not know how I ever felt that way”.

Another teacher put forth his opinion, stating, “We have to work together towards the common goal of improving our students’ reading skills.” Seven small categories garnered one or two mentions from the teachers regarding changes they saw in themselves. These comments ranged from learning to slow down when teaching to realizing that they did not have to grade everything. Interestingly, as with the middle school teachers, a comment about taking students skills for “granted” was reported. One teacher, commenting on the ability of students to comprehend information from text, said, “It is a skill I take for granted and I take it for granted that my students have mastered it already.”

Level III Analysis: Themes

According to the research practices of grounded theory, categories can be combined into thematic coding that produce evidence as to how individual categories relate to one another (Charmaz, 2006). This allows transference of derived research findings, with respect to numerous small and similar categories, to be combined into fewer themes that help define and elucidate the research findings. For this study, all of

the categories previously presented in the Level II Analysis have been analyzed for similarity and combined into thematic segments. The results are displayed in tables that relate the categories that were gathered into the appropriate theme. These tables support the narrative and procedural thinking used to develop the themes. Additional figures associated with the data shown can be found in Appendix C.

Thematic Analysis of Instructional Challenges: Middle School

The first research question dealt with the instructional challenges that the participant teachers found in their classrooms. Though the perspectives of the 25 middle school science teachers and the 37 high school science teachers varied a bit, the instructional challenges could be grouped into five main themes. The five themes, as shown in Table 9, were (a) Difficulty Reading, (b) Comprehension, (c) Use of Time, (d) Vocabulary, and (e) Motivation. (See also Appendix C, Figure 14).

The categories that were combined for “Difficulty Reading,” “Vocabulary,” and “Motivation” are self-explanatory. Four categories were combined into one “Comprehension” theme because all of the categories represented an inroad as to how comprehension is achieved in learning. Probably of foremost importance is “Lack of prior knowledge,” as the addition of new knowledge needs something with which to affix. “Adapt lesson plans” can be seen as a way to improve comprehension, because the ultimate goal of teaching is to impact comprehension of the subject presented. Adding more print materials to classroom in a variety of ways supports making the classroom “print-rich” which supports comprehension.

Table 9

Themes: Instructional Challenges of Middle School Teachers

Themes	Instructional Challenge Categories
Difficulty Reading	Difficulty reading. Issues with technical text.
Comprehension	Comprehension. Lack of prior knowledge. Struggle to make print-rich. Adapt lesson plans.
Use of Time	Lack of time. High stakes assessment. Reduce wasted time.
Vocabulary	Vocabulary.
Motivation	Increase incentive to read.

“Use of Time” was supported by three categories. “Lack of time” and “Reduce wasted time” fit well into this theme and need no explanation. The category “High stakes assessment” refers to the time pressures that a number of teachers feel in terms of dealing with state assessments and the district demands that are placed on certain subject matter teachers in terms of their time and those assessments.

As previously mentioned, Table 9 displays the results of the middle school teachers’ instructional challenges after being organized into themes. As can be seen, the themes of “Comprehension” and “Vocabulary” together garnered a little over 50% of the responses collected at a frequency of 25 of the 48 responses. The third largest theme for these middle school teachers was “Difficulty Reading,” accumulating nine of the 48 responses. “Motivation” and “Use of time” rounded out the themes with frequencies of

eight and six responses respectively. It is worth noting that once categories were grouped into themes, 72% of middle school teachers' instructional challenges in the classroom directly related to the troubles the student had with reading itself as reflected by the combined percentages for the top three themes.

Thematic Analysis of Instructional Challenges: High School

The categories that reflected high school teachers' viewpoints of instructional challenges were combined into the same themes used for the middle school science teachers' challenges. They are displayed in Table 10. See also Appendix C, Figure 15. The five themes are (a) Difficulty Reading, (b) Comprehension, (c) Use of Time, (d) Vocabulary, and (e) Motivation. Participating high school teachers were more specific when describing exactly the problems in terms of reading difficulties observed in their students. Clearly, the students did not find the textbooks or classroom reading materials accessible as described by the first few challenge categories in Table 10. Three challenges comprised the "Comprehension" theme. The first category, comprehension, was self-evident. The challenge of high school science teachers to make their lessons connect to the world and to use their texts more effectively, all contribute to students' comprehension. In the third theme, the "How to teach both" category needs to be briefly explained. Several high school teachers commented on the fact that they felt challenged by adding reading to their already full content area lesson plans, indicating they lacked time. Lastly, in regard to the challenges that make up the fifth theme, "Motivation," "Do

not care about school” and “Frequent absences” were not mentioned in the middle school list of challenges. Thus, they were predominately high school issues.

Table 10

Themes: Instructional Challenges of High School Teachers

Themes	Instructional Challenge Categories
Difficulty Reading	Textbook above reading level. Read below level.
Comprehension	Comprehension. Connect to world. More effective use of text.
Use of Time	Time. How to teach both.
Vocabulary	Vocabulary.
Motivation	Frequent absences. How to motivate to read. Do not care about school.

As seen in Table 10, high school teachers’ instructional challenges can be divided into five themes. The “Comprehension” theme which represents a frequency of 36 of 112 responses and “Vocabulary” with 26 of 112 responses top the list with “Difficulty Reading” which has a frequency of 22 of 112 responses in third place. This was very similar to the middle school results. For high school teachers, “Motivation” was a bigger themed issue than for teachers at the middle school level, garnering almost a fifth of the responses , whereas “Use of Time” was a much smaller issue for high school teachers and a much larger issue for teachers of middle school students..

When the results of the high school and middle school science teachers' themes were combined, an overall picture of the relative importance of the instructional challenges appears. The combined results are displayed in Appendix C, Figure 16. According to the frequencies that that participant teachers reported that supported the themes, "Comprehension" was the greatest instructional challenge confronting teachers. The second greatest theme was "Vocabulary" followed closely by "Difficulty Reading." The "Motivation" issue was fourth on the list, following the previous theme closely, and the fifth theme area, "Use of Time," registered the smallest return of the total teacher responses.

Thematic Analysis of Instructional Challenge Mitigations: Middle School Teachers

Strategies and tools that science teachers chose to mitigate their classroom challenges could again be grouped into five themes. These themes, displayed in Table 11 (See also Appendix C, Figure 17) with their corresponding instructional strategies, were: (a) Comprehension Development, (b) Vocabulary Development, (c) Instruction (Explicit), (d) Print-rich Environment, and (e) Assessment. A discussion of each of the themes, as they emerged from the categories, follows.

Table 11

Themes: Instructional Challenges of Middle School Teachers

Instructional Strategy Themes	Instructional Strategy Categories
Comprehension Development	Graphic organizers. Build prior knowledge. KWL. Questioning/Clarifying techniques. Use of journals/notebooks. Summarize text. Relationship to text. Directed reading questions. Students develop ppts. Scaffolding.
Vocabulary Development	Vocabulary development. Use/Create word walls. Science word-a-day. Etymology. Illustrations with words. Vocabulary bookmarks.
Instruction (Explicit)	Read-alouds. Modeling (think-alouds). Extra for lower level readers. Think-alouds. Sustained quiet reading. Differentiation (Learning Communities).
Print-rich Environment	Adding articles about topic. Increased classroom library. Increased print-rich environment.
Assessment	Calculated readability of text. Formative assessment use.

As shown in Table 11, there were 10 instructional strategies that contributed to the theme, “Comprehension Development.” Instructional strategies that move students to revisit information from text, prompting them to question, summarize and otherwise

organize information according to their new understanding promotes comprehension and adds to long term memory (Fisher & Frey, 2008; Gunning, 2012; Mayer, 2011; Plaut, 2009). For example, instructional strategies such as KWL, (acronym for “What do you think you know?”, “What do you want to know?”, and “What do you want to learn?”) and directed reading questions help guide students’ thinking as they work through text and build a comprehensive picture of the reading. Summarizing and graphic organizer activities help students visualize facts and stitch together concepts that are paramount in building comprehension.

The instructional strategies that are listed as the components of the “Vocabulary Development” theme are somewhat understandable. Some participant middle school teachers were vague about their use of vocabulary development and just listed it as a strategy itself, but others were more explicit. Strategies that caused students to visually interact more with words such as “Word walls” and “Science word a day” can be easily seen as a constant interaction with vocabulary, whereas other strategies such as “Vocabulary bookmarks,” “Etymology,” and “Illustrations with words” are independent exercises in vocabulary development.

The “Instructional (Explicit)” theme warrants some discussion. Though it may seem redundant to express this theme with these two words, they were the words of choice of the participants. Explicit instruction ensures that the students are on the same “page” as the instructor. In many cases, comprehension-building takes place as the teacher uses strategies to show precisely how to negotiate the actual learning. Based on the participant teachers words, it was clear that “modeling” in one form or another was

important in this theme in both one-on-one work, i.e., “Extra for lower level readers” and work in groups in whatever way the teachers saw fit, i.e., “Learning communities” and “Differentiation.” “Sustained quiet reading” can also be seen as instruction in the form of practice.

The theme of “Print-rich environment” referred to how participant middle school science teachers enhanced their rooms with appropriate opportunities to engage with words and print that can underscore the importance of ideas and promote literacy. As shown in Table 11, middle school teachers did this by adding to their classroom libraries and adding articles about the topics being taught. In addition, some teachers just used the catch category “increase print-rich environment” to indicate their way of mitigating instructional challenges in their classrooms. The last theme was “Assessment.” Here, the categories represent ways a few teachers used assessment to move them toward alleviating their instructional issues.

Middle school teacher participants used instructional strategies in different ways and for different purposes. The top three instructional themes garnered very similar results from teachers. The top choice to ease instructional challenges was through strategies that worked on comprehension development. The themes of “Instruction (Explicit)” and “Vocabulary development” registered nearly the same frequency of responses at 40 and 39 returns respectively of the 146 total responses. The three combined themes constituted 85% of the responses, indicating a sincere effort by middle school science teachers to augment their teaching with more straightforward teaching methods and an emphasis on science vocabulary and comprehension development. The

fourth largest theme involved improving the classroom in terms of making it a print-rich environment. This theme registered just over one-tenth of the teachers' responses, whereas the last theme, "Assessment," garnered only a few of the middle school participants' responses.

Thematic Analysis of Instructional Challenge Mitigations: High School Teachers

The themes that emerged in grouping the categories of strategies that high school teachers employed to decrease their instructional challenges were identical to those identified by middle school participants. What differed were some of the actual strategies and tools that were chosen. Table 12 displays the themes that emerged from the instructional challenges of high school science teachers. (See also Appendix C, Figure 18).

Table 12

Themes: Instructional Challenges of High School Teachers

Instructional Strategy Themes	Instructional Strategy Categories
Comprehension Development	Questioning. T.H.I.E.V.E.S. KWL. Journals. Graphic organizers. Activating prior knowledge. Making reading guides for text. Summarize text.
Vocabulary Development	Vocabulary development. Utilize word walls. Class library. Art connection to vocabulary. Etymology. Word games.
Instruction (Explicit)	Modeling (Think-alouds). Explicit instruction. Silent sustained reading. Read-alouds. Collaborative learning.
Print-rich Environment	Print-rich environment. Adding articles. Current events related to study topic.
Assessment	Scaffold exams. Formative assessment.

In the theme, “Comprehension Development,” most of the strategies such as KWL, graphic organizers, and summarizing text, reappeared. The high school science teachers, however, added a tool called T.H.I.E.V.E.S., an instructional tool that allows a student to preview a chapter of any text. This is notable in terms of the comments of the

high school teachers when describing their instructional challenges. The two instructional challenges previously listed in the “Difficulty Reading” theme in Table 4 stated that the textbook was above the reading level of the students and that the students read below the level at which they should be reading. The next two themes did not differ much from the instructional strategies that were used and reported by the middle school teachers. As seen in Table 12, these two themes, “Vocabulary Development” and “Instruction (Explicit)” list very similar instructional strategies as previously discussed with the middle school teachers. High school science teachers found that increasing the print-environment in their classrooms was also a worthwhile strategy. Several instructors mentioned the value of adding current events and articles as a way of better relating their study topics, to the study of science. In the “Assessment” theme, high school teachers reported that they used formative assessment and scaffolded exams to help guide their assessments in science.

As with the middle school teachers’ responses, high school teachers’ category responses that built the theme of “Comprehension Development” generated the most responses. Although this response figure was a small amount compared with those of middle school teachers, it supports the premise that both groups believed that the lack of comprehension of the course text and other materials was the most important challenge that needed to be mitigated. The themes of “Vocabulary Development” and “Instruction (Explicit)” remained very close to those of the middle school teachers’ responses, emerging as the second and third most used strategies to mitigate instructional challenges.

When the middle school and high school instructional mitigations for “Comprehension Development” were combined, a frequency of 108 of the total 349 responses was found. “Vocabulary Development” and the “Instruction (Explicit)” theme, which accounted for the almost the same number of responses, came very close to “Comprehension Development” as a participant concern. It is interesting that the three top themes remained fairly steadfast throughout all of the data, indicating that, for whatever reason, most teachers consistently targeted their efforts toward the overall student difficulty with reading and comprehension of course reading materials. (See also Appendix C, Figure 19).

The last two themes as represented by responses of high school science teachers were again very similar in results to those of the middle school teachers and in terms of the combined totals. Approximately one-tenth of the high school teachers’ responses centered around the theme, “Print-rich Environment.” This result was very close to the middle school participant result. A similar scenario can be constructed for the “Assessment” theme, which delivered a very small combined percentage of the total participant responses. And finally, as represented by the small number of responses, it is clear that “Assessment” occupied the lowest position in the minds of all teachers as represented in terms of all themes generated about mitigating teachers’ instructional challenges in the classroom.

Thematic Analysis of Teachers' Observed Changes in Middle School Students

Coding categories into themes for the analysis of the changes that teachers saw in their students at both secondary level yielded similar results. The five themes that emerged from the data dealt with a number of disparate premises descriptive of the categories that teachers described seeing in their students. The themes are as follows: “Self-efficacy,” “Motivation/Engagement,” “Vocabulary,” “Comprehension,” and “Enjoyment.” These themes are displayed in Table 13. (See also Appendix C, Figure 20. For middle school teachers, the “Self-efficacy” theme was characterized by the four categories: “Feel like in control of learning,” “Grades improved,” “Feel more successful,” and “Overcome fear of mistakes.” These four categories typify students who have gained more control over themselves and their learning, thus contributing to better feelings about themselves and supporting the theme, self-efficacy.

The second theme, “Motivation/Engagement,” contained five categories, one of which gives rise to the theme name (Increased level motivation/engaged). Four of the categories display characteristics of being engaged/being motivated, e.g., being receptive to new learning strategies, answering more questions and engaging in more discussions, reading more, and reading in class now versus not reading in class before.

Table 13

Themes: Changes Middle School (MS) Teachers Observed in Their Students

Themes	Categories Observed in Students
Self-efficacy	Feel like [I'm] in control of learning. Grades improved. Feel more successful. Overcame fear of mistakes.
Vocabulary	Increased level motivation/engaged. Receptive to new learning strategies. Answering more questions: more discussions Motivation/Engagement. Reading more. Will read in class now.
Comprehension	Raised comprehension. Increased background knowledge.
Enjoyment	Complaining has decreased. Class is more enjoyable. Less behavior issues.

The third and fourth themes, “Vocabulary” and “Comprehension” are self-explanatory. The fifth theme, “Enjoyment,” resulted from middle school teachers’ observations that complaining had decreased, comments from students that “the class was more enjoyable” increased, and that teachers indicated they experienced fewer behavioral problems from the students.

Upon closer inspection of these results, it can be seen that the highest theme that recorded responses was in the area of motivation and engagement with 25 of the 58 teachers’ responding to this theme.

Self-efficacy, the essence of which is closely tied to engagement and motivation, registered the second greatest response with about half as many responses by the middle school participants. Together these two top groups garnered two-thirds of the responses, indicating that teachers had identified an important component in student performance that may have been affected by their instructional changes. In terms of the previous discussion on the need to increase students' vocabulary and comprehension, it is encouraging that these two same-named theme groups generated almost a quarter of the total responses. It is also interesting that the "Enjoyment" constituent of this thematic analysis registered a smaller, but substantial number of the responses. This theme was rendered as an almost pleasant surprise for the teachers who volunteered it.

Thematic Analysis of Teachers' Observed Changes in High School Students

The categories that made up the "Self-efficacy" theme for the high school teachers in terms of changes that the teachers saw in their students were very similar to the middle school teachers' observations. These categories and themes are recorded in Table 14. (See also Appendix C, Figure 21). At this instructional level, the students have typically improved their grades as well as their instructional decisions about their own learning. Teachers also described these students as feeling more supported and successful with an increased confidence and self-esteem.

The high school science teachers' "Motivation/Engagement" theme contained fewer categories than did that of middle school teachers but had nearly the same percentage of reported answers. The three categorical areas that the teachers reported

included that students asked more questions and discussed more, were less frustrated and more engaged in their work, and that they had become active readers. The “Vocabulary” and “Comprehension” themes captured nearly the same categories as mentioned by middle school teachers. One interesting category was that the students used background knowledge to “decipher models/illustrations.” Like middle school teachers, high school teachers noted that fewer class management issues increased classroom enjoyment for teachers and students.

