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Exploring the Influence of Peer-Assisted Learning Strategies (PALS) in Increasing Reading Comprehension of Grade-Level Biology Text and Biology Self-Efficacy in Students with Learning Disabilities: A Formative Experiment

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EXPLORING THE INFLUENCE OF PEER-ASSISTED LEARNING STRATEGIES (PALS) IN INCREASING READING COMPREHENSION OF GRADE-LEVEL BIOLOGY TEXT AND BIOLOGY SELF-EFFICACY IN STUDENTS WITH LEARNING DISABILITIES: A FORMATIVE EXPERIMENT

by

K. Lea Priestley

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ABSTRACT

Exploring the Influence of Peer-Assisted Learning Strategies (PALS) in Increasing Reading Comprehension of Grade-Level Biology Text and Biology Self-Efficacy in Students with Learning Disabilities: A Formative Experiment

by

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Utah State University, 2020

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The purpose of the present study was to determine the influence of Peer-Assisted Learning Strategies (PALS) on the reading comprehension of grade-level biology text and biology self-efficacy in students diagnosed with learning disabilities (LD).

The present study examined the data using a convergent mixed-method design within a formative design experimental framework. The quantitative data collected included researcher-developed assessments which measured the reading comprehension of grade-level biology text and the construct of biology self-efficacy was measured by a modified Self-Efficacy Questionnaire for Children (SEQ-C). All assessments were administered both pre- and postintervention. Individual gain scores were calculated to compare the pre- and postintervention reading comprehension scores which were further

analyzed using a single sample *t*-test. The significance of unit reading comprehension assessments were calculated using a repeated measures ANOVA with four pairwise comparisons. Descriptive statistics were reported, and a paired sample *t*-test was run on the data from the modified SEQ-C.

Qualitative data were gathered using student notebooks, focus student interviews, teacher interviews, and the researcher notebook which supplied triangulation of the data. An unstructured first read was performed on the qualitative data. The first-cycle coding methods of unstructured first read, Emotion Coding, and In Vivo Coding, were used to analyze the qualitative data; and, Longitudinal Coding was used for the second-cycle coding method. An additional cycle of coding was used with the teacher data to look for factors that enhanced or inhibited the intervention.

Analysis of the results show that despite the small sample size, significance was reached with the quantitative data results on the pre- and postintervention reading comprehension assessments and the modified SEQ-C. A small effect size (d = .44) was found using the pairwise comparison data from the baseline (Unit 1) to Unit 4 reading comprehension assessment scores. Thus, the data suggested that the PALS intervention can have a positive effect on the reading comprehension of grade-level biology text and biology self-efficacy. However, these results should be interpreted with caution due to the short duration of the present study (12 weeks) and small sample size (n = 7).

(203 pages)

PUBLIC ABSTRACT

Exploring the Influence of Peer-Assisted Learning Strategies (PALS) in Increasing Reading Comprehension of Grade-Level Biology Text and Biology Self-Efficacy in Students with Learning Disabilities: A Formative Experiment

K. Lea Priestley

The present study used a formative design experiment framework which does not answer a research question but addresses a pedagogical goal. The goal of this study was to determine the influence of Peer-Assisted Learning Strategies (PALS) on the reading comprehension of grade-level biology text and biology self-efficacy with students diagnosed with learning disabilities. As a result of this intervention, it was expected that students would better understand biology text and feel better about themselves as a biology student.

Students were separated into pairs, or dyads, with each pair having a stronger reader and a weaker reader. These dyads participated in a series of three structured learning activities: Partner Reading, Paragraph Shrinking and Prediction Relay. Biology self-efficacy assessments and researcher-developed reading comprehensive assessments were administered both pre-and postintervention and after each biology unit. Student notebooks, the researcher notebook, teacher interviews, and focus student interviews were used to gather qualitative data throughout the study. The results suggested that the PALS intervention can have a positive effect on the reading comprehension of grade-level biology text and biology self-efficacy for students with learning disabilities.

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I stand on the shoulders of giants. Those who have paved the way before me and all the work they have contributed to their respective fields. And most importantly, the two Dr. Priestleys who came before me, who, by marriage, are distant relatives.

The first Dr. Priestley is credited in 1774 with discovering oxygen, and later, carbon dioxide, which he infused to create the very first soda water in 1767. He is also the founder of the Unitarian Church in the United States. Dr. William Overend Priestley was credited with being the father of modern obstetrics in England in the late 1800s and was later knighted. These men were credits to the scientific field, and I hope to contribute, too, to the scientific community in my lifetime.

I would like to thank my Heavenly Father for nudging me down this path and smoothing the way before me. I am thankful for the members of my committee, Drs. Cindy Jones, Amy Piotrowski, Christa Haring-Biel, Steven Camicia, and especially Dr. Marla Robertson, my chair, as well as all my professors as Utah State University for all the help and encouragement they have given to me over the past four years. I would also like to thank Dr. David Reinking and Dr. Barbara Bradley for their kind words and input, without whom this dissertation would not be possible.

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CHAPTER 1

The world in the 21st century is technology- and science-based, and students need to possess the skills to read and comprehend scientific text to be successful in the workplace and navigate their lives (National Science Education Standards, 1996). However, this can be problematic for students with learning disabilities (LD). Students with LD have "a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations" (Individuals with Disabilities Education Act [IDEA], 2004). Students with LD also struggle with both working and short-term memory, which also can impact classroom success (Swanson & Zheng, 2013).

As most students with LD receive science education in classrooms with their typically-developing peers (Seifert & Espin, 2012) and must meet the minimum academic test scores on state standardized tests (NCLB, 2002) to graduate, their performance in these general education classes is impacted by their disability. Since traditional science instruction in a general education setting is primarily textbook and lecture-driven, students with LD face challenges learning science content due to their difficulties in reading and comprehending science text, which can impact the successful completion of assignments and courses (Bakken, Mastropieri, & Scruggs, 1997; Therrien, Taylor, Hosp, Kaldenberg, & Gorsch, 2011).

According to Chauvin and Theodore (2015), one of the current struggles in the field is in defining the differences between content area literacy and disciplinary literacy

and their application in the classroom. Content area literacy is focused on the similarity of reading strategies across disciplines like summarizing, questioning, and making inferences which when applied to science, history, or mathematics which can help students comprehend the content area text (Chauvin & Theodore, 2015). Shanahan and Shanahan (2017) argued that there is a growing body of research which supports the idea that literacy is significantly different across disciplines. Disciplinary literacy addresses text using the skills of critical thinking, communication, collaboration, and creativity but looks different for each discipline (Chauvin & Theodore, 2015). In order to be successful across different disciplines, Shanahan and Shanahan (2017) stated that "students must understand how literacy is used in that discipline and how they themselves can create and critique knowledge in that discipline" (p. 19). However, "content area literacy is still a valuable part of instruction and content literacy strategies such as summarizing, predicting, and visualizing remain core strategies for content area literacy" (Chauvin & Theodore, 2015, p. 3).

The goal of improving content area literacy for students with LD has been an area of concern within education for many years, especially with the present challenges of educational reform and high-stakes testing (Pearson, Moje, & Greenleaf, 2010; Simpkins, Mastropieri, & Scruggs, 2009). The results of the 2015 National Assessment of Educational Progress (NAEP; National Center for Educational Statistics, 2015) showed the average scaled scores in science for students with disabilities were 124 for both 8th and 12th graders, as compared with 158 and 153 for students in 8th and 12th grades without disabilities, respectively. These scores showed that students with LD scored almost thirty points below their typically-developing peers on national assessments. This

indicated the need for improved interventions for students with LD in science classrooms. Both the NAEP (2015) science scores as well as the academic demands for science are tied to performance in reading, and the NAEP (2015) scores corroborated previous research which showed that secondary students with LD read several grade levels below their typically-developing peers (Seifert & Espin, 2012) and struggled with phonics, language comprehension, and reading fluency (Fuchs, Fuchs, Mathes, & Lipsey, 2000). Bakken et al. (1997) found some evidence that students with LD improved their comprehension of science text through a variety of interventions. The present study attempted to address the need for improved interventions for students with LD by exploring the feasibility of using Fuchs et al.'s (1997) Peer-Assisted Learning Strategies (PALS) in an inclusion biology classroom. An inclusion biology classroom is one where the general education teacher and a special education teacher co-teach a class consisting of both students with LD and/or other disabilities along with typically-developing peers.

Peer-Assisted Learning Strategies (PALS) is a reading intervention developed in the 1990s by Fuchs and Fuchs with their colleagues at Vanderbilt University (Fuchs & Fuchs, 1998; Fuchs et al., 1997; Fuchs et al., 2001; Sáenz, 2007). The purpose of PALS (Fuchs et al., 1997) is to increase strategic reading behaviors, reading fluency, and comprehension (Sáenz, Fuchs, & Fuchs, 2005). PALS was also developed to help teachers differentiate instruction in inclusive classroom settings (Fuchs et al., 1997; Sáenz et al., 2007), and originally was a supplement to a primary reading curriculum (What Works Clearinghouse, 2012).

Previous research showed that unstructured peer interactions are often ineffective (Fuchs, Fuchs, & Burish, 2000; Palinscar & Brown, 1989). Fuchs et al. (1997)

incorporated structured interactions into PALS which provided students with scripted ways to respond to each other, specifically having the students engage in frequent interaction while reading, giving each other immediate corrective feedback, and using turn-taking language as both the tutor and tutee. This approach is featured in all five currently available versions of PALS (Fuchs Research Group, 2019): Kindergarten PALS, First-grade PALS, a grade 2-6 version of PALS in English and Spanish, and High School PALS.

There are three structured learning activities within the PALS (Fuchs et al., 1997) intervention: Partner Reading, Paragraph Shrinking, and Prediction Relay. Partner Reading allows the students to practice oral reading fluency with complex text as well as summarize the text. Paragraph Shrinking focuses on identifying the main idea, and Prediction Relay enables students to use context-clues in the paragraph to predict what will happen next. The components of PALS (Fuchs et al., 1997) are an effective way to implement these three basic comprehension activities for any level of text and are founded on the principles of effective content area literacy strategies. However, despite the effectiveness of research-based interventions, studies (Pajares, 1996; Pintrich & DeGroot, 1990; Schunk, 1991) have shown there are other factors that impact learning success in students with LD.

One factor that can impact learning success in students with LD is self-efficacy. Self-efficacy is the belief that one has about their ability to be successful at a specific task (Pajares, 1996). Science self-efficacy is the specific aspect of self-efficacy that can impact the acquisition of science content knowledge for students with LD, in addition to their reported challenges in academic performance. Science self-efficacy is a new sub-

concept of academic self-efficacy that has been examined in the recent literature and is defined as a student's ability to succeed in science tasks or courses (Chen & Usher, 2013; Lofgran et al., 2015; Thompson, Anderson & Nashon, 2008).

The research described that a student's belief in their ability to succeed in science-related activities can influence how they engage and participate in science classes or to consider future careers with a strong science base (Chen & Usher, 2013; Lofgran et al., 2015). Students need both the skills (content knowledge and cognitive strategies) and the will (self-efficacy) to be successful in the science classroom, and these two factors can impact the potential of students with LD to learn science concepts. With these constraints on learning, it is necessary to use research-based interventions to aid students with LD to develop greater science self-efficacy and to increase their success in reading and comprehending science text and retaining science content knowledge (Mason & Hedin, 2011).

Rationale

It has been a long-term challenge to improve content area learning for students with LD (Simpkins, Mastropieri, & Scruggs, 2009). There is some evidence that students with LD can learn skills to improve their expository text comprehension, including science text by using strategies like text structure training, paragraph restatement training, and traditional comprehension instruction training (Bakken et. al., 1997; Mastropieri & Scruggs, 1992; Scruggs, Brigham, & Mastropieri, 2013). These studies concluded that accommodations for students with disabilities in a general education science class were compatible with science instruction, but that applying these accommodations, especially

differentiation of instruction, can be overwhelming to general education teachers (Committee on Conceptual Framework, 2012; Scruggs et al., 2013).

Rationale for PALS (Fuchs et al., 1997) as the instructional intervention. Additionally, the CCSS standards (Committee on Conceptual Framework, 2012), state that differentiation should include using research-based interventions to improve the comprehension of science text in students with LD. With that direction, PALS (Fuchs et al., 1997) was a logical intervention to use in the present study because it has been at the core of many research studies for nearly twenty years. PALS (Fuchs et al., 1997) also allowed for the differentiation of instruction which is essential for success of students with LD in the classroom, according to the CCSS (Committee on Conceptual Framework, 2012). However, there are gaps in the PALS (Fuchs et al., 1997; Fuchs, Fuchs, & Burish, 2000; McMaster, Fuchs, & Fuchs, 2007) literature that have informed the present study.

Most of the studies since 2000 with PALS (Fuchs et al., 1997) were conducted with younger students (Fuchs et al., 2000; McMaster et al., 2007; Thorius & Graff, 2018), and a few studies were conducted with junior high students (Mastropieri et al., 2006). Only a handful of studies explored using PALS (Fuchs et al., 1997) in social studies and math for students with LD in a high school setting (Breece, 2012; Calhoon & Fuchs, 2003; Fuchs et al., 2001; Sprörer & Brunstein, 2009; Thorius & Graff, 2018), and no studies address PALS (Fuchs et al., 1997) with science content or text at the same level. Based on the research with PALS (Fuchs et al., 1997) and considering the gap in the research at the secondary level and using science text, there was a need to explore the effectiveness of the PALS (Fuchs et al., 1997) intervention in increasing reading comprehension of science text among students with LD in a high school setting. For this

study, the topic was narrowed to look at the reading comprehension of grade-level biology text among students with LD in an inclusion biology classroom.

Rationale for science self-efficacy as a factor. Not only do researchers need to consider why some students struggle to learn and thrive in school due to academic challenges, they need to examine the role of motivation, or self-efficacy, in the learning process (Pintrich, 2003). Pintrich (2003) asserted there is a "clear need for more research on this issue of the calibration of knowledge, expertise, efficacy, and competence beliefs in classroom contexts" (p. 671). There were few studies that focused on science self-efficacy among high school populations (Gomaa, 2016 ; Lofgran et al., 2015), but none were found on the self-efficacy of students with LD as it relates to the comprehension of science text. There was a gap in the current research that examines both the academic and motivational component of educating students with LD in science. The present study can apprise teachers of an instructional intervention that could be utilized in other general education science classes which include students with LD.

Rationale for the formative experiment framework as a method. This investigation used a formative experiment design which is a non-traditional research method. Formative experiments have been successful in past studies with a teacher and researcher working together (Reinking & Watkins, 2000). As a teacher at Desert Star High School, the option to conduct the present study with a biology teacher that the researcher was assigned to co-teach with for the 2019-2020 school year was presented and accepted by the teacher, school administration, and the district. To accommodate for this study, the topic of science self-efficacy was narrowed to biology self-efficacy as that was the assigned science class to co-teach during that school year. A formative

experiment (Bradley & Reinking, 2011; Reinking & Bradley, 2008; Reinking & Watkins, 1998; Reinking & Watkins, 2000) was used to better understand how the use of PALS (Fuchs et al., 1997) affected both reading comprehension of biology text and biology self-efficacy in high school students with LD.

Formative experiments are a relatively new research methodology. Ann Brown's (1992) work in design research paved the way for the development of this methodology. After conducting quantitative educational experiments in her lab, she found it difficult to implement these findings into the classroom. Thus, the formative experiment methodology was born out of the concerns of educational researchers like Brown who wished to examine educational interventions from multiple theoretical perspectives and mixed methodologies, as well as focus on how educational outcomes and relationships are impacted by an educational intervention and communicate those results in a useable way to educators (Reinking & Bradley, 2008).

Reinking and Bradley (2008) were among the researchers who were dissatisfied with the conventional methodologies used in classroom research. Under their lead, the formative experiment framework emerged. Formative experiments were designed to develop, test, and refine educational theory within an authentic classroom setting by focusing on a pedagogical goal rather than answering a research question (Reinking & Bradley, 2008). Interventions used in an authentic instructional context are the core of formative experiments and are designed to address a problematic area of instruction (Reinking & Bradley, 2008). Through implementing innovative instructional practices, a formative experiment can improve instruction and at the same time close the gap between research and instructional practice (Bradley & Reinking, 2011). A collaborative

relationship should exist between the researcher and the classroom teacher as they recursively examine the data throughout the study (Reinking & Watkins, 2000). Then, based on the data, the intervention is modified as they continually monitor the effectiveness of the intervention and work to meet the pedagogical goal (Bradley & Reinking, 2011; Reinking & Bradley, 2008; Reinking & Watkins, 2000).

Essential Characteristics of the Formative Experiment Framework

Essential characteristics of formative experiments are listed below (Reinking & Bradley, 2008, pp. 16-22), with a description of how the present study fits into a formative experiment design.

1. *Intervention-centered in authentic instructional contexts* - This study examined if the PALS (Fuchs et al., 1997) intervention influenced the reading comprehension of grade-level biology text and biology self-efficacy in an inclusion biology class.
2. *Guided by theory* - This study was guided by three different theoretical frameworks: pragmatism, sociocultural perspective, and Social Cognitive Theory (Bandura, 1986). Multiple theoretical perspectives are common in a formative experiment design. These are described in detail in Chapter 2.
3. *Goal oriented* - The pedagogical goal of this study was to look at the influence of PALS (Fuchs et al., 1997) on the reading comprehension of grade-level biology text and biology self-efficacy in students with LD in an inclusion classroom.

4. *Adaptive and iterative* – After each assessment, the unit was examined to see if the data showed movement toward the pedagogical goal. Improvements for the next unit were determined and then put into effect.

5. *Transformative* - PALS (Fuchs et al., 1997) has the potential to improve the reading comprehension of grade-level biology text and biology self-efficacy in students with LD. This potential would include future research potential of PALS (Fuchs et al., 1997) in inclusion classrooms.

6. *Methodologically inclusive and flexible* - This study used both qualitative and quantitative methods to provide a holistic understanding of the study.

7. *Pragmatic* - This study used both teacher-made materials and validated measures to gain a better understanding of the pedagogical goal.

Further discussion of the formative experiment framework is found in Chapter 3.

Purpose of the Study

The purpose of the present study was to add to the corpus of research knowledge in the field by using a formative experiment to explore the influence of the PALS (Fuchs et al., 1997) intervention to increase the comprehension of biology text and biology self-efficacy in students with LD which was closely aligned with the pedagogical goal. This study was patterned after Palinscar, Magnusson, Collins, and Cutter's (2001) work who used a formative design experiment in inclusive classrooms, but this study was on a smaller scale. Palinscar et al. (2001) addressed PALS (Fuchs et al., 1997) in an inclusive elementary science classroom, whereas this study addressed PALS (Fuchs et al., 1997) at the high school level in an inclusive biology classroom. Conducted in an in vivo setting,

this study could inform teachers of another instructional intervention that could be used in other science classrooms.

The present study follows the formative experiment framework outlined by Reinking and Bradley (2008) which asks the following:

1. Was the pedagogical goal of increasing the comprehension of grade-level biology text and biology self-efficacy in secondary students with LD relevant to the field, and what previous theories and past research supported the choice of that goal?
2. Did the PALS (Fuchs et al., 1997) intervention have the potential to achieve the pedagogical goal and why?
3. What are the factors that enhanced or inhibited how effective, efficient and appealing PALS (Fuchs et al., 1997) was in achieving the pedagogical goal of increasing the comprehension of grade-level biology text and biology self-efficacy in secondary students with LD?
4. What modifications were made to the PALS (Fuchs et al., 1997) intervention in order to achieve the pedagogical goal in ways that were appealing and engaging to all stakeholders?
5. What were the unanticipated positive and negative effects that the PALS (Fuchs et al., 1997) intervention produced?
6. Were there changes in the instructional environment as a result of the PALS (Fuchs et al., 1997) intervention?

The first and second question of the framework are discussed in Chapter 3. The remaining guiding questions were used to analyze the study after implementation and are discussed in detail in Chapters 4 and 5.

Definition of Terms

Following are definitions of terms that are important to this study.

Content area literacy: literacy strategies focused on the similarity of reading strategies across disciplines like summarizing, questioning, and making inferences when applied to science, history, or mathematics that can help students comprehend the content area text (Chauvin & Theodore, 2015).

Disciplinary literacy: literacy practice that addresses text using the skills of critical thinking, communication, collaboration, and creativity. Disciplinary literacies are specific literacy practices used in different disciplines (Shanahan & Shanahan, 2017).

Formative experiment: relatively new research methodology (branch of design-based research) which conducts studies in classrooms utilizing a pedagogical goal as its basis instead of research questions. This methodology was designed to improve, analyze, and refine educational theory within a classroom setting. Its aim is to determine what inhibits or enhances a chosen intervention's effectiveness in achieving a pedagogical goal and how the intervention might be implemented more successfully (Reinking & Bradley, 2008).

Inclusion classroom: a classroom where the general education teacher and a special education teacher co-teach a class consisting of both students with LD and/or other disabilities along with typically-developing peers.

Learning disabilities (LD): "a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do

mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia" (IDEA, 2004). For the present study, those students who have a learning disability in the area of reading comprehension were included as participants but reading comprehension might not be their only disability area.

Pedagogical goal: expected student learning outcomes (not research questions) and key in formative experiment design (Reinking & Bradley, 2008).

Peer-Assisted Learning Strategies (PALS): reading intervention developed by Fuchs et al. (1997) at Peabody Teacher's College at Vanderbilt University. This intervention consists of three activities designed to increase reading comprehension: Partner Reading, Paragraph Shrinking, and Prediction Relay.

Self-efficacy: the belief one has about their ability to be successful at a specific task (Pajares, 1996).

Science self-efficacy: a student's belief in their ability to be successful in science tasks or courses (Chen & Usher, 2013; Lofgran et al, 2015; Thomas, et al., 2008).

CHAPTER 2

REVIEW OF THE LITERATURE

The pedagogical goal of the present study was to improve the comprehension of grade-level biology text and biology self-efficacy among students with LD using the PALS (Fuchs et al., 1997) intervention in an inclusion classroom. Looking at the pedagogical goal, why that goal was valued and important, and what theory and previous empirical work inform the ability to accomplish the pedagogical goal was examined (Reinking & Bradley, 2008; Reinking & Watkins, 2000) to answer the first guiding question of the formative experiment framework.

In the first section of the literature review, the methodology for the formative design experiment framework (Reinking and Bradley, 2008) was explained and the relevant literature supporting the framework was addressed. The next section defined the theoretical framework of this study using pragmatism, sociocultural perspective, and the self-efficacy component of Bandura's Social Cognitive Theory (1986) by examining the impact of self-efficacy on an individual's development. Then, the development of self-efficacy and the role of academic self-efficacy on achievement were examined, and the discussion moved from there to science self-efficacy specifically. Instruments to measure science self-efficacy were also reviewed. The following sections reviewed the literature on how reading comprehension affects self-efficacy and science performance and the importance of teaching explicit instructional strategies to secondary students with LD.

The next section addressed the specific instructional strategies and interventions of Classwide Peer Tutoring (CWPT) (Delquadri, Greenwood, Whorton, Carta, & Hall (1986) and Peer-Assisted Learning Strategies (PALS) (Fuchs et al., 1997) which were shown to increase reading comprehension and academic performance in students with LD. Then, the review looked at studies on how PALS (Fuchs et al., 1997) affected reading comprehension and self-efficacy with secondary students with LD, followed by the current state of PALS (Fuchs et al., 1997) research. The chapter concluded with a summary of the elements discussed and their relevance to the present study.

Locating the Studies

An initial search was conducted for the topics of design experiment, formative experiment, PALS (Fuchs et al., 1997), self-efficacy, science self-efficacy, and science literacy, using ERIC, PsychINFO, Education Source, Professional Development Collection, ProQuest, and Google Scholar to locate research that would inform this study. The search terms used included: *formative experiment, design experiment, peer assist** or *peer teaching*; *learning disabilities* or *special needs*; *secondary education* or *high school*; *self-efficacy* or *effects*; *science self-efficacy* and *science education*. First, these topics were searched separately, then in all combinations of the three topics using the Boolean operators “and” and “or”, and finally with all combinations searched again adding the topic of learning disabilities (LD).

Inclusion Criteria

The articles for the present study's literature review met the following inclusion criteria if they: appeared in a peer-reviewed journal or published dissertation within the past thirty-five years, contained at least one or more topics covered in the review, or addressed one of the theoretical frameworks for this study. The reference sections of identified articles were examined to identify additional sources for the review. Formative experiment studies which met the inclusion criteria are listed below.