Table 14

Themes: Changes High School (HS) Teachers Observed in Their Students

Themes	Categories Observed in Students
Self-efficacy	Instructional decisions improved. Feel supported/successful. Grades improved. Increased confidence/self-esteem.
Motivation/Engagement	Students ask more questions/discuss more. Less frustrated/more engaged. Have become active readers.
Vocabulary	Vocabulary use has increased.
Comprehension	Overall comprehension improved. Use background knowledge to decipher models/illustrations.
Enjoyment	Classroom management improved.

When looking at themes for the high school participants, once again the theme with the highest frequency of responses was “Motivation/Engagement.” This theme and

the second highest theme, “Self-efficacy” when combined, totaled a little less than two-thirds of the total teacher responses. This was the same percentage as determined for middle school science teachers. Together, the combined themes of “Vocabulary” and “Comprehension” totaled almost one-third of the total responses, slightly fewer than at the middle school level. Of interest is the fact that the “Vocabulary” theme did not change from middle school to high school, but the “Comprehension” theme was greater at the high school level than the middle school level. This indicated that this area represented a great concern for high school teachers as evidenced by its importance as an instructional challenge. The remaining theme category was the “Enjoyment” theme, registering as much of the reported categories as “Vocabulary.”

When the middle school and high school themes about how all science teachers viewed the changes seen in their students were combined, major themes were evident. As expected, the top two themes, “Motivation/Engagement” and “Self-efficacy,” when combined, registered almost two-thirds of the reported responses. Also, significant changes can be observed in the areas of vocabulary and comprehension, two of the major instructional challenges that teachers at both instructional levels discussed. The added benefit of the teachers’ instructional changes was in the area of enjoyment, rounding out the remaining one of ten responses. (See Appendix C, Figure 22 for further details.).

Thematic Analysis of Middle School Teachers’ Observed Changes in Themselves

Table 15 presents the data related to the changes middle school science teachers observed in themselves. (See also Appendix C, Figure 23). The following four themes

emerged from the analysis of the categories: (a) Assumptions/Beliefs, (b) Self-efficacy, (c) Motivation, and (d) Collaboration.

Table 15

Themes: Changes Middle School (MS) Teachers Observed in Themselves

Themes	Changes Observed in Themselves
Assumptions/Beliefs	It is my responsibility. I had to take things for granted. Students need to feel they are in control. I can support reading in many ways. I must constantly monitor.
Self-efficacy	Identify difficulties. Differentiate needs. Lessons run more smoothly. Need to be comfortable with strategies. Can motivate students.
Motivation	I am more excited about teaching.
Collaboration	I learned to communicate with students.

Middle school teachers had five main categories that comprised their “Assumptions/Beliefs” theme and directly related to how they taught. The main assumption in this group was that they had taken for granted that the students were able to read and comprehend text without intervention and guidance. Beliefs for this group were reflected in the categories that related to (a) teachers’ responsibilities in teaching reading skills with science, (b) students’ need to be in control of their learning, (c) teachers’ support for reading in many ways in their classrooms, and (d) teachers’ responsibility to constantly monitor their students learning.

The second theme of “Self-efficacy” came about because of expressed outcomes by teachers that led them to feel better about and in more control of their teaching. The categories contributing to this theme were (a) being able to identify difficulties that the students were having, (b) differentiating those needs, (c) having their lessons run more smoothly, (d) being able to motivate the students, and (e) understanding the students’ need to be comfortable with instructional strategies.

The third theme, “Motivation” included any reported comments dealing with motivation as it related to the teachers and their teaching. For the middle school teachers this involved five categorical contributions that dealt with becoming more excited about their teaching. The last theme identified for middle school science teachers involved several comments about improved communication skills culminating in a theme called “Collaboration.”

When looking at the frequency of middle school participant responses, one gains further insight into the changes that middle school teachers observed in themselves. The most prominent theme for these middle school teachers was “Self-efficacy,” returning a frequency of 21 responses. Self-efficacy was further supported by the participants’ discussions that fell into the theme of “Motivation.” In terms of these two themes, just over half of the changes teachers saw in themselves revolved around their comfort and confidence with their own teaching skills and their ability to control what was happening in their own classrooms. Also supporting teachers’ thoughts about their new skills and abilities was an apparent change in their “Assumptions/Beliefs” as presented by approximately a third of the responses that were gathered into this theme. In addition,

middle school teachers saw themselves as better collaborators with the students as indicated by a small return of responses contained in the “Collaboration” theme.

Thematic Analysis of High School Teachers’ Observed Changes in Themselves

The themes that emerged from the category data as to changes high school teachers observed in themselves were exactly the same as those identified for middle school teachers. They are detailed in Table 16. (See also Appendix C, Figure 24). However, there were only two common categories for both groups in the first theme, “Assumptions/Beliefs.” In both groups, teachers recognized that it is the teachers’ responsibility to teach reading and that they took these skills for granted. For high school teachers, some of the other concerns in this theme were that they recognized their attitude changes to teaching, that they learned to slow down in their teaching, and that everything their students completed did not have to be graded.

There were two reported categories that the high school teachers submitted that contributed to the theme of “Self-efficacy.” These categories dealt with giving students who struggled in class more attention and feeling like a better teacher after the new implementations took place in their classrooms. The third theme, “Motivation,” was comprised of categorical comments that the teachers’ professional development had made it easier for them to differentiate in their classrooms and that they saved teaching time in the end. The “Collaboration” theme included one comment submitted as to teachers sharing their findings with colleagues.

Table 16

Themes: Changes High School (HS) Teachers Observed in Themselves

Themes	Changes Observed in Themselves
Assumptions/Beliefs	Attitude changes to teaching. Learned to slow down. Reading and vocabulary is my responsibility. I took skills for granted. I do not have to grade everything.
Self-efficacy	Give strugglers more attention. Feel like a better teacher.
Motivation	Made it easier to differentiate. Saved teaching time in the end.
Collaboration	I am sharing my experience.

Though the themes for middle and high school science teachers were identical, there were differences in the categorical frequencies that became the themes. The theme of “Assumptions/Beliefs” cornered nearly two-thirds of the high school teachers’ categories reported, but middle school teachers reported only about half that amount. On the other hand, “Self-efficacy” results were approximately half for high school science teachers in comparison to the frequency of comments about self efficacy that were registered for middle school teachers. For these high school teachers, the “Motivation” theme was discussed as much as the middle school teachers. However, high school teachers had fewer comments related to “Collaboration” than did middle school teachers. When frequencies of the combined themes of both the middle and high school science teachers in regard to changes and improvements in instruction that teachers observed in themselves after the professional development artifacts were examined, the results

showed an impact of a personal nature. The results of the analysis are contained in Appendix C, Figure 25. The “Assumptions/Beliefs” theme represented the greatest area of change that the teachers commented on with nearly half of all teachers’ categorical comments contributing to this theme. “Self-efficacy” followed closely, adding to this introspective examination of themselves as teachers. The “Motivation” theme registered less than one-tenth of the total responses, and the “Collaboration” theme garnered a few comments.

Summary

The production of data for this research was completed in three ways. In Analysis I, a quick word search was executed to give insights into teachers’ issues in the classroom before a thorough reading of the reflective assignments was completed. The combined pages that contained the teachers written reflective assignments involved in the search were 256 pages. These results showed that “reading problems” was by far the largest challenge of the 11 instructional challenges proposed by the author. The total times this phrase was mentioned in the teachers’ reflective assignments was 1,548 times contrasted with the second most mentioned phrase, “Increase incentive to read,” which was mentioned 674 times. The third largest instructional challenge was “Lack of vocabulary” with 569 mentions throughout the science teachers’ reflective assignments. These facts identified the top three teachers’ challenges in the realm of reading and emphasized the difficulty of teaching students when they lack reading skills.

The second word/phrase search that was performed before the grounded theory research began reflected teachers' thoughts about teaching. Only two words, "stress" and "frustration," and one phrase, "Student's don't know what to do," were part of the search. Interestingly, stress and frustration yielded only six and nine returns respectively. However, the phrase, "Students don't know what to do," registered a total of 3,173 mentions throughout both parts of the reflective assignments. These searches proved to be insightful and useful in responding to the research questions.

The four research questions were presented via the categories that grounded theory produced first followed by a presentation of the themes that were produced out of those categories. Tables were produced to illustrate what categories were placed into what themes. The tables and accompanying narratives served to clarify the findings of this ground theory research. Figures are available in Appendix C to augment display of the results.

The first research question dealt with the instructional challenges that the science teachers saw in their own teaching situation. The categories that were derived via grounded theory were compiled separately as per middle school and high school. The issues identified ranged from comprehension to frequent absences. The four top challenges for both levels dealt with issues of comprehension, vocabulary, motivation in terms of reading, and all around reading difficulties. The thematic examination for each level reveals the same issues. In addition to the previous discussion and perhaps the best way to summarize each question in an overarching way, is to use the additional figures found in Appendix C. The figures are a visual representation of the frequency of the

participants' responses in terms of simple percentages of the total responses. These figures serve to enhance the grounded theory findings and provide a visual depiction that is easy to comprehend.

The best overall picture of the instructional challenge issue was presented in Figure 16 where the results of all the instructional themes were combined into a single figure. This figure makes clear that the biggest single issue presented to these teachers was related to "Comprehension," and constituted 32% of teachers responses. Following this instructional challenge in descending order were: Vocabulary, 23%; Difficulty Reading, 20%; Motivation, 18%; and Use of Time, 7%. These challenges are somewhat intertwined and ultimately come together to produce proficient readers at grade level.

The second research question dealt with the instructional tools or strategies that the teachers used to mitigate the challenges that they observed in their own classrooms. Figures 8 and 9 illustrate the total similarities and differences between the middle school and high school teachers' choices. Figures 17 and 18 show these mitigation categories gathered into themes. The best graphic to give overall insight into the themes is Figure 19 which shows that the most used mitigations used by both middle and high school teachers dealt with "Comprehension Development" at 31%. Closely following were instructional strategies and tools that encouraged "Vocabulary Development" at 28% and "Instruction (Explicit)" at 27%. In addition, these teachers made efforts to improve the print-rich environment of their classrooms (11%) and a few used assessments to augment what they did in terms of reading improvement (3%).

The third research question addressed changes that middle and high school science teachers saw in their students after the instructional changes were implemented. Figures 10 and 11 were used to display all the categories that the middle school and high school teachers saw in their students. The largest change from the middle school perspective was “Answering more questions; more discussions” area. High school teachers noticed that “overall comprehension improved.” These categories were combined into themes and displayed in Figures 20 and 21. In both cases, the teachers recorded the greatest change in their students as being in the “Motivation/Engagement” category. This was reflected in Figure 22, combining the changes observed in students at both secondary levels. “Motivation/Engagement” registered 32% of the changes teachers mentioned, and “Self-efficacy” accounted for 30% of the changes. “Comprehension,” a student attribute that teachers mentioned often in the challenge section, garnered 20% of the combined views of changes seen in students. Also mentioned as positive changes were “Vocabulary” and “Enjoyment,” both at 9% of the reported mentions.

The fourth research question sought to determine the ways professional development helped middle and high school science teachers to change and improve their instruction. The reporting in this section of the analysis focused, therefore, on the changes teachers saw in themselves after they implemented the changes to their instruction. Figures 12 and 13 presented the changes that the teachers reported. The largest change that the middle school teachers reported was that they could motivate students, and the second was that it was their responsibility to teach reading in their content area. For the high school teachers, the largest change they saw was the change in

attitude about teaching that they experienced; second was that they felt like better teachers. These categories were gathered into themes, and the results are displayed in Figures 23 and 24. For the middle school teachers the largest theme dealt with “Self-efficacy” at 49% of the returns, and “Assumptions/Beliefs” represented 35% of the responses. For the high school teachers, “Assumptions/Beliefs” was by far the largest theme at 63% of the return, and “Self-efficacy” returned a smaller portion of the return at 25%. These thematic results were also combined for middle and high school teachers and were displayed in Figure 25. In the combined view, the largest theme mirrored the separate views of middle and high school teachers: “Assumptions/Beliefs” generated 47% of responses, whereas “Self-efficacy” garnered a 39% result. For this question, the remaining two thematic areas, “Motivation” and “Collaboration” encompassed 9% and 5% respectively.

It is clear that the teachers involved in developing the reflective assignment in this research understood their instructional challenges as they saw them in their own classrooms and that these challenges included reading difficulties as a major issue. It also seems clear that teachers were able to apply at least some instructional strategies or tools to the mitigation of those strategies. At least part of the proof of this lies in the comments that the teachers shared to support the positive changes that they saw in their students and themselves. Chapter 5 will provide a further summary and discussion of the findings and offer implications for the continuance of teaching reading and comprehension skills along with the content area of science.

CHAPTER 5 RESULTS

Introduction

The grounded theory research process is authentic in that it brings to the forefront and gives voice to real issues that affect research participants in their teaching. In this chapter, organized around the four research questions, the voices of the participant teachers are presented as part of the summary and discussion of the research findings. The quotations, fragments of the coded reflective assignments, are used to support, in part, answers to the research questions as per grounded theory research practice. An interpretative commentary aligns and grounds the participant teachers' experience with research that was presented in the literature review.

Following a restatement of the purpose of the study, a review of the preliminary word search, the results of the data analysis for the four research questions are summarized and discussed. The chapter is concluded with a discussion of the overall emergent themes, conclusions based on the findings, implications for practice, and recommendations for future research.

Purpose of the Study

This qualitative, grounded theory study was conducted to understand the influences of reading in the content area training on the ongoing teaching practices of a purposive sample of 62 secondary science teachers. The researcher conducted the investigation using the reflective assignments associated with a 14-week, Florida online reading professional development (FOR-PD).

Summary and Discussion of the Findings

Starting Point--Word Searches

The word search that was employed before the coding of the participant teachers' reflective assignments was significant in that it provided an overall picture of student difficulties and teachers' instructional challenges in the classroom. Compiled results from the first word search indicated that the largest responses were in the areas pertaining to students' difficulty with (a) reading, (b) vocabulary, and (c) motivation to read. This was a preview of what the teachers shared later in the actual coding of the reflective assignments and was consistent with what National assessment results show in terms of reading difficulties in students (Achieve, 2005; Alliance of Excellent Education, 2009). The fact that these three issues far outnumbered other pertinent issues such as high stakes testing, issues of time, and even discipline problems was compelling. It was apparent for this group of 62 science teachers that tackling reading problems, in order to mitigate its diminutive effects on the learning of science, outweighed the other challenges that were offered in this word/phrase search.

The results of the second word/phrase search that was executed was to get an overall picture of teachers' attitudes about their teaching. The two words that could be seen to apply to many teachers' attitudes about teaching, "stress" and "frustration," were rarely used in the reflective assignments. Given the enormity of the reading difficulty comments, this was surprising. These teachers were, however, several weeks into a voluntary, online professional development course that they likely hoped would help them with their own instructional difficulties. Thus, the relevance of the course to their

own situations may have diminished these feelings. Knowing that the goal of the professional development was to guide them to mitigating their own difficulties as it related to their own classroom situations would erase the stress and frustration factors in the hope of identifying and dealing with their own issues.

The third word search was the phrase “Students don’t know what to do.” This phrase, and the large number of times (over 3,000) it was mentioned or discussed, should be troubling to educators and is consistent with what other researchers have found in terms of critical thinking skills and the ability to extrapolate existing knowledge (ACT, 2006; Bybee & McCrae, 2009; Wagner, 2008). The frequency of this statement in this search adds clarity to the “difficulty reading” problem also mentioned. This could be indicative of what seems to be missing in secondary classroom instruction, what adolescent students need to augment reading comprehension in science, and what professional development teachers need to accomplish this.

Research Question 1

What types of instructional challenges did middle and high school grade science teachers report they chose to work on as part of their professional development?

Teachers’ instructional challenges in this study reflected their students’ weakness in reading comprehension along with vocabulary uptake. Participating science teachers at both middle and high school levels identified the majority of their instructional challenges in the area of reading difficulty, reading comprehension, and vocabulary. To help visualize this fact, the cumulative percentages of these three thematic areas

represented 72% and 78% of middle school and high school teachers' instructional challenge responses, respectively. Even though the issues of how time was used in the classroom and the challenges of motivation ranked lower in importance as indicated by the lower percentage of responses, it was clear that these issues were intimately intertwined with the challenges of reading and interpreting text. In the words of one high school science teacher, "The students are not motivated to read the technical language that is presented in their biology books and that is required for them to understand and pass the course."

As Schleppegrell and Fang, (2008) noted, educational researchers have estimated that fewer than one-third of students between Grades 8 and 12 read well enough to do successful work in school. As participant teachers reported, these classroom difficulties lead students to become even more unmotivated to work at any learning in their science classes. According to Quate and McDermott (2009), if students continue in this mode, especially if they live in poverty, they will be more apt to join the dropout ranks.

In this study, it was clear that teachers were compelled to find a way to boost students' motivation and engagement in addition to increasing science comprehension, vocabulary, and reading ability. Like many researchers, the participant teachers in this study came to understand that they could not increase science literacy until they could increase basic literacy (Klaus-Quinlan & Cazier, 2009; Moje, 2008; Norris & Phillips, 2003; Shanahan & Shanahan, 2008).