Table 1

Examples of Previous Formative Experiments

Author(s)	Focus of the formative experiment
De Corte, Verschaffel, & Van De Ven, 2001	Improving reading comprehension through explicit strategy instruction in upper primary students
Taboada & Rutherford, 2011	Developing science content knowledge and vocabulary with elementary ELL students
Ivey & Broaddus, 2007;	Bilingual literacy in Latina/o adolescents
Gersten, Baker, Smith-Johnson, Dimino, & Peterson, 2006	Teaching social studies to middle school students with learning disabilities
Reinking & Watkins, 2000	Use of multimedia book reviews to increase elementary students' independent reading
Oshima, Oshima, Murayana, Takenaka, Nakayama, & Yamguchi, 2004	Japanese elementary science education with computer support for collaborative learning
Bradley & Reinking, 2011	Increasing quality and quantity of teacher-child language interaction in preschool
Welch, 2000	Formative approach to team teaching in elementary classrooms
Palinscar, Magnusson, Collins & Cutter, 2001	A design experiment involving science learning in inclusive classrooms

Formative Experiments

Since formative experiments represent a newer research methodology, there were few peer-reviewed studies which used the formative experiment framework. This framework was originally developed by Brown (1992), then further developed by

Reinking and Watkins (2000) and later, by Reinking and Bradley (2008), as well as studies by Bradley and Reinking (2011a, 2011b, 2011c). Reinking and Watkins' (2000) study laid the groundwork for the method and was informative in the design for this study as they used an intervention to increase reading, but in elementary students. The study by Bradley and Reinking (2011b) dealt with student-teacher interactions in preschoolers and was only relevant to this study as it showed the further development of the formative experiment since 2008.

De Corte, Verschaffle, and Van De Ven (2001) examined how to improve reading comprehension through explicit strategy instruction in the upper primary grades. Their study informed the present study as it involved implementing an instructional reading strategy to improve reading in a regular classroom. Ivey and Broaddus (2007) were one of the first to use a formative experiment to study motivational factors of reading in a secondary setting, albeit a middle school population of at-risk Latinx students. Their work was helpful to this study as it confirmed that motivation, or self-efficacy, in reading can be successfully examined within the formative experiment framework.

There were three studies which added to the corpus of research knowledge that a formative experimental design was compatible with science topics. The examination of science topics through a formative experiment design was studied by Oshima et al. (2004), Taboada and Rutherford (2011), and Palinscar et al., (2001). Oshima et al. (2004) focused on learning science content using computer-based collaborative learning strategies, while science content and student motivation in English Language Learners (ELLs) were the goal of Taboada and Rutherford's (2011) study. The study of Oshima et al. (2004) informed this study as it used cooperative or peer learning of science content.

Taboada and Rutherford's (2011) study looked at both motivation and the reading science content for at-risk populations, which was helpful for the present study. The formative experiment that most informed this study was the one conducted by Palinscar et al. (2001). They used the formative experiment framework in an inclusive science classroom, which covered most of the variables in this study. However, Palinscar et al.'s (2001) study was conducted over the course of two years, which was not feasible for a dissertation study.

The first known formative experiment involving students with LD was conducted by Gersten, Baker, Smith-Johnson, Dimino, and Peterson (2006), which showed this methodological choice could be implemented in a population of students diagnosed with disabilities. Welch's (2000) study supported the choice to use the PALS (Fuchs et al., 1997) intervention in a team-taught setting for this study, along with the researcher's prior experience with team teaching biology in an inclusion classroom. These studies were informative to the present study as they justified the methodological choice of the formative design experiment framework (Reinking & Bradley, 2008) using a team-taught delivery method in an inclusion biology classroom.

Theoretical Framework

Several theoretical positions, (which is common in the formative experiment) including pragmatism, sociocultural perspective (Wertsch, 1985, 1991), and Social Cognitive Theory (Bandura, 1986) were used to frame the present study. Formative design experiments are framed by pragmatism (Dewey, 1916), while the PALS (Fuchs et al., 1997) intervention is grounded in the sociocultural perspective (Wertsch, 1985,

1991), and the variable of biology self-efficacy is based on Bandura's Social Cognitive Theory (1986). These three frameworks composed the legs of a theoretical tripod to frame this study.

Pragmatism. Pragmatism in educational research was first promoted by John Dewey (1916) and its latest proponents are Johnson and Onwuegbuzie (2004). As a tradition, pragmatism sees what works to accomplish mutually valued goals to further human well-being (Johnson & Onwuegbuzie, 2004). It is more likely to focus on what is useful to practitioners and less likely to focus on grand theories of causation (Reinking & Bradley, 2008). Reinking and Bradley (2008) assert that formative experiments are "consistent with pragmatism's view of theory, experimentation, and causality" (p. 38). Pragmatism is also the theoretical basis for including mixed methods within the formative experiment framework.

Sociocultural perspective. The PALS (Fuchs et al., 1997) intervention is rooted in the sociocultural perspective (Wertsch, 1985, 1991). Expanding on Vygotsky's (1978) sociocultural lens, Wertsch (1985, 1991) viewed social interaction as fundamental in the development of cognition and that students can learn from others who are more advanced cognitively than they are (Zone of Proximal Development). Wertsch (1985, 1991) developed the ideas of Vygotsky (1978) to promote mediated action to include a sociocultural context. Vygotsky (1978) stated that the impact of the agent (the student) on the mediated action using a cultural tool (the reading intervention) is that as the agent (student) "consumes" (Vygotsky, 1978) or uses the tools (the reading intervention), the agent (student) typically uses patterns (their interactions with the tool and the other agent) to transform the cultural tool (the reading intervention). However, just as Reinking and

Watkins (2000) asserted in their formative experiment framework, there can be unintended and sometimes undesirable consequences as a result of agentic behavior in employing the cultural tools. Researchers also posited that it is possible to demonstrate that mind is not only limited to what transpires in one's brain but is often accomplished with the assistance of cultural tools and more capable peers (Lima, Ostermann, & Rezende, 2014; Wertsch, 1985, 1991). This perspective is in line with the development of PALS (Fuchs et al., 1997) as a cultural tool which utilizes more capable peers to promote greater reading ability among those peers who struggle with reading.

Social Cognitive Theory (Bandura, 1986). The theoretical framework for the self-efficacy component of this study is based on Bandura's Social Cognitive Theory (1986). Pajares (1996) asserts that a joint effort to raise academic confidence and competence is achieved through authentic mastery experiences, and interventions should be designed accordingly. Bandura's Social Cognitive Theory (1986) theory recognized the relationships "between the three major classes of determinants in triadic reciprocal causation" (p. 6). These three determinants are: behavior, internal personal factors, (e.g. cognitive, affective, and biological events) and the external environment, which affect each other in varying amounts depending on the situation (Bandura, 1986). Self-efficacy acts upon the three major classes of determinants to influence outcome expectancies. From that, individuals construct outcome expectancies based on personal efficacy which affects "how they think, motivate themselves, feel and behave" (Bandua, 1986, p. 19).

Self-efficacy component. Along with academic performance such as learning from grade-level text, self-efficacy is another factor that can impact the acquisition of knowledge for students with LD. Self-efficacy is the belief of students about their ability

to be successful at a specific task (Pajares, 1996). Social Cognitive Theory (Bandura, 1986) posits that human achievement is dependent on interactions between one's behaviors, thoughts and beliefs, as well as environmental conditions (Bandura, 1986, 1997; Schunk & Pajares, 2002). Yet, self-efficacy differs from self-concept in that self-efficacy is a "context-specific assessment of competence to perform a specific task" while self-concept includes the self-evaluation of general competence and feelings of self-worth "associated with the behaviors in question" (Pajares, 1996, p. 561). Self-efficacy, according to Bong and Skaalvik (2003), "is presumed to explain and predict one's thought, emotion, and action" (p. 5). Bandura's (1986) conceptual framework has generated extensive research that has extended self-efficacy's role as the mechanism underlying changes in behavior, as well as the maintenance and generalization of that behavior (Schunk, 1991).

Self-efficacy factors. There are four major sources of information that shape beliefs of self-efficacy: previous mastery experiences, vicarious experiences, verbal persuasion from significant others, and physiological reactions (Bandura, 1986, 1997). Yet, Bandura (1986) asserts that information gathered from these sources do not influence and individual's self-efficacy automatically. An individual then uses inferential cognitive processes to evaluate the contributions of their personal and situational factors of perceived ability, task difficulty, task effort, how much external assistance is needed, the number and patterns of successes and failures, their perceptions of similar models, and the credibility of persuaders (Schunk, 1989, 1991).

Self-efficacy development. The development of self-efficacy is an important part of an individual's development. Bandura (1997) and Schunk and Pajares (2002) assert

that home influence can have positive effects on self-efficacy if parents provide experiences that stimulate a child's curiosity and allow for mastery experiences. The next influence in the development of a child's self-efficacy is their peers. Peers can influence children's self-efficacy through *model similarity*, or those vicarious experiences that children and adolescents can use to navigate unfamiliar tasks by observing peers perform those tasks (Ginsburg-Block, Rohrbeck, Fantuzzo, & Lavigne, 2008; Schunk & Pajares, 2002). In addition, during adolescence important changes that occur within family, school, and peer environments can have a significant impact on adolescent's self-efficacy (Schunk & Meece, 2006).

Self-Efficacy Research

Academic self-efficacy. Self-efficacy is a construct that can explain and predict students' learning and academic achievement (Runnells, 2012). However, self-efficacy beliefs are multidimensional, as students form perceptions of their capabilities that are both task-and domain-specific. One of those specific areas of self-efficacy is academic self-efficacy. Academic self-efficacy is the belief that students have of their abilities that they can successfully perform academic tasks at specific levels and is most affected by previous mastery experiences over the three other sources of science self-efficacy (Bong & Skaalvik, 2003; Schunk, 1991, 1995; Zimmerman, 1995).

However, students need both the will (self-efficacy) as well as skills (background knowledge and cognitive strategies) to be successful in the classroom (Pajares, 1996; Pintrich & De Groot, 1990; Schunk, 1991). Even at the beginning of an educational task, students differ in their academic self-efficacy and abilities to acquire

knowledge, perform tasks, and master content (Schunk, 1991). When students have positive academic self-efficacy, their choices in "academic engagement, goal-setting, task choice, persistence and efforts, intrinsic motivation, strategy use, performance and achievement, and even career selection" are positively affected (Bong & Skaalvik, 2003, p. 7).

Peer influence on academic self-efficacy. According to Bandura, (1986), peers can be a powerful force in the "development and social validation of intellectual self-efficacy" (p. 234) and tend to become more important as children grown older. Peers contribute to the social construction of academic self-efficacy in several ways. One way is that students gather comparative information regarding academic capabilities from teacher reports of peer performance and their academic performance. The other way peers shape self-efficacy beliefs is through their functioning as tutors and the modeling of academic proficiencies, and both can learn much through these experiences. However, at-risk children whose messages from other sources (home, school, and peers) may be conflicting and can also negatively affect academic self-efficacy (Ginsburg-Block, et al., 2008; Hampton & Mason, 2003; Lackaye & Margalit, 2008).

Academic self-efficacy of secondary students with LD. Studies have shown that children with LD often reported lower overall self-efficacy than their typically-developing peers (Lackaye & Margalit, 2008; Lackaye, Margalit, Ziv, & Ziman, 2006; Matheson, 2015) as well as demonstrating decreased academic achievement (Schunk, 1989; Wilson & Michaels, 2006; Grolnick & Ryan, 1990). By the time students reach high school, struggling students (both LD and non-LD) have experienced "considerable failure and negative competence feedback at school" (Grolnick & Ryan, 1990, p. 177).

High school students with poor reading skills are more likely to have lower self-esteem, greater discipline problems, and are more likely to drop out of school (Fuchs, Fuchs, & Kazdan, 1999).

Yet, some research showed that low-self efficacy scores for students with LD may not be directly related to their LD, but due to the lack of development of positive self-efficacy from Bandura's four sources (Hampton & Mason, 2003; Lackaye, et al., 2006; Matheson, 2015). In Hampton and Mason's (2003) study, they examined the relationships among LD and non-LD secondary students' self-efficacy beliefs, their sources of self-efficacy, and how self-efficacy affected academic performance. Their results supported the hypothesis that a status of LD did not have a direct effect on self-efficacy beliefs, but it did have an indirect effect through ineffective development of the four sources of self-efficacy outlined by Bandura (1986), which impacted academic performance.

Lackaye et al.'s (2006) study focused on comparing the self-perceptions of adolescents with and without LD in Israel while controlling for both gender and academic performance using a global cross-domain self-efficacy measure. The researchers used the *Academic Self-efficacy Scale* (Zimmerman et al., 1992) and an adapted version of the *Self-Efficacy Questionnaire for Children* (SEQ-C; Muris, 2001) in their study. The results of Lackaye et al.'s (2006) study reported significant differences between the LD group and the non-LD group in academic self-efficacy and social self-efficacy, while emotional self-efficacy was not statistically significant between groups. It was posited that the lower academic self-efficacy reported by students stemmed from a lack of access to positive sources of self-efficacy information (fewer successful academic experiences,

less access to positive peer models with LD, less teacher support). Furthermore, the authors suggested that the lower social self-efficacy of adolescents with LD "may be related to their lower personal interest in the areas of study, resulting in decreased effort" (Lackaye et al., 2006, p. 118). The researchers' use of the modified SEQ-C (Muris, 2001) showed that this instrument could measure academic self-efficacy in students with LD.

Several factors in adolescent development are important to consider as research showed that some students' self-efficacy declined as they moved through school (Pintrich & Schunk, 1996; Schunk & Pajares, 2002). Researchers attributed this decline to several factors, including the stresses associated with school transitions, increased competition, more high-stakes testing, and less teacher attention to individual students' progress. Brubacher, MacMahon, and Keys (2018) found that African American and Latinx high school students also experienced anxiety as a result of decreased self-efficacy, which reinforced Bandura's (1997) assertion that positive self-efficacy beliefs can have an effect on student's abilities to manage their emotions by decreasing stress, anxiety, and depression.

Yet, Klassen (2006) argued that students with LD can be overconfident in their abilities to carry out academic tasks, fail to effectively prepare for those tasks, show a lack of awareness of their strengths and weaknesses, and possess ineffective self-advocacy. This study showed that students can lack *calibration* (italicized in the original), or the ability of how well "self-efficacy relates to actual performance on a required task" (Schunk, 2009, p. 41). According to Klassen (2006), students who overestimated their capabilities can sometimes fail, which then lowered their motivation and then their self-

efficacy for the task. Margolis and McCabe (2003) added from their research that using curriculum-based assessments for frequent feedback, modifying length and number of assignments, and having work at the proper independent level for students with LD helped to increase their academic self-efficacy, mitigating the overconfidence seen in Klassen's (2006) study participants. Since self-efficacy is situational, it is important for the studies in self-efficacy to be viewed for the specific area of interest as well.

Science-self-efficacy and related measures. The literature in science self-efficacy is new, but is grounded in solid research, and has informed the present study as a key factor that can influence academic success in science in students with LD. Several studies of self-efficacy addressed secondary students in science classrooms, but did not specifically address students identified as LD (Britner & Pajares, 2006; Chen & Usher, 2013; Lofgran et al., 2015; Thomas et al., 2008). The researchers in the studies listed in this section developed their own measures of science self-efficacy. These measures were analyzed for their appropriateness for use in the present study.

In Britner and Pajares' (2006) study, they used Bandura's (1997) four sources of self-efficacy to predict the change in science self-efficacy beliefs in 319 middle school students. Since self-efficacy is a construct specific to the area being studied, measures of science self-efficacy are crucial to obtaining accurate data on students' science self-efficacy. Britner and Pajares (2006) developed a scale adapted from the work of Lent, Lopez, Brown, and Gore (1996) in mathematics and used Marsh's (1990) Academic Self-Description Questionnaire (ASDQ-1) to develop a new science self-efficacy scale. This new scale, the Sources of Science Self-Efficacy Scale, (Britner and Pajares, 2006), consisted of four subscales that measured mastery experiences, vicarious experiences,

social persuasions, and physiological states. This scale was not readily available and not used in this study.

Another study by Chen and Usher (2013), examined the four sources of self-efficacy in relation to science self-efficacy using latent profile analysis models. They surveyed 1225 secondary science students in four different educational settings: a traditional high school, a charter high school, a STEM magnet high school, and a traditional middle school. Students fell into four groups: Mastery, Moderate, Multi-Source, and At-Risk. The At-Risk group reported significantly lower science self-efficacy ($M = 3.50$; $p < .001$) than the Moderate, Mastery, or Multi-Source group and received the lowest grades in science when compared with their peers ($M = 74.4$; $p < .001$).

Thomas et al. (2008) are a group of Canadian researchers who explored the development of the SEMLI-S, an instrument they developed to measure science self-efficacy. The development of this instrument and their research was conducted in China and does not seem to align with the science standards or expectations for students in the United States, which is why this instrument was rejected for use in the present study.

In another study, Gomaa (2016) examined 60 secondary students with LD in Israel and used a pre- and posttreatment comparison repeated measures design with random assignments in science classes. The metacognitive strategy training intervention was implemented with the regular classroom science teacher, though the specific details of the metacognitive strategy instruction was not described in the article. Despite no significant differences at pretest, Gomaa's (2016) study showed that as a result of metacognitive strategy training, students with LD increased in both their science process

skills and their science self-efficacy when compared with the control group. Gomaa (2016) was the only researcher who developed an instrument, *Science and Me*, that addressed students with LD studying science. The use of her measure was rejected for the same reason as Thomas et al.'s study (2008) as it was developed for students in another country.

School transitions were posited to influence the development of science self-efficacy in a study conducted by Lofgran, Whiting, and Smith (2015). They used purposeful sampling to select their 1,126 participants in sixth, seventh, eighth, and ninth grades. The SEQ-C developed by Muris (2001) was modified to fit their study's purpose to examine science self-efficacy, which measures the four sources of self-efficacy according to Bandura (1997). The modified SEQ-C (Lofgran et al., 2015) measures the perceived ability of the student to pay attention in science class, participate in class, do homework, and get good grades on assignments and tests, which were determined by the researchers and the work of Muir (2000) to be factors affecting science self-efficacy. The science self-efficacy scale had scores with a range from 7-35 on the 5-point Likert-type scale. According to Lofgran et al. (2015), a principle components analysis was performed and confirmed that the seven questions held together in one measure which showed content validity for the modified SEQ-C was ($a = .86$), using Cronbach's alpha to describe internal consistency. The SEQ-C (Lofgran et al., 2015) pre- and postintervention data were compiled and described and several regression analyses were conducted. The ninth graders were used as a comparison group and then the sixth-grade participants were used as a comparison group.

This review of previous research reinforced the need for a measure of science

self-efficacy that can be used in conjunction with other variables when conducting educational research to obtain a more complete picture of a student's performance in a science classroom. Although all of the measures above had merit in measuring science self-efficacy in students, there were pros and cons to each measure. In examining the measures listed above, the modified SEQ-C (Lofgran et al., 2015) was the most compatible with the nature of the formative experiment framework and was the measure chosen for the present study. Permission was obtained from the authors to use the instrument for this study.

Effects of Poor Reading Comprehension on Students with Learning Disabilities

Even though research has made significant contributions to the understanding of self-efficacy and academic motivation, there has been a lag from theory to practice, and educational stakeholders are more interested in effective interventions to change children's inaccurate and harmful self-efficacy beliefs (Pajares, 1996). These interventions for students with LD have primarily focused on reading comprehension as almost all teachers and educational researchers would concur reading comprehension as a foundational skill necessary for acquiring knowledge in every subject area (Alvermann, 2002; Lee, 2014). High-quality core instruction that is scientific and research-based has been mandated at the federal level for both general and special education through both the Every Student Succeeds Act (ESSA, 2015) and the Individuals with Disabilities Education Act (IDEA, 2004).

However, in the 40 years since Durkin's seminal study (1978-1979) regarding the need for appropriate reading comprehension instruction, there seems to have been little

progress made in improving reading comprehension for students at either the elementary or secondary level. According to the current results of the Nation's Report Card (NAEP, 2018) students showed only 1% progress in reading achievement scores (36% to 37%) from 8th through 12th grade with no significant difference in scores since 2015. The performance on high-stakes assessments like NAEP (2018) has been generally much lower for struggling readers, including those with LD. As Fuchs, Fuchs, Mathes, and Lipsey (2000) have noted, students who are diagnosed with LD experienced more severe forms of reading problems than those poor readers who have not been identified as LD. Poor reading comprehension has lead to lower academic proficiency in secondary content areas, perpetuating what Stanovich (1986) termed as the Matthew Effect, where those struggling students continue to perform lower and lower than their peers, and those who start school performing well, continue to perform well. One result from a study by Mastropieri, Scruggs, and Graetz (2003) found that struggling readers at the secondary level also must overcome the challenge of the disparity between their reading ability and the reading materials required in their content area courses in middle and high school.

Besides overall reading comprehension, science literacy has been at the forefront of science educators' and researchers' areas of concern (Cervetti & Pearson, 2012; Pearson, Moje, & Greenleaf, 2010) in the 21st century. Science literacy is defined as someone who is familiar with the diversity and unity within the natural world, understands key concepts and principles of science, and uses scientific knowledge and ways of thinking about individual and social purposes (Glynn & Muth, 1994). According to the most recent NAEP Science scores (NAEP, 2018), 34% of 8th grade students scored as proficient in science, and only 22% showed proficiency by 12th grade. Students with

LD and other learning difficulties typically made up part of the almost two-thirds of students not proficient in science or reading in 8th grade and 75% of the students not proficient in those subjects by 12th grade. Thus, much work needs to happen to increase reading comprehension and science proficiency in secondary students, especially among those with LD. Many studies looked at ways to increase reading and science content knowledge scores with elementary and middle school populations (Mastropieri, et al., 2006; McCleery & Tindal, 1999; Scruggs, Mastropieri, Bakken & Brigham, 1993), but little research was found with high school students, especially those with learning disabilities (Breece, 2012; Calhoon & Fuchs, 2003; Fuchs et al., 2000; Fuchs et al., 2001; Sprörer & Brunstein, 2009).

The combined challenges of impaired reading comprehension and poor self-efficacy, especially in content areas such as science, can lead to negative educational outcomes. When compared to their typically-developing peers, high school students with reading difficulties have lower self-esteem, are more likely to have discipline problems, and are more likely to drop out before graduation from high school (Fuchs et al., 1999; Fuchs et al., 2001). These studies have indicated a gap in the literature for research which examined the reading comprehension of grade-level biology text and biology self-efficacy in secondary students with LD.

Effects of Instructional Strategies on Self-Efficacy and Academic Achievement

Pajares (1996) emphasized that classroom interventions should be carefully designed to foster increased self-efficacy using incremental successful mastery experiences. With struggling learners' ineffective approaches to academic tasks,

teachers need to "explicitly and systematically teach them the secrets of learning–the strategies that produce success" (Margolis & McCabe, 2003, p. 164). Schunk and Miller (2002) stated that some learning strategies that include peer modeling and frequent teacher feedback have been shown to increase self-efficacy and achievement among adolescents. Wilson and Michaels (2006) argued that teachers' instructional practices can also play a crucial role in increasing students' self-efficacy and positively impacting academic achievement. They claimed that creating emotionally safe classrooms and teaching using informed curriculum decisions (curriculum design and homework) were ways educators could achieve these goals.

Providing instructional strategies in literacy is one way for adolescents to succeed in high school. Adolescent literacy can be defined as "having the skills and abilities that allow students to be successful in reading, writing, thinking, and communicating about the variety of texts they encounter and that prepare them to be lifelong learners" (Runnells, 2012, p. 2). Consistently low reading and writing scores in adolescents indicate that investigating effective methods for improving instructional practice is warranted (Runnells, 2012). For literacy instruction to be effective for adolescents, Alvermann (2002) asserted that it must address the issues of self-efficacy and engagement with a variety of texts in multiple settings.

There are several types of instructional strategies that have shown to build academic self-efficacy beliefs in students by: (1) combining modeling with explanations of concepts (2) direct instruction in task analysis and proximal goal setting; (3) supplying explicit feedback on student performance; (4) supplying attribution feedback and (5) teaching positive self-talk strategies combined with self-encouragement (Bandura, 1977,

1989; Pintrich & DeGroot, 1990; Schunk, 1991; Shawaker & Dembo, 1996; Zimmerman, 1990).

Several researchers in the past few decades have focused their studies on developing strategies and interventions shown to be helpful in increasing academic content knowledge by improving reading comprehension as well as self-efficacy in students with LD. Classwide Peer-Tutoring (CWPT) (Delquadri et al., 1986) and Peer-Assisted Learning Strategies (PALS) (Fuchs et al., 1997) are two effective strategies that used peer support to increase reading comprehension in struggling readers with LD. Some of these studies also used self-efficacy as a dependent variable (Gomaa, 2016; Lee, 2014).

Classwide peer tutoring. Researchers involved in the Juniper Gardens Children's Project at the University of Kansas developed a classwide peer tutoring program in the 1980s (Delquadri et al., 1986; Greenwood, Delquadri, & Hall, 1989). This program used a Vygotskian (1978) sociocultural lens, as his theory views the role of social interaction as fundamental in the development of cognition, and that students can learn from others who are more cognitively advanced than they are (Zone of Proximal Development). Delquadri et al.'s (1986) Classwide Peer Tutoring (CWPT) was a system that allowed students increased opportunities for reading practice combined with immediate feedback (Calhoon, 2005). The program consisted of peer dyads organized by the teacher that allowed students to take ownership of their own learning with outcomes that led to increased academic engagement and high levels of mastery while receiving immediate corrective feedback (Delquadri et al., 1986; Greenwood, et al., 1989; Mastropieri, Scruggs, & Berkeley, 2007; Sáenz, McMaster, Fuchs, & Fuchs, 2007). The

components of Delquadri et al.'s (1986) CWPT contained: (a) tutor/tutee reciprocal roles (b) frequent opportunities to practice as well as receive constructive feedback on a student's performance, (c) weekly evaluations, (d) self-regulation through performance monitoring, (e) both individual and group positive reinforcers, and (f) publicly-shared performance outcomes (Ginsburg-Block, Rohrbeck, Fantuzzo, & Lavigne, 2006). Researchers have shown that CWPT (Delquadri et al., 1986) increased students' performance in reading not only at the elementary level (Greenwood et al., 1989; Sáenz et al., 2007), but also at the secondary level (Maheady, Harper, & Sacca, 1988).

Peer-assisted learning strategies (Fuchs et al., 1997). Building on the CWPT (Delquadri et al., 1986) model, Fuchs and Fuchs and their colleagues at Vanderbilt University developed Peer-Assisted Learning Strategies (PALS) in the 1990s (Fuchs & Fuchs, 1998; Fuchs et al., 1997; Fuchs et al., 2001; Sáenz, 2007) and extended CWPT (Delquadri et al., 1986) research by conducting large-scale, rigorous experimental and quasi-experimental studies of PALS (McMaster, Fuchs, & Fuchs, 2007). The most significant difference between CWPT (Delquadri et al., 1986) and PALS (Fuchs et al., 1997) was the inclusion of ongoing curriculum-based measurement (CBM) procedures, including computer-based CBMs (Ginsburg-Block et al., 2008; Greenwood, Maheady, & Delquadri, 2002). Another important change from the CWPT (Delquadri et al., 1986) model was that students in PALS (Fuchs et al., 1997) activities serve in a one-to-one reciprocal relationship as both the tutor and tutee during each activity, thus allowing lower-achieving students the opportunity to actively participate in the role as tutor (Lee, 2014). This important change, according to Lee (2104), can have positive effects on students with LD, who are mostly the tutee in non-PALS (Fuchs et al., 1997) classrooms.

Since its inception, PALS (Fuchs et al., 1997) has examined effects for low-performing students with and without learning difficulties as well as including average-to high-performing students. Most studies in the literature were quasi-experimental and used a treatment-comparison, pre- and posttest design, though there were some qualitative case studies that gave a richer picture of the PALS (Fuchs et al., 1997) intervention. PALS (Fuchs et al., 1997) has been implemented across grade levels in a variety of school settings, from high-poverty, Title I schools to non-Title I schools in both urban and suburban settings (Fuchs & Fuchs, 2005; Fuchs et al., 1997; Fuchs et al., 2001, Mathes et al., 1998; Sáenz et al., 2007). A few studies have targeted middle-school populations (Calhoon, 2005; Spörer & Brunstein, 2009), and high-school participants with various reading and behavior difficulties (Stenhoff & Lingugaris/Kraft, 2006). Also, few studies used peer tutoring in general education classrooms, and not in resource rooms or behavior classrooms (Alzahrani & Leko, 2018; Fuchs et al., 1999; Marchand-Martella, Martella, Orlob, & Ebey, 2000).

More recently, PALS (Fuchs et al., 1997) has also been explored as an intervention for English language learners (Sáenz, Fuchs, & Fuchs, 2005). According to Sáenz et al. (2005), the PALS (Fuchs et al., 1997) program can also serve as an RTI intervention and as an integral part of implementing IEP goals or 504 educational plans. Using PALS (Fuchs et al., 1997) as an RTI Tier 2 intervention not only benefited the student in question, but all learners, thus potentially reducing the need for more intensive levels of intervention in the classroom (McMaster & Fuchs, 2016). However, other than a primary focus on reading comprehension, only a few studies were found on secondary content areas (Calhoon & Fuchs, 2003; Kroeger & Kouche, 2006), with no studies using

science text using PALS (Fuchs et al., 1997) specifically.

PALS (Fuchs et al., 1997) in elementary schools. PALS was first implemented with students in second through sixth grade (Fuchs et al., 1997). In the PALS 2-6 program, training sessions with scripted lessons are used for teachers and students to learn the program (Fuchs Research Group, 2019). The program is implemented for three 35- minute sessions each week during the normal language arts period. Students are paired using a curriculum-based or standardized reading measure, pairing a more advanced reader with a struggling reader. All reading materials chosen for the PALS (Fuchs et al., 1997) reading activities are at the level of the lower reader (Fuchs et al., 2001). The students are assigned to one of two teams and earn points for their performance, which are kept on score cards. The student who serves in the role of coach gives the points. Teachers reinforce positive behavior and performance by circulating through the classroom during the sessions. At the end of the week, the class applauds the winning team and second place team and every four weeks, the dyad pairs are changed as are the team assignments.

PALS 2-6 (Fuchs Research Group, 2019) includes three activities: Partner Reading, Paragraph Shrinking, and Prediction Relay, with each activity having a set point value. The first activity, Partner Reading, allows the more proficient reader to read aloud for the first 2 minutes, and then the less proficient reader reads aloud from the same text for the next 2 minutes. If the student serving in the role of tutee makes a mistake while reading, the student serving in the tutor role has the partner re-read the sentence. At the end of this activity, the less proficient reader retells what happened in the text (Lee, 2014). The goal of this activity is to practice fluency and accuracy in the reading of text

(Lee, 2014; Simmons, et al., 1994).

With the second PALS 2-6 (Fuchs et al., 1997) activity, Paragraph Shrinking, the more proficient reader starts reading the text and the less proficient reader requires the partner to answer questions like, “What or who is the paragraph mainly about?” or “What is the important thing about the what or who?” and asks the reader to tell the main idea of the passage in 10 words or less. This activity takes about 4 minutes, and the less proficient reader then reads another paragraph and tells the more proficient reader the main idea of the paragraph just read (Fuchs et al., 2017; Lee, 2014). According to Fuchs et al. (2017) and Lee (2014), the purpose of this activity is to provide opportunities for students to monitor their comprehension while attempting to reduce textual information.

The final PALS 2-6 (Fuchs et al., 1997) activity, Prediction Relay, allows students to make predictions about the next information presented in expository text or what happens next in narrative text. The more proficient reader makes a prediction first and then reads the next section or part of the story and tells the less proficient reader if the prediction was accurate or not. Then, the students switch roles for this activity.

Results from studies conducted by Fuchs et al. (1997) and Kearns, Fuchs, Fuchs, McMaster, & Sáenz (2015) showed students of teachers who implemented PALS (Fuchs et al., 1997) had larger gains in fluency and reading comprehension than students in non-PALS (Fuchs et al., 1997; Kearns et al., 2015) classrooms, as well as larger gains than the expected growth of typical students between third and sixth grade. The effectiveness of PALS (Fuchs et al., 1997) earned a “best practice” status by the U.S. Department of Education Program Effectiveness Panel (Fuchs et al., 2001). Due to the success of PALS 2-6 (Fuchs Research Group, 2019), the program was extended to include Kindergarten

PALS (Fuchs Research Group, 2019) and First-Grade PALS (Fuchs Research Group, 2019) programs.

PALS (Fuchs et al., 1997) in secondary schools. In their meta-analysis of intervention studies, Wexler, Reed, Pyle, Mitchell and Barton (2015) cited multiple studies using peer-mediated interventions such as PALS (Fuchs et al., 1997) at the elementary level, a few at the middle school level, and even fewer studies published on the secondary level (Calhoon & Fuchs, 2003; Fuchs et al., 2001; Josephs & Jolivette, 2016). Given that reading problems continue past the elementary school years, evidence-based interventions are also necessary for secondary students. In addition, Fuchs et al. (1999) found that the reading problems of secondary students may be exceptionally difficult to remediate when they looked at the effects of PALS (Fuchs et al., 1999) on high school students with serious reading problems. Fuchs et al. (1999) focused on implementing PALS (Fuchs et al., 1997) in nine high school resource and remedial reading classes. A limitation of the Fuchs et al.'s (1999) study was that the students did not have a typically developing peer as a model, but a student that had LD like themselves, which might have been one reason for the moderate effect size ($p = .34$). The PALS (Fuchs et al., 1997) intervention was also not used every day, but only 2.5 times per week for 16 weeks. The Fuchs et al.'s (1999) study also incorporated a questionnaire about student's beliefs about their reading attitudes and working with other students. The authors also used their own measure of reading comprehension, which may or may not have yielded valid results since the instrument was validated on students in second through sixth grade, even though the reading level of the chosen participants was in the same grades, their actual grade level was 9^{th} through 12^{th} grade.

As a result of Fuchs et al.'s (1999) study, the high school PALS curriculum (Fuchs et al., 2017) was published, and updated two years later (Fuchs Research Group, 2019). PALS for High School Students (Fuchs Research Group, 2019) differs from the PALS 2-6 (Fuchs Research Group, 2019) version in four distinct ways. Instead of switching partners every four weeks, high school students participating in PALS (Fuchs Research Group, 2019) can change partners every day. This can help alleviate problems of increased absenteeism at the secondary level and can build tolerance in working with others. However, this was not feasible for the present study as the daily change resulted in too much confusion in the classroom and detracted from the validity of the study. Second, the motivation system for PALS for High School Students (Fuchs Research Group, 2019) is based on a work theme. The pairs can earn PALS dollars (Fuchs Research Group, 2019) that are deposited into checking accounts. With their earnings, the students can write checks to order items donated by local businesses from a PALS (Fuchs Research Group, 2019) catalog. Third, students who participate in PALS (Fuchs Research Group, 2019) at the high school level read more informational and expository text and not narrative text exclusively like PALS (Fuchs et al., 2017) for the younger grades. Finally, PALS for High School Students (Fuchs Research Group, 2019) can be implemented five times each week instead of the three 35-minute sessions weekly for PALS 2-6 (Fuchs Research Group, 2019).

PAL research and self-efficacy. The PALS (Fuchs et al., 1997) intervention has not directly addressed the concept of self-efficacy, but one intervention strategy, peer-assisted learning (PAL) has been posited as effective in promoting positive social-emotional outcomes for students, including self-concept, in elementary students

(Ginsburg-Block et al., 2006; Ginsburg-Block, et al., 2008). According to Bandura (1997), peer models raise “students’ beliefs in their efficacy for learning, for the subject matter, and their actual achievement” (p. 234). The reasons for the success of PAL (Ginsburg-Block, et al., 2006) in producing positive social-emotional outcomes were the use of structured roles, opportunities for autonomy, group contingencies, and individualized evaluation procedures. In addition to research, instructional design principles need to be incorporated in curriculum that provide accurate and timely feedback regarding self-efficacy and skill competence (Pintrich & Schunk, 2002), which is achieved through the use of the PALS (Fuchs et al., 1997) intervention. Further research is needed to determine the effectiveness of social-emotional outcomes like self-efficacy in PALS (Fuchs et al., 1997)for adolescents, which justifies the rationale of using PALS (Fuchs et al., 1997) to increase biology self-efficacy in secondary students with LD in the present study.

Current state of PALS (Fuchs et al., 1997) research. Special educators have long emphasized the diagnosis and remediation of disabilities and their role in students’ learning. Thorius and Graff (2018) envisioned that PALS (Fuchs et al., 1997) could become an “empowering literacy intervention for students of color and/or English learners with mild disabilities” (p. 165) by validating and sustaining the dynamic, diverse, and unique identities of students of color and English learners (ELs), viewing students of color and ELs with disabilities as expert learners with their higher-achieving PALS (Fuchs et al., 1997) peer and “empowering students to challenge school and societal inequities that may contribute to challenges in reading performance in the first place” (p. 165). But, for peer tutoring at the secondary level to move beyond the

classification as only a potentially evidence-based strategy, more research needs to be conducted (Alzahrani & Leko, 2018). These research studies (Thorius & Graff, 2018; Alzahrani & Leko, 2018) influenced the design of this study as they show how the PALS (Fuchs et al., 1997) intervention can empower students with LD and add to the body of research that Alzhrani and Leko (2018) state that the field still lacks.

With this in mind, the present study was designed to add to the corpus of research on PALS (Fuchs et al., 1997) as an evidence-based intervention for students with LD. PALS (Fuchs et al., 1997) was chosen as an intervention as it had “the potential to achieve the pedagogical goal” (Reinking & Bradley, 2008, p. 74), which is a guiding question of the formative experiment framework. In implementing PALS (Fuchs et al., 1997) in an inclusion classroom, this study confirmed the view of students with LD as expert learners just as their typically-developing peers are viewed. Fuchs, Fuchs, Mathes, and Martinez (2002) cited PALS (Fuchs et al., 1997) as an intervention that supported Thorius and Graff’s (2018) assertion that in classrooms where PALS (Fuchs et al., 1997) is used, students with LD are viewed as having the same social standing as their typically-developing peers, whereas in non-PALS (Fuchs et al., 1997) classrooms students with LD are not viewed as having the same social standing as their typically-developing peers. Thorius and Graff’s (2018) research heavily influenced the choice to use the PALS (Fuchs et al., 1997) for this study.

Summary

The formative experiment framework was chosen after a review of literature found it had shown positive results in studies with both science topics and students with LD. According to the literature, a formative experiment is grounded in several theoretical frameworks. This study brought the topics of PALS (Fuchs et al., 1997), which comes from a sociocultural perspective, and biology self-efficacy, which comes from Bandura's Social Cognitive Theory (1986), together in one research study and used pragmatism as the theoretical foundation of the formative experiment.

The formative experiment framework provided a way to study the effects of the PALS (Fuchs et al., 1997) intervention in an inclusion class and to possibly modify the dosage, time spent on each PALS (Fuchs et al., 1997) activity, or any other factor that could move the results closer to the pedagogical goal of increasing the comprehension of grade-level biology text or biology self-efficacy in secondary students with LD. The PALS (Fuchs et al., 1997) intervention was chosen as it was a well-researched intervention that had earned a "best practice" status by the U.S. Department of Education Program Effectiveness Panel (Fuchs et al., 2001) but had not been researched with science text and secondary students with LD. The research in the present study's literature review supported using a formative design experiment to study PALS (Fuchs et al., 1997) within an in vivo inclusion biology classroom to determine its influence on reading comprehension of grade-level biology text and biology self-efficacy in secondary students with LD.

CHAPTER 3

METHODOLOGY

The methodology for the present study was based on the research literature for formative experiments, the PALS (Fuchs et al., 1997) intervention, reading comprehension of grade-level science text, science self-efficacy, and the theoretical perspectives of pragmatism, sociocultural perspective (Wertsch, 1985, 1991), and Social Cognitive theory (Bandura, 1986). In this section, the research design, pedagogical goal, research site, participants, data collection, research timeline, and data analysis were discussed within the formative experiment framework (Reinking & Bradley, 2008; Reinking & Watkins, 2000). Limitations of the study are also presented.

Formative experiments are a relatively new mixed methods research design, which can be included in the category of design research. This methodology, based on Brown's (1992) work, was developed by Reinking and Watkins (2000), and further developed by Reinking and Bradley (2008). This study employed a convergent parallel mixed-methods design (Creswell & Poth, 2018) to collect data on the PALS (Fuchs et al., 1997) intervention being used to meet the pedagogical goal. Using the formative experiment research design strengthened the dependability and methodological rigor of the present study (Creswell & Poth, 2018; Lee, 2014).

Increased comprehension of grade-level biology text and biology self-efficacy were chosen as factors to examine within the formative experiment framework since a thorough review of the literature showed that secondary students with LD struggle not

only in reading, but reading comprehension of content area texts, especially in science (Simpkins, Mastropieri, & Scruggs, 2009; Pintrich, 2003; Palinscar et al., 2001). The struggles students with LD face in reading comprehension can also impact their self-efficacy in science which is defined as a "students' belief in their ability to succeed in science tasks, course or activities" (Britner & Pajares, 2006, p. 486).

Pedagogical Goal

The pedagogical goal of the present study was to improve the comprehension of grade-level biology text and biology self-efficacy among students with LD using the PALS (Fuchs et al., 1997) intervention in an inclusion classroom.

Research Site

According to Reinking and Bradley (2008), one of the goals of data collection in a formative experiment is to use thick description to characterize the instructional context (Reinking & Bradley, 2008), a procedure used by many qualitative researchers (Merriam & Tisdell, 2016; Ravitch & Carl, 2016; Thomas, 2016). The thick description for this study was obtained through both quantitative and qualitative data sources which included observations as a teacher-researcher at the school.

This study was conducted following all IRB protocols (see Appendix A). The present study took place in the Fall Semester of 2019 at a large urban high school in the Southwest United States where the researcher was a faculty member. The school's population had approximately 3,276 students enrolled in grades 9–12 and included approximately 500 students who received special education services. According to the

2018-2019 Timberland School District (pseudonym) demographics, Desert Star High School (pseudonym) population had multiple ethnicities: 73.5% white, 26.4% Hispanic, 3.3 % Black/African-American, 4.7 % Native American, 2.6 % Asian, 0.3% Pacific Islander, and 1.3% students with two or more races. There were 32.63% of students at Desert Star High School (DSHS) receiving free and reduced lunch.

The instructional climate at DSHS was collegial, with most teachers viewing themselves as team players. Teachers and students were respectful of one another for the most part, with a school climate of understanding and working together toward achieving student success. There was one principal, four vice-principals (one per grade level), and a Dean of Students on the administrative team at DSHS.

Desert Star High School had applied for A+ status in the state and appeared in the top 25 high schools in *US News and World Report* high school rankings. Teachers at DSHS school voluntarily gave up 30 minutes of their hour lunch each day to be available to students who were failing and at-risk of failing for individual tutoring, make-up test-taking, and other help that the students needed. If students were passing all their classes, they had a one-hour lunch period each day.

The formative experiment was conducted as a teacher-researcher paired to co-teach with a general education biology teacher, Mrs. Jones, (a pseudonym). Having a general education teacher and a special education teacher co-teach general education courses was a special education delivery model used at DSHS. A study with a similar type of teacher demographics was implemented in a formative experiment by Reinking and Watkins (2000).

It was common for students with LD to partner with their typically-developing peers in general education classes as lab partners and to have peer tutors at DSHS. This setting lent itself to the PALS (Fuchs et al., 1997) intervention as the students were used to this model within the inclusion classroom. The use of peer-teaching was also supported by Maheady (1998) who was told in a focus interview when asked why the students did not get tired of the PALS (Fuchs et al., 1997) program, “What’s the alternative, working by ourselves or listening to the teacher, and we’ve been doing that stuff for years” (p. 60).

A school-wide initiative was in place at DSHS as part of the school’s Strategic Improvement Plan to encourage the development of literacy in all areas of the curriculum. Teachers were asked in the fall and in the spring to teach two lessons incorporating learning tasks to increase reading comprehension into their content area. This initiative provided a biology teacher who was open to the intervention, as the groundwork for incorporating lessons to increase reading comprehension was already an expectation at DSHS.

At DSHS, students had class for 52 minutes a day for four days a week, and an abbreviated class period of 40 minutes one day a week to allow for early release. During the semester the study took place, there was also a week-long fall break at the beginning of October, a long weekend for Veteran’s Day, as well as a three-day Thanksgiving break. All of the early release days and breaks in addition to unplanned school assemblies in the school schedule reduced the number of class periods available to implement the intervention. The present study began six weeks into the fall semester

which was seen as another factor impacting the number of class periods available to implement the intervention.

In the classroom where the study took place, the teacher, Mrs. Jones, had the students come up with the class rules they would follow, and those were posted in the classroom. The school's honor code, "How do you live your life when no one is watching?" was also posted in every classroom. Other school policies for safety of the students included locking the classroom door during class time and having students sign in and out if they leave the classroom for any reason. These practices allowed for an environment that was open for an intervention study like PALS (Fuchs et al., 1997).

Participants

The inclusion criteria for the present study's participants were students who were randomly assigned to Mrs. Jones's class by the administration. Approximately half of the students included were those with an Individualized Education Plan (IEP), who were students diagnosed with a Learning Disability (LD) which is "a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations" (IDEA, 2004) and received services in the area of reading comprehension. The other half of the class were typically-developing peers.

Data Collection

The present study met the goals of data collection for a formative experiment (Reinking & Bradley, 2008). Data collection methods for a formative experiment consist of using both quantitative and qualitative sources. For this study, the data collection methods were broken down for both parts of the pedagogical goal: the reading comprehension component and the self-efficacy component and are found in Figure 1. The data from the pre- and postintervention reading comprehension assessments as well as the unit reading comprehension assessments were collected as the quantitative data for the reading comprehension component of the formative experiment. Qualitative data for this component consisted of the student notebook entries, the researcher notebook, teacher interviews, and focus student interviews. For the self-efficacy component of the study, the quantitative data collected was the pre- and postintervention modified SEQ-C (Lofgran et al., 2015). The same qualitative sources were used for this component of the study as for the quantitative piece. Table 2 shows the timeline for data collection.

Quantitative Data Collection

The quantitative data collection for this study was collected preintervention, during the intervention, and postintervention. Researcher-created pre- and postintervention reading comprehension assessments, unit reading comprehension assessments, and the modified SEQ-C (Lofgran et al., 2015) were used as the measures of reading comprehension and biology self-efficacy.

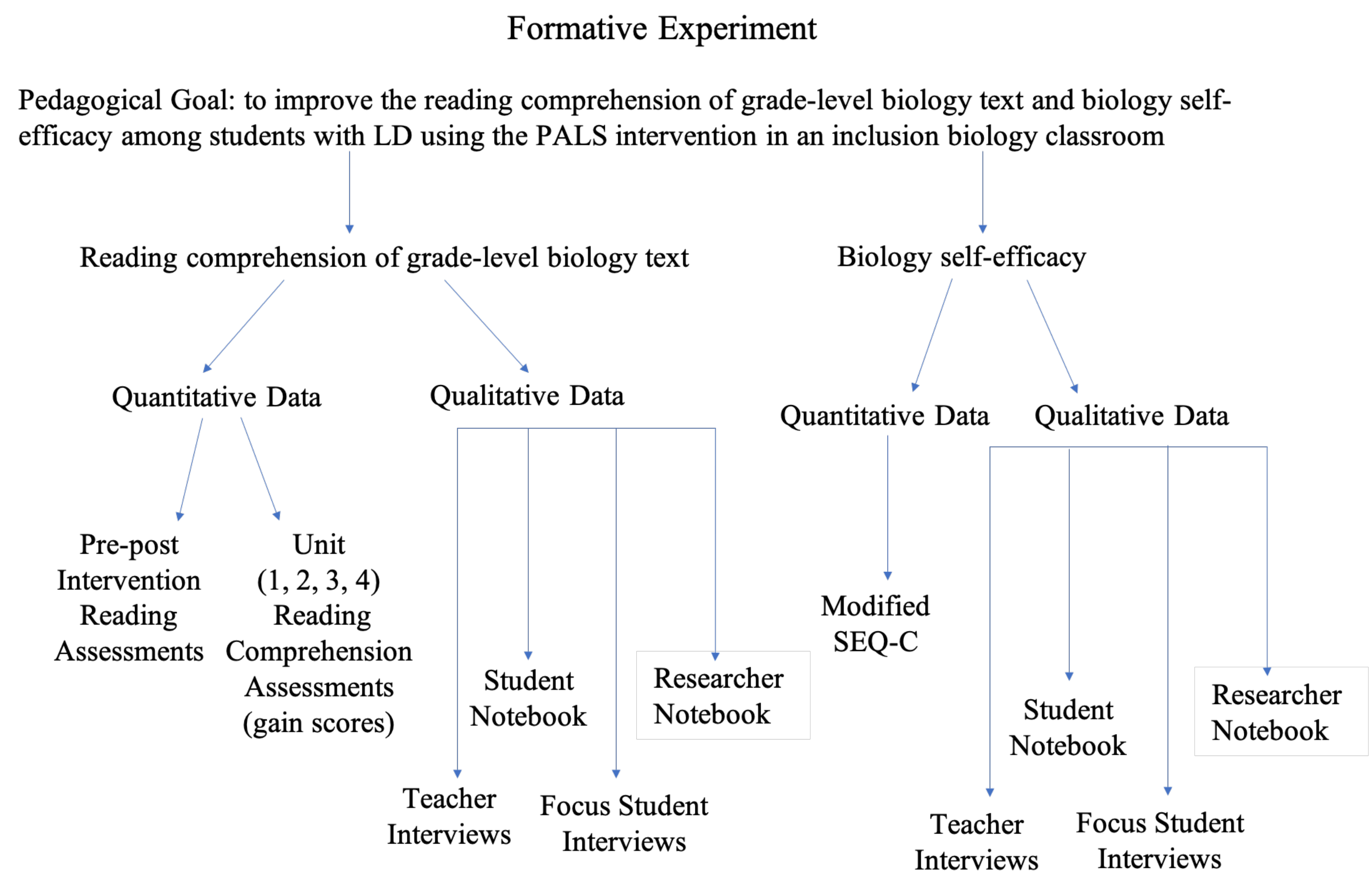

Figure 1 *Data Collection Overview*

Table 2
Data Collection Timeline

Data Collection	**Quantitative Data**	**Qualitative Data**
Preintervention	• preintervention reading comprehension assessment • unit 1 reading comprehension assessment (baseline) • modified SEQ-C (Lofgran et al., 2015)	• student notebook • focus student interview • teacher interview
During Intervention	• unit 2, 3, 4 reading comprehension assessments	• researcher notebook • teacher interviews
Postintervention	• postintervention reading comprehension assessment • modified SEQ-C Lofgran et al., 2015)	• student notebook • researcher notebook • teacher interview • focus student interview

Pre- and postintervention reading comprehension assessments. A pretest consisting of two approximately 400-word grade-level biology passages were read aloud by each student with a five-minute time limit for each passage (see Appendix B for sample passage). The passages aligned with the biology content of the course but were not on topics the students covered during this study and were taken from Biology (Miller & Levine, 2008), an older Timberland School District biology text, and other online sources.