Comprehension and vocabulary proved to be a pivotal part of the difficulty in reading challenge. In the high school and middle school combined challenge,

comprehension surpassed all other challenges followed by vocabulary in second place. Tightly intertwined, it is difficult to tease out the separation of these two skills in the role of science reading. One middle school teachers stated, in regard to students' comprehension problems, "I have students who can read the words on the page, but when I ask them to tell me what they just read in their own words, they are clueless." Another teachers summarized, "Many of my students are reading below their level and with science they find it even more challenging to read because they are not familiar with many of the words and terminology." Heller and Greenleaf (2007) described a high school graduate as being able to infer and synthesize from text which is well beyond basic skills. Clearly, this was not the case with these teachers' students.

Reading difficulty is not only directly tied to the difficulty of the text in terms of vocabulary, but also sentence structure, and the text structure itself (National Institute for Literacy, 2007; Schleppegrell & Fang, 2008). As has been documented, over 70% of middle school and nearly 80% of high school teacher participants reported that instructional challenges in their classrooms revolved around issues of comprehension, vocabulary, and difficulty in reading. The teachers remarked about how these difficulties impacted and hampered their ability to teach their content subject matter. It is also important to note that the teachers did not know how to deal with these problems as reflected not only by the comments of some teachers in their reflective assignments, but also by the fact that they were willing to participate in a 14-week course dedicated to these issues.

The Theme of Motivation

Motivation and engagement are important and intertwined components to significant learning (Quate & McDermott, 2009). According to Brunning et al.(2004), intrinsic motivation, rather than external motivations like rewards or punishment, overall tends to lead to better results. Part of these actions involves a sense of self-determination and control in addition to the role of self-efficacy. Cognitive psychologists assert that students must have confidence that their efforts will lead to success in order to be motivated to engage. As can be seen, one of the challenges with which these teachers struggle, is student motivation to engage in classroom activities or reading. Overall, the motivation issue captured 18% of the combined middle school and high school themed reported responses of participants. Because it has already been posited that reading difficulty, comprehension, and vocabulary themes can be combined into one large issue with various components, motivation can be seen as taking second place in importance. This implies that teachers recognized the significant effect that motivation has on their students.

The motivation theme played a slightly bigger role for high school teachers at 19% than for middle school teachers at 16%. For the high school teachers, two categories of concern, in addition to motivating students to read, were noteworthy. These teachers, unlike middle school teachers, recognized that some high school students' attitudes towards school as illustrated by the categories, "do not care about school" and "frequent absences," revealed a deeper motivation issue. This is congruent with research findings that the longer students stay in school, unmotivated and unengaged, while falling

behind in grade level, the less motivated they become to come to school and participate (Biancaraosa & Snow, 2004; Quate & McDermott, 2009).

Research Question 2

In what ways did middle and high school science teachers report that they used to facilitate learning from the professional development to resolve their chosen instructional challenges?

As part of the reflective assignment, participant teachers had to not only identify their own classroom challenges but also had to implement a plan of action to mitigate those challenges using the ideas offered via the professional development. This plan of action was to be put into effect for many weeks, hopefully several months since the assignment ran through the 14-week course. This “apprenticeship” aspect of professional development, where one actually practices as part of the course, allows teachers control of their own learning. Dillon et al. (2010) found that the application of learning in this manner and for long duration, builds knowledgeable and confident teachers who can better define what they need to do in their content area. Additionally, Heller and Greenleaf (2007), explained that content teachers who do receive intensive training and support manage to incorporate literacy instruction into their classroom courses in spite of other teaching pressures. The following discussion recounts how the participant science teachers in the present study chose to change their teaching practice to accomplish their action plans.

The tools and strategies that the teachers chose varied from middle school to high school teachers, but the themes stayed relatively the same. The strategies and tools were implemented to attend to problems whether they involved comprehension issues or strategies to increase word recognition and vocabulary. For example, a high school teacher may have chosen the use of T.H.I.E.V.E.S. to augment the text format in a Chemistry class, and a middle school teacher may have demonstrated Previewing-Headings check using a Think-Aloud. The use of both of these tools work to achieve the same goal for students, that of increasing metacognitive awareness as they read, thereby boosting comprehension of the text. Thus, in this example, the two strategies shares the same themes.

Comprehension Development Theme

It is obvious from the challenges that participant teachers' listed that the greatest concern was to increase comprehension in their science classrooms, understanding that reasoning ability in science is crucial and unique to each discipline and thus each science course (Shanahan & Shanahan, 2008), these teachers embarked on applying tools and strategies to their own challenges in their own classrooms. According to Mayer (2011) this is cognitively appropriate because instruction can be described as managing how students come to knowledge via instructional experiences. In this research, high school teachers mentioned eight instructional strategies that they applied to their situations, and middle school teachers reported the use of ten strategies. These strategies were manipulated by teachers to fit their own content material. According to Zygouris-Coe

(2010), this concurrence of teaching allows students to understand reading as part of that particular content area and understand its uniqueness to that content area's learning process.

As in all learning, in science the concept of background or prior knowledge is vital to the construction of scientific knowledge and understanding. According to Mayer (2011), prior knowledge "guides knowledge construction in the working memory" and further scaffolds understanding building schema (p. 35). For science students, background knowledge is crucial for the formation of comprehension. Brain researchers have found that elaborations, i.e., adding an individual's knowledge base to new knowledge via a concept map, and informational questioning are regarded as "comprehension-fostering activities" (National Research Council, 2000, p. 107). In this study, high school and middle school teachers reported via the mitigation lists prior knowledge as an area that was necessary to activate and build upon. One middle school science teacher stressed the importance stating, "All of these strategies are building prior background, interpreting the content, and connecting ideas with one another." Another teacher defined these activities as ". . . activating their prior knowledge to make connections between new material and previously learned material." In conjunction with these teachers' statements of the useful purpose of prior knowledge, Grant and Fisher (2010) listed some tools and strategies that are efficient elicitors of prior knowledge. Some examples of these strategies and/or tools are directed reading-thinking activity (DR-TA), questioning activities (QAR), KWL charts (what do I know/what do I want to know/what have I learned) and other graphic organizers. Gunning (2012) added other

strategies such as anticipation guides, predicting, previewing strategies, and using questions to attain certain goals. Mayer (2012) asserted that summarization along with visualization are tools at the apex of comprehension and can give the learner absolute feedback as to where in the learning process comprehension has taken place.

Summarizing activates cognitive processes that serve to organize learned material in rational arrangements that lock in prior knowledge in the structure. In reviewing the tools and strategies that the teachers used, it is clear that these same strategies were also reported by teachers to be appropriate for mitigation of their classroom challenges with comprehension. Appendix D contains 26 figures detailing the many instructional strategies use to augment comprehension.

Vocabulary Development and Print-Rich Environment Themes

Second in terms of instructional challenges for teachers in this study was the issue of the development of vocabulary. Included in this vocabulary development effort was the creation of a print-rich environment in participant classrooms. Therefore, even though “print-rich environment” constituted the fourth largest theme, it is included with the implications for vocabulary expansion in the discussion.

Overall, 28% of the mitigations that all teachers reported dealt with vocabulary issues. Since vocabulary underpins the understanding and linkage of concepts in each area of science, it is imperative that students have a good grasp of vocabulary and of the word parts that contribute to scientific understanding (etymology). Vocabulary development can happen in a variety of ways including the use of word walls, drawing on

contextual clues, the employment of semantic charts, and other graphic organizers such as Frayer models, creating vocabulary word sorts, and learning word parts and roots (Grant & Fisher, 2010; Gunning, 2012). Word walls display the words in the classroom and repeatedly present the words to the students for quicker recognition and comprehension purposes. Word walls also allow manipulation of the words for various activities if the teacher so desires. Mayer (2011) stated that in the process of cognition, working memory is very limited in terms of processing and holding. Because of that, a learner must see the word many times before it is converted to long-term memory. Adding word walls and making classrooms print-rich help to stimulate working and long-term memory, thus, making scaffolding new knowledge easier. Print-rich classrooms are rooms that have subject related words on the walls, bulletin boards, or even hanging from the ceiling in order to utilize space. Participant teachers also made small classroom libraries available to the students. One high school science teacher described his classroom space as “print-rich with various books, magazines, word wall, and students work.”

Participant teachers employed an array of vocabulary building tools to combat their students’ difficulties with word and word usage. In addition to word walls, they had students draw illustrations to go with their vocabulary words, they played word games, and chose “science word of the day” to augment certain important words. Both high school and middle school teachers reported adding the study of word parts (etymology) to their practice. The study of etymology helps students get better at new word recognition,

makes comprehension of the word easier, and makes the word easier to apply to other related words (Gunning, 2012).

Instruction (Explicit) Theme

The third largest reported mitigation was in the area of instruction, specifically, “explicit instruction”. Explicit instruction refers to very direct teaching methods that focus students’ attention to certain areas that are important and model for the student the skills that the teacher wishes the student to be able to perform. The combined total mitigations for high school and middle school “instruction” was 27%, just a bit below “Vocabulary Development” and the top rated “Comprehension” mitigations. Thus, it was clear that this mitigation was also very important to participant teachers. Modeling, also known as “Think-alouds,” purposefully guide students by demonstrating the teachers’ thinking out loud as the teacher moves through the particular assignment (Gunning, 2012; National Research Council, 2000). According to McConachie and Petrosky (2010), this sort of explicit accountable talk exhibits the expert thinking that is necessary for novice learners to copy. One high school science teacher described how he used this skill in his class: “[I] will model to students how the text is organized and what kind of information can be learned from each part of the text.” These exercises help knowledge transfer and metacognition in the students, as they learn from the “expert” learner (Bruning, 2004). The importance of this strategy as a mitigation was evident in that 34 of the 55 participants noted that the theme of explicit instruction was useful.

Another mitigation employed by participant teachers in this research was “read-alouds.” A “read-aloud” is typically performed by the teacher for purposes of allowing students to hear fluid reading. In the voice of one of the high school teachers, “I volunteer to read aloud to them from these articles; I found that the students enjoy when I read to them and will prefer to hear me read aloud to them rather than read silently on their own.” According to Grant and Fisher (2010), having students listen to expert reading allows students to concentrate on content presented with a focus on critical thinking outcomes. This type of modeling helps teachers move through difficult science text, unraveling complicated sentence structure for students and explicitly teaching students to do the same (Fang, 2008; Schleppegrell & Fang, 2008). Wellington & Osborne (2011) viewed this interaction between the text, teacher, and student as a structured and scaffolded exercise that helps build a knowledge framework for students.

Assessment Theme

For participant teachers in this study, the assessment theme was subordinated to all the other themes, playing a very minimal role in terms of ways to mitigate instructional challenges. This theme generated only 4% of the 146 responses for middle school teachers and 3% of the 203 responses for high school teachers. For both sets of teachers, the use of formative assessment was mentioned approximately 10 times total. Formative assessments are designed to provide information to the teacher as to the students’ background knowledge via the use of a multitude of different strategies (Grant & Fisher, 2010). According to cognitive psychologist, Willingham (2009), this activity is

appropriate, since students cannot move to the critical thinking level if they lack the essential background knowledge. Formative assessment and background knowledge are intertwined; and as previously noted, background knowledge assessment was used often by participant teachers. Formative assessment was moved to this category because teachers mentioned other types of assessment also. For example, one middle school teacher calculated the readability of the textbook and then remarked “My textbook was geared for a college student at a level of 12.9 with a readability ease of 36, which makes this document harder to decipher than an insurance policy.” In reference to high schools, one teacher discussed scaffolding exams “using Bloom’s Taxonomy as my guide.” Thus, formative assessment was used rather broadly by teachers but the mention of summative assessment never appeared in participant teachers’ reflective assignments.

Research Question 3

Based on participating teachers’ stated views, what changes did middle and high school science teachers see in their students after the instructional changes were implemented?

This research question was concerned with the changes that participant teachers saw in their students over the time period that spanned the challenge mitigations. Results varied between the two teaching groups, but as a whole one-third of the thematic responses dealt with positive changes seen in regard to student motivation and engagement. Additionally, almost another third also saw positive changes in student self-efficacy. Apparently, the teaching style changes by the participant teachers affected

students at a deep, personal level. Interestingly, one of five teachers indicated the students' learning changes were characterized by an increase in comprehension. Teachers also indicated students' learning changes improved in vocabulary and class enjoyment.

Researchers have shown that students can exhibit positive change and improved self-efficacy when given the chance to improve their abilities (Brunning et al., 2004; Dweck, 2010). In this study, the use of strategies and tools to slow and separate science instruction into smaller components, thereby diminishing frustration and fear of failure, appears to have impacted students enough to have a significant influence on their motivation, engagement, and self-efficacy. This was consistent with Mayer's (2011) four components that support instructional motivation (personal, activating, energizing, and directed). The participant teachers' use of instructional strategies helped students direct their learning so that comprehension could happen. The psychology of learning reminded teachers that the uptake of factual knowledge, largely supported by prior knowledge, paves the way for skillful thinking which requires practice, and, in so doing, ends in comprehension and proficiency (Willingham, 2009). It has been demonstrated that the use of strategies and instructional tools as implements of practice can increase vocabulary and comprehension, thereby impacting student engagement, motivation, and academic scores (Fang & Wei, 2010; Greenleaf et al., 2011; Robinson et al., 2004). Additionally, teachers who integrate literacy in their instruction for all students instead of as a method of remediation for some stand to positively impact learning for all (Moje et al., 2006). In this grounded theory study, it was apparent that student engagement and

motivation were elevated in tandem with the students' vocabulary and comprehension skills that were guided by the instructional changes that the teachers implemented.

Research Question 4

Based on participating teachers' stated views, what ways did the professional development effectively help middle and high school science teachers to change and improve their instruction?

Almost half of the participant teachers in this study claimed changes in their own teaching assumptions and beliefs. This rate was twice as great in high school teachers when compared to middle school teacher group. For high school teachers, this was ranked as the highest return, while positive self-efficacy changes, registered as second most important. Middle school teachers' responses proved to be exactly opposite revealing that self-efficacy changes had the greatest impact. Again, these results reflect deeply personal changes and could be a sign of how well-structured, ongoing professional development impacted these participant teachers, highlighting the fidelity of the professional development.

The overarching goal of the professional development was to increase knowledge and augment the practice of this knowledge within the participant teachers' classroom situations. The extraction of the knowledge from the online professional development in terms of the instructional strategies, their choice and application, allowed participants to have access to a wide-ranging resource and extended immersion time in terms of application. Additionally, participant teachers had time to reflect on the implementation

of their chosen instructional strategies and the effects on their students. According to Dede et al. (2009), these attributes make sustained online professional training an effective way to provide training to busy professionals, thereby resulting in marked changes in the participants. The fact that nearly half of the 62 teachers commented on the positive changes in their own assumptions and beliefs was testament to the effectiveness of the professional development. Because action research of this sort is constructivist in nature and resides in a social setting, teachers' beliefs about how learning is constructed in their students and assumptions about themselves as teachers can be examined (National Research Council, 2000). One high school teacher spoke of his attitude changes, remarking, "I was disenchanted with teaching and my role as an educator; I no longer see reading inabilities as a 'road block' but an opportunity to use a diverse array of strategies." Equipping himself through engagement in this professional development made this participant feel empowered and affected his feelings about his role as educator.

It is clear from the analysis of data for this question that students believed they gained much from the changes in their teachers' teaching. The findings of Garet et al. (2001) showed that effective professional development that is sustained, practiced, and integrated with the academic subject matter is more likely to produce participants with enhanced knowledge and skills. One participant teacher described it as follows: "I can teach reading during my content area class while managing to stay on track with my content area pacing guide. Teaching reading actually makes my job of teaching science easier." Another high school science teacher shared his changed perception about his own role in teaching reading by saying,

Prior to this class I had little understanding of how important teaching reading was within my content. To be quite honest I never thought of it as that important. I just figured that my responsibility was to teach my content not the ability to read. Let me be the first to say how wrong I was.

This is an important point when considering the integration of reading into this content area. Well-designed professional development, that builds in a sustained timeframe which allows practice and reflection, can give teachers time to see actual change in their classroom which can then motivate continued implementation of new practices.

According to Heller & Greenleaf (2007), well-planned, directed professional development can produce teachers who become confident about their ability to blend literacy instruction with their content area instruction. This fact is clear from the data collected under the “self-efficacy” theme which was the second highest theme for change in all participant teachers and garnered the greatest change for middle school teachers. Interestingly, this theme can be reflected upon in a circular manner from the student to the participant teacher and back to the student again. Brunning et al. (2004) stated that teachers’ behaviors and expectations are influenced by self-efficacy conclusions that are reached by assessing how their students are impacted by their teaching. When teachers see that they can influence students and make inroads into their students learning, their personal self-efficacy about their teaching skills increases. In this case, participant middle school science teachers increased in attributes that contributed to their higher self-efficacy pertaining to their teaching. These skills included being able to identify reading

difficulties, differentiate student needs, run lessons more smoothly, and motivate students in addition to becoming more comfortable in using strategies. High school teachers described their increase in self-efficacy as science teachers by indicating that they were better able to give struggling students more attention and that they felt like better teachers. The very act of being able to persevere and move struggling students to a higher achievement level is indicative of self-efficacious teachers (Brunning et al., 2004). In this case, it appears that both students and teachers benefitted from the instructional changes and, by extension, the online professional development overall.