The use of pre- and posttests was based on the work of Sáenz, Fuchs, and Fuchs (2005) who conducted a study using PALS (Fuchs et al., 1997) with elementary students using a measure called The Comprehensive Reading Assessment Battery (CRAB) developed by Fuchs, Fuchs, and Hamlett (1989). The CRAB (Fuchs et al., 1989)

consisted of administering two 400-word folktale passages both pre- and postintervention and having ten comprehension questions about one passage, with a read-aloud portion and a maze portion about the other passage. As the present study was with a secondary population, a modification of the CRAB (Fuchs et al., 1989) assessment administered in Sáenz, Fuchs, and Fuchs' (2005) study was developed by the researcher and used to measure the pre- and postintervention reading comprehension of grade-level biology text of the students.

Ten short answer comprehension items of "high thematic importance" (Sáenz et al., 2005, p. 240) were developed for the passages with Mrs. Jones to ensure that the points of recall to test oral reading comprehension were relevant and valid for the texts (see Appendix C). Immediately following the assessment, the students were asked to orally recall the content. Then, each student was asked to orally respond to four questions similar to those given in the PALS (Fuchs Research Group, 2019) intervention Partner Reading activity, three questions were asked to elicit oral responses to items regarding main idea, corresponding to the PALS (Fuchs Research Group, 2019) activity of Paragraph Shrinking, and the final three questions were asked to elicit oral inferential responses like the Prediction Relay activity.

The Lexiles for the pre- and postintervention reading comprehension passages were determined by using Lexile.com to ensure that the grade-level of the text, which is estimated to be between 1085L to 1400L for 10th grade and the grade where most students take biology.

The students were given five minutes to read each passage, as Hasbrouk and Tindal (2017) found that students in the fourth and sixth grades at the beginning of the

year performing at the average range (50%) read between 94-132 correct words per minute (CWPM). At DSHS where the present study was conducted, the typical reading level of students with LD in 10th grade at the beginning of the year fall into this range of reading at a fourth to sixth grade level, based on their scores from the San Diego Quick Assessment of Reading Ability (LaPray & Ross, 1969) which was administered in the Timberland Public School District to all students enrolled in reading classes through the special education department. Thus, the five-minute time frame found by Hasbrouk and Tindal's study (2017) fits the population of the students in this study, since the time limit for the passage is to allow for the students to read for understanding, not to assess oral reading fluency.

After data collection on the intervention ended, a similar reading comprehension assessment was administered to the students. This assessment used two different 400-word grade-level biology passages on topics not covered in the units and were used to compare the students' gain scores from the preintervention assessment. The same type and number of questions from the preintervention assessment were given on the postintervention assessment. These posttests were not counterbalanced.

Unit reading comprehension assessments. In DSHS, the science department had started implementing the new science standards (Next Generation Science Standards, NGSS, 2013) in some science classrooms before the state-wide mandate went into effect in the 2020-2021 school year. Instead of traditional unit format for lessons, the material is presented in Data Storylines (NGSS, 2013) instead and questions for that storyline are answered in individual lessons. This new format lead to challenges in finding appropriate text for these assessments.

Similar to the pre- and postintervention reading comprehension assessments, an additional passage on the unit topic of approximately 400-words at a 10^{th} grade level Lexile between approximately 1085L and 1400L were given to the students to read individually and then they answered ten comprehension questions after each biology unit posttest (see Appendix B and C for a sample). These unit reading comprehension assessments covered similar content as the unit posttest and were used to analyze the influence of the PALS (Fuchs et al., 1997) intervention on the reading comprehension of grade-level biology text. The same questioning format was used for each of the unit tests. The students were allowed to use the passage while taking the assessment, as they were allowed to use their notes on the part of the unit test given by Mrs. Jones. Due to the recursive nature of the formative experiment, the data from the unit reading comprehension assessments were used as a source of information in determining changes to better meet the pedagogical goal. These assessments were used to examine if reading comprehension was impacted by students' prior knowledge as the unit reading comprehension assessments were on similar topics as the unit content. The data was exported to a spreadsheet for statistical analysis after the intervention.

Modified SEQ-C (Lofgran et al., 2015). The modified SEQ-C (Lofgran et al., 2015) was administered to all the students in the class pre- and postintervention (see Appendix D). See Appendix K for documentation of permission. This instrument was originally developed by Muris (2001) to measure self-efficacy in middle and high school children. Lofgran et al. (2015) modified the instrument for use with science students to be more in line more current with the existing self-efficacy research.

Out of all the instruments currently available to measure science self-efficacy (Gomaa, 2016; Muris, 2001; Thomas et al., 2008), the modified SEQ-C (Lofgran et al., 2015) was most closely matched for the population and demographics of the present study. The modified SEQ-C (Lofgran et al., 2015) was also chosen as it was internally consistent (Cronbach's alpha coefficient of .88 for academic self-efficacy), had construct and criterion-related validity (Muris, 2001), and it adhered to Bandura's guidelines for constructing self-efficacy instruments (Bandura, 2006b). However, in order to measure *biology* self-efficacy more specifically for this study, the word "science" in Lofgran et al.'s (2015) measure was replaced with "biology", and the wording was slightly modified to reflect less potential bias in the measure. Students rated their beliefs about their competence in biology on a 5-point Likert-type scale (1 = not at all to 5 = very well). The modified SEQ-C (Lofgran et al., 2015) yields a score for possible scores in a range from 7 to 35 points. Gender was also updated to reflect the category of "Other" in addition to the traditional binary gender classification. The demographic information (gender and ethnicity) on the modified SEQ-C (Lofgran et al., 2015) was gathered but not used in this study. The data was recorded and stored in a spreadsheet for coding and analysis.

Qualitative Data Collection

Student notebook. Lee (2014) used student notebooks to record the students' satisfaction with the PALS (Fuchs et al., 1997) intervention, and her work influenced the use of this data source in the present study. Student responses to the developed questions

were designed to solicit more information regarding the students' perception of their biology content knowledge and were kept in their biology notebooks.

The questions for the preintervention student notebooks were: (a) what strategies do you use to read grade-level science text, (b) how do you feel about science and/or biology in particular, (c) do you experience problems reading grade-level science text, (d) do you feel that you have confidence in doing well in your science classes? However, after the intervention, the students were asked to write about: (a) how have the PALS (Fuchs et al., 1997) activities influenced your reading of grade-level biology text, (b) how they feel about the particular PALS (Fuchs et al., 1997) activity, (c) if they experienced any problems with the PALS (Fuchs et al., 1997) activities, and (d) if they felt like they had more or less confidence in biology class as a result of the PALS (Fuchs et al., 1997) activities. The students were encouraged to report both negative and positive experiences with the PALS (Fuchs et al., 1997) intervention in their student notebook. The students first journaled about the intervention when the PALS (Fuchs et al., 1997) training lessons began and then journaled again after the the postintervention assessment was completed.

Merriam and Tisdell (2016) recommend that "collection and analysis should be a *simultaneous* process in qualitative research" (p. 195). To follow this recommendation, photocopies were made of the students' entries in their student notebook, so the coding of the initial entries could begin while the study was in progress. The entries were coded for the presence or absence of student's comments pertaining to biology self-efficacy and comments relating to their performance on the unit reading comprehension tests.

Researcher Notebook. A detailed notebook was kept throughout the study. The notebook consisted of field notes with participant observations and quotes from the

students and Mrs. Jones, the procedures for the day's lessons, and notes from the informal teacher interviews. Additional information including dates of the PALS (Fuchs et al., 1997) readings, incentives list, next steps for the intervention, and other data were also recorded in the notebook. This data was used to provide thick descriptions of the intervention and of changes made during each cycle of data collection.

Focus student interviews. De Corte et al. (2001) as well as Reinking and Watkins (2008) used small, purposeful samples of students to conduct semistructured focus student interviews which yielded positive results, so this same methodology was used to inform this portion of the present study. Data was collected and analyzed from an interpretive, participant-observation stance, and this stance requires that the researcher be involved closely with the students (Erickson, 1986). At the beginning and at the end of the intervention, semistructured interviews (see Appendix G and H) were conducted on a small, purposeful sample of two students to collect additional data to determine the influence of PALS (Fuchs et al, 1997) on their reading comprehension of biology text and biology self-efficacy. The focus student interviews were conducted with the students with LD who scored the highest on the state language arts assessment and the student with the lowest score on the state language arts assessment. In this study, both focus students were male. The original student with the lowest score on the state language arts assessment at preintervention was dropped from this study due to lack of participation in the intervention so a second student with the next-lowest score on the state language arts assessment was used for the postintervention focus student interview. In addition, these interviews also served as member checks for the emerging data (Lincoln and Guba, 1985).

The questions for the focus student interviews were derived from the modified SEQ-C (Lofgran et al., 2015) and open-ended questions were added to elicit more rich responses for triangulation of data between their interview responses, student notebook responses, and the researcher notebook which yielded more consistent and transferable results (Merriam & Tisdell, 2016; Ravitch & Carl, 2016; Thomas, 2016). Each interview was recorded, transcribed, and hand-coded using the coding methods listed in the data analysis section below.

Teacher interviews. A close and collaborative relationship (Cole and Knowles, 1993) developed with Mrs. Jones during the study and important conversations happened daily that guided the daily classroom routine. Before the intervention, a semistructured interview was conducted with Mrs. Jones and the questions that guided that interview are included in Appendix I. This interview was recorded, transcribed, and coded.

Informal interviews were conducted after each unit to determine what changes if any, were needed to move toward the achievement of the pedagogical goal of increased reading comprehension of biology text and biology self-efficacy of the students. Any decisions that were made to modify the intervention during these interviews were documented in the researcher notebook. After Unit 4, Mrs. Jones was interviewed for the final time using questions included in Appendix J. The final interview was also recorded, transcribed, and coded.

Reinking and Watkins (2000) asserted that data collection ends not when the pedagogical goal has been achieved, but at some arbitrary point dictated by practical constraints. One constraint for high school populations is that schedules change, and students often do not have the same class schedule in the spring semester as the fall

semester, so this study was designed for one semester. The study was completed at the end of the first semester in mid-December.

Research Timeline

The procedures for the present study occurred in four phases and are described in Table 3: (a) preparation, (b) PALS (Fuchs et al., 1997) training, gathering and analyzing baseline data, (c) implementing the PALS (Fuchs et al., 1997) intervention with ongoing data collection and analysis, and (d) coding postintervention data.

Table 3

Research Procedure Phases

Phase 1: Preparation (Spring/Summer 2019)	• Met with principal to explain study timeline, obtain district permission • Obtained permissions and consent, assigned students • Prepared protocols and PALS (Fuchs et al., 1997) lessons
Phase 2: PALS (Fuchs et al., 1997) Training; Gathered and Analyzed Baseline Data; (August/September 2019)	• PALS (Fuchs et al., 1997) scripted training activities • Gathered baseline data, began coding • Administered SEQ-C (Lofgran et al., 2015) • Administered preintervention assessment
Phase 3: Implementation of Intervention, Analysis (September-November 2019)	• Student notebook entry • Implemented PALS (Fuchs et al., 1997) intervention during biology Units 2, 3, 4 • Met with biology teacher; analyzed data, and adjusted instruction as needed after baseline, Units 2, 3
Phase 4: Postintervention (December 2019)	• Administered postintervention SEQ-C (Lofgran et al., 2015) reading comprehension assessment and entered into SPSS (25) • Final coding of qualitative data

Phase 1: preparation. Support from the principal was obtained for the present study. After the committee approved the study proposal, permission was obtained from the Timberland Public School District (pseudonym) to implement the study. The study conformed to IRB protocol. After IRB approval, the informed consent letter was translated into Spanish for parents of potential participants. Then, the informed consent letter for the potential participants and their parents was sent home with the students to obtain written permission to access student records, participate in the study, and to use student notebook excerpts in the published dissertation.

The class size was 27 at the beginning of the study, but permission was only obtained from 18 students, so there was a group of nine PALS (Fuchs et al., 1997) student dyads, with the present study only using data from those students with learning disabilities. The students' reading scores from the previous year's state assessment were used as the basis for assigning students to the PALS (Fuchs et al., 1997) dyads. Using the same procedure to pair students in a PALS (Fuchs et al., 1997) classroom developed by Fuchs, Fuchs, and Burrish (2000), the highest reader was paired with the middle reader, then the second middle reader paired with the lowest reader, and so on, until all the students are paired.

The other tasks for this study that were completed during the summer of 2019 were preparing the pre- and postintervention reading comprehension assessments, unit comprehension reading assessments, the modified SEQ-C (Lofgran et al., 2015) protocols, and the PALS (Fuchs Research Group, 2019) training lesson materials.

Phase 2: gathering/analyzing baseline data and PALS (Fuchs et al., 1997) training. Another goal of data collection in the formative experiment framework is that baseline conditions and performance should be established before the intervention is introduced and the formative experiment begins. Baseline data allows the researcher to establish a benchmark to measure progress in meeting the pedagogical goal using data that was both qualitative and quantitative in nature.

This phase of the study began with the administration of the researcher-designed preintervention reading assessments patterned after Sáenz, Fuchs, and Fuchs' (2005) study. The modified SEQ-C, (Lofgran et al., 2015) which measured biology self-efficacy, was also administered to the students during this time. Then, this preintervention data was coded and entered into SPSS (25) for initial analysis. The qualitative baseline data was the students' first responses in their student notebook entries and the responses from the preintervention focus student interviews. The results of the baseline data collection and analysis are reported in Chapter 4.

The baseline unit was taught in conjunction with the PALS (Fuchs Research Group, 2019) training lessons, and the Unit 1 test score was considered as the baseline test score. The topics covered during the baseline unit were how to test hypotheses, followed by three additional topics on leaf structure and function, photosynthesis, and cell structure and function.

A series of six training lessons were included in the PALS For High School Students manual (Fuchs Research Group, 2019): Learning About PALS (Fuchs Research Group, 2019), Partner Reading, Paragraph Shrinking, Prediction Relay, Check Writing, and Reading for Information. The training lessons required the students be taught

specific content in a scripted format regarding the PALS (Fuchs Research Group, 2019) intervention and reading activities which consisted of filling out guided notes and taking a quiz at the end of each lesson. The original design was to cover the six training lessons over 12 days, during half the class periods. However, due to modifications in the intervention, an overview lesson and Lessons 2, 3, and 4 covering the reading activities were presented during this phase of the intervention. Further details of the modifications are discussed in Chapter 5.

Partner Reading is an activity where the dyad reads a paragraph to each other and restate the content of the paragraph they just read, one serving as reader and the other as coach, with the coach letting the reader know of any mistakes made while reading the paragraph, and the two students switch roles for the next paragraph. The purpose of the Paragraph Shrinking activity is for the reader to state the main idea of the paragraph. Prediction Relay allows both students to use their inference skills to predict what the next paragraph might say. These activities are modeled for the students in the scripted training activities, with the teacher serving as coach and the students in different scenarios during the activities (McMaster et al., 2008).

There was a gradual integration of students into the PALS (Fuchs Research Group, 2019) activities throughout the four half days of training lessons, with both teachers circulating throughout the room to provide feedback and to monitor the activities (McMaster et al., 2008). Incentives of candy, gum, and drinks were earned by the students for their participation in the reading activities. Students could also save their incentive points, called PALS (Fuchs et al., 1997) dollars for a gift card to retailers of

their choice at the end of the study. Further explanation of this process is found in Chapter 4.

Phase 3: implementation of formative experiment. The biology units consisted of weekly content, a weekly quiz for each section, followed by a unit test. The material used for this course was taken from Argument-Driven Inquiry in Biology (Sampson et al., 2014) and other online resources. These units were taken from the new Next Generation Science Standards (NGSS, 2013) which was implemented in Mrs. Jones' classroom before the Timberland Public School District's mandate for implementation during the 2020-2021 school year. She was one of two biology teachers who decided to implement the new science standards the year before the district mandated teachers to do so.

The NGSS (2013) are new science standards for K-12 science education. The standards are research-based but provide educators flexibility to design learning experiences to meet local educational needs and stimulate students' interests in the sciences as well as preparing them for college, careers, and citizenship (NGSS, 2013). The new science standards rely heavily on labs, writing up arguments to support claims from lab results, and analyzing and graphing data.

During each Argument-Driven Inquiry in Biology (Sampson et al., 2014) unit, there was an overview of the topic on Day 1 of the unit. For Days 2-5, a lab handout or reading from the text was covered. During the first day, the students employed the PALS intervention activities of Partner Reading, Paragraph Shrinking, and Prediction Relay (Fuchs Research Group, 2019) with this text. On Day 6, a video was shown from the Amoeba Sisters' You Tube channel or a Next Generation (NGSS, 2013) video on the

unit's topic. The students filled in guided notes developed by Mrs. Jones while watching the video. Days 7 and 8 were typically a guided-inquiry lab on the topic, and on Day 9, the students used the PALS (Fuchs Research Group, 2019) activities to re-read the guided notes as a review before the administration of the unit test on Day 10. Holidays, special events at DSHS, and Mrs. Jones' absences often prolonged these assignments for additional days to make each unit about three weeks long. After each unit biology test, the unit reading comprehension assessment was administered and coded into SPSS (25).

The PALS intervention (Fuchs et al., 1997) has been used for over twenty years and was chosen as it had the potential to achieve the pedagogical goal, which answered one of the questions in the formative experiment framework. Typically, PALS (Fuchs Research Group, 2019) interventions for elementary and junior high studies are implemented for approximately 35 min a day for 5 days (175 minutes per week) and for varied amounts of time, some as long as a school year (Calhoon & Fuchs, 2003; Fuchs et al,, 2000), which was not a reasonable expectation in the secondary biology classroom, or during a formative experiment study. Secondary biology classrooms are more lab-based and hands-on, with only approximately 52 minutes of instruction per period per day, so they contain less reading than in the lower grades. The present study ran for the first three biology units past the baseline which was for twelve weeks.

The total dosage for the intervention was comprised of four different time categories reported in Table 4. The total dosage time for the intervention was 968 minutes. Due to the individual nature of the focus student interviews, those times were not included in the total dosage time for the intervention.

Table 4

Total Intervention Dosage

Assessment	Time
Pre/post reading comprehension assessments and modified SEQ-C (Lofgran et al., 2015)	10 minutes per assessment x 9 students x 4 = 360 minutes
PALS (Fuchs Research Group, 2019) training	5 lessons x 40 minutes = 200 minutes
PALS (Fuchs et al., 1997) readings	20 x 10 readings = 200 minutes
Unit reading comprehension assessments	52 minutes x 4 = 208 minutes

Phase 4: postintervention. The postintervention reading comprehension assessments and the postintervention modified SEQ-C (Lofgran et al., 2015) data was entered into SPSS (25) for analysis. In addition to the quantitative data, the post-ntervention focus student interviews, semistructured and informal teacher interviews, and the final student notebook entries were coded during this time using the qualitative coding methods described later in the chapter.

Data Analysis

Quantitative Data Analysis

Pre- and postintervention reading comprehension passages. Following the study conducted by Lang et al. (2009), individual gain scores were used to measure the change in scores from pre- to posttest on the reading comprehension passages. Gain scores are used when a researcher is evaluating the effects of a treatment or intervention over time. The change (gain) from pretest to posttest was computed for each participant

by subtracting each person's pretest score from their posttest score. A positive gain score indicated that the posttest score was greater than the pretest score, while a negative gain score indicated that the posttest score was less than the pretest score (Gravetter & Wallnau, 2014).

In the present study, it was expected that the PALS (Fuchs et al., 1997) intervention would lead to increased reading comprehension of grade-level biology text so the gain scores should be positive. The general approach to gain score analysis is to analyze the gain scores in an analysis of variance with the intervention as the between-subjects factor. Then, the significance of those gain scores are calculated using a one sample *t*-test. A limitation of this type of analysis is that the growth might or might not be significant for this sample class who are receiving the same instruction.

Unit reading comprehension assessments. The reading comprehension tests for the biology units during the baseline and intervention phase were analyzed using a *t*-test for repeated-measures (Gravetter & Wallnau, 2014). The null hypothesis for this *t*-test would show that there was no change in reading comprehension of grade-level biology text as a result of the PALS (Fuchs et al., 1997) intervention. The alternative hypothesis for this study was that there was a treatment effect that caused the scores to be systematically higher or lower at the end of the intervention.

Descriptive statistics were used to report the scores from baseline to Unit 2, Unit 2 to Unit 3, and Unit 3 to Unit 4. Then, these scores were analyzed via a repeated measures analysis of variance (1-way rmANOVA) in SPSS (25) to determine the significance of those scores (within-subjects factor = observation number: 1, 2, 3, or 4). Three planned pairwise comparisons (time 1 vs 2, 2 vs 3, 3 vs 4) for adjacent time points

were performed as well as an overall pairwise comparison time 1 vs 4). The Bonferroni correction for multiple comparisons was applied to all four *t*-tests. Bonferroni's correction adjusts the statistical significance to help ensure that false positive results are not obtained when multiple tests are conducted.

An effect size for the pairwise comparisons were also calculated. Coe (2002) posits that effect sizes are an important tool and more accurate than statistical significance in interpreting the effectiveness of intervention studies. Statistical significance combines the effect size and the sample size (Coe, 2002). When the sample size is small, an effect size can often show a better picture of the results of a given intervention (Coe, 2002).

Modified SEQ-C (Lofgran et. al., 2015). The means, standard deviations, and growth or regression for the pre- and postintervention scores for the modified SEQ-C (Lofgran et al., 2015) were calculated using SPSS (25) and displayed in a table in Chapter 4 (see Tables 7 and 8). The work of Lee (2014) and Calhoon and Fuchs (2003) informed the present study as they both used these types of statistical analysis in their research using the PALS (Fuchs et al., 1997) intervention at a secondary level. A limitation of this method is though it is not ideal to take the means of Likert-type scale data, it is a common approach in some educational research (Erdem, Usal, & Saka, 2018). Erdem et al. (2018) used the means and standard deviations of their students' perceptions of their technological proficiencies for each item on their Likert-type scale survey (Erdem et al., 2018) and following their pattern, the individual items on the modified SEQ-C (Lofgran et al., 2015) are reported in Chapter 4.

After reviewing the descriptive statistical data, the decision was made to further analyze the data using a paired sample *t*-test to compare the two scores since the data compared the variable within subjects. This analysis was run in SPSS (25) and the results are displayed in Chapter 4 (see Table 9). Computation of gain scores was also performed with the data for the integrative analysis and are also displayed in Chapter 4.

Qualitative Data Analysis

Multiple sources of data are necessary to obtain a deep understanding of the intervention and its effects, which produce rigor in a study (Reinking & Bradley, 2008). Table 4 includes the data sources and the influence each may have on the reading comprehension of grade-level biology text and on biology self-efficacy. The student notebooks as well as the researcher notebook, the focus students' pre- and postintervention interviews and all teacher interviews were coded and analyzed using the methods below (see Figure 2) to determine both the students' perception of the PALS (Fuchs et al., 1997) intervention's influence on their reading comprehension of grade-level biology text and biology self-efficacy.

Table 5

Qualitative Data Analysis

Data Source	PALS Influence on Reading Comprehension of Grade-Level Biology Text	PALS Influence on Biology Self-Efficacy
Student Notebook	• Decisions regarding pedagogical goal • Emotions present regarding reading comprehension • Patterns of perceived increase or decrease of reading comprehension	• Decisions regarding pedagogical goal • Emotions present regarding self-efficacy • Patterns of perceived self-efficacy over time
Researcher Notebook	• Factors influencing decisions regarding pedagogical goal	• Factors influencing decisions regarding pedagogical goal • Description of observed self-efficacy behaviors
Teacher Interview	• Factors influencing decisions regarding pedagogical goal	• Factors influencing decisions regarding pedagogical goal • Description of observed self-efficacy behaviors
Focus Student Interviews		• Emotions present regarding self-efficacy • Patterns of perceived self-efficacy over time

Unstructured first read. There was an unstructured first read of the qualitative data as suggested by Ravitch and Carl (2016) as a necessary step to become oriented with the entire data corpus for each cycle of data. This was a first reading of the data without coding "to get the overarching context and sense the lay of the land" (p. 245). For the present study, an unstructured first read of the qualitative data took place after one cycle of data collection (one unit) when the students completed the baseline unit reading comprehension. This process was repeated for each unit's data. These coding cycles were also used on the student notebooks and focus student

interviews. The students' notebooks, focus student interviews, teacher interview transcripts (both formal and informal), as well as the researcher notebook provided the triangulation of data necessary to ensure the qualitative data are reliable (Merriam & Tisdell, 2016; Ravitch & Carl, 2016).