Conclusions

The concluding grounded theory that was derived from this teacher reported grounded theory research can be stated as follows: When it is effective, online professional development (a) is designed to build teacher knowledge that will guide instructional practice; (b) is designed to promote teacher critical reflection on new knowledge, classroom instruction, and student learning; (c) is sustained over time; (d) is job embedded; (e) is inclusive of authentic and relevant professional development experiences; (f) allows teacher choice over assignments; and (g) provides teachers with time to reflect, implement new learning, collect data, and reflect on impact of instructional changes on student learning. (See Figure 3. The theoretical framework that offered a lens for consideration in this research, can be seen to be intricately woven into this derived grounded theory. As shown in the results of this research, teachers as adult learners (Knowles' Andragogy Theory) who were exposed to an effective online

professional development, as outlined in Guskey’s Model, were able to make improvements in the learning situations that surrounded their students (Vygotsky’s Social Constructivism).

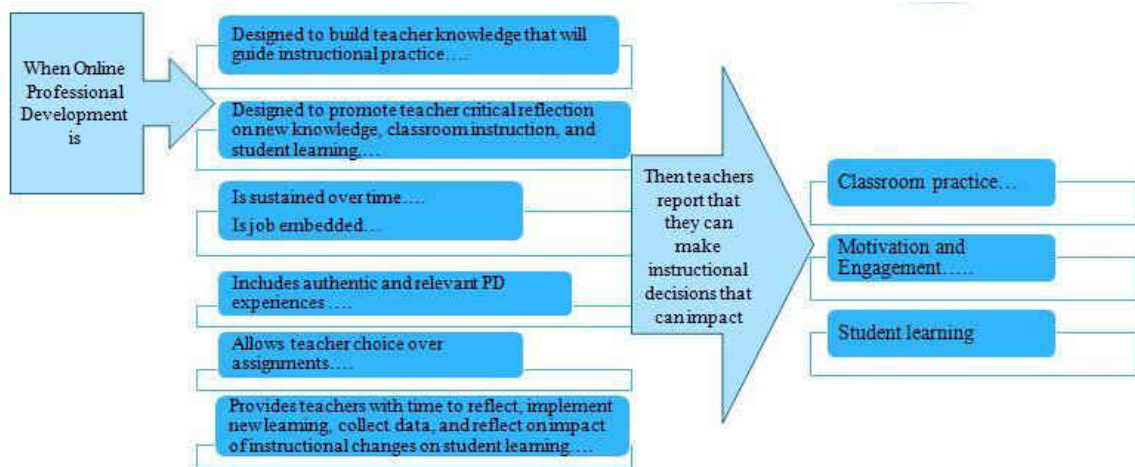


Figure 3. Emergent Grounded Theory Model.

Most teachers experience challenges in their classrooms, and a multitude of professional development programs have been developed to facilitate education as to how to alleviate these challenges. In this instance, after completing a 14-week online professional development in reading, 62 middle and high school science teachers’ reflective assignments were chosen for grounded theory research purposes. These reflective assignments revealed the real reading issues within these science teachers’ classrooms in their own words. The reflective assignments enabled the researcher to determine how the teachers utilized the information provided via the professional development to mitigate these problems and how those changes impacted the teachers

and the students. The grounded theory process of coding and subsequent assembling into themes provided a verbal and numerical look into the merits of the sustained online professional development.

Based on the findings of the study, several conclusions regarding the worth of this type of professional development, its impact on the students and teachers involved, and its contribution to existing research on reading in the content area can be made. Several findings that emerged from this study that could warrant a single positive conclusion: the online professional development was successful in the eyes of the participants. As adult learners, science teachers in this study showed that they were able to access, attain, and implement usable knowledge via an online system that was available to them on their own time. This was consistent with the results of other studies in which the value of a learning mode that is accessible to adult learners and applicable to the needs of the adult learner was demonstrated (Dede et al., 2009; Dillon et al., 2010; Garet et al., 2001; Guskey, 2002; Loucks-Horsley et al., 2003). Importantly, even though the subject matter was reading, science teachers demonstrated that they could integrate reading into their science teaching by implementing instructional strategies and tools that mitigated their challenges. Because of this fact, this study should add to the research by indicating that science teachers can make informed decisions about incorporating reading in their instruction to support students' content, literacy needs, and development when they participate in professional development that equips them with the knowledge, experiences, and tools they need to make changes in their instruction.

This process was personalized to each individual situation as to how teachers chose to resolve their own issues. This ownership was clear as indicated by the statements made by the participant teachers who were motivated by being able to solve their instructional issues. Teachers not only indicated that they saw a positive change in the challenges as presented by the students, but they also identified positive behavioral changes in their students. Teachers also provided evidence of their own changes, citing changes in their assumptions, beliefs, and motivations to teach. Thus, it can also be concluded that via the information dispersed through this sustained online professional development, science teachers were clearly able to create positive change in their classrooms regarding the reading challenges that they were experiencing.

In addition to the positive changes, teachers were able to move to a higher level of effective teaching. The elicitation of background knowledge is of paramount importance in science education. Becoming better at extracting what students know or do not know and then building on that knowledge leads to better engagement and sense-making of the science. Helping students build comprehension as they navigate difficult text or text structures by modeling or using various sorts of graphic organizers, builds self-efficacy in students and elevates engagement. Effective teachers take time to reflect and then use that reflection to adjust their teaching. In addition, effective professional development should also provide teachers with classroom relevant experiences that allow for teacher choice and job-embedded assignments. These assignments should promote teacher engagement with new learning and critical reflection about strategies that can improve classroom instruction and support student learning. Even though the professional

development's emphasis was on reading, these science teacher participants were able to absorb and implement what was necessary to improve their own class situations and alleviate learning challenges.

Implications for Practice

This study has made a contribution to two research bases: (a) the research on the effects of sustained online professional development and (b) research that supports the integration of reading/literacy into science teaching. In regard to both areas, this research had positive results.

This research exemplifies that online professional development that is centered on reflective, relevant, job-embedded activities can impact practicing science teachers' ability to improve literacy in the science classroom. This research also showed that professional development appears to need to be sustained over time to give teachers time to assimilate information, apply different strategies, assess those mitigations, and adjust their instruction accordingly. In this case, it was clear that science teachers can make informed decisions about incorporating reading into their instruction that can affect the students' uptake of science information and comprehension. Teachers and students appear to benefit from such professional development, even in personal areas such as self-efficacy and motivation.

Additionally, many participant teachers commented that they would continue to explore other ways to integrate reading via instructional activities to their unique situations in teaching science. Particularly compelling were the teachers' inquiries as to

where they might get more information to further their own learning. This was a clear indication that there is still much to do in terms of arming science teachers with adequate and appropriate information. It is also a clear invitation to shift preparation of pre-service teachers to be able to better integrate literacy into all science teaching. This research was appropriate in relation to positive changes that can be made to better prepare science teachers for future challenging science and engineering standards with the goal to adequately educate all students to the highest levels possible.

Recommendations for Future Research

The array of strategies and tools can be overwhelming for science teachers who are very often in a hurry to remedy certain difficulties they see in their students. In regard to this, future studies of the impact of the integration of reading in science education could center on what kinds of instructional strategies work best for particular outcomes. For example, it would be interesting to know if certain instructional strategies or tools work better than others in certain sciences or if they are equally useful in all coursework. Many teachers commented, in concluding their reflective assignments, that they wished to have access to more information in their classrooms, indicating that more research into the specific needs of these teachers is warranted. Also, more research in the area of differentiating between the six secondary levels and those specific instructional needs, could be beneficial for these teachers of science.

Additional research could be conducted to more fully understand the relationship between teacher/student motivation and the implementation of mitigating literacy

strategies in content area coursework. Understanding how the use of professional development and strategies can mitigate teachers' reading comprehension challenges in the classroom can serve to motivate students and keep teachers teaching effectively in the classroom. Providing students with relevant science coursework and tools that can improve their comprehension will add to the supply of U.S. technical workers that can move the economy forward in the future. This is one of the goals of 21st century education.

APPENDIX A
FOR-PD TRAINING: REFLECTIVE ASSIGNMENT INSTRUCTIONS

Specific Instructions for the reflective assignment as the teachers received in the FOR-PD training.

I. Identification and description of an instructional challenge.

Please select a challenge you are experiencing with the reading development or reading instruction of either a specific student or a group of students. As you go through this course, select what is real and relevant to you, what needs fixing, or what keeps you up at night.

Steps:

- a. Identify a reading instructional challenge you would like to resolve as you are learning more about effective reading research and instruction.
Describe who you are, the grade level you teach (or other position you have at your school), and your views about reading and reading instruction (or the role of reading in the content areas if you are a content area teacher).
- b. Briefly describe what is going on in your classroom (or school, if you do not have your own classroom) in terms of reading or reading instruction.
- c. Briefly describe the challenge and what steps you have taken so far to address it, even if your current plans have not produced the desired results.

II. Implementation of a plan of action, reflection, and next steps.

In this section, please (a) describe the development of your plan of action; (b) describe and briefly discuss results, thoughts, observations, and questions related to the implementation of your action plan; (c) reflect on decisions and changes you made in your instruction or work with students in your classroom or school; and, (d) discuss the next steps that will follow the implementation of your plan of action and what you have been learning in this course. You may even raise additional questions as you plan for future steps.

Sample instructional challenges include the following: Were there any special steps you took to adjust your instruction or assist your readers with their learning? What specific changes did you make either in your instruction or in your own classroom? Which reading strategies worked best, and for which students or purposes? What was the impact of your plan of action, if any, on your students or your own teaching? What worked well? What was challenging? What did not work well? What are some areas you would still like to continue to learn more about? What are your next steps?

Steps:

- a. As you learn more in this course about reading development, research and instruction, start developing a plan of action using ideas from the course (e.g., research principles, strategies, and resources).

1. Briefly describe what the elements of your plan of action are and also provide a short rationale for your decisions. For example: what strategies, content, or materials did you select? How, why, when, with whom, where, and under what conditions do you plan to use them?
- b. Describe your plan of action in detail and provide a rationale for the instructional decisions you made to address the challenge at hand. For example: what changes you made, what strategies you might have selected to implement, what instructional changes you made, what resources you included, etc.
- c. Describe how, and for how long, you implemented your plan of action and share observations from its implementation.
- d. Discuss the impact of your plan of action on the challenge you identified, and also on you as a teacher. Have any of your views about reading and reading instruction, or the challenge you were facing, changed as a result of your learning in this course and the instructional decisions you made?
- e. Discuss next steps and unanswered questions.

(Note: All materials pertaining to the Reflective Assignment in this dissertation is copyrighted and cannot be used without permission from the author.)

(Zygouris-Coe, 2009)

APPENDIX B
INSTITUTIONAL REVIEW BOARD APPROVAL



University of Central Florida Institutional Review Board
 Office of Research & Commercialization
 12201 Research Parkway, Suite 501
 Orlando, Florida 32826-3246
 Telephone: 407-823-2901 or 407-882-2276
 www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

**From: UCF Institutional Review Board #1
 FWA00000351, IRB00001138**
To: Vassiliki I Zygouris-Coe
Date: January 20, 2012

Dear Researcher:

On 1/20/2012, the IRB approved the following minor modification to human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Modification Type:	Carmen Woodhall has been added as a research associate
Project Title:	Florida Online Reading Professional Development (FOR-PD) Evaluation Research
Investigator:	Vassiliki I Zygouris-Coe
IRB Number:	SBE-06-03846
Funding Agency:	Florida Department of Education
Grant Title:	
Research ID:	1046257
Grant ID:	
IND or IDE:	

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in IRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Maratori on 01/20/2012 05:00:46 PM EST

IRB Coordinator

APPENDIX C
FIGURES: CATEGORIES, TOOLS, CHANGES, CHALLENGES, AND THEMES

Note: Figures have been placed in this appendix to augment visualization of the results acquired through the data analysis. The number of teacher participants is noted in the lower right of the figure and the number of total teacher participant responses is noted on the left of the figure for each category and theme figure. The themes also contain a percentage for each bar indicating the percentage of total responses represented by that theme.

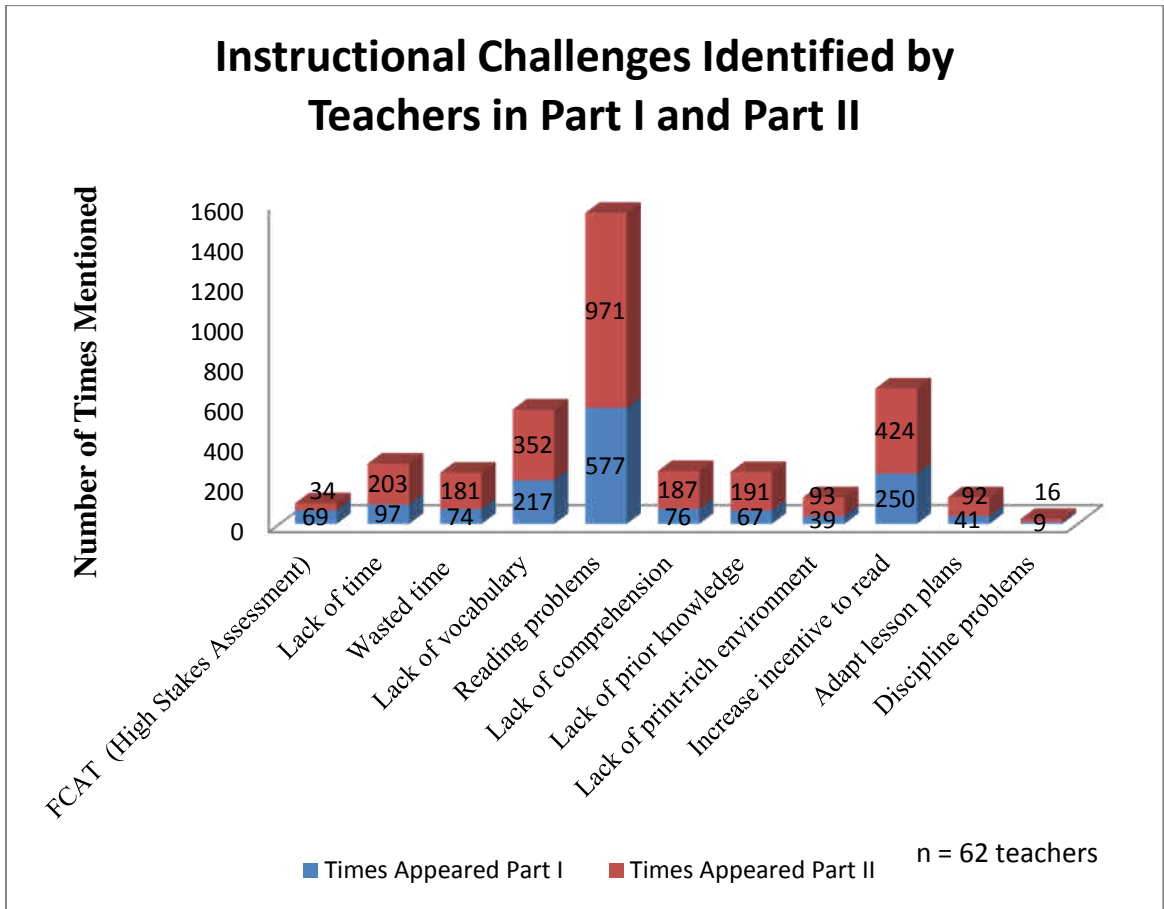


Figure 4. Word and phrase search results in reflective assignments, Parts I and II.