First cycle coding. The first cycle coding method used a mixture of Emotion Coding and In Vivo Coding as suggested by Saldaña (2016). Emotion Coding (Saldaña 2016) is useful for studies that involve a wide variety of data forms and provides "deep insight into the participants' perspectives, worldviews, and life conditions" (Saldaña, 2016, p. 125). He found In Vivo Coding particularly useful for beginning qualitative researchers who are learning how to "prioritize and honor the participant's voice" (Saldaña, 2016, p. 106). The emotions present relating to both reading comprehension of grade-level biology text and biology self-efficacy in the student notebooks, the focus student interviews, and the teacher interviews were coded using Emotion Coding (Saldaña, 2016). During the process of In Vivo Coding (Saldaña, 2016), direct quotes were recorded from the students' experiences which exemplified positive or negative comments about the reading comprehension of grade-level biology text and self-efficacy to use in the text of the present study.

Second cycle coding. The second cycle coding of the qualitative data used Longitudinal Coding (Saldaña, 2016, p. 261) to find patterns in the data. Though originally developed for longitudinal studies, there was value in this coding process as the data collected were used to show changes in students' perceptions of their reading comprehension of grade-level biology text and biology self-efficacy over the course of

the study. Saldaña (2016) suggested that there can be qualitative increases, decreases, and constancy in students' data over time.

There are seven descriptive categories to organize and analyze the qualitative data in longitudinal coding (Saldaña, 2016, p. 262) which are:

1. *Increase and emerge*: includes what data shows an increase or emergence in biology text comprehension or biology self-efficacy over time.
2. *Cumulative*: lists cumulative changes in biology text comprehension or biology self-efficacy over the units.
3. *Surges, Epiphanies, Turning Points*: includes any surges in biology text comprehension or biology self-efficacy epiphanies or turning points shared by students during the intervention.
4. *Decrease or cease*: includes observations from the data that show decreases or cessation in biology text comprehension or biology self-efficacy epiphanies or turning points shared by students during the intervention.
5. *Constant and Consistent*: includes those items are consistent over time during the study, and often contains the most data.
6. *Idiosyncratic*: records subtle shifts or outlier data.
7. *Missing*: contains any data that is missing that would influence the students or intervention.

Second cycle coding data for the students' perception of their reading comprehension of grade-level biology text and biology self-efficacy are woven throughout Chapter 4.

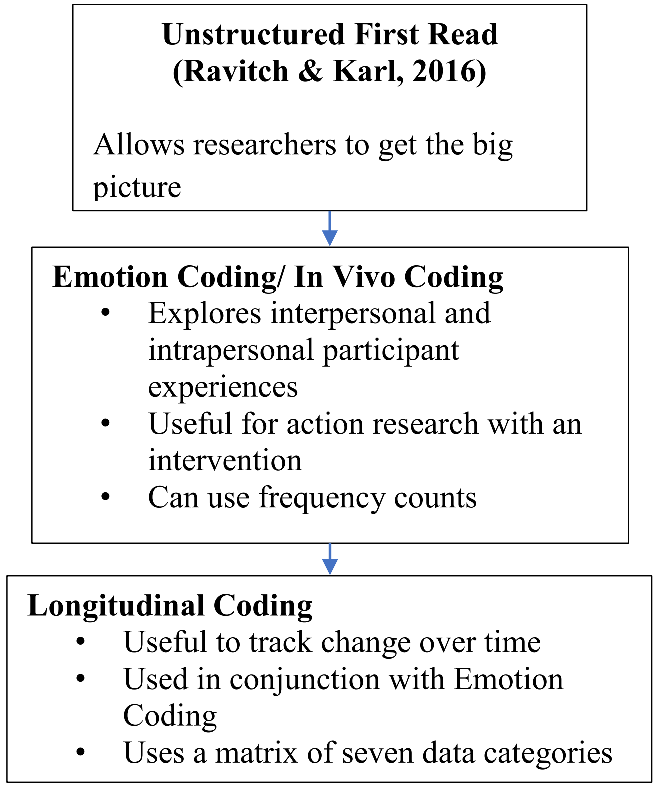

Figure 2. Qualitative Coding Scheme

Additional coding. Often, additional coding is necessary with qualitative data (Merriam & Tisdale, 2016), especially when new questions are posed when analyzing data in a formative experiment. In order to answer the question in the formative experiment framework of what factors inhibited and enhanced the movement toward the pedagogical goal, additional coding was necessary to look for those patterns and themes in the data. The data were reviewed and coded specifically for these factors in the formal and informal teacher interviews, the focus student interviews, and the student notebook entries. This additional coding scheme yielded

much richer data than the proposed coding scheme, especially with the teacher interviews.

Limitations of the Study

According to Dede (2004), formative experiments raise methodological issues and have limitations, just like any other form of research. Several limitations for the present study are outlined below.

Brief duration of the study. Other formative experiments were conducted using data from a full school semester (Bradley & Reinking, 2011; Sáenz et al., 2005) to several years (Reinking & Watkins, 2000). However, Colwell and Reinking (2016) conducted a formative experiment in middle school history for only ten weeks, which was similar to the brief duration of twelve weeks in this study. The study's timeframe included a week for fall break, three days off for Thanksgiving Break, and several class periods devoted to mandatory district testing. Every Wednesday was an early release day, and classes were shortened by 10 minutes. This limitation could be minimized by possibly implementing studies in the spring semester when there are fewer breaks in the academic schedule.

Sample size. A small sample size was a limiting factor in this study which can result in a lack of statistical power as well as a lack of generalizability to a larger population. This study's sample size was affected by receiving only 18 out of 27 informed consent forms, which led to 9 dyads. Then, two students were absent for more than 25% of the intervention, and consequently those students' data were not used in the study.

Lack of a control group. According to Reinking and Bradley (2008), formative experiments do not require a control group. This study did not use a control group, which could weaken the validity of the study results. However, using a control classroom with business-as-usual (BAU) conditions while also aiming to reach the set pedagogical goal could strengthen a study's results. Reinking and Bradley (2006) stated that with a control group, the data could be compared to find "points of convergence or divergence which could enhance theory development and case-to-case generalizations" (p. 53).

Lack of same-age peers in the study. Another possible limitation is the mixed ages and grades of the students. This limitation concerns internal validity. Unknown at the time of the present study design, DSHS allowed ninth-grade students to sign up for biology, since students are allowed skip the general science class that most ninth-grade students enroll in their first year of high school and take biology, chemistry and physics. Also, DSHS classified students in grade levels by credits earned, so some students in the study showed on the roll book as 9th grade students, but they were the age of a 10th grade student. Five students in the study were 10th grade students in both age and credits, while two students were on the roll as 9th grade students because they had failed one or more classes their first year of high school. One of the students who was dropped from the study was a 12th grade student taking biology and other science classes to graduate. With this dynamic, the additional time in school experienced by the senior could have provided some advantage (Sáenz et al., 2005) and could have been a limitation for this study.

Weaknesses of using self-reporting measures. The lowest performing students are often the most inaccurate when using self-reporting measures (Rosen, Porter, &

Rogers, 2017). However, the triangulation of qualitative data with the quantitative measures was used to ensure the most reliable and valid data for the small sample size.

Fidelity of implementation (FOI) of the PALS (Fuchs et al., 1997) intervention. During a formative experiment, there are expectations that FOI will not be followed. Several changes were made to the intervention that affected the FOI are outlined earlier in the chapter. These changes included: 1) training days for the PALS (Fuchs et al., 1997) were not presented in sequence; 2) the timing of the lesson implementation was modified; 3) the training materials were changed to all informational text; and 4) the partners during the intervention did not change. Even though changes are inherent in a formative experiment, these changes did affect the FOI of the intervention.

Summary

This section has presented the methodology covering the relationship between PALS (Fuchs et al., 1997), reading comprehension of grade-level biology text, and biology self-efficacy in secondary students with LD for the present study. The research used a convergent parallel mixed-methods design (Creswell & Poth, 2018) within a formative experiment framework (Reinking & Bradley, 2008). The pre- and posttest reading comprehension passages, the biology unit reading comprehension assessments, and the modified SEQ-C (Lofgran et al., 2015) instruments were described for quantitative data sources. The student and researcher notebook, the pre-and postintervention focus student interview questions as well as formal and informal teacher interview protocols were the qualitative data collected for this study. Samples of all

assessments, interview questions, and protocols are provided within the chapters or the appendices. Data analysis techniques for both the qualitative and quantitative portions of the study were reported. The limitations of the study were also discussed.

CHAPTER 4

RESULTS

This chapter describes the results of this formative experiment in relation to reaching the pedagogical goal which was to improve the reading comprehension of grade-level biology text and biology self-efficacy among students with LD using the PALS (Fuchs et al., 1997) intervention in an inclusion biology classroom.

The results of the quantitative data from the pre- and postintervention reading comprehension assessments, unit reading comprehension assessments, and the results from the pre- and postintervention modified SEQ-C (Lofgran et al., 2015) are presented, followed by the qualitative findings from data analyzed from the biology teacher, and focus students. Next, the integrated results are reported which were taken from comparing the notebook entries of the students with LD with the gain scores from their pre- and postintervention reading comprehension assessments and their modified SEQ-C (Lofgran et al., 2015) scores.

Quantitative Results

Pre- and postintervention reading comprehension assessments. A pretest for assessing the reading comprehension of grade-level biology text was administered at the beginning of the study. The pretest consisted of two approximately 400-word passages from the grade-level biology text with questions that were patterned after the comprehension tasks addressed in the PALS (Fuchs et al., 1997) learning activities. The

students were given five minutes to read aloud each passage, then after each passage three questions were asked of the student that dealt with retell, four with main idea, and three with prediction, all skills necessary for the PALS (Fuchs et al., 1997) reading activities of Partner Reading, Paragraph Shrinking, and Prediction Relay. The students' answers were recorded and scored. The same procedure was followed at the end of the intervention for the administration of the posttest for assessing the reading comprehension of a grade-level biology text.

The comparison of the pre- and postintervention scores was used to calculate individual gain scores (see Table 5). The data for six students (pseudonyms) were used for this analysis as one student, Stephanie, missed the pretest days but was there for the rest of the intervention. There were three students, (Felicia, Lexi, and Tracy) who made slight gains of 28%, 24%, and 26%, respectively. Two other students, Steven and Peter, showed moderate gains of 47% and 37%. Interestingly, one student named John did not show a positive gain, but a negative gain score of -120%.

Table 6

Individual Gain Scores on Reading Comprehension Assessments

Student (pseudonyms)	Pretest Score	Posttest Score	Student Gain Score
Felicia	35%	53%	.28
Stephanie	Not used	Not used	Not used
Lexi	1%	25%	.24
Steven	40%	68%	.47
Tracy	5%	35%	.26
Peter	25%	53%	.37
John	90%	78%	-1.2
Total	Average Gain	Score	.047

Drawing on the work of Lang et al. (2009), a further analysis was needed for the students' scores using a single sample *t* test (Gravetter & Wallnau, 2014). The single sample *t* test (Gravetter & Wallnau, 2014) is used to "compare a single sample mean to a population mean when the population standard deviation is not known" and its purpose is to determine "if the null hypothesis should be rejected, given the sample data" ("The One Sample T-Test", 2019).

The null hypothesis for this *t* test was that there was no change in the students' reading comprehension of grade-level biology text scores from pre- to posttest as a result of the intervention ($H_0 : \mu = 0$). The alternative hypothesis was that there was a treatment effect that causes the scores to be higher or lower at the end of the intervention ($H_1 : \mu \neq 0$). A single sample *t*-test was run in SPSS (25) and showed that the difference in the pre- and postintervention scores between the current sample ($n = 6$, $M = 7$, $SD = 6.36$) and the hypothesized value (0.000) were statistically significant, $t(6) = 2.67$, $p = .043$, 95% CI [.330, 13.70], $d = 1.10$. Thus, the null hypothesis was rejected as the *p* value was less than .05.

Unit reading comprehension tests. After each unit, an approximately 400-word reading comprehension passage from the unit content with similar types of questions to the pre- and postintervention reading comprehension assessment was administered to the students. The students were allowed to use their notes on the test to remain consistent with Mrs. Jones' classroom practices. The reading comprehension tests for the biology units during the baseline and intervention phase were then analyzed in a *t* test for repeated measures (Gravetter & Wallnau, 2014). The null hypothesis ($H_0 : \mu = 0$) for this

t test was that there would be no change in reading comprehension of grade-level biology text as a result of the PALS (Fuchs et al., 1997) intervention. The alternative hypothesis ($H_1 : \mu \neq 0$) was that there was a treatment effect that caused the scores to be systematically higher or lower at the end of the intervention.

The scores were analyzed via a repeated measures analysis of variance (1-way rmANOVA) in SPSS (25) to determine the significance of those scores (within-subjects factor = observation number: 1, 2, 3, or 4). The omnibus ANOVA test just fell short of establishing significance of change over time, even with the small sample size, $F(3, 18) = 2.652$, $p = .080$. Thus, there was not a statistically significant difference in the scores for the unit reading comprehension scores from Time 1 to Time 4.

In addition, three planned pairwise comparisons (time 1 vs 2, 2 vs 3, 3 vs 4) for adjacent time points were performed as well as an overall pairwise comparison time 1 vs 4 (baseline to Unit 4). The Bonferroni correction for multiple comparisons was applied to all four *t* tests. A Bonferroni correction is a simple but effective correction that is applied to the data to control for Type 1 Error rates when multiple tests of significance are run (Gravetter & Wallnau, 2014).

In visually examining the data (see Figure 3), the pairwise comparison data showed that student scores slightly decreased 5.49% ($SE = 8.08$, $d = -0.26$) from baseline to the first postintervention reading assessment. However, this was not a significant change over time, ($p > .999$). Next, a large increase of 19.29% ($SE = 7.51$, $d = 0.97$) was observed from the second posttest to the third posttest. This pairwise comparison did reach significance ($p = .043$). There was a slight decrease of 5% ($SE = 4.63$, $d = -0.41$) again for results of the Unit 3 to Unit 4 assessment. And due to the slight decrease, once

again this did not reach significance ($p > .999$). In comparing the baseline to Unit 4, assessment, there was a slight increase in scores ($SE = 7.6$, $d = 0.44$).

Thus, there was a small overall effect size from baseline to Unit 4, even with the small sample size. Coe (2002) reports that Cohen's *d* shows the difference between two means and is "particularly valuable for quantifying the effectiveness of a particular intervention… rather than its statistical significance (which conflates effect size and sample size)" (p. 1). Coe's (2002) findings correctly describe the findings from the present study's data because even though statistical significance was not reached with this data, it still met Cohen's (1988) convention for a small effect size ($d = 0.44$).

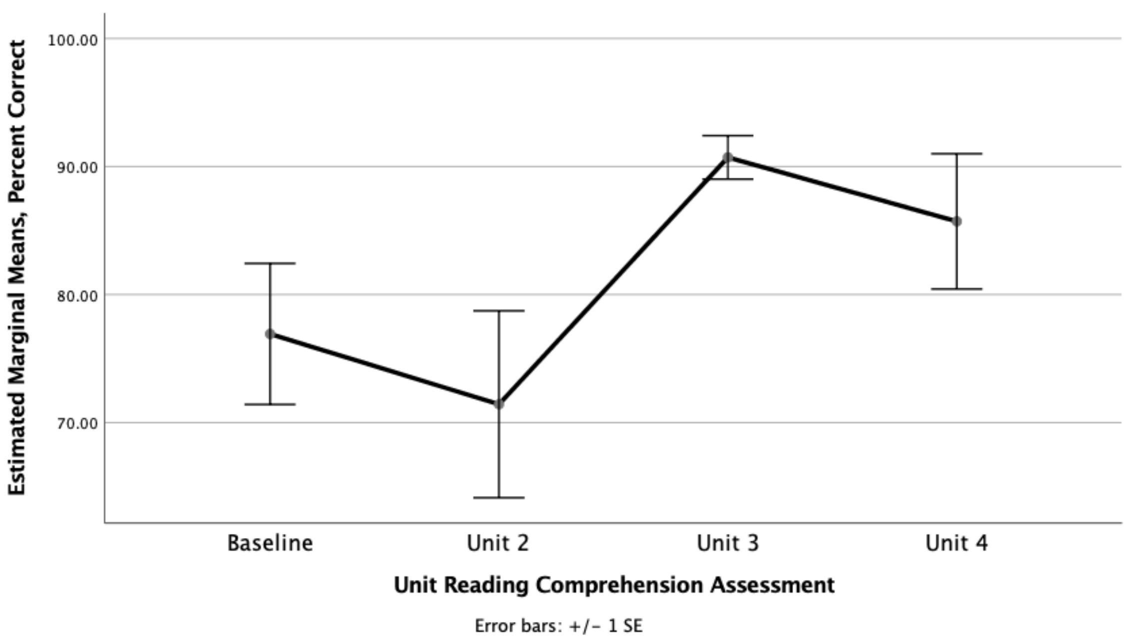

Figure 3. Reading comprehension assessment pairwise comparison data from Baseline to Unit 2, Unit 2 to Unit 3, Unit 3 to Unit 4 using Estimated Marginal Means

Modified SEQ-C (Lofgran et al. , 2015). The modified SEQ-C (Lofgran et al., 2015) was administered to the students both pre- and postintervention to determine if a change in self-efficacy occurred as a result the intervention. The descriptive statistics of the means, standard deviations, and differences are shown in Table 7. Two studies (Lee, 2014; Calhoon & Fuchs, 2003) used this type of statistical reporting in their research using the PALS (Fuchs et al., 1997) intervention at the secondary level. A limitation of this method is though it is not ideal to take the means of Likert-type scale data, it is a common approach in some educational research (Erdem et al., 2018).

Table 7

Descriptive Statistics of Modified SEQ-C (Lofgran et al., 2015) Items

Items		*Pre-*		*Post*		*Diff.*
		M	*SD*	*M*	*SD*	
I01	How well can you study biology when there are other interesting things to do?	3.00	1.069	3.25	1.035	0.316
I02	How well can you study for a biology test?	2.88	1.246	3.25	.866	0.284
I03	How well do you succeed in finishing all of your biology homework every day?	3.75	.886	3.75	.866	0.500
I04	How well can you pay attention during biology class?	3.63	.916	3.75	.866	0.368
I05	How well do you succeed in passing biology class?	4.00	.756	3.88	.835	-0.383
I06	How well do you succeed in satisfying your parents with your biology schoolwork?	4.13	.991	3.63	.744	-0.115
I07	How well do you succeed in passing a biology test?	3.00	1.069	3.38	.744	0.500

However, using descriptive statistics alone does not show a complete picture of the data. To complete the analysis, individual gain scores were calculated and are reported in Table 8 below. Additionally, a paired sample *t*-test was performed and is shown in Table 9.

Table 8

Individual Gain Scores on the Modified SEQ-C (Lofgran et al., 2015)

Student (pseudonyms)	Pretest Score	Posttest Score	Student Gain Score
Felicia	69%	71%	.06
Stephanie	60%	69%	.23
Lexi	89%	69%	-1.8
Steven	65%	100%	1.0
Tracy	74%	71%	.12
Peter	83%	63%	-1.1
John	63%	66%	.08
Total	Average Gain	Score	-.20

A paired sample *t*-test was used to compare the two scores since the data compared the variable within subjects (see Table 9). The purpose of the *t*-test is to find if there is statistical evidence to have the mean difference of a certain outcome to be significantly different from zero (Gravetter & Wallnau, 2014). The null hypothesis ($H_0 : \mu = 0$) was that no statistically significant difference existed in biology self-efficacy as measured by the modified SEQ-C (Lofgran et al., 2015) scores from pre- to postintervention. The alternative hypothesis ($H_1 : \mu \neq 0$) was that there a statistically significant difference that existed in biology self-efficacy as measured by the modified SEQ-C (Lofgran et al., 2015) scores from pre- to postintervention. The data met the

sphericity of Mauchly's test (*p* = >.05) , meaning that the variances between the pairs of scores are approximately equal and that the probability of a Type II error is reduced (Gravetter & Wallnau, 2014).

Table 9

Modified SEQ-C (Lofgran et al., 2015) Paired Sample t-Test Results

		M (SD)		SEM	95% CI		t	df	Sig. (2-tailed)
SEQ-C Pre SEQ-C Post	7	1.90	1.47	.56	[.55,	3.26]	3.43	6	.014

Note: CI = Confidence Interval.

In the present study, a one-tailed paired samples *t*-test was used as the data was expected to fall in only one direction, or tail, of the normal distribution. The directional hypothesis was that the students' scores of biology self-efficacy would increase from pre- to posttest. A one-tailed paired samples *t*-test revealed that there was a significant difference (*M* = 1.90) in the scores between preintervention (*M* = 3.5, *SD* = .518) and postintervention (*M* = 1.58, *SD* = 1.32) conditions; *t*(6) = 3.43, *p* = ≤ .05. The *t* value and the *p* value were determined by looking at the SPSS (25) output which gave the results for a two-tailed test (see Table 6) and that number was divided by two to obtain the score for a one-tailed test; *t*(6) = 1.72, *p* = ≤ .05. Therefore, the null hypothesis was rejected, as it showed statistical significance *r*(6) = -.103), *p* < .007, but also showed a small negative correlation between the intervention and the self-efficacy as reported by the students.

Biology self-efficacy. This section compared the students' modified SEQ-C (Lofgran et al., 2015) gain scores to their pre- and postintervention reading

comprehension gain scores for alignment between the two factors. Felicia, Stephanie, Steven, Tracy, and John showed between a 24% and 47% gain from their pretest scores. In comparing the pre- and postintervention reading comprehension gain scores with the modified SEQ-C scores (Lofgran et al., 2015), these scores show that two students did not align. Lexi had a 180% decline in her modified SEQ-C (Lofgran et al., 2015) score, while Peter showed a 110% decline in perceived self-efficacy, even though his pre- and postintervention reading comprehension assessment scores show otherwise.

Qualitative Results

Thick description is the first goal of data collection in a formative experiment and is a procedure used by many qualitative researchers (Merriam & Tisdell, 2016; Ravitch & Carl, 2016; Thomas, 2016). The qualitative data sources provided the thick description for this study. Those qualitative sources included student notebooks, focus student interviews, semistructured and informal teacher interviews, as well as the researcher notebook. The purposes of including qualitative data in this study was to document the decision-making process during the formative experiment and to describe the themes and patterns across the teacher, students, and focus student data. The topics of reading comprehension of grade-level biology text and biology self-efficacy were explored for each stance.

General education biology teacher. The teacher interview data consisted of semistructured pre- and postintervention interviews which were transcribed, analyzed, and coded as well as informal interviews recorded in the researcher journal. In analyzing the data from both sources, three categories emerged: formative experiment factors which

enhanced or inhibited the effectiveness, efficiency, and appeal of the intervention in relation to the achievement of the pedagogical goal, as well as comprehension factors, and self-efficacy factors.

Formative experiment factors. One of the questions of the formative experiment framework asks is, "What factors enhance or inhibit the effectiveness, efficiency, and appeal of the intervention in regard to achieving the set pedagogical goal?" (Reinking & Bradley, 2008, p. 75). An additional round of coding was performed on the teacher interviews and researcher notebook entries to look for these particular factors in the data. This question seemed best answered with data from the teacher, as the other types of coding did not seem to fit with the teacher data.

Enhancing factors: In the first informal teacher interview, Mrs. Jones reported observing some students helping each other with vocabulary words and having on-task interaction with the text as a factor that enhanced the intervention during the PALS (Fuchs et al., 1997) intervention.

Another enhancing factor related by Mrs. Jones in the postintervention interview was that some students were "better able to answer questions when randomly called on as we went through the semester, from the beginning of the semester until towards the end" of the intervention. During the baseline phase before the intervention the reluctance of the students to answer questions in class was observed, even when called upon.

However, the primary appeal for the students that enhanced the intervention and was a positive factor in reaching the pedagogical goal were the incentives that the students had an opportunity to earn. Students had opportunities to earn candy, soda or chips each month, or save their PALS dollars (Fuchs Research Group, 2019) to earn a gift

card from a chosen retailer at the end of the intervention. The incentives were conveyed as an enhancing factor in both the teacher and the focus student interviews. Until the first incentives were awarded, many students were skeptical, but after the first incentives were delivered at the end of the first month, Mrs. Jones reported that the students knew "they're legit." One student reported that "the prizes are just an added bonus."