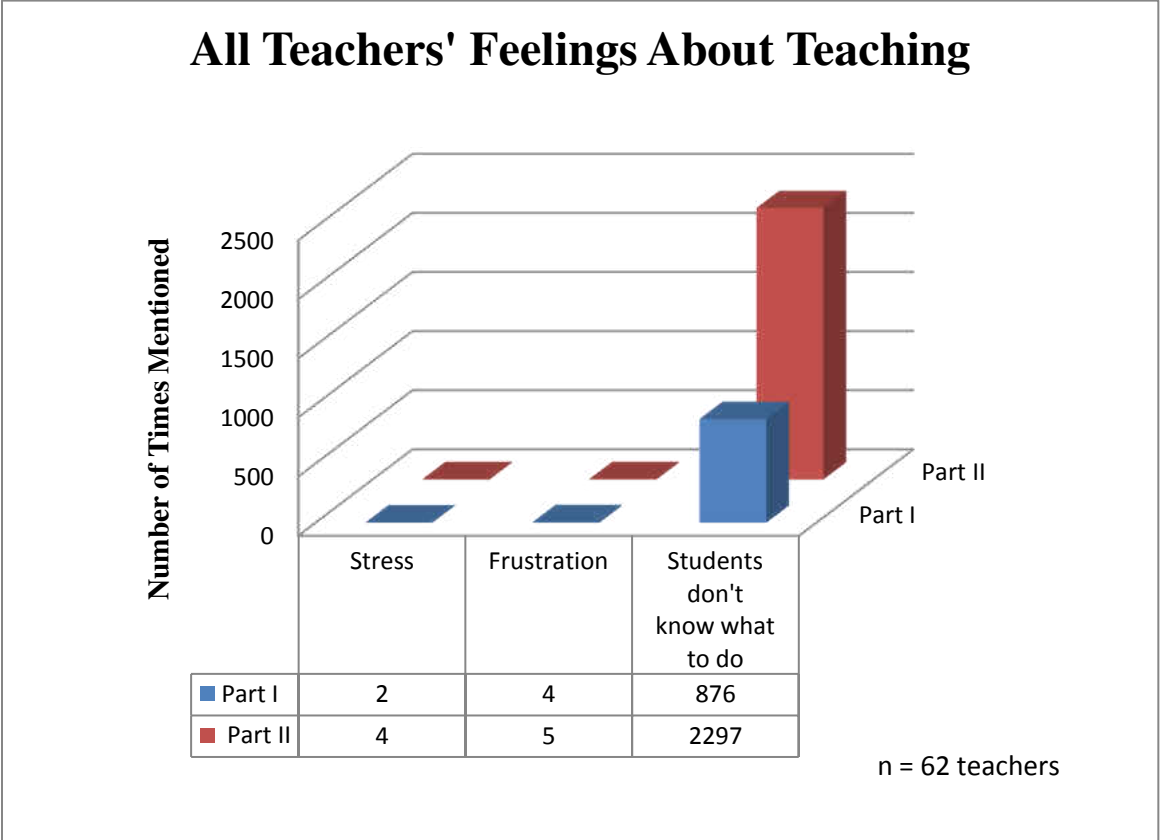


Figure 5. Word and phrase search involving inquiries about teachers' feelings about teaching.

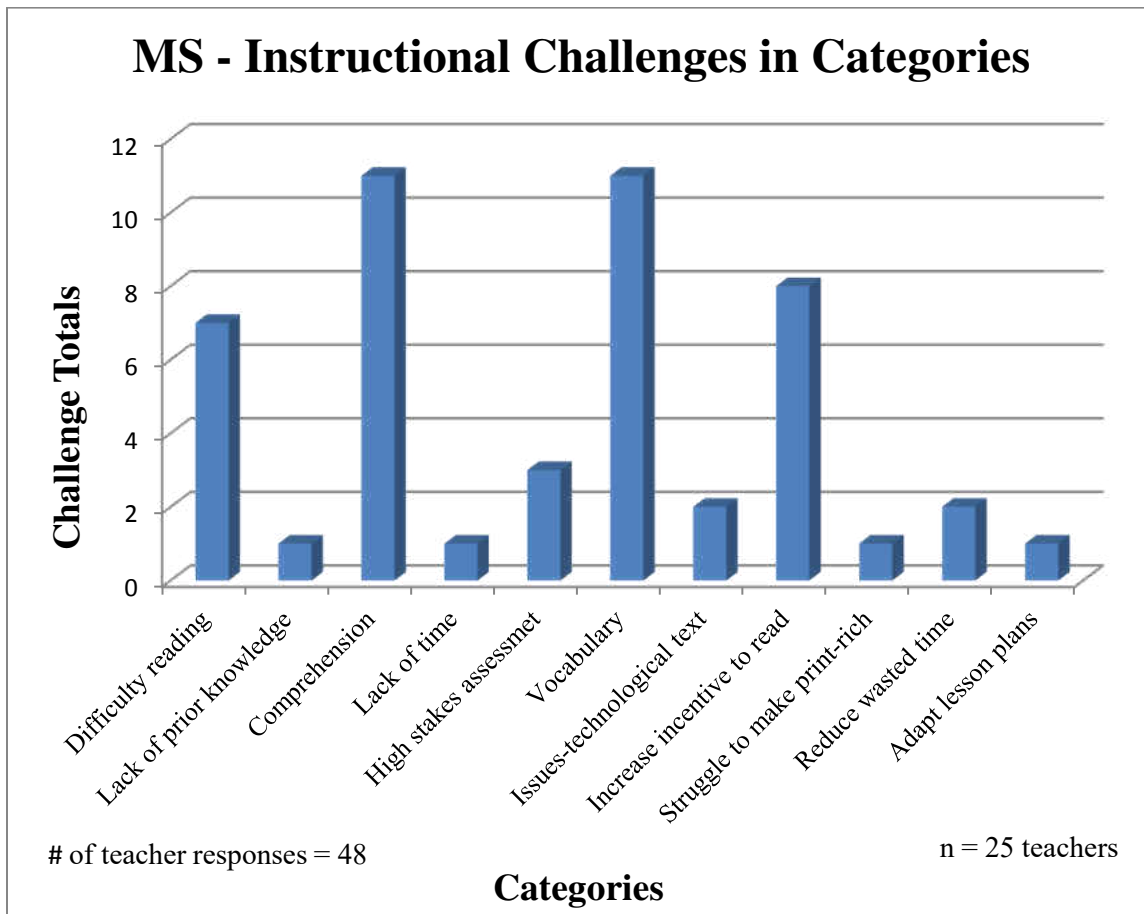


Figure 6. Categories of instructional challenges reported from middle school (MS) teachers.

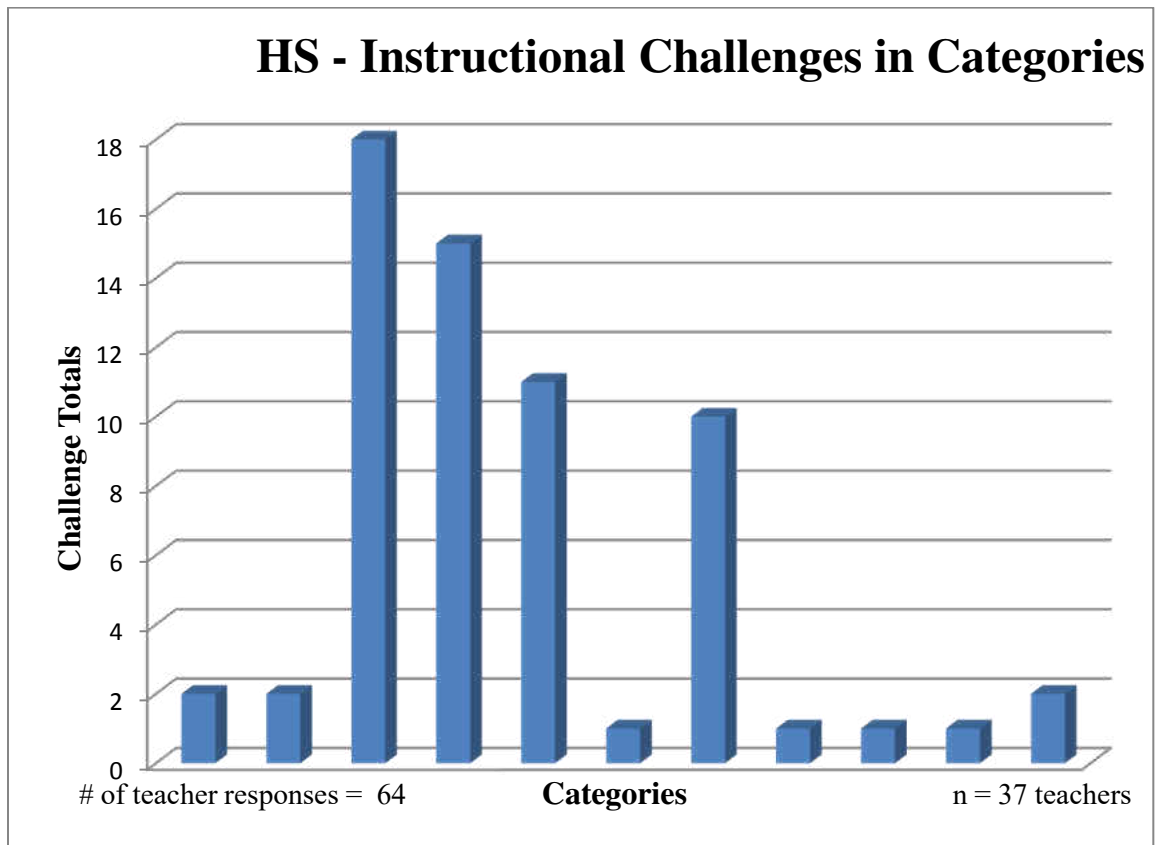


Figure 7. Categories of instructional challenges reported from high school (HS) teachers.

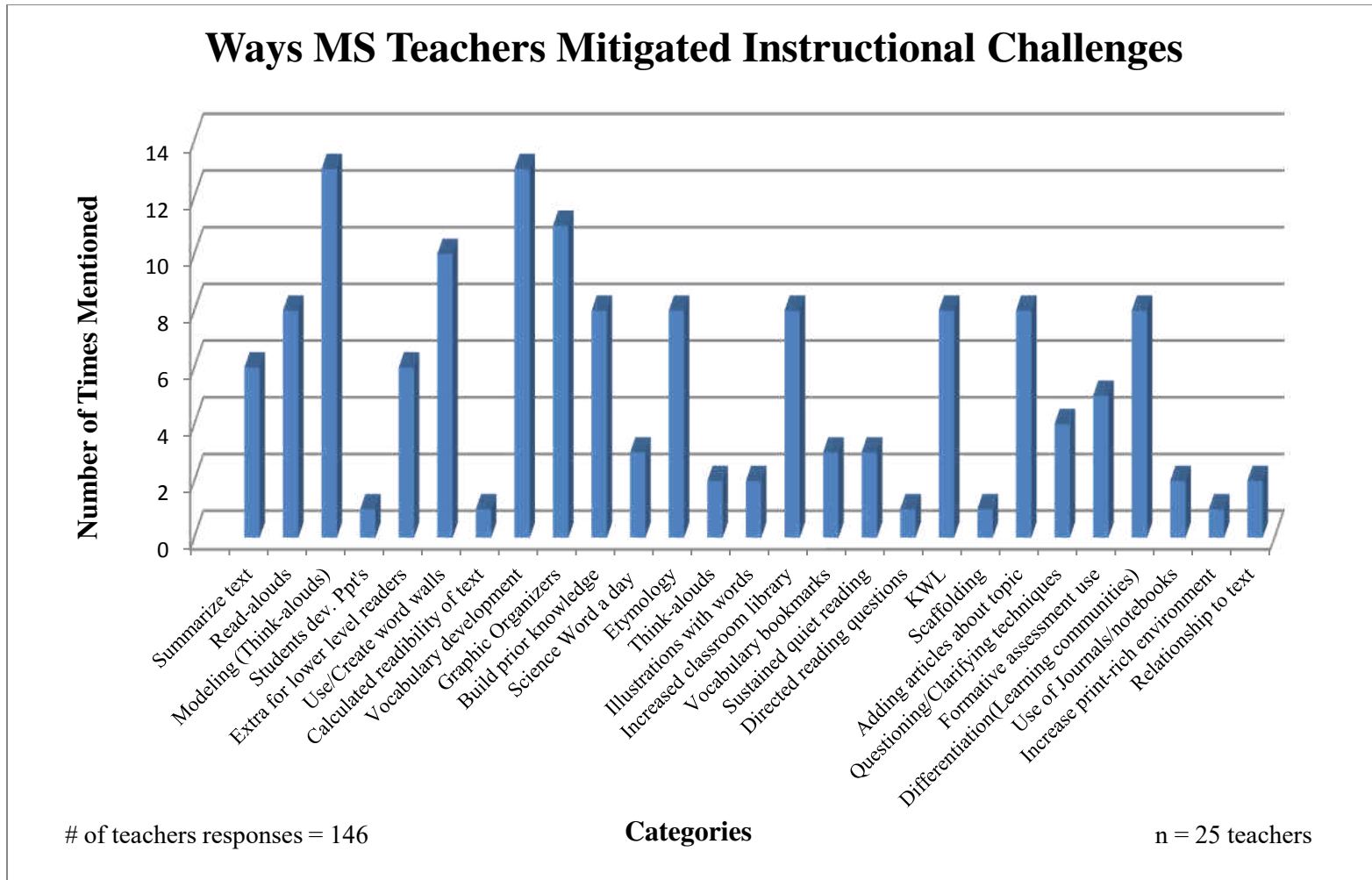


Figure 8. The instructional tools that middle school (MS) teachers chose from their PD experience to mitigate their classroom challenges.

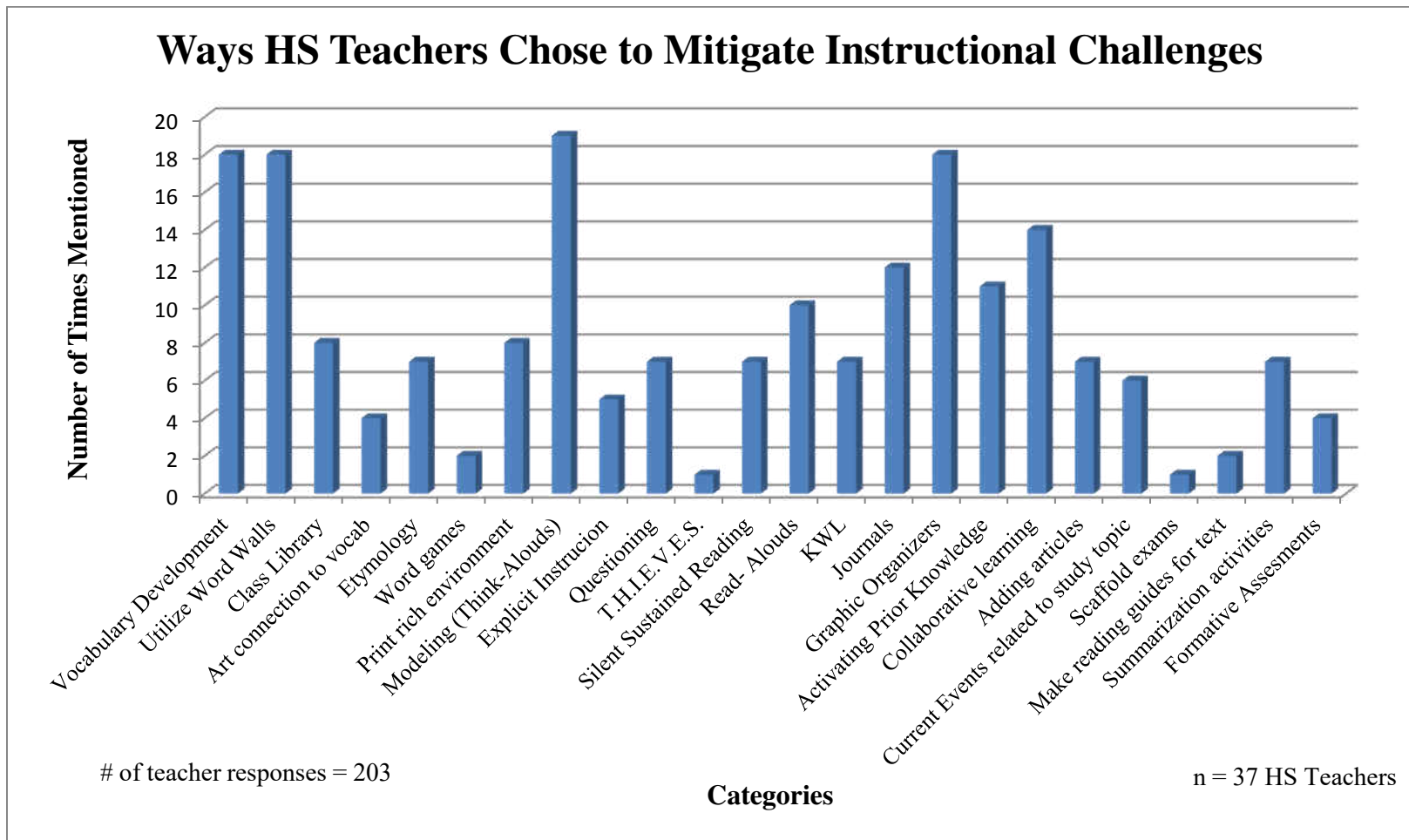


Figure 9. The instructional tools that high school (HS) teachers chose from their PD experience to mitigate their classroom challenges.

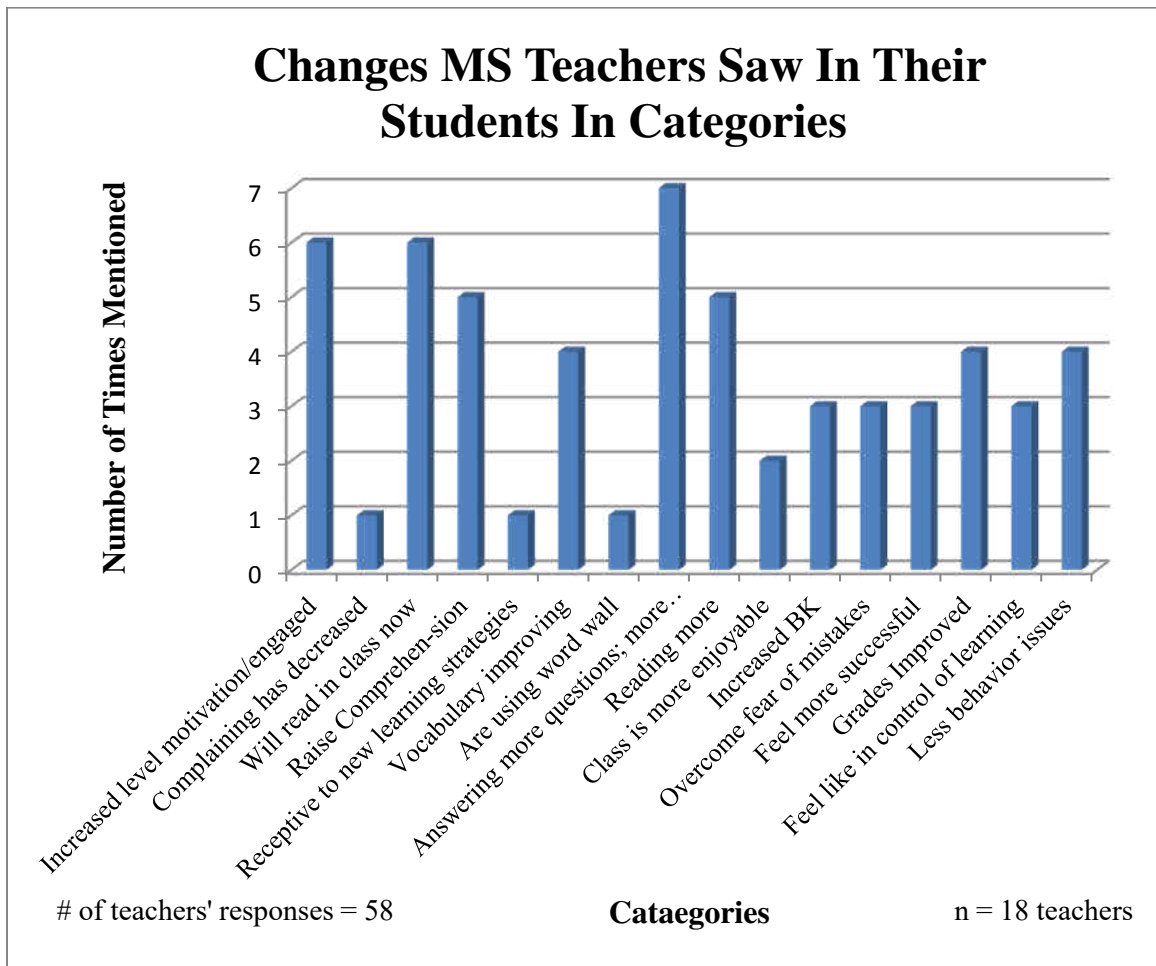


Figure 10. Changes that middle school (MS) teachers observed in their students after implementing various instructional tools they learned about in the PD experience.

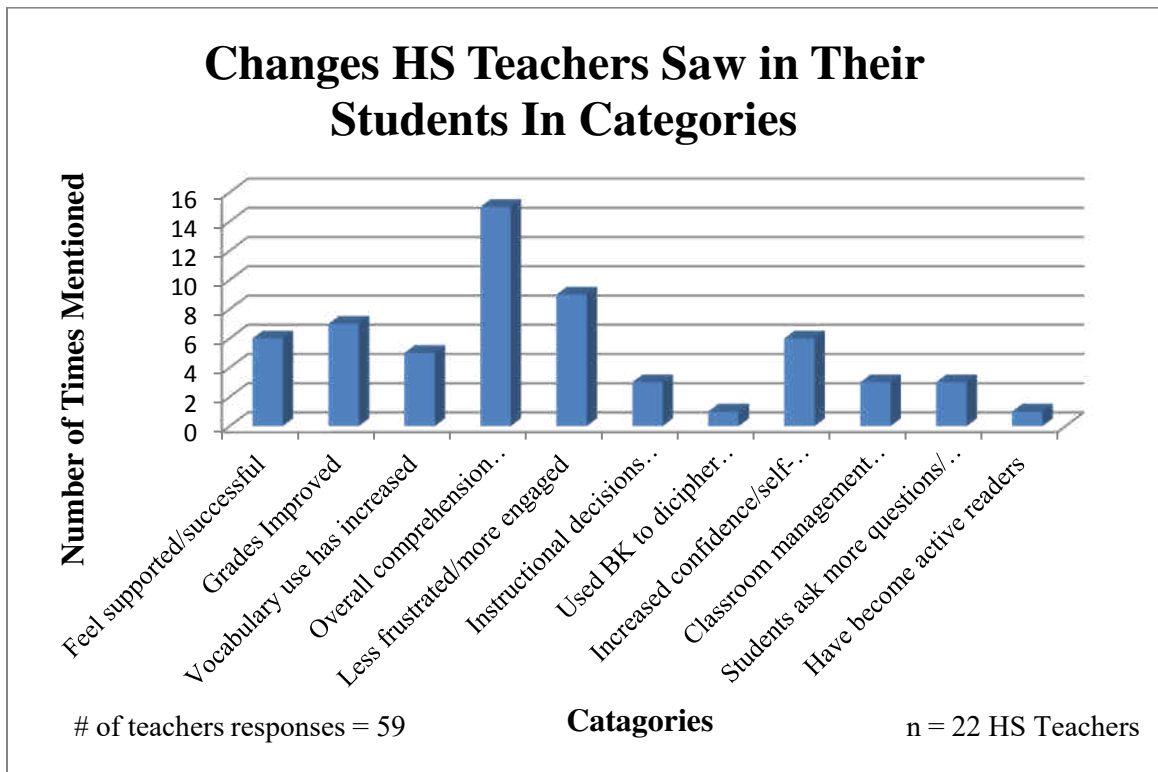


Figure 11. Changes that high school (HS) teachers observed in their students in implementing various instructional tools they learned about in their PD experience.

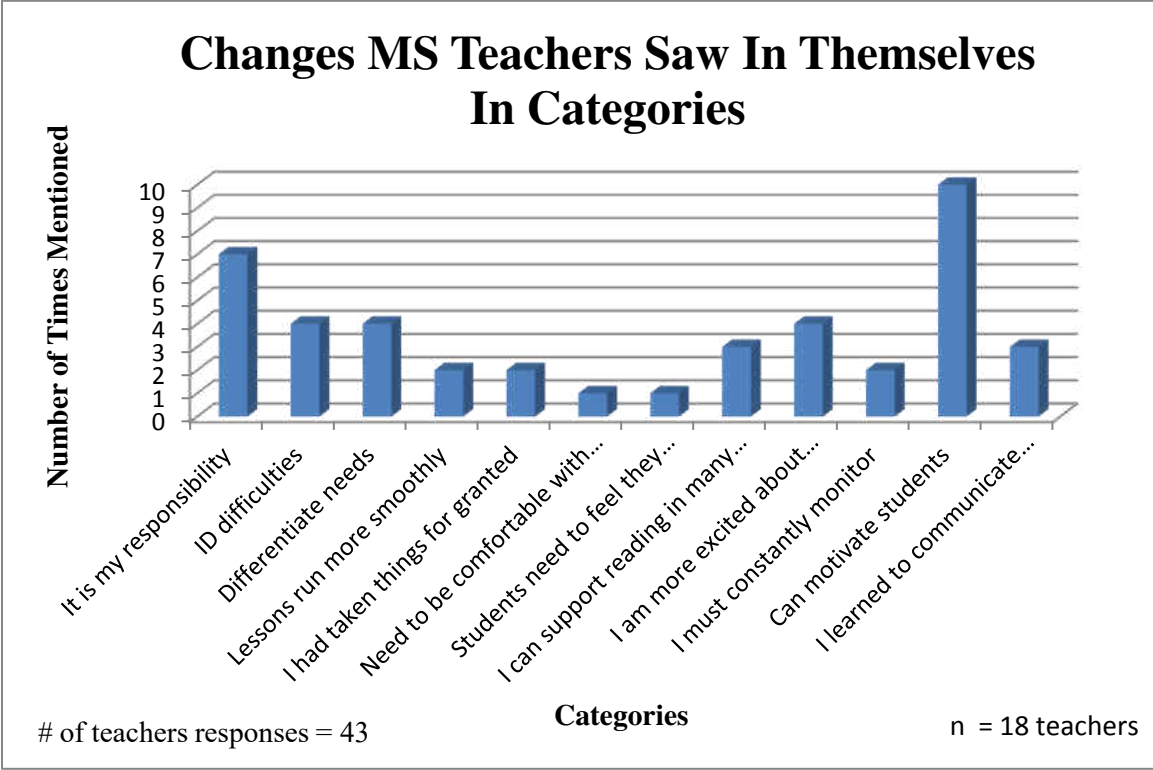


Figure 12. Changes that middle school (MS) teachers observed in themselves after implementing professional development tools and strategies.

Changes HS Teachers Saw In Themselves In Categories

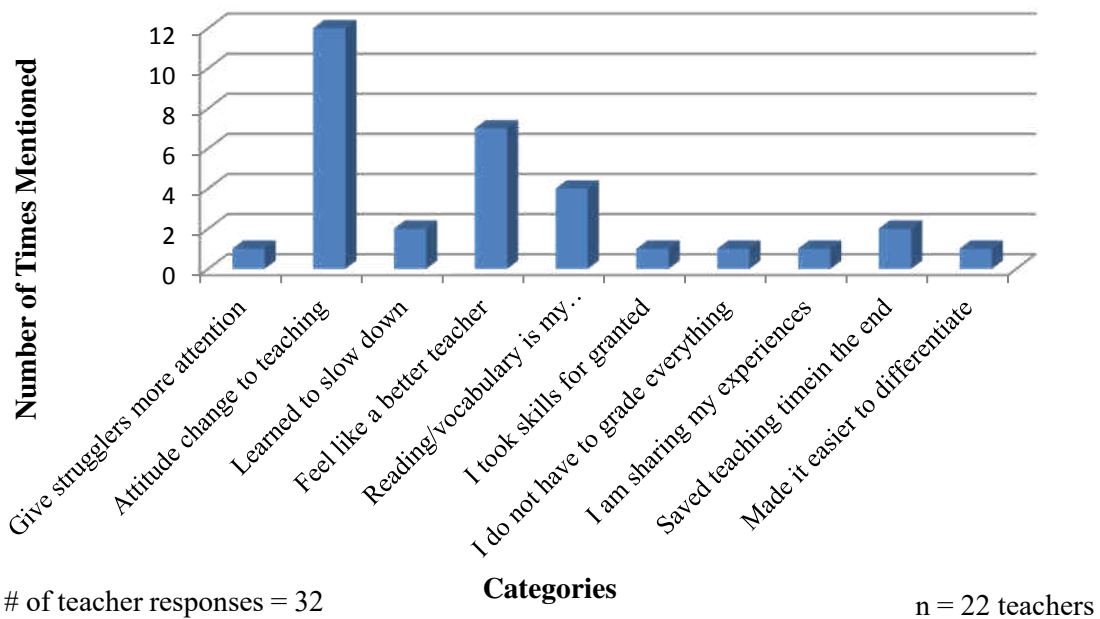


Figure 13. Changes that high school (HS) teachers observed in themselves after implementing professional development tools and strategies.

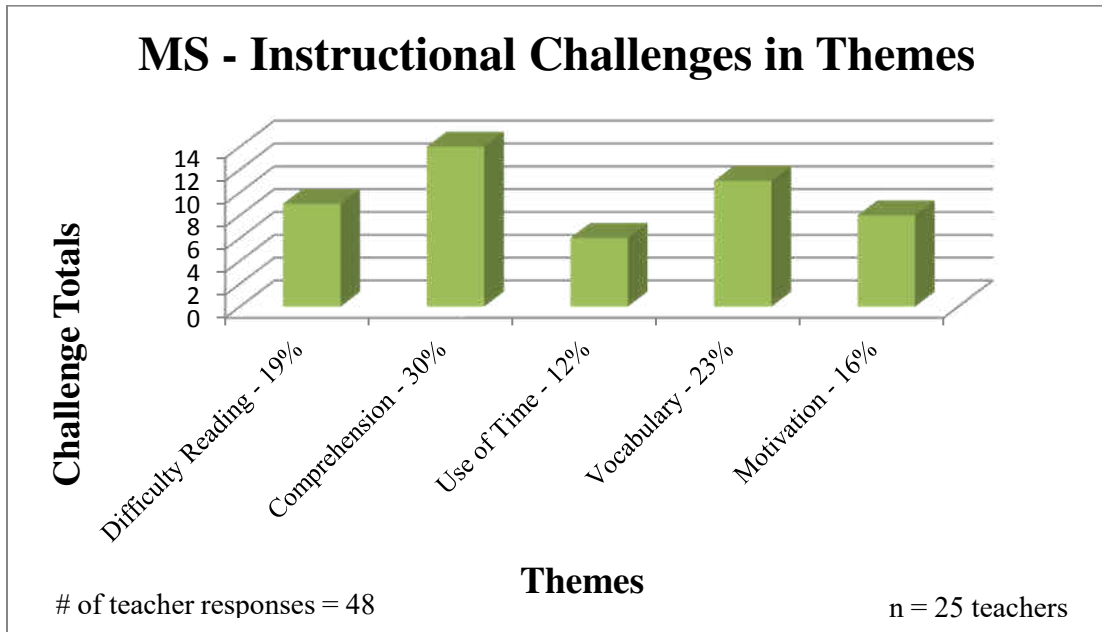


Figure 14. Instructional challenges reported from middle school (MS) teachers organized into themes.

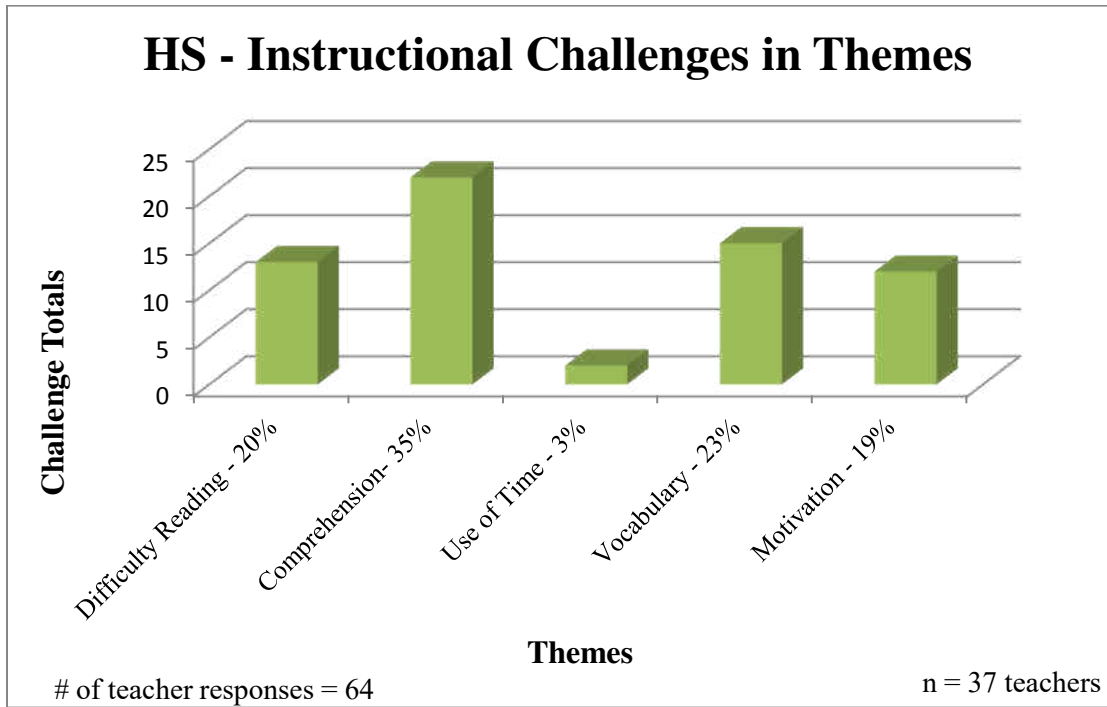


Figure 15. Instructional challenges reported from high school (HS) teachers organized into themes.