Inhibiting factors. One inhibiting factor from the perspective of Mrs. Jones recorded in the postintervention interview was that the students were "uncomfortable with the reading; that it makes them apprehensive or shy or embarrassed maybe, about them having to read out loud in front of a peer," which was coded as uncomfortable in the Emotion Coding (Saldaña, 2016) scheme. This factor could have inhibited the movement toward the pedagogical goal with the students not having a complete buy-in at the beginning of the intervention, but with some students, this factor persisted throughout the intervention. Mrs. Jones stated in the postintervention interview that she observed that the class was "a really, really, quiet class, so you don't get a lot of volunteering…there's just some students that were still having a hard time getting it."

Another factor that Mrs. Jones reported related to inhibiting the efficiency of the PALS (Fuchs et al., 1997) intervention was the protracted way in which the PALS (Fuchs Research Group, 2019) training took place, which was coded as frustration. During Mrs. Jones's observations and reported over the course of several informal teacher interviews, she wished that there was "a succinct way of, like, training them." She felt that training could have happened at the start of the school year and not six weeks into the semester due to the time constraint.

In addition, it was observed that the PALS (Fuchs Research Group, 2019) training

lessons were not designed for a traditional secondary classroom. Mrs. Jones reported in the first semistructured interview that she thought that the training lessons should be more like "an on-the-job training" and to have the lessons taught "as they're doing it, instead of doing the notes."

Comprehension factors. During the interview after the first unit, Mrs. Jones stated that some students' knowledge appeared to be increasing as they asked for help with unfamiliar vocabulary words and concepts during the PALS (Fuchs et al., 1997) readings, but she noted that some students did not "put in a whole lot of effort" into the dyad readings, and that some of the partners "weren't in tune enough to be able to provide any correction or guidance, with anything…so that is kind of frustrating."

Her observation was that the on-task interaction of the students increased as well as their interaction with the text by the end of the intervention. Mrs. Jones observed that some scores went up for the first unit test past baseline which she attributed to the additional reading with the PALS (Fuchs et al., 1997) intervention, though some individual student scores went down during this time.

In the final interview, Mrs. Jones saw an increase of students interacting with each other and with the text which she thought resulted in some increase in the reading comprehension of grade-level biology text due to the score increases. She also reported that, "I feel like those kids who really could use that push, got that push with the PALS" (Fuchs et al., 1997).

Self-efficacy factors. In the postintervention semistructured interview, the focus student interviews, as well as the researcher notebook, the theme that emerged was a dichotomy in student perception. Some students reported that the intervention gave them

confidence. With those students, Mrs. Jones' perception was that PALS (Fuchs et al., 1997) improved in the students' ability to be "more comfortable with it (the intervention) and felt probably safer, in being able to ask those questions and that help and that guidance from their peers." Mrs. Jones also stated that she was "really impressed with their questions," and their answers to questions that she asked in class of them regarding the material.

However, other students reported in their student notebooks that they did not like the intervention, and their biology self-efficacy was "the same" or they didn't feel that they had "gained or lost any confidence from the activities." Mrs. Jones reported in the final semistructured teacher interview that her perception was that some students did not like having "the responsibility placed on them…to actually go through the behaviors of learning," and not being "spoon-fed" the content to them due to the nature of the PALS (Fuchs Research Group, 2019) activities.

Focus students. Out of the seven students, two students were chosen to participate in pre- and postintervention focus student interviews. The student with LD who scored the highest on the state language arts assessment the prior year was chosen as Focus Student 1, and the student who scored the lowest on the assessment was chosen as Focus Student 2. There were two students with the lowest test score on the state language arts assessment. Initially, the female with the lowest test score was chosen since Focus Student 1 was a male. However, the original Focus Student 2 had multiple absences and missed more than the 25% of the intervention. This attendance rate of 75% was chosen as the cutoff for final participation in the study. Therefore, Focus Student 2 was replaced with an alternate, so the preintervention interview for that student is missing. The focus students were given pseudonyms to help

protect their privacy and both were male.

Analysis of the data began with Emotion Coding (Saldaña, 2016) of the pre- and postintervention focus student interviews, and their student notebook entries. Emotions regarding how well the focus students thought they could read and comprehend grade-level biology text and how they perceived their biology self-efficacy were coded from the text of the focus student interviews pre- and postintervention, and their student notebook entries. The overall themes from the data were presented. The In Vivo Coding (Saldaña, 2016) provided the quotes from the interviews to support the qualitative themes. Similarities and differences between the focus students were also discussed.

Focus student 1 (John). John, a sophomore, has an educational diagnosis of Autism Spectrum Disorder and received services for a learning disability in the area of reading comprehension. John's father is deceased, and he lives with his mother and stepfather in a middle-class neighborhood within the school boundaries. There is a perception that students with Autism Spectrum Disorder do not understand humor, but that is not accurate. John has a dry sense of humor and was also very particular about getting the correct answers on his work and would ask many questions to ensure he had the right answer. He scored the highest on the state language arts test the previous year out of the group of students with learning disabilities in this inclusion biology class. John was paired for the PALS (Fuchs et al., 1997) intervention with the general education student with the highest score on the state language arts test the previous year, patterned after the study of Fuchs, Fuchs, and Burrish (2000). This dyad was a workable match and the general education student was able to interact at John's level and answer the many questions that he had.

Reading comprehension of grade-level biology text. At the beginning of the intervention, John reported in his student notebook that he did not "experience any problems reading," which was coded as confidence. For John, the emotions coded postintervention included engagement as he stated in his interview that biology was a "fun experience" and "very intriguing." He reported being better able to know "exactly what to read and what to look for" as a result of the intervention. The longitudinal analysis of the data for John showed that since the intervention it was easier for him to pay attention and he understood better what to read and what to look for in the grade-level biology texts for the PALS (Fuchs Research Group, 2019) readings. Finally, John stated in his notebook that he did not think his reading comprehension of grade-level biology text had increased or decreased, but his gain scores showed a severe decline of -120% from his pre- to postintervention reading comprehension assessment. In both his pre- and postintervention focus student interviews, John stated that he would earn a "B" in the biology class, which was the grade that he earned for the semester.

Biology self-efficacy. Emotions coded at preintervention for John were of confidence, desire, and an expectation he would do well. Fear was also noted by John in the preintervention interview who reported that they had to do well in the class, "because if I don't do pretty well, then my mother will have my head." At the final interview, John reported that he did not think he experienced any change in biology self-efficacy and his scores on the modified SEQ-C (Lofgran et al., 2015) correlated with that self-report. The pattern was observed in the data was that John had a very accurate perception of his biology self-efficacy.

Focus student 2 (Peter). Klassen (2008) stated that some students with LD possess a high degree of self-efficacy which matches their performance, while other students do not. The most evidence of the latter in Focus Student 2, Peter. Peter was the alternate focus student but was not able to participate in a preintervention interview as another student was the original Focus Student 2. Also a sophomore, Peter was quiet at times but was very social with the right peers. He had diagnosed learning disabilities in reading, writing, and struggled with executive functioning, which impacted his self-advocacy skills and his ability to turn in assignments on-time. Last year, Peter attended a small charter school in the area and his parents made the decision to place him with his older sister in the public school where the present study took place during the 2019-2020 school year. Peter lived with his parents and his older sister in an upper-class neighborhood near the school.

Reading comprehension of grade-level biology text. Preintervention, Peter stated in his student notebook that he did not really experience problems reading grade-level biology text and had the confidence to do well in the biology class, although the data from his state ELA scores, preintervention assessment scores, and IEP data showed otherwise.

Peter stated in his postintervention focus student interview that it was easier to pay attention after PALS (Fuchs et al., 1997) because he "was getting more information out of the textbook reading" by reading in pairs. In addition, his scores for the unit tests were idiosyncratic, with an increase of almost 10% from baseline to Unit 2, a 5% increase from Unit 2 to Unit 3, and then a sharp decrease of 30% from Unit 3 to Unit 4,

and it was after that test that he reported boredom in his postintervention interview. Yet, overall, he showed a gain score of 37% on his pre- and postintervention reading comprehension assessments.

One factor that could have contributed to the boredom and sharp decrease in scores from Unit 3 to Unit 4 scores was that Peter had just returned from a week-long trip to see a college football team playoff, so he missed a week of school and was only a few weeks away from a tropical vacation with his family during the semester break, which was a frequent topic of conversation for Peter. Another factor that was recorded in the researcher notebook was that Peter's partner was absent a lot, so that led to Peter being paired with other students and not having a consistent partner could have influenced his test scores.

Biology self-efficacy. In his preintervention student notebook entry, Peter stated that he had confidence in his ability to do well in biology class. However, his gain scores on the modified SEQ-C (Lofgran et al., 2015) did not report the same outcome as his student notebook data. The modified SEQ-C (Lofgran et al., 2015) items preintervention were all marked as "pretty well" with one score of "very well," whereas postintervention, the scores for the modified SEQ-C (Lofgran et al., 2015) items dropped on six out of the seven items from "pretty well" to "somewhat well," indicating a drop in his self-efficacy scores on most items, and his gain scores dropped 110% from pre- to postintervention.

The primary emotion that was coded postintervention with Peter was boredom as recorded in his postintervention student notebook entry. He stated that the intervention "was boring and a waste of time" and that it "didn't help as much as I thought it would." Peter also reported in his postintervention focus student interview that he was "not really

like a science person, you know" and wanted to major in business in college.

A negative outcome for Peter was that he did not have the same partner for the PALS (Fuchs et al., 1997) readings as his partner was one of two students who were dropped from this study for attendance issues. As a result, Peter was paired with several students whose partners were also missing that day. Due to his partner's excessive absences, Peter may have failed to develop the relationship with his PALS (Fuchs et al., 1997) partner the way the other students did. However, Peter did report in his postintervention that he did enjoy meeting new people, but that was the only thing he enjoyed about the intervention. Not having a consistent partner for the PALS (Fuchs et al., 1997) intervention could have been a factor in Peter's perception reported in his student notebook that the intervention did not help him as much as he thought it would, as well as his report in the postintervention focus student interview of him perceiving the intervention as "boring and a waste of time."

The theme that emerged from Peter's data was one of inflated confidence in his abilities. In his postintervention focus student interview he also stated that he received a better grade on tests and thought that he would do better in the class as a result of the PALS (Fuchs et al., 1997) intervention. He reported that he would earn a high "B" or low "A" in the biology class, which again showed an overconfidence in his abilities, as he earned a final grade of a "C" for the semester.

Focus student similarities and differences. Both students predicted they would do well in biology during the fall semester as a result of PALS (Fuchs et al., 1997). John and Peter both related that they would get a "B" and Peter thought he might earn a low "A." Both liked biology initially, but only John continued to like biology class by the

end of the semester.

Neither John nor Peter were accurate in their self-assessment of their reading comprehension of grade-level biology text. John showed a -120% decline from pre- to postintervention. Peter reported that he didn't see much improvement in his reading comprehension of grade-level biology text, but his scores increased by 37%. However, John was accurate in his predictions about his biology self-efficacy, whereas Peter was not, and he showed an overconfidence in his abilities in those areas. In addition, John reported that biology was a "fun experience" whereas Peter found it "extremely boring." John also did not have problems with written expression like Peter, and this was very evident in the differences in their written responses in their student notebooks. John wrote several sentences for each answer, while Peter wrote one- or two-word responses.

Another variable that could have influenced John's positive self-efficacy was his enrollment in Advancement via Individual Determination (AVID) elective courses which taught study skills to students to help prepare them for college. This program was offered in the Timberland Public School District and it taught soft skills to support average students whose parents did not attend college to achieve increased success in their high school and postsecondary education. As Peter's father was a college graduate, he was not eligible for these courses.

Summary

Analysis of the results shows that despite the small sample size, significance was reached with the results of the quantitative data from the pre- and postintervention

reading comprehension assessments. The scores from the Unit 2 to Unit 3 reading comprehension assessment reached significance ($p = .043$) and a small effect size was found using the pairwise comparison data for the baseline to Unit 4 reading comprehension scores on unit tests ($d = 0.44$) . The data suggest that the PALS (Fuchs et al., 1997) intervention can have a positive effect on the reading comprehension of grade-level biology text. Scores for the modified SEQ-C (Lofgran et al., 2015) also showed significance for the student scores from pre- to-postintervention, though there was a small negative correlation, $r(6) = -.103$), $p < .007$.

The qualitative data of the focus student interviews, formal and informal teacher interviews, and the researcher notebook provided a triangulation of the data. This data also showed that there was a dichotomy among the perspective of Mrs. Jones and the students, with some students reporting that the intervention helped their reading comprehension of grade-level biology text or their biology self-efficacy and others who did not. These results showed that most students' scores were not aligned with their perceptions of their abilities to comprehend grade-level biology text or of their biology self-efficacy. However, these results should be interpreted with caution due to the short duration of the present study (12 weeks) and small sample size ($n = 7$).

CHAPTER 5

DISCUSSION AND CONCLUSIONS

The beginning of this chapter provides a review of the present study, a discussion of the major findings which include changes to the intervention, and the summary of progress toward the pedagogical goal regarding the factors of reading comprehension of grade-level biology text and biology self-efficacy. For each factor, the study's quantitative, qualitative, and integrative results are discussed. The implications for both theory and practice of the factors of the formative experiment are included in this section.

Review of the Study

The purpose of the study was to examine the influence of PALS (Fuchs et al., 1997) on the reading comprehension of grade-level biology text and biology self-efficacy on students with LD in an inclusion biology classroom. The effectiveness of this intervention had not been studied before in an inclusion biology classroom.

Previous research showed that since reading problems persist past the elementary school years, evidence-based interventions are also necessary for secondary students to make progress (Wexler et al., 2015). Despite the implementation and study of many programs to remediate students' reading, little progress has been shown in the literature to increase reading comprehension in students with LD, especially at the secondary level (Wexler et al., 2015).

PALS (Fuchs et al., 1997) was chosen for this study as it is a research-based

intervention which is grounded in the sociocultural perspective (Wertsch, 1985, 1991) and Vygotsky's (1978) Zone of Proximal Development. PALS (Fuchs et al., 1997) is a cultural tool which utilizes more capable peers to promote greater reading ability among those peers who struggle with reading. Even though the PALS (Fuchs et al., 1997) intervention has been studied extensively for over 20 years, there were very few studies conducted with PALS and secondary students with LD (Breece, 2012; Calhoon & Fuchs, 2003; Fuchs, et al., 1999; Fuchs et al., 2001; Sprörer & Brunstein, 2009; Thorius & Graff, 2018), and no studies with PALS in a high school science classroom setting. However, Fuchs et al. (1999) found that even though secondary students with serious reading problems may be exceptionally difficult to remediate, there were some positive effects of PALS (Fuchs et al., 1997) on their reading performance.

The present study looked at the factors of reading comprehension of grade-level biology text and biology self-efficacy through the lens of a formative experiment (Reinking & Bradley, 2008). The formative experiment framework is grounded in pragmatism (Dewey, 1916) which lends itself to research methodologies which focus on shortening the timeline from research to practice (Johnson & Onwuegbuzie, 2004) so that what is useful to practitioners can be implemented in classrooms sooner than is typical for the field (Reinking & Bradley, 2008). The formative experiment framework also views the study from many perspectives and justifies the use of mixed methods, which provides richer data.

The self-efficacy piece of the study was informed by Bandura's (1986) Social Cognitive Theory. His theory recognizes the relationships "between the three major classes of determinants in triadic reciprocal causation" (Bandura, 1986, p. 6): behavior,

internal personal factors, and the external environment, which affect each other in varying amounts depending on the situation and then those determinants influence outcome expectancies. Bandura's (1986) research contends that peer models raise "students' beliefs in their efficacy for learning, for the subject matter, and their actual achievement" (p. 234). Thorius and Graff's (2018) study showed that students with LD in classrooms where PALS (Fuchs et al., 1997) was used were viewed as having the same social standing as their typically-developing peers, which extends Bandura's (1986) theory. However, Klassen (2006, 2008) reports in the literature that students with LD tend to overestimate their performance on reading tasks, and thus their self-efficacy. This overestimation of performance can lead to lower self-efficacy and performance over time, which can contribute to the Matthew Effect (Stanovich, 1986).

The factors of reading comprehension of grade-level biology text and biology self-efficacy have been shown in previous research to have the potential to positively influence student outcomes. The present study was designed to fill a gap in the research to examine how PALS (Fuchs et al., 1997) could influence the reading comprehension of grade-level biology text and biology self-efficacy in students with LD in an inclusion biology classroom. The formative experiment framework used a convergent, parallel, mixed design in a classroom setting to understand the influence of the PALS (Fuchs et al., 1997) intervention on these factors.

After gathering baseline data, the PALS (Fuchs et al., 1997) intervention was implemented for 12 weeks with 9 dyads, but the data from only seven LD students in the inclusion biology classroom who participated in the study were used. During the study quantitative data was collected in the form of pre- and postintervention reading

comprehension assessments, unit reading comprehension assessments, and the pre- and postintervention modified SEQ-C (Lofgran et al., 2015) from the students to compare their performance on comprehending grade-level biology text and biology self-efficacy before, during and after the PALS (Fuchs et al., 1997) intervention. The qualitative data collected was in the form of student notebook entries, focus student interviews, formal and informal teacher interviews, and the researcher notebook to provide triangulation of the data.

Discussion of Major Findings

Changes During the Formative Experiment

Changes are inherent in the nature of formative experiments as the data are recursively examined. The basis of a formative experiment rests on one of the questions from the formative experiment framework (Reinking & Bradley, 2008), which asks "(h)ow can the intervention be modified to achieve the pedagogical goal more effectively and efficiently and in a way that is appealing and engaging to all stakeholders?" (p. 76). Documenting the factors that led to adaptations of the intervention and their effectiveness to achieve movement toward the pedagogical goal were made in an iterative cycle throughout the intervention during informal discussions with the general education biology teacher, Mrs. Jones.

Informal discussions with Mrs. Jones occurred almost daily and were documented in the researcher notebook. The role of these informal teacher interviews in a formative experiment provide opportunities for teacher input on the intervention, to discuss

modifications that could move the intervention toward the pedagogical goal, and to review the goals and objectives of the intervention strategies (Reinking & Bradley, 2008). During these discussions, the data from the researcher notebook (including observations of student behavior) and test scores were used to determine what factors enhanced or inhibited the intervention's effectiveness and made changes accordingly. These discussions and the documentation of changes show our interpretation of the effects of the instructional moves that were made to enhance the intervention, which satisfies another goal in the formative experiment framework (Reinking & Bradley, 2008). As with many formative experiments, most of the changes that occurred were at the beginning of the intervention. A summary of the changes to the formative experiment is presented in Table 10 and a discussion of the results of this study follows.

Table 10

Formative Experiment Changes

Time Period	Original Design	Modification(s)
Baseline to Unit 2	6 Lessons	4 half days preintervention, 1 at the end of Unit 2
	Lesson 5 and 6 taught next	Lesson 5 was moved to the end of Unit 2, Lesson 6 incorporated into all the lessons
	12 half days preintervention	5 Lessons, 4 preintervention
	Lesson presentations 1-4 occurred gradually over 7 weeks	Lesson presentations 1-4 occurred within the first week
	Lesson materials looked out-of-date	Lesson materials were re-typed and reproduced
	Visual presentations were to be delivered in a document camera format	Visual presentations were reproduced and delivered in a PowerPoint format and the keys were available on Canvas
	Lesson passages were all narrative text	Lesson passages were changed to informational text
	Lesson quizzes not specified to be counted as grades	Lesson quizzes were counted as grades
	Incentives were donations from area businesses	Incentives were purchased
	No notes on quizzes	Use of notes on quizzes
	Prediction Relay was used in the intervention	Prediction relay did not work
Unit 2 to Unit 3	No passage type specified	Use of biology textbook or biology websites
	Partners changed every week	Partners remained the same throughout the intervention
	Student notebooks not part of the intervention	Student notebook entries only pre- and postintervention
Unit 3 to Unit 4	Number of readings not specified	Planning showed only 8 readings; added two more

Baseline (unit 1) to unit 2. The day after the present study was approved, a meeting was held with Mrs. Jones to plan the PALS (Fuchs Research Group, 2019) training lessons. Details of this meeting were recorded in the researcher notebook. Below are descriptions of the training lessons and documented changes made to the intervention from implementation after the baseline (Unit 1 to Unit 2) based on these records.

PALS (Fuchs Research Group, 2019) training lessons. The PALS (Fuchs Research Group, 2019) training lessons in the manual are: Lesson 1: Learning About PALS (Fuchs Research Group, 2019), Lesson 2: Partner Reading, Lesson 3: Paragraph Shrinking, Lesson 4: Prediction Relay, Lesson 5: Check Writing, and Lesson 6: Reading for Information. Lessons 1 through 4 were required before the intervention started as their content covered the overall procedures for the intervention and the reading activities. Lessons 2 through 4 had students practice the three reading activities during the baseline phase. The scripted training lessons are in a guided notes format and there are quizzes at the end of each lesson, which was consistent with the way Mrs. Jones presented materials to her classes. The goal of the training lessons was to ensure students understood how to participate in the PALS (Fuchs et al., 1997) reading activities of Partner Reading, Paragraph Shrinking, and Prediction Relay.

Number of lessons modified. One of the first decisions made in the formative experiment was to reduce the number of training lessons from six to five during the baseline unit. This decision was made due to the amount of class time the PALS (Fuchs Research Group, 2019) training lessons would take since the intervention began six weeks after the semester started. This decision was in line with the PALS (Fuchs

Research Group, 2019) protocol, as Lesson 6 was outlined as a discretionary lesson. Lesson 6, Reading for Information, deals with reading informational text, and since that was the only type text used in the biology class, the decision was made to embed that content in the other training lessons where it seemed appropriate. This decision had a neutral effect, since the topic of the Reading for Information lesson was embedded in the other training lessons, so the students were not aware of the reduced number of lessons.

Changes in lesson presentation. The decision was also made during this meeting to delay Lesson 5, Check Writing, until the end of October when the students would be writing checks for the incentives they earned during the first data cycle of the intervention. If Lesson 5 was presented after Lessons 1 through 4, the information for the check writing lesson would need to be retaught since the first incentive check writing experience would not occur until six weeks after the intervention began. Since students with LD are known to often have working memory and short-term memory issues (Swanson & Zheng, 2013) , this change seemed a more logical way to present the check writing lesson information, instead of frontloading it at the beginning of the baseline phase of the intervention. The topic of check writing was mentioned briefly in Lesson 1, during the overview of the intervention, and then taught during the actual intervention when it was needed.

Training days modified. Another decision made during that meeting was that the remaining four PALS (Fuchs Research Group, 2019) training lessons were taught for 8 days, during the first half of the class periods. These training sessions lasted for half the class period, or approximately 25 minutes, which was the same amount of time that the PALS (Fuchs Research Group, 2019) manual prescribed. During the baseline unit, one

PALS (Fuchs Research Group, 2019) lesson was presented each day, and the corresponding quiz given the next day. As a result of the modifications, the training sessions were changed to four days for half of the class period for the first four PALS (Fuchs Research Group, 2019) training lessons, with the quiz given directly after the lesson. This reduced the impact that the PALS (Fuchs Research Group, 2019) training had on the regular lesson delivery schedule. However, this modified training schedule did not allow for information to be repeated or taught at a slower pace, which would have been helpful to some of the students. It was necessary to repeat the directions for the reading activities several times individually to a few students.

Timing of lesson presentation: The PALS for High School (Fuchs Research Group, 2019) manual outlined an implementation schedule with an overview of the procedures, the training lessons, and the Partner Reading activity to be presented during the first two weeks of the intervention. The Paragraph Shrinking activity was supposed to be implemented in weeks three through five, with the final activity, Prediction Relay, being introduced in week seven, then all three activities being used with the PALS (Fuchs et al., 1997) readings from weeks seven until the end of the semester. Due to the abbreviated length of the intervention, the recommended implementation schedule in PALS manual (Fuchs Research Group, 2019) for the Partner Reading, Paragraph Shrinking, and Prediction Relay reading activities could not be used.

Since this implementation schedule was not workable, the training lessons were presented in order during the first four days of the training. The introductory lesson was given on day one, and the first activity in the PALS (Fuchs Research Group, 2019) intervention, Partner Reading, was presented on the second day of training. During the

third training day, students practiced Partner Reading and then the second reading activity, Paragraph Shrinking was implemented. Both reading activities were practiced on that day. Finally, on the fourth day of training, Prediction Relay was introduced and practiced after the students practiced the first two reading activities. Discussed later in this section is a problem that occurred on the fourth day of training with the implementation of the Prediction Relay reading activity. The effect of this change was not as detrimental as predicted in the researcher notebook. The students were observed acting relieved that they would not be practicing the individual activities for several weeks at a time and had the opportunity to earn points for participating in the intervention.

PALS (Fuchs Research Group, 2019) training lesson materials. The training lesson materials were included in an implementation manual and model lessons provided on an accompanying CD. Upon inspection, these materials had not actually been updated in many years, despite the new copyright date. The manual's cover and binding were new, but the same training lessons from the original edition were copied and placed into a new cover while the original materials recorded on videocassette were burned onto a CD.