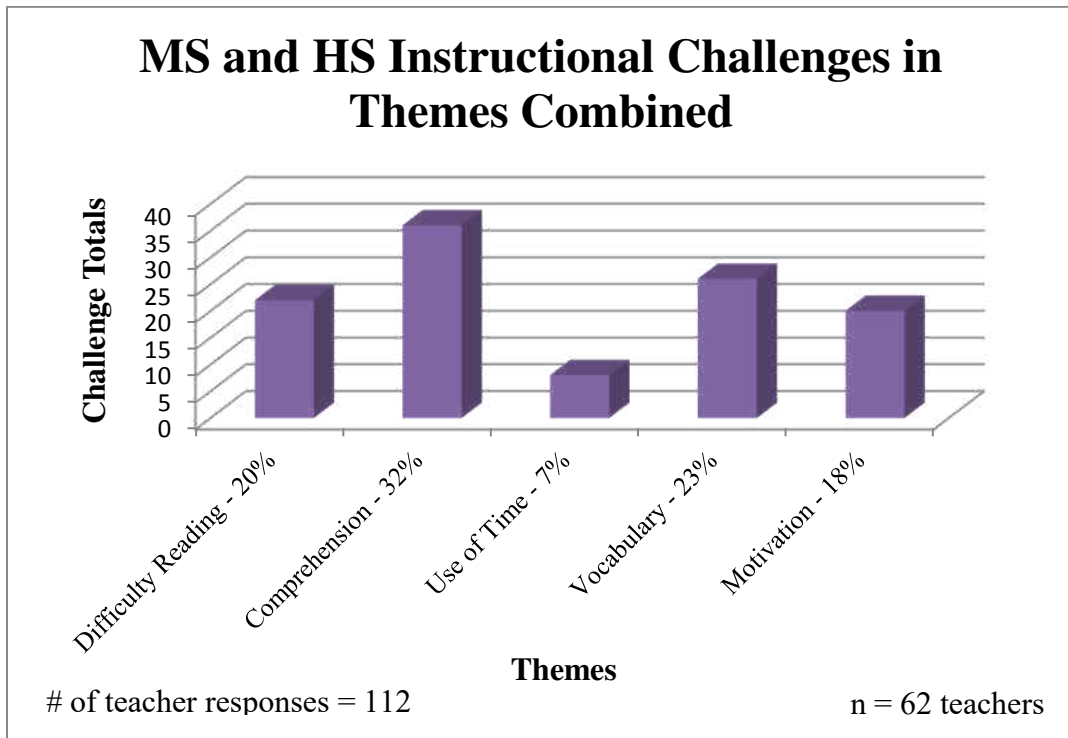


Figure 16. Combined instructional challenges of middle school (MS) and high school (HS) teachers organized into themes.

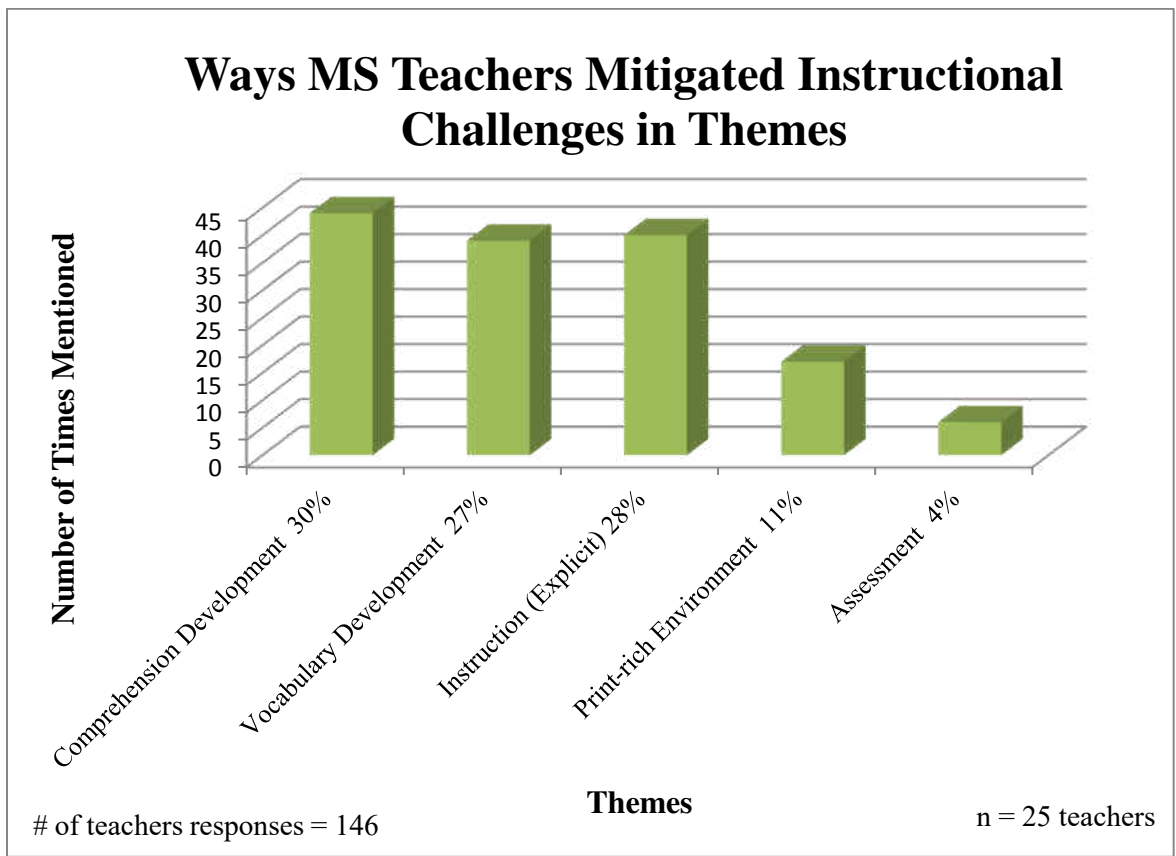


Figure 17. Themes: Mitigations for middle school (MS) teachers' instructional challenges

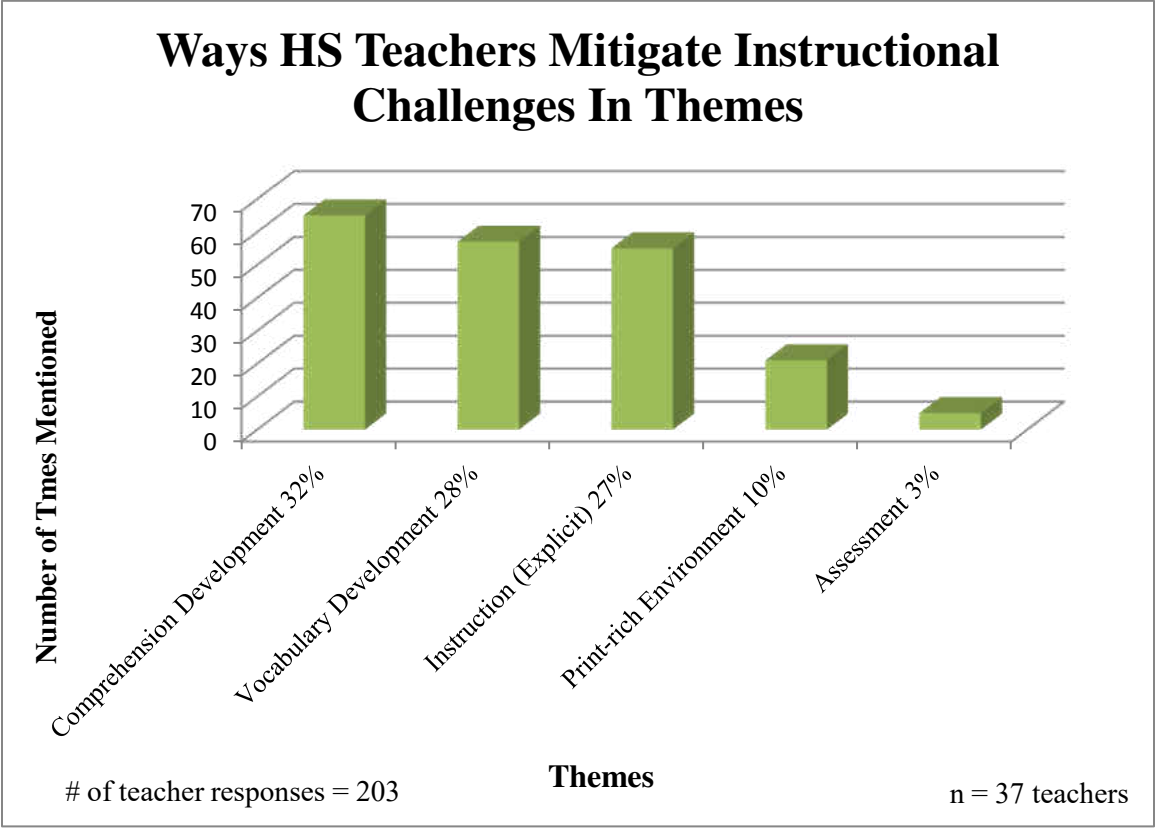


Figure 18. Themes: Mitigations for high school (HS) teachers' instructional challenges.

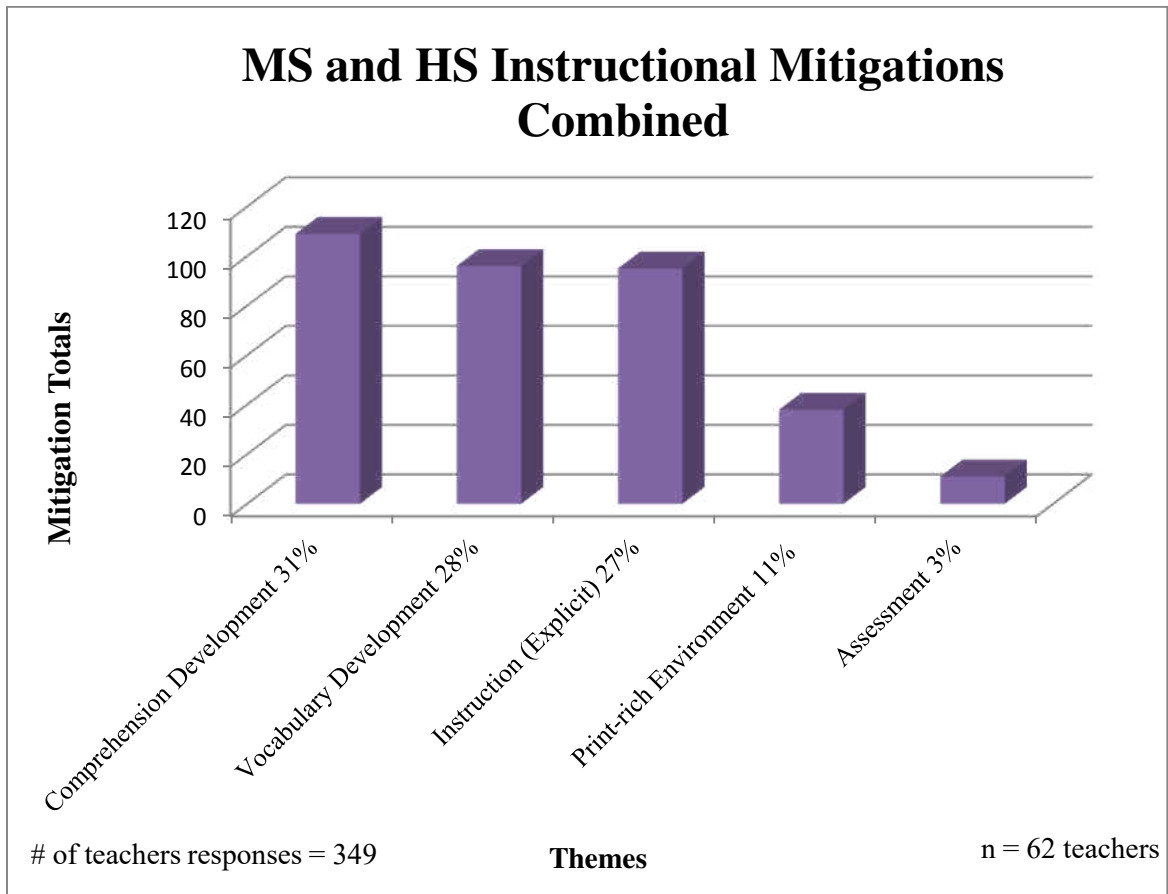


Figure 19. Themes: Mitigations for combined middle school and high school (HS) teachers' instructional challenges.

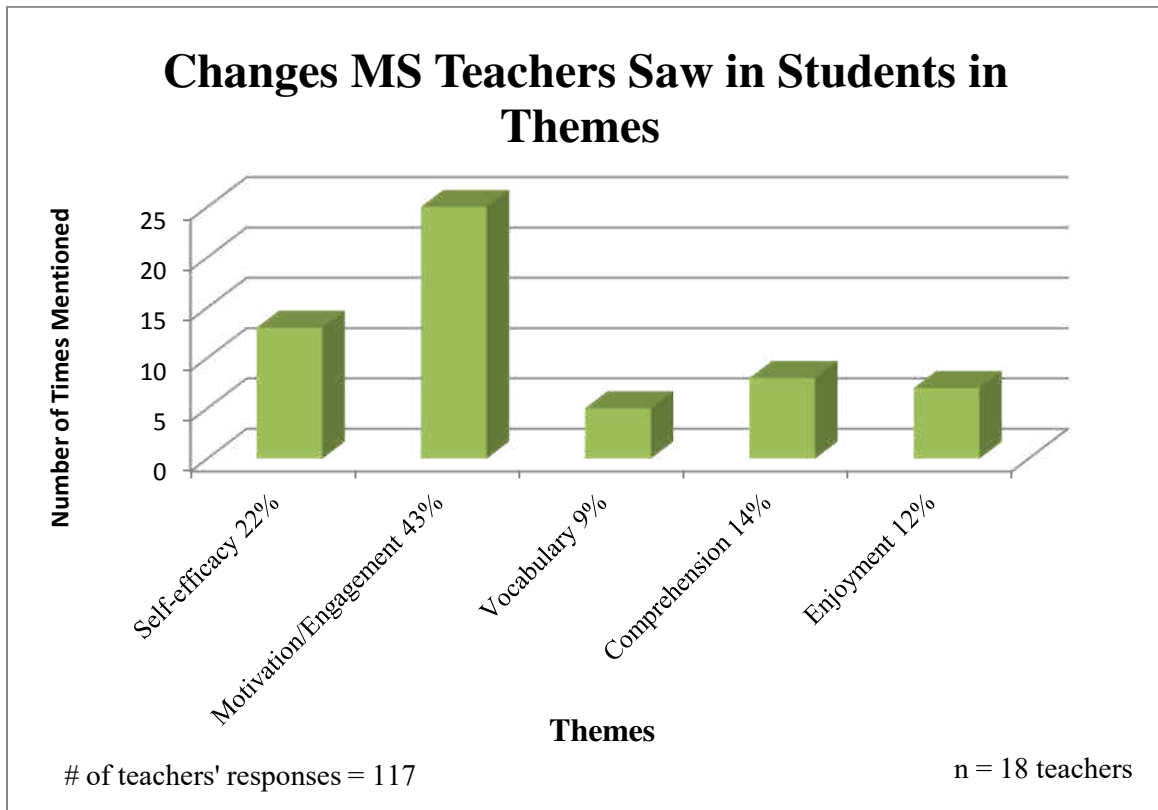


Figure 20. Themes: Changes middle school (MS) teachers observed in their students.

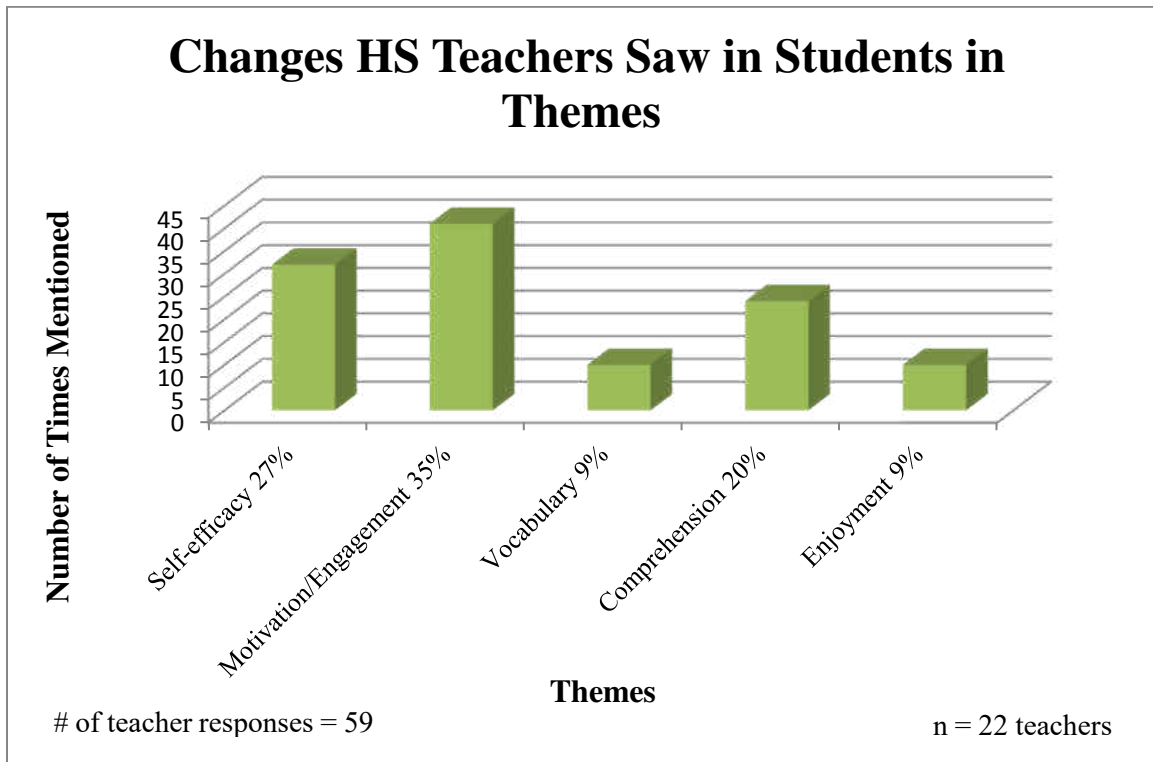


Figure 21. Themes: Changes high school (HS) teachers observed in their students.