Reproducible materials updated. When looking at the PALS (Fuchs Research Group, 2019) manual during the first meeting, the reproducible materials for the training lessons were in an outdated font, the materials were not correctly centered on the page, and the masters provided had evidence of a disintegration of text quality from being copied multiple times. At the conclusion of that meeting, it was decided that the guided notes and quizzes from the PALS for High School Manual (Fuchs Research Group, 2019) needed to be re-typed into a more modern font that the students were used to materials

being presented in to ensure that the materials did not detract from participation in the intervention's training lessons.

Visual presentations updated. Another decision made at that meeting was to update the visual presentations to help the students to fill out the guided notes that were part of the PALS (Fuchs Research Group, 2019) training lessons. The original presentations were overhead presentations, and overhead projectors or document cameras were no longer available at DSHS. In the updated format, the lesson materials were projected on the whiteboard from the computer, and the blanks for the guided notes on the white board were filled out by the researcher while the students filled out their own copies at their desk as the lesson progressed. The keys to the visual presentations were also placed on the class website on Canvas, the learning management system used at DSHS, to help students who needed more time to complete the guided notes or who were absent. The goal of the training lessons was to ensure the students understood how to participate in the PALS (Fuchs Research Group, 2019) reading activities of Partner Reading, Paragraph Shrinking, and Prediction Relay. This change was helpful as the students who were absent or needed more time were able to access the visual presentations and complete their work instead of just taking a lower score for not completing the work.

Lesson passages. Next, a decision was made to replace the narrative PALS (Fuchs Research Group, 2019) lesson passages used for the training lessons with a biology passage that students needed to read during the days the PALS (Fuchs Research Group, 2019) training lessons were presented. This decision was based on the fact that the PALS (Fuchs Research Group, 2019) intervention was used primarily in a special

education reading class in the previous high school research (Breece, 2012; Calhoon & Fuchs, 2003; Fuchs et al., 2001; Sprörer & Brunstein, 2009), where both narrative and expository texts were presented. A decision was made that students would read the same passage to practice the three PALS (Fuchs Research Group, 2019) activities on the three days of training for Lessons 2, 3, and 4. The effects of this change were helpful for the students as they had practice with the text as a review for the upcoming Unit 2 test.

PALS (Fuchs et al., 1997) training lesson assessments. In order to demonstrate learning when using reading activities in the PALS (Fuchs Research Group, 2019) training lessons, a quiz was administered after each training lesson per the PALS (Fuchs Research Group, 2019) protocol. These quizzes consisted of fill-in-the blank items which assessed students' knowledge of key concepts covered during the training lessons. The students were allowed to use their guided notes on the lesson quizzes, since the goal of the training lessons was to ensure students understood the PALS (Fuchs Research Group, 2019) reading activities and how to implement them with the grade-level biology text. This practice was also consistent with Mrs. Jones' test-taking format, but quiz-taking protocols were not specifically covered in the PALS for High School (Fuchs Research Group, 2019) manual. To help ensure full participation in the training activities, the decision was made to have the guided notes and the lesson quizzes from the training lessons count as grades in the gradebook.

PALS (Fuchs Research Group, 2019) reading activity modification. According to the PALS for High School Students (Fuchs Research Group, 2019) manual, the students each read for the required five minutes during the first training activity, Partner Reading, and then spent two minutes each with the retell portion of the activity. Next,

each student read the subsequent paragraphs in the biology passage (a modification for our training) and told their partner a synopsis of the paragraph in 10 words or less for the Paragraph Shrinking activity. In the directions for using the third activity, Prediction Relay, with informational text, the teacher tells the students to make a prediction about "what they'll talk about next in the article" (p. 102), instead of what will happen next in a narrative text. However, the students were usually finished with the assigned passage during the training lessons after they completed the first PALS (Fuchs Research Group, 2019) activity, Partner Reading.

After seeing this trend, an informal interview was conducted once the training lessons were completed. Two decisions were made at this time based on the observations of most of the students finishing the passages before they were able to reach the Prediction Relay activity. One decision that was made was to have the students re-read the assigned biology passage and then apply the principles of Paragraph Shrinking to the same passage they read for Partner Reading. Another decision that came from that meeting was that the third PALS (Fuchs Research Group, 2019) activity, Prediction Relay, did not work in the present study and would not be used. This was due to both the brevity of the passages that were found on the topics covered in the biology units and that there was very little prediction needed for the biology passages that the students read.

Unit 2 to unit 3. Four changes were made during this timepoint. Changes were made to the types of passages used for the PALS (Fuchs et al., 1997) readings, not switching partners during the intervention, incentives, and the number of entries required in the student notebooks.

Passage type. As a result of another informal teacher interview, an additional change made during this stage of the formative experiment was to the types of passages used for the PALS (Fuchs et al., 1997) readings. Any type of passage can be used for the PALS (Fuchs et al., 1997) readings. Up to this point, the district biology text was used to obtain the material for the PALS (Fuchs et al., 1997) readings. We discovered that the biology text contained outdated material needed for Unit 2. As a result of this discussion, the decision was made to use either the biology textbook or text from a department-approved website (www.ck12.org) for future PALS (Fuchs et al., 1997) readings.

Partners during PALS (Fuchs et al., 1997). Additionally, the PALS (Fuchs et al., 1997) intervention had the students change partners on a regular basis throughout the intervention. This only worked when the types of students have similar scores on their state English Language Arts test. The decision was made in one of the informal teacher interviews documented in the researcher notebook to not change partners due to the small number of students in this study. More importantly, the criteria of pairing the students based on their state Language Arts test scores could not be maintained like the study conducted by Fuchs et al., (2000). This decision also allowed for less variability in the data due to the influence of different partners. The observed impact of this decision was that Mrs. Jones reported that the students' comfort level with each other had increased and they were able "to interact on-task, with the text and with each other" more than they were during the baseline Unit (Unit 1).

However, there were some students who did not get along well with their partners and needed extra prompting to participate in the PALS (Fuchs et al., 1997) activities. Those students typically did not like to participate in any classroom activities, so this was

not a behavior specific to the intervention. The other students were observed to have a good working relationship with their partners, even though most were not observed interacting outside of the PALS (Fuchs et al., 1997) intervention.

Student notebooks. Another change documented in the researcher notebook was the decision that was made for students not to provide a journal entry each week. When coding the first entries from the student notebooks, it was observed that the student entries were very short. A meeting was set up with Mrs. Jones that afternoon to look at the data. As a result of that meeting, a decision was made to collect data only at the beginning and end of the intervention to match the number of times data was collected from the pre- and postintervention reading assessments, the focus student interviews, as well as the administration schedule of the modified SEQ-C (Lofgran et al., 2015). The concern was that requiring weekly entries in their student notebooks would result in lack of participation on the part of the students, and consequently, a lack of useable data for the present study. As the basis for this decision, Lee (2014) worked with elementary students and journaling every week worked in their study, but secondary students (especially those with LD) often have difficulty writing (Cook & Bennett, 2014), so this particular method of data collection was not effective with this sample of secondary students with LD.

Unit 3 to unit 4. According to the last informal teacher interview recorded in the researcher notebook, only one decision was made to modify the intervention during this timepoint. When planning for the last two sub-themes (units) of the Data Storyline, "How does a seed become a tree?" (NGSS, 2013), there were only two short readings available on the district-approved website. The decision was made to have the students

re-read the last two PALS (Fuchs et al., 1997) passages as a review, leading to a total of ten reading opportunities.

Mrs. Jones reported after observing the students participating in the PALS (Fuchs Research Group, 2019) training lessons that she thought it was "a good tool" and "that is has a benefit, for sure…in a high school science class." Mrs. Jones was open to using PALS (Fuchs Research Group, 2019) during another semester if the training lessons were modified to have the PALS (Fuchs Research Group, 2019) lessons to include "hands-on training, maybe, instead of doing all the notes" or quizzes that the manual suggests.

Summary of Progress Toward Pedagogical Goals

Formative experiments, by their very nature, attempt to connect theory to practice by "discovering workable instruction and relevant theory in the real world" (Reinking & Bradley, 2008, p. 8). The pedagogical goal for the present study was to increase the reading comprehension of grade-level biology text and biology self-efficacy using the PALS (Fuchs et al., 1997) intervention. The two factors of this pedagogical goal are examined with respect to the quantitative, qualitative, and integrated results.

The present study connected theory to practice for both factors by examining not only the quantitative results but using the qualitative results to tell the story of the data. The ways that the conditions of this study informed both theory and practice as they emerged from this study are discussed in this section. This analysis is important to have researchers understand the theoretical and philosophical underpinnings of the study as well as giving practical consideration for classroom teachers. In addition, understanding

the theory behind the practice is becoming more important for educators as they grapple with a myriad of instructional choices to increase skill and engagement in the classroom.

Reading comprehension of grade-level biology text. Reading comprehension of grade-level science text is problematic in students with LD (Bakken et al., 1997; Therrien et al., 2011). The PALS (Fuchs et al., 1997) intervention has been shown to mitigate comprehension problems in secondary students with LD (Breece, 2012; Calhoon & Fuchs, 2003; Fuchs, et al., 1999; Fuchs et al., 2001; Sprörer & Brunstein, 2009; Thorius & Graff, 2018). The results for the quantitative, qualitative, and integrative assessments are discussed in this section.

Discussion of quantitative results. The quantitative measures administered in the study were the pre- and postintervention reading comprehension assessments as well as unit reading comprehension assessments. These measures of reading comprehension of grade-level biology text provided a generalized overview of student performance before and after the PALS (Fuchs et al., 1997) intervention as well as during three timepoints in the intervention.

Pre- and postintervention reading comprehension assessments. Measures of reading comprehension were developed that were patterned after the Fuchs et al. (1999) study which used two 400-word passages that were administered both pre- and postintervention. Individual gain scores were calculated (see Table 6), but data from only six students were used for this analysis since one student missed the day the preintervention reading comprehension was administered but was present for the rest of the intervention. Five out of the six remaining students showed gains (26%-47%) and one student showed a -120% decline in scores.

In examining the data, the results of this part of the study could have been influenced by John, Focus Student 1, who was diagnosed with autism. John showed the steepest decline in pre- and postintervention reading comprehension assessment scores. However, he obtained a mid-to-high score on the English Language Arts section of the state reading test. His score on the state reading test showed that he is competent in his reading comprehension skills. But, when the postintervention assessment was administered, it was noted in the researcher notebook that John appeared to be fixated on something else other else other than the assessment. Thus, this behavior could have affected his score on the postintervention reading comprehension assessment.

Further analysis of the data was conducted using a single sample *t*-test (Gravetter & Wallnau, 2014) to compare the sample mean to a population mean when the population standard deviation is not known ("The One Sample T-Test", 2019). Despite the small sample size and the outlier data, the results calculated from the pre- and postintervention reading comprehension assessments were statistically significant, $t(6) = 2.67$, $p = .043$, 95% CI [.330, 13.70], $d = 1.10$. A statistically significant result in this comparison of pre- and postintervention reading comprehension scores shows that PALS (Fuchs et al., 1997) appeared to have value in increasing the reading comprehension scores of grade-level biology text in students with LD in an inclusion biology classroom.

Unit reading comprehension assessments. The present study's omnibus ANOVA almost reached significance, which was important to note with a sample size of only seven ($p = .080$). Three pairwise comparisons were conducted after the repeated measures ANOVA on the unit reading comprehension assessments. The second pairwise comparison (between Unit 2 and Unit 3) reached significance ($p = .043$).

These quantitative results could have been influenced by several factors. One possible factor could be that there was an outlier score for this sample, which could have influenced the final results. Another possible explanation for the increase in significance from only one pairwise comparison was that there was an additional reading during Unit 2 to Unit 3 than during any of the other timepoints. Also, for the remaining two timepoints (Unit 3 and Unit 4), there were two breaks: a one-week fall break and a three-day Thanksgiving Break, which could have also influenced the scores, since short-term memory is a factor that can negatively impact students with LD (Swanson & Sheng, 2013). The unfamiliar topics of cellular respiration and cellular reproduction were covered in Units 3 and 4 and those topics had the shortest PALS (Fuchs et al., 1997) readings for each topic, which could have also contributed to the lower scores.

The quantitative analysis confirms previous research which shows PALS (Fuchs et al., 1997) as an intervention that can produce positive results in students with LD. In this study, the intervention transformed the learning environment by using the PALS (Fuchs et al., 1997) activities to "explicitly and systematically teach them the secrets of learning—the strategies that produce success" (Margolis & McCabe, 2003, p. 164). In addition, the study extends the previous research by obtaining statistically significant results in increasing reading comprehension using the PALS (Fuchs et al., 1997) intervention in an inclusion biology class. These results also support the research of Colwell and Reinking (2016) who found statistically significant results using a formative experiment in a high school social studies class for only ten weeks. Thus, the study's findings show that despite a small sample size and brief duration, PALS (Fuchs et al., 1997) can yield statistically significant results using a formative experiment framework

to increase the reading comprehension of grade-level biology text in an inclusion biology classroom.

Discussion of qualitative results. The results for this data were coded using Emotion Coding and Longitudinal Coding (Saldaña, 2016). In Vivo Coding (Saldaña, 2016) provided the quotes used throughout the study. An additional round of coding was performed on the teacher data to include factors that enhanced or inhibited the PALS (Fuchs et al., 1997) intervention, which are discussed in this section. The qualitative results included data gathered from the formal and informal teacher interviews as well as the student notebook entries and pre- and postintervention focus student interviews. The researcher notebook provided additional description of the classroom, students, and the general education biology teacher, Mrs. Jones.

Teacher interviews. There was a distinct contrast in the emotions coded for the results shared by Mrs. Jones, which accurately reflected the performance of the entire class, and not just the students who participated in the intervention. In one of the first informal teacher interviews recorded in the researcher notebook, Mrs. Jones stated that she observed students "helping with the vocabulary and I really liked having them do the retell." Another way Mrs. Jones felt that the intervention positively transformed the learning environment was in the dialogue between the dyads and "breaking down a reading about a biology topic gave the participants a deeper understanding of the content." She reported in the formal postintervention interview that she felt that some students were "getting so much more out of it (the biology readings) versus if they just read it on their own." On the other hand, Mrs. Jones also indicated in one of the first informal interviews that some students were not "in tune enough to be able to provide

any correction or guidance with anything…so that is kind of frustrating." However, in the postintervention formal teacher interview, she observed as the intervention went on that "I feel like it (the intervention) got better as we went through the process and they became more comfortable with it." Then, later in the same interview, she stated that they are "uncomfortable with the reading…having to read out loud in front of a peer…because of their limitations in reading." The Longitudinal Coding (Saldaña, 2016) shows Mrs. Jones' conflicting emotions throughout the study and paints an accurate picture of the range of students who participated in the intervention.

Student notebooks. At the beginning of the intervention, the analysis of the data showed that five out of the seven students reported in the preintervention student notebook reflection that they did not have any problems reading science text. However, the data from their state ELA scores, preintervention scores on the baseline assessment, and their IEP data showed lower than average scores. The theme that emerged from this data was one of inflated confidence in their ability to read and comprehend grade-level science text preintervention. This is consistent with Klassen's (2008) research which shows that some students with LD have "overly optimistic academic beliefs that may hinder learning and academic success" (p. 91).

Pre- and postintervention reading comprehension gain scores and student notebook entries. Additional analysis of the student notebook data using Longitudinal Coding (Saldaña, 2016) found that the self-reporting data of scores from the pre- to postintervention reading comprehension assessments of grade-level biology text aligned with three of the students (see Table 11). Three students reported a slight or better ability to read grade-level biology text in their student notebooks, and three reported no change

at all after using the intervention. Those students who reported no change in their ability to read and comprehend grade-level biology text in their student notebooks had pre- to postintervention reading comprehension gain scores which showed significant gains, which did not align with their self-report.

Felicia reported she had an increase in the reading comprehension of grade-level biology text and showed a 28% gain from pre- to-postintervention. Stephanie's results could not be used for this analysis, as she did not have data for the preintervention reading comprehension assessment due to her absence. Lexi also stated in her student notebook that she was better able to read and comprehend grade-level biology text after the intervention and had a gain score of 24% from pre- to postintervention. There was a gain score of 26% for Tracy, who also reported in her notebook that she had "gotten better, but not a lot," which aligned with her perception of the amount of their score's increase.

Table 11

Reading Comprehension Gain Scores Compared with Student Notebook Entries

Student (Pseudonyms)	Student Gain Score	Comprehension Reported in Student Notebook
Felicia	.28	"It has let me read a lot more [*sic*] better."
Stephanie	Not reported	Not used
Lexi	.24	"I have learned more words"
Steven	.47	"hasent change [*sic*]"
Tracy	.26	"I've gotten better, but not a lot."
Peter	.37	"It didn't help as much as I thought it would."
John	-1.2	"The PALS activities haven't really changed my reading capability. I'm good."

There were other three students who reported little to no change in their student

notebooks and their perceptions did not align with their scores when comparing their notebook entries with their gain scores from the pre- to-posttest for reading comprehension. The scores for Tracy increased by 47% from pre- to postintervention, but she stated they did not see any change in her ability to comprehend grade-level biology text. Peter reported that the intervention “didn’t help as much as I thought it would” but his scores from pre- to postintervention also showed a 37% increase. The most contradictory report of pre- to postintervention scores came from John, who reported no change in his student notebook, yet had a 120% decrease in his pre- to postintervention scores. The data showed a pattern of students’ self-report of their ability to read and comprehend grade-level biology text that did not match with their student notebook entries which could have been a factor that played a role in their perceived biology self-efficacy.

*Unit test scores and student notebook entries***.** The seven students’ scores are reported in Table 12 below. Three students’ unit test scores (Felicia, Lexi, and Tracy) corroborated with their student notebook entries which reported an increase in the perception of their ability to comprehend grade-level biology text. Four students (Stephanie, Steven, Peter, and John) reported that they didn’t think their ability to comprehend grade-level biology text had changed much or as much as they thought it would.

There are idiosyncratic scores for Steven as he scored 100% on the baseline (Unit 1), dropped 50% on Unit 2, and then his scores stayed stable at 90% for Unit 3 and 4. The scores for Peter were also idiosyncratic, but the scores were 74% at baseline (Unit 1), 85% and 90% on Unit 2 and 3, and fell to 60% on Unit 4. Finally, John stated in his

notebook that he did not think his reading comprehension of grade-level biology text had increased, but he had 10% increase from his baseline (Unit 1) scores to Unit 2 and then 20% from Unit 2 to Unit 3, and then his scores stayed stable from Unit 3 to Unit 4. The results of comparing student scores with their notebook entries confirmed Klassen's (2006, 2010) work that students with LD can be overestimate or underestimate their perceptions of their performance on academic work.

Table 12

Unit Test Scores Compared to Student Notebook Entries

Student (pseudonyms)	Baseline	Unit 2 Test Score	Unit 3 Test Score	Unit 4 Test Score	Comprehension Reported in Student Notebook
Felicia	72%	50%	90%	95%	"It has let me read a lot more [sic] better."
Stephanie	85%	65%	85%	75%	"I don't think it changed it much."
Lexi	54%	75%	90%	95%	"I have learned more words"
Steven	100%	50%	90%	90%	"hasent change [*sic*]"
Tracy	85%	75%	90%	95%	"I've gotten better, but not a lot."
Peter	74%	85%	90%	60%	"It didn't help as much as I thought it would."
John	95%	90%	100%	100%	"The PALS activities haven't really changed my reading capability. I'm good."

Overall, the PALS (Fuchs et al., 1997) intervention seems to have positively influenced the reading comprehension of grade level biology text for some students. In examining their student notebooks at the end of the intervention, over half of the students reported some level of increased reading comprehension of grade-level biology text as a

result of the intervention.

Conditions that improve theory for PALS (Fuchs et al., 1997). One of the conditions identified from this intervention that works well to improve theory is pairing general education students with those who have LD, using a method based on state reading scores like Fuchs et al.'s (2000) study. This method of pairing students aligns with the Vygotskian (1978) view using the Zone of Proximal Development as a cultural tool where students can learn from others who are more cognitively advanced than they are.

The present study also confirms the tenet of sociocultural theory (Wertsch, 1985, 1991) which promotes social interaction as fundamental in the development of cognition. PALS (Fuchs et al., 1997) also supports Bandura's (1986) Social Cognitive Theory as the PALS (Fuchs et al., 1997) dyads provide a social interaction fundamental to cognitive development where the students with and without LD serve in both roles as the tutor and coach during the intervention. In this study, PALS (Fuchs et al., 1997) showed significant results from the pre- and postintervention reading comprehension assessment scores as well as a small effect size in the timewise comparison from the baseline (Unit 1) to Unit 4 in the intervention's ability to increase the reading comprehension of grade-level biology text in students with LD in an inclusion classroom.

Conditions that do not improve theory for PALS (Fuchs, et al., 1997). There can be unintended and sometimes undesirable consequences of students' behavior (agentic behavior) in employing the cultural tool (the intervention), according to Reinking & Watkins' (2000) study. Wertsch's sociocultural perspective (1985, 1991) might also explain why there were struggles with some students' participation in the

PALS (Fuchs et al., 1997) intervention which led to Mrs. Jones' observation that some students didn't put effort into the intervention or provide their partner with correction or guidance like they should. According to Wertsch and Tulviste (1992), when two students are functioning at the same academic level, they are not functioning at the same mental level when they address an academic task. Thus, students who are challenged academically by the biology content might not respond in the same ways as students who possess the appropriate academic skills for the task, and thus the undesirable consequence of lack of participation which can lead to lower grades in the class. This lack of participation can also be evident in the poor attendance of certain students. However, there were usually at least two students absent per class period, and those students were paired together for the one class. As the PALS (Fuchs et al., 1997) readings didn't happen every day, that didn't impact the intervention for most students. However, it seemed to affect Peter, as his partner was consistently absent, which could have influenced Peter's self-efficacy.

Conditions that improve practice for PALS (Fuchs, et al., 1997). Again, a condition from this intervention which improves theory is one that could also work well to improve practice in the general education classroom is pairing general education students with those who have been diagnosed with LD. If teachers use the data from standardized state tests to pair strong students with those who struggle like Fuchs et al. (2000) study, this could yield better results with partner and group work than if teachers paired students randomly, as is a practice in many classrooms. Random pairing can lead to two weak students being partners who might not learn as much as if they were

purposefully paired with stronger students using the data-driven method employed in their study.

This study also found that the unit with the greatest number of PALS (Fuchs et al., 1997) readings (between Unit 2 and Unit 3) was the timepoint in the pairwise comparison analysis that reached significance on the unit reading comprehension assessments. This finding supports using multiple readings during the PALS (Fuchs et al., 1997) intervention with students with LD in inclusion classrooms. These outcomes show conditions that improved practice when using the PALS (Fuchs et al., 1997) intervention in an inclusion classroom.

Conditions that do not improve practice for PALS (Fuchs, et al., 1997). The PALS (Fuchs et al., 1997) lesson materials were not written with general education students in mind. A previous study by Fuchs et al. (1999) used PALS (Fuchs et al., 1997) materials in secondary special education and remedial reading classrooms. The wording and format of the training seemed to be geared to the special education and struggling student population. In the present study, the general education students and Mrs. Jones (as well as some of those students with LD) found the materials to be very simple and the guided notes as not helpful in teaching the three reading activities used in the intervention. Mrs. Jones suggested there could be practice with a few content area readings to demonstrate the PALS (Fuchs et al., 1997) activities rather using than the guided notes and quizzes.

It is possible that long breaks can affect the effectiveness of the PALS (Fuchs et al., 1997) intervention. One way to offset the difficulties with short-term memory many students with LD face (Swanson & Zheng, 2013) could be to have students reread a

PALS (Fuchs et al., 1997) passage the first day of their return from a break to refresh their minds of what was covered before beginning new instruction.

The PALS (Fuchs et al., 1997) intervention does not seem to work well for some students for yet unknown reasons, which has been cited in the literature (McMaster, Fuchs, Fuchs, & Compton, 2005). Based on the study's results, this intervention might not be effective for students who are diagnosed with autism or oppositional defiant disorder. Two of the students in this study had those diagnoses. The student with autism and the student with oppositional defiant disorder are two of the students who provided outlier responses in the present study. Practitioners should be aware of these factors when choosing to implement PALS (Fuchs et al., 1997) in their classrooms.

Biology self-efficacy. The modified SEQ-C (Lofgran et al., 2015) produced results that were statistically significant between pre- and postintervention (p = .007). This study refutes Fuchs et al.'s (1999) results that it might be unrealistic to expect changes in self-efficacy in a semester, especially in students with LD. Despite reaching significance with the modified SEQ-C (Lofgran et al., 2015), the results for the overall t test seems to have been impacted by three outlier student scores. The negative correlation coefficient of -.103 (-10.3%) from the t test shows a slight negative correlation from pre- to postintervention. This negative correlation indicated that several factors were possibly at play to explain that score.