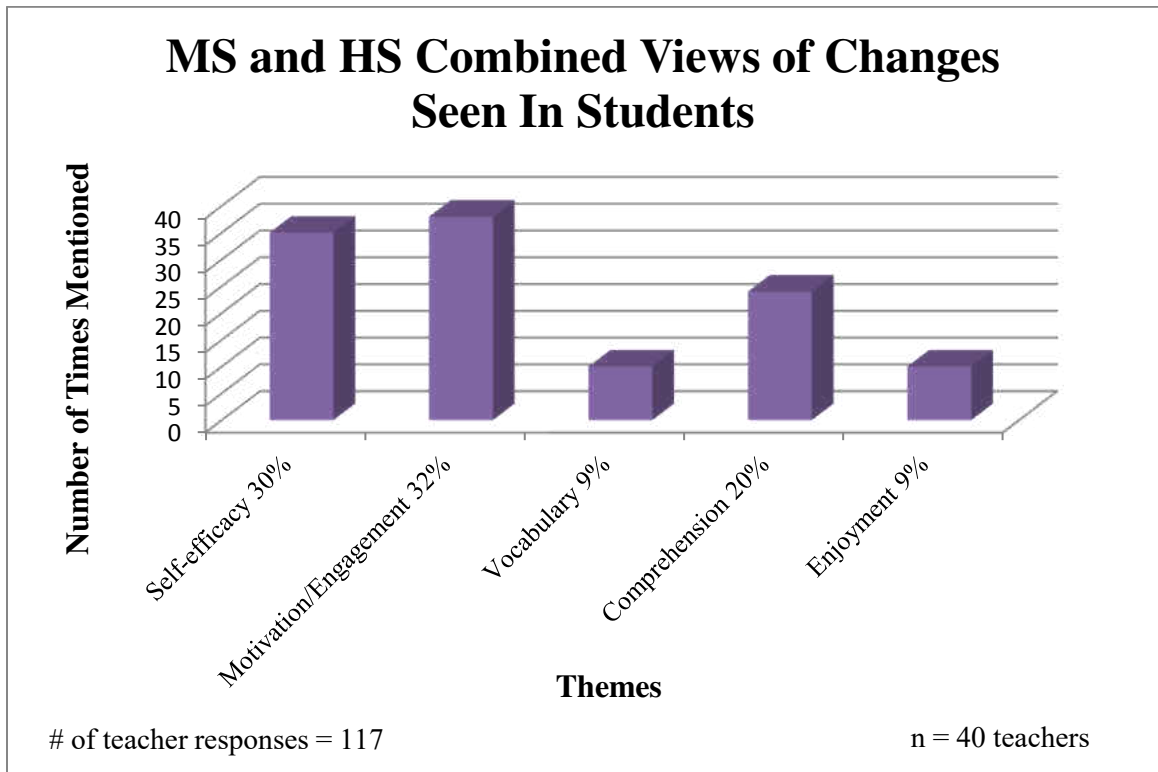


Figure 22. Themes: Combined changes middle school (MS) and high school (HS) teachers observed in their students.

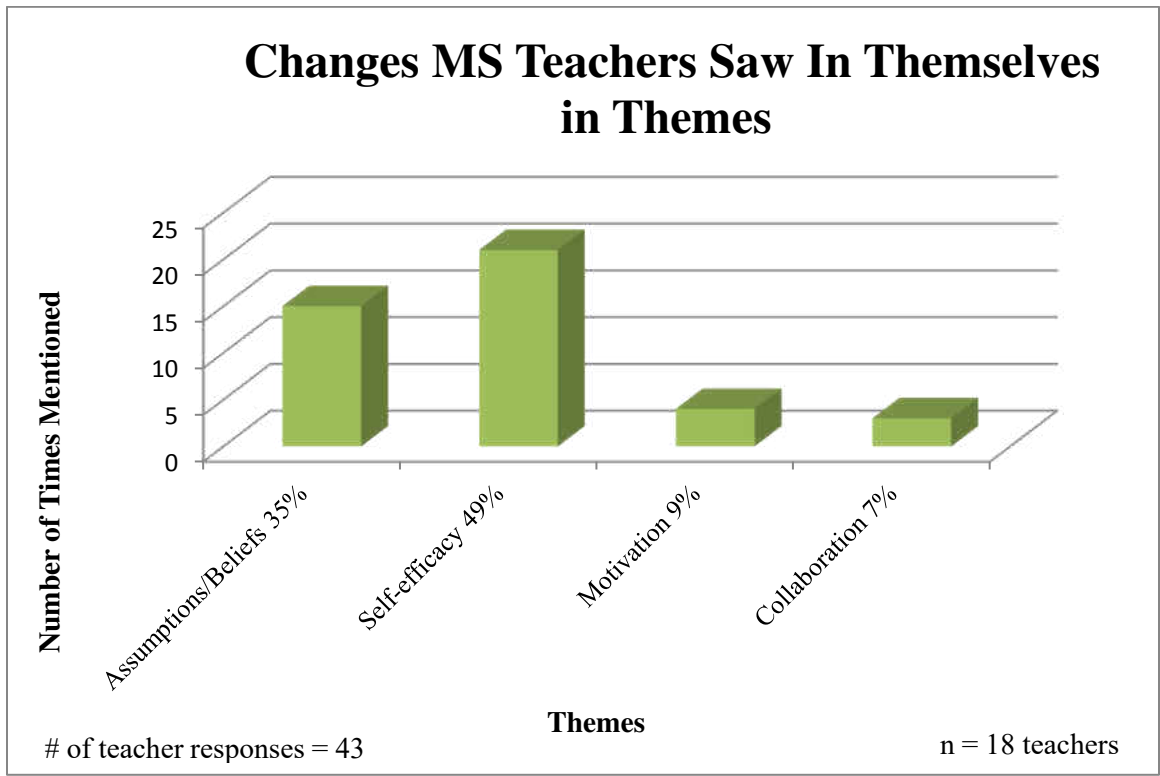


Figure 23. Changes that middle school (MS) teachers observed in themselves.

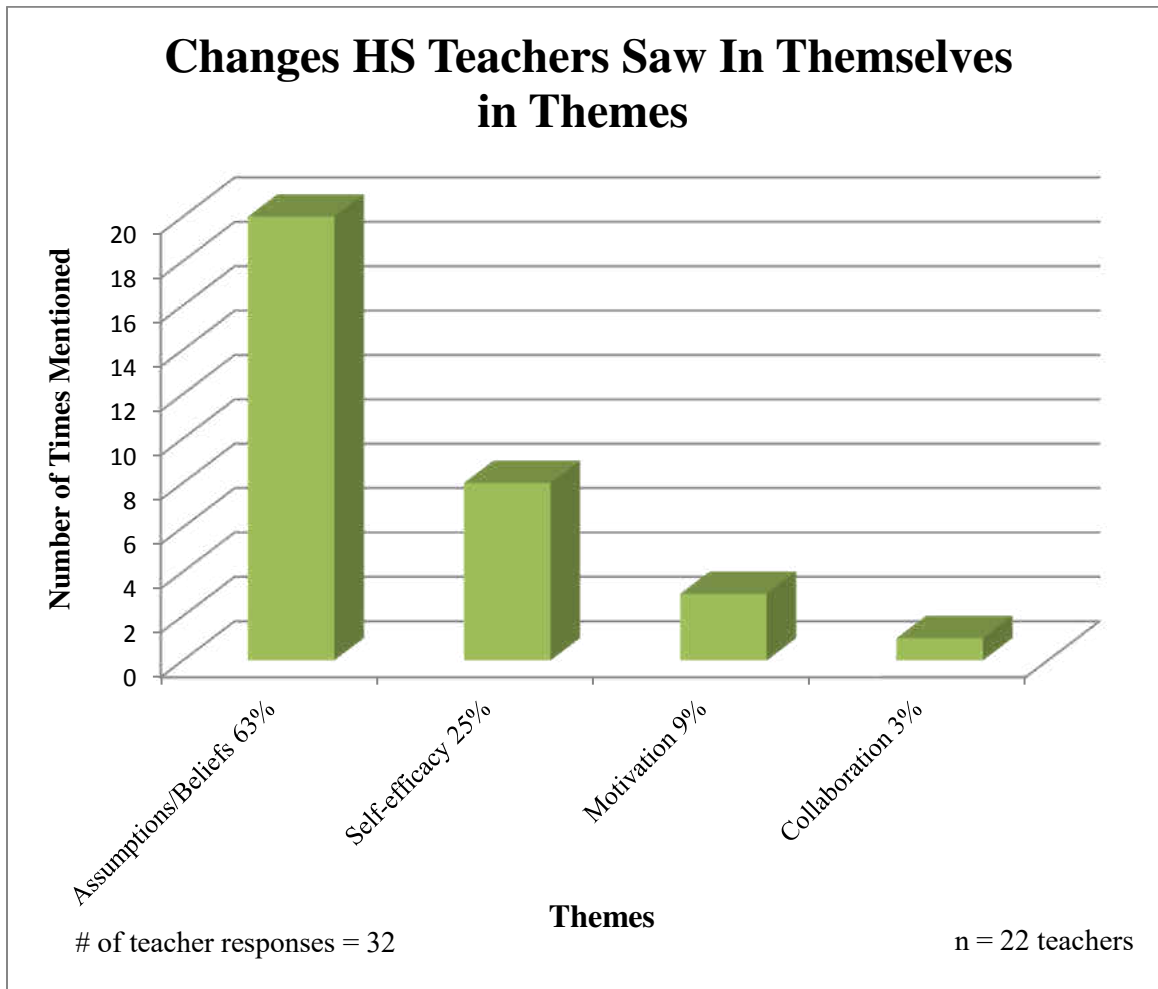


Figure 24. Themes: Changes high school (HS) teachers observed in themselves.

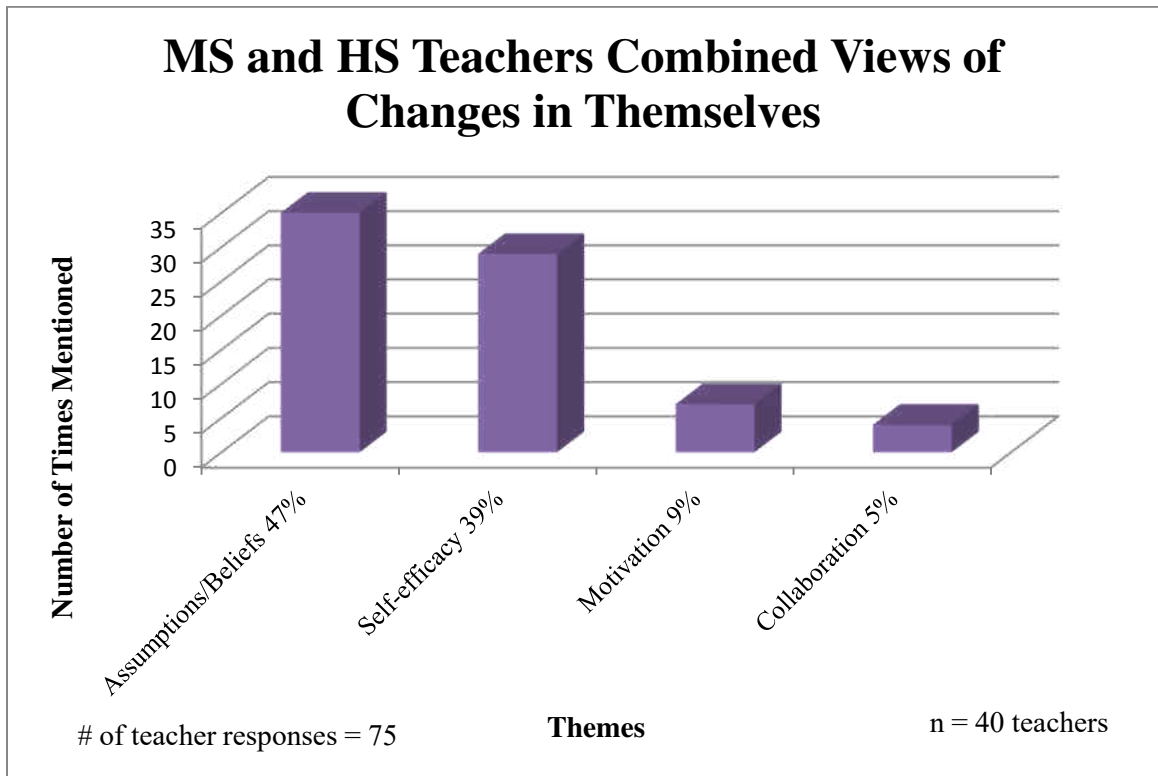


Figure 25. Themes: Combined changes middle school (MS) and high school (HS) teachers observed in themselves.

APPENDIX D
INSTRUCTIONAL STRATEGIES USED TO AUGMENT COMPREHENSION

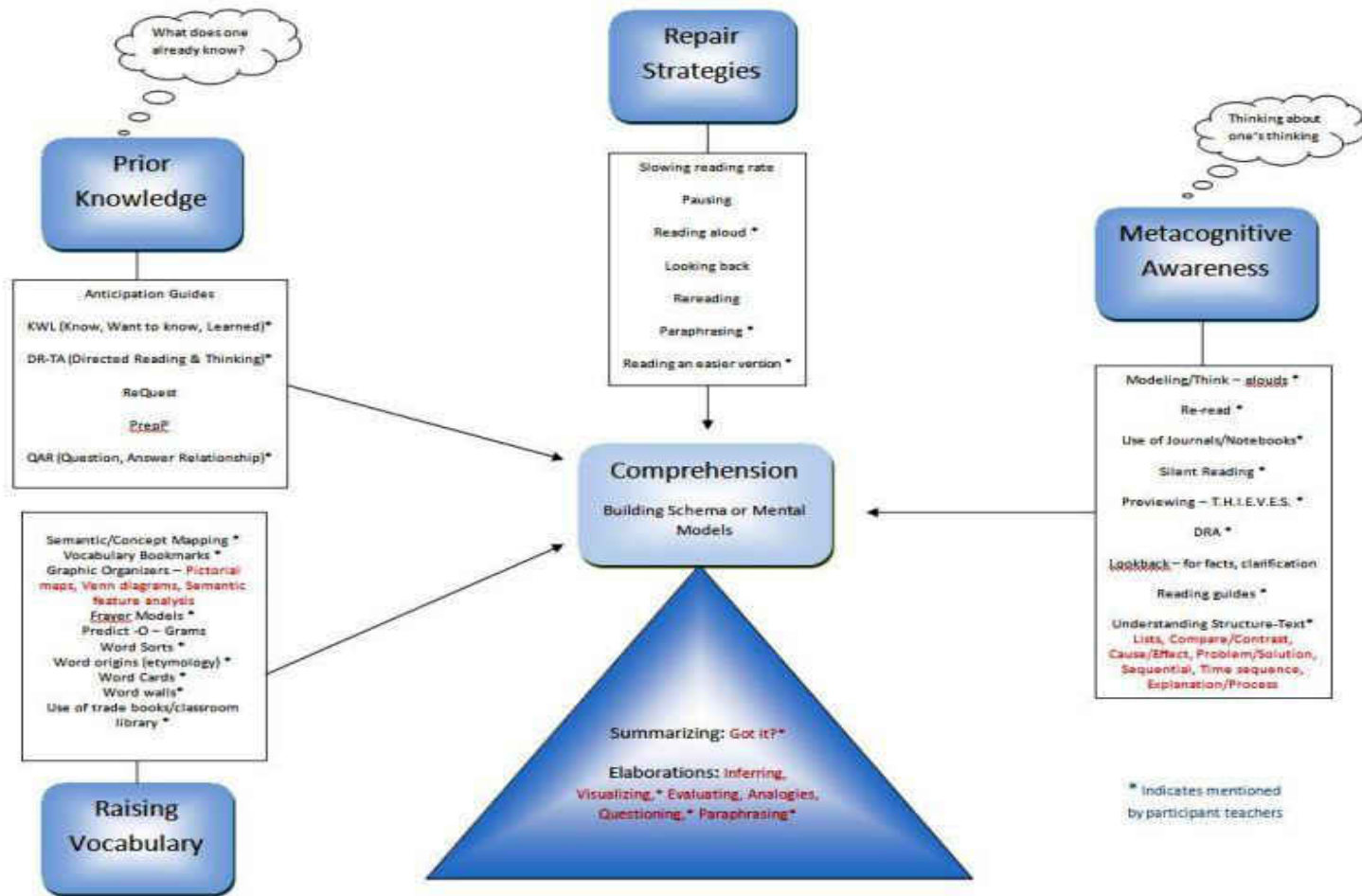


Figure 26. Instructional Strategies Used to Augment Comprehension

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