Scores for the modified SEQ-C (Lofgran et al., 2015) in this study show that three out of seven of the students with LD were overconfident in their reporting of biology self-efficacy which yielded outlier scores. When using Longitudinal Coding (Saldaña, 2016) to compare the student notebook data with the gain scores from the modified SEQ-

C (Lofgran et al., 2015), the reported change in biology self-efficacy from pre- to postintervention did not match for these three students. Thus, the focus of the discussion in this section will be concentrated on the three students with outlier scores, the possible reasons behind them, and the stories from the qualitative data to provide a deeper analysis of the data.

Self-efficacy of students with LD has been studied extensively by Klassen (2002, 2006, 2008, 2010). Klassen's (2006) findings that some students with LD are overconfident in their abilities, leading to negative self-efficacy, seem to be present in three students in this study. However, there are differing possible stories for each of their outlier scores.

Lexi. A definite discrepancy existed for Lexi who reported that she had more confidence in her postintervention student notebook entry yet showed a significant decline of -180% in her self-efficacy gain score from pre- to postintervention. According to Klassen (2010) some students may have a more realistic perception regarding their performance at the end of the intervention than at the beginning. When analyzing this student's qualitative and quantitative data, the data seemed to point towards this explanation for her, as she continued to work hard and pass the course with an average final grade.

Steven. Klassen (2008) also asserted in his findings that some students who have overly optimistic efficacy beliefs might possess faulty task analysis skills, a lack of awareness of their strengths and weaknesses, or poor preparation on the student's part. Hampton and Mason (2003) also suggested that students who report overconfidence could have other factors that lead to that overconfidence. Based on analysis of the data,

these are possible explanations for the outlier score for Steven. He reported in his student notebook that he did not experience any change in his biology self-efficacy from pre- to postintervention, which was not consistent with their self-report of a 100% gain on their modified SEQ-C (Lofgran et al., 2015) assessment. Steven was observed just circling the answers and that action was recorded in the researcher notebook. This action resulted in an outlier score of 35/35. His prior overconfident behaviors were also observed in his classroom talk and recorded in the researcher notebook.

Peter. Klassen's (2006) findings that there are other students with LD who are overconfident in their abilities and possess ineffective self-advocacy might align with the results for Peter, who also had a self-advocacy goal on his IEP. Peter also reported inflated confidence in his abilities to achieve an above average grade in biology class. He reported that he would earn a high "B" or low "A" in the biology class, which again showed an overconfidence in his abilities, as he earned a final grade of a "C" for the semester.

Peter had a 37% gain on the pre- to postintervention reading comprehension assessment and a -110 % gain from pre-to post-intervention on the modified SEQ-C (Lofgran et al., 2015) scores. He recorded in his student notebook that PALS (Fuchs et al., 1997) "didn't help as much as I thought it would" with his reading comprehension of grade level biology text, and that he "experienced boredom" and did not answer the last question in the student notebook that dealt with biology self-efficacy. The responses from Peter were consistent with a student who might possess low self-advocacy skills. It appeared from the quantitative and qualitative data that his lack of performance could have been due to his inability to manage his own learning.

Table 13

Modified SEQ-C (Lofgran et al., 2015) Gain Scores and Student Notebook Entries

Student (pseudonyms)	Student Gain Score	Confidence Reported in Student Notebook
Felicia	.06	"I had a little more confidence."
Stephanie	.23	"Maybe a little more but still not much…"
Lexi	-1.8	"I had more confidence."
Steven	1.0	"hasent (sic) change (sic)"
Tracy	.12	"more confidence"
Peter	-1.1	No response
John	.08	"I don't feel I've gained or lost any confidence from the activities."

Conditions that improve theory for self-efficacy. Bandura's (1997) research has found that the use of peer models raised students' beliefs about their self-efficacy for learning specific subjects as well as their actual achievement, which is in line with the PALS (Fuchs et al., 1997) intervention's theoretical framework. The students and Mrs. Jones reported that the dyads fostered positive social interactions, which in turn, led to students taking more ownership of the learning and interacting with their typically-developing peers. These actions led to an increase in positive verbal and non-verbal support of the students with LD.

Several positive peer relationships were observed to have carried over to outside of the biology classroom and were recorded in the researcher notebook. This finding extends Bandura's (1997) research that peer models raise "students' beliefs in their efficacy for learning, for the subject matter, and their actual achievement" (p. 234) as

well as Thorius and Graff's (2018) assertion that students with LD in classrooms where PALS (Fuchs et al., 1997) was used were viewed as having the same social standing as their typically-developing peers.

Conditions that do not improve theory for self-efficacy. According to the research, when poor past performance is combined with academic failure in students with LD, two outcomes (Hampton & Mason, 2003; Klassen, 2008) can occur. The student can become overconfident in their abilities (Klassen, 2008) and then experience additional failure or struggles in the learning environment, which counteracts the positive effects of the peer models outlined in Bandura's (1986) Social Cognitive Theory. This outcome happens when some students experience academic failure, their self-protective nature developed over time results in them portraying themselves in a positive light (Klassen, 2008). Additionally, Klassen (2008) asserts that "(o)verly optimistic efficacy beliefs might reflect poor preparation, faulty task analysis, and a lack of awareness of one's strengths and weaknesses" (p. 97).

On the other hand, the student can also experience repeated failure which may cause students to not engage with future tasks and not persist under stressful conditions (Klassen, 2010). As a result, these experiences reinforce the negative self-efficacy, which does not confirm Bandura's (1986) Social Cognitive Theory. Both of these outcomes were observed in this study.

However, a third outcome was observed in the present study and might warrant further research. With the negative correlation of -.103 (-10.3%) obtained with the modified SEQ-C (Lofgran et al., 2015), one interpretation could be that the longer the PALS (Fuchs et al., 1997) intervention is implemented, some students experience lower

the biology self-efficacy. It could be possible that the intervention caused a decrease in self-efficacy because the students became more aware that their overconfidence at the beginning of the intervention was not realistic and became more realistic in their reporting of their biology self-efficacy by the end of the intervention.

Conditions that improve practice for self-efficacy. Schunk and Meece (2006) state that some learning strategies have been shown to increase self-efficacy and achievement among adolescents. This study confirms Alvermann's (2002) research which found that teaching literacy instructional strategies including comprehension monitoring, cooperative learning, and summarizing during the PALS (Fuchs et al., 1997) intervention positively addressed the issues of biology self-efficacy and engagement in the classroom. Klassen (2006) found that students with LD exhibit lower levels of metacognitive awareness of reading strategies, which negatively influences their self-efficacy beliefs. Using an intervention like PALS (Fuchs et al., 1997) makes those reading strategies explicit, thus reducing the need for the use of metacognitive awareness. Thus, this study found that the PALS (Fuchs et al., 1997) intervention also has the potential to increase biology self-efficacy by providing explicit reading strategies instruction.

Conditions that do not improve practice for self-efficacy. When students with LD overestimate their self-efficacy (Klassen, 2006), this can result in a condition leading to repeated failure, which can negatively impact the student, teacher, and the learning environment. Educators not being aware of the tendency for students with LD to overestimate their performance on reading comprehension tasks even when receiving a failing grade can lead to frustrations for the student and the teacher. Knowing that some

students with LD have these overconfident beliefs about their self-efficacy can be key to improving the teaching strategies of students with LD.

Implications for Future Research

How does the PALS (Fuchs et al., 1997) intervention compare and contrast the effects of the intervention across diverse contexts? This framework question is geared toward larger-scale studies as they "provide greater opportunity to compare and contrast an intervention's implementation and effects across a broader range of contexts" (Reinking & Bradley, 2008, p. 53). This question has a place in the present study when thinking about future research projects.

Scope of study. Without outside funding, it would be impossible to supervise and train the teachers and additional researcher needed to implement an intervention in more than one classroom. In future research, conducting a similar study with a control group would potentially strengthen the findings by adding to the corpus of data for the study. A larger study would increase the chances of a larger number of participants and mitigate the loss of students for absenteeism, transfer, or any other reason. Future research could also examine the data for the typically developing peers in the study and not just those with LD, possibly showing the value of the PALS (Fuchs et al., 1997) intervention for struggling students not identified with LD.

Timing of the study. As a recommendation for future research in secondary content areas, starting as early in the semester as possible to have the greatest amount of time to see the maximum effects of the intervention would be the best practice to follow. This is important as in secondary schools, students often change schedules and do not

continue with the same teacher during the second semester.

Number of readings. Another factor a future researcher should consider before beginning and intervention study would be to determine the number of PALS (Fuchs et al., 1997) readings that could be covered during the semester. The more reading opportunities students have, the higher the probability is to see an increase in their reading comprehension of the content area text.

Length of readings. Collaborating with the general education teacher and determining the length of the PALS (Fuchs et al., 1997) readings is an important task to consider before beginning an intervention using PALS (Fuchs et al., 1997). Having readings with a high word count is necessary to complete all three PALS (Fuchs et al., 1997) reading activities. Having this knowledge before the intervention begins is necessary to maintain one area in the Fidelity of Implementation (FOI) of the intervention.

Type of self-efficacy measure. Using the modified SEQ-C (Lofgran et al., 2015) yielded sufficient data for the study. However, obtaining a measure like the one used by Britner and Pajares' (2006), which extensively covered all four of Bandura's (1997) components of self-efficacy, might influence the self-efficacy results for a future study.

Relationship building. To ensure constructive working relationships within the PALS (Fuchs et al., 1997) dyads, team building activities could be used at the beginning of the intervention. This would allow the partners could get to know one another which could positively influence how well they work with one another throughout the intervention.

Students non-affected by the PALS (Fuchs et al., 1997). Most students receive

some positive benefit from the PALS (Fuchs et al., 1997) intervention. However, there are a small number of students that do not experience a benefit from the PALS (Fuchs et al. 1997) intervention (McMaster et al., 2005). In this study, students with LD who also were diagnosed with autism and oppositional defiant disorder provided some outlier responses which possibly could have been attributed to behaviors seen in students with those diagnoses. Documented in the researcher journal during the postassessment interview, the student with autism was fixated on an object and was not fully focused on the learning task. Also documented in the researcher journal was the behavior of the student with oppositional defiant disorder who just circled the highest score of 5 for all items on the postintervention modified SEQ-C (Lofgran et al., 2015) before turning in their questionnaire.

A way to mitigate this challenge when performing future research would be to have the administration screen for other identified educational factors that could negatively impact the study and control for those variables before the study began. Future research could also address this population of students to see what factors might play into the students' lack of progress using the intervention.

Co-teaching in an inclusion classroom. Future research would be impacted by the decision to implement a formative experiment with PALS (Fuchs et al., 1997) in an inclusion classroom. A synergistic, collaborative relationship is necessary between the general education teacher and the special education teacher, and this type of relationship dynamic is not easily cultivated. Additionally, special education teachers are often not familiar with or are uncomfortable with content area subject matter, and general education teachers can be wary about other teachers wanting to take over their classroom.

Clear expectations of teaching roles and duties are crucial conversations to have for co-teaching partnerships during the design phase of the study.

Disciplinary literacy strategies. The three reading activities in the PALS (Fuchs et al., 1997) intervention are content area literacy strategies, not disciplinary literacy strategies. Fang and Coatam (2013) clarify this difference by stating that disciplinary literacy strategies focus on discipline-specific cognitive strategies, language skills, and habits of practice, whereas content area literacy strategies are those strategies which can be used across many disciplines. Researching disciplinary literacy strategies for science that can impact students with learning disabilities comprehension of grade-level biology text is another avenue for future research. Some examples of disciplinary literacy strategies that could be topics for future research could be analyzing the effects of "building background knowledge specific to the discipline, learning specialized vocabulary, and deconstructing complex discipline-specific text structures" (Chauvin & Theodore, 2015, p. 3).

Concluding Thoughts

This study provided students with LD an opportunity to increase their comprehension of grade-level biology text as well as their biology self-efficacy in an inclusion classroom setting. The study's findings and limitations are reviewed in light of past and current research and presented in this chapter. Statistically significant results were reported for the pre- and postintervention reading comprehension assessments and the modified SEQ-C (Lofgran et al., 2015), despite small sample sizes and brief duration

of the intervention. Based on the students' report in their student notebooks and the focus student interviews, the qualitative findings from the study also indicate that most students did receive benefit from the PALS (Fuchs et al., 1997) intervention.

There are two main takeaways from this present research. The findings from the study confirm the previous research that the PALS (Fuchs et al., 1997) intervention can be a viable option to increase the reading comprehension of students with LD not only in the resource setting, but in general education courses at the secondary level. The present study extends the possibility of future research using the PALS (Fuchs et al., 1997) intervention in inclusion classrooms. Outlier data in the findings were analyzed, adding to the research that the PALS (Fuchs et al., 1997) intervention does not increase the reading comprehension of grade-level text with certain subgroups of special education students, including students with Oppositional Defiance Disorder (ODD) and Autism Spectrum Disorder (ASD). Other future research recommendations were discussed. The need still exists for further research on the topics of increasing reading comprehension of grade-level biology text and biology self-efficacy as well as in other science and social studies courses in high school students with LD.

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Appendices

Appendix A

IRB Approval Letter

From: **Institutional Review Board** irb@usu.edu
Subject: Approval Letter for Protocol 9793
Date: September 12, 2019 at 1:55 PM
To:
Cc:

OFFICE OF RESEARCH UtahStateUniversity

Letter of Approval

From: Melanie Domenech Rodriguez, IRB Chair
Nicole Vouvalis, IRB Director
To: ***Marla Robertson***
Date: ***September 12, 2019***
Protocol #: ***9793***
Title: ***EXPLORING THE INFLUENCE OF PEER-ASSISTED LEARNING STRATEGIES (PALS) IN INCREASING READING COMPREHENSION OF GRADE-LEVEL BIOLOGY TEXT AND BIOLOGY SELF-EFFICACY IN TENTH-GRADE STUDENTS WITH LEARNING DISABILITIES: A FORMATIVE EXPERIMENT***

Your proposal has been reviewed by the Institutional Review Board and is approved under expedite procedure #7 (based on the Department of Health and Human Services (DHHS) regulations for the protection of human research subjects, 45 CFR Part 46, as amended to include provisions of the Federal Policy for the Protection of Human Subjects, January 21, 2019):

> *Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.*

This approval applies only to the proposal currently on file for the period of approval specified in the protocol. You will be asked to submit an annual check in around the anniversary of the date of original approval. As part of the IRB's quality assurance procedures, this research may also be randomly selected for audit. If so, you will receive a request for completion of an Audit Report form during the month of the anniversary date of original approval. If the proposal will be active for more than five years, it will undergo a full continuation review every fifth year.

Any change affecting human subjects, including extension of the expiration date, must be approved by the IRB **prior** to implementation by submitting an Amendment request. Injuries or any unanticipated problems involving risk to subjects or to others must be reported immediately to the Chair of the Institutional Review Board.

Prior to involving human subjects, properly executed informed consent must be obtained from each subject or from an authorized representative, and documentation of informed consent must be kept on file for at least three years after the project ends. Each subject must be furnished with a copy of the informed consent document for their personal records.

Upon receipt of this memo, you may begin your research. If you have questions, please call the IRB office at (435) 797-1821 or email to irb@usu.edu.

The IRB wishes you success with your research.

Appendix B

Pre- and Postintervention Oral Reading Comprehension Passage (Sample)

Post-Intervention Biology Reading Assessment Protocol Passage 2

Oral Reading Comprehension: Form and Function in Flatworms

Read these specific directions to the student:

I would like you to read a biology passage to me. I want you to understand what you read, not to see how fast you can read the words. If you do not know a word, I will read the word for you. Keep reading until I say, "Stop," or you finish the passage. Be ready to tell me all about the biology passage when you finish. (Place the passage in front of the student).

To begin testing: ***Put your finger under the first word of the passage.*** (Point to the first word of the passage). ***Ready, begin.***

Total Words:____________
Errors: Including Skipped Words:____________
Total Words Correct:____________

Form and Function in Flatworms

0 Because flatworms are thin and most of their cells are close to the external environment, materials can pass easily
19 into and out of their bodies. All flatworms rely on diffusion for some essential body functions such as respiration,
38 excretion, and circulation. Other processes are carried out in different ways in different species. Free-living flatworms
55 have organ systems for digestion, excretion, response, and reproduction.

64 Parasitic species of flatworms, such as the fluke which probably evolved from free-living ancestors. As the worms
82 evolved into parasites, internal organs and other structures were modified or even lost. As a result, parasitic species
100 are typically similar in structure than their free-living relatives.

110 Free-living flatworms can be carnivores that feed on recently dead animals. Like cnidarians, flatworms have a
127 digestive cavity with a single opening, or mouth, through which food and wastes pass. Near the mouth is a muscular
147 tube called a pharynx. Flatworms extend the pharynx out of the mouth. The pharynx then pumps food in to the
167 digestive cavity, or gut. Once inside, food is digested by cells of the gut, where digestion and nutrient absorption take
187 place. Digested food diffuses from the digestive cavity into all other body tissues.

200 Parasitic worms feed on blood, tissue fluids, or pieces of cells within the host's body. Many parasitic worms obtain
219 nutrients from foods that have already been digested by their host. Therefore, most parasitic worms do not need a
238 complex digestive system. Many parasitic species have a digestive tract that is simpler than that of free-living forms.
257 Some species have a pharynx that pumps food into a pair of dead-end intestinal sacs for digestion. Tapeworms, on
277 the other hand, have no digestive tract at all. They live within the intestine of the host, such as a cow or a human, and
302 simply absorb digested nutrients that are in their host's intestine.

312 Because their bodies are so flat and thin, many flatworms do not need a circulatory system to transport materials.

Post-Intervention Biology Reading Assessment Protocol Passage 2

Oral Reading Comprehension: Form and Function in Flatworms

331 Instead, flatworms rely on diffusion to transport oxygen and nutrients to their internal tissues, and to remove carbon
349 dioxide and other wastes from their bodies. Flatworms have no gills or other respiratory organs, and no heart, blood
368 vessels, or blood.
371 Some flatworms have flame cells that function in excretion. Flame cells are specialized cells that remove excess water
389 from their body. They may also filter and remove metabolic waste such as ammonia and urea. Many flame cells are
409 joined together to form a network of tubes that empties into the outside environment through tiny pores in the
428 animal's skin.
430

Taken from: Biology, Miller and Levine (2008), p. 684, 404 words, estimated 1000L

Appendix C

Pre- and Postintervention Oral Reading Comprehension Questions (Sample)

Oral Reading Comprehension: Form and Function in Flatworms **Passage 2**

Read these specific directions to the student:

I would like you to read a biology passage to me. I want you to understand what you read, not to see how fast you can read the words. If you do not know a word, I will read the word for you. Keep reading until I say, "Stop," or you finish the passage. Be ready to tell me all about the biology passage when you finish. (Place the passage in front of the student).

To begin testing: ***Put your finger under the first word of the passage.*** (Point to the first word of the passage). ***Ready, begin.***

	Student Recall		Follow Up Question	Incorrect Response
	Correct response provided during recall **2**		*Partial Credit* **1**	*Incorrect response* **0**
1	*Key Concept + detail:* *Flatworms rely on diffusion for some essential bodily functions* *(+)* • *Respiration* • *Excretion* • *Circulation*	☐ (+) ☐	*What functions do flatworms rely on diffusion for?* • *Any one of the answers for number 1* • *Breathing* • *Their heart pumping*	• *Don't know* • *Any other response*
	Correct response provided during recall **2**		*Partial Credit* **1**	*Incorrect response* **0**
2	*Key Concept + detail:* *Flatworms are carnivores that feed on* *(+)* • *Tiny aquatic animals* • *Recently dead aquatic animals*	☐ (+) ☐	*What type of food do flatworms eat?* • *Any of the answers for number 1* • *Dead animals*	• *Don't know* • *Any other response*
	Correct response provided during recall **2**		*Partial Credit* **1**	*Incorrect response* **0**
3	*Key Concept + detail:* *Parasitic Flatworms feed on blood, tissue fluids, or pieces of cells within the host's body.* *(+)* • *Obtain food that has already been digested by its host* • *So, tapeworms have no digestive system*	☐ (+) ☐	*What are some things that parasitic flatworms eat?* • *Blood* • *tissue fluids* • *pieces of cells*	• *Don't know* • *Any other response*
	Correct response provided during recall **2**		*Partial Credit* **1**	*Incorrect response* **0**
4	*Key Concept + detail:* *Flatworms are flat and thin and have no:* *(+)* • *Gills* • *Heart* • *Blood* • *Blood vessels*	☐ (+) ☐	*What are some organs that flatworms do not have?* • *Any one or two answer(s) from number 4*	• *Don't know* • *Any other response*

Oral Reading Comprehension: Form and Function in Flatworms

Passage 2

Main Idea

Now I am going to ask you some other questions. *Read each question aloud to the student. Circle the 2 when the student's response matches the possible responses in the 2 column, circle a 1 when the student's response matches the possible responses in the 1 column, and circle a 0 if the student's response matches the responses in the 0 column. Write the student's response in the "Other:" line if you are unsure how to score the response, then score the response later.*

	Question: ***According to the text, what do free-living flatworms have that parasitic flatworms do not?***		
	Key Concept: Flatworms that are free-living have organ systems.		
	Correct response provided during recall **2**	*Partial Credit* **1**	*Incorrect response* **0**
5	*Sample responses* *They have organs for:* ● *Excretion* ● *Digestion* ● *Response* ● *Reproduction*	*Sample responses:* ● *Any one or two of the answer(s) for number 5*	*Sample responses:* ● *Don't know* ● *Any other response*
	Question: ***According to the text what do parasitic flatworms do for food?***		
	Key Concept: Parasitic flatworms obtain nutrients from food that has already been digested by its host.		
	Correct response provided during recall **2**	*Partial Credit* **1**	*Incorrect response* **0**
6	*Sample responses:* ● *Nutrients from already digested food from the host*	*Sample responses:* ● *Getting food from its host*	*Sample responses:* ● *Don't know* ● *Any other response*
	Question: ***According to the text, what specialized cells do some flatworms have?***		
	Key Concept: Some flatworms have flame cells that serve as cells for excretion, removing excess water from the body..		
	Correct response provided during recall **2**	*Partial Credit* **1**	*Incorrect response* **0**
7	*Sample responses:* ● *Flame cells*	*Sample responses:* ● *Excretion cells*	*Sample responses:* ● *Don't know* ● *Any other response*

Oral Reading Comprehension: Form and Function in Flatworms **Passage 2**

Prediction
Read these specific directions to the student:

Say, ***Now I am going to ask you a few more questions. As you answer the questions, please be sure to justify your answer.*** Circle the 2 when the student provides the correct answer to the question within the context of the passage. Circle the 1 when the student only provides a partial answer but does not justify it. Circle the 0 when the student is not able to answer the question or gives an incorrect response.

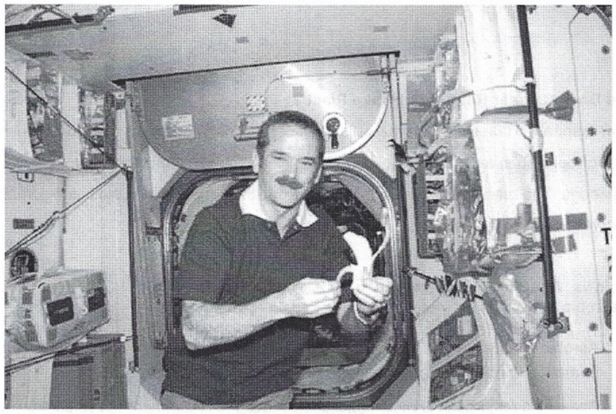
	Question: ***What can you predict will happen to a parasitic flatworms host?***		
8	*Parasitic flatworms take nutrients from the host, causing it to lose weight and if untreated, can cause death.*		
	Correct response provided during recall **2**	*Partial Credit* ***1***	*Incorrect response* ***0***
	Sample responses: ● *The host will lose weight.* ● *The host can die.*	*Sample responses:* ● *The host will get sick.*	*Sample responses:* ● *Don't know* ● *Any other response*
	Question: ***What can you predict will be absent in the body of a parasitic flatworm?***		
9	*Key Concept: A parasitic flatworm will not have a developed digestive tract since it gets nutrients from its host.*		
	Correct response provided during recall **2**	*Partial Credit* ***1***	*Incorrect response* ***0***
	Sample responses: ● *Parasitic flatworms do not need a complex digestive tract to get nutrients.*	*Sample responses:* ● *Don't have a stomach*	*Sample responses:* ● *Don't know* ● *Any other response*
	Question: ***Where can you predict that many free-living flatworms live?***		
10	*Key Concept: many free-living flatworms live in aquatic enviornments.*		
	Correct response provided during recall **2**	*Partial Credit* ***1***	*Incorrect response* ***0***
	Sample responses: ● *Free-living flatworms live in aquatic or water environments.*	*Sample responses:* ● *None for partial credit.*	*Sample responses:* ● *Don't know* ● *Any other response*

Retell Subtotal	______
Main Idea Subtotal	______
Prediction Subtotal	______
Oral Comprehension Subtotal	______

Appendix D

Unit Reading Comprehension Passage (Sample)

Biology Reading Assessment
Cellular Respiration



Introduction

If you're like astronaut Chris Hadfield in **Figure** above, you grab a piece of fruit when you need a boost of energy. Most fruits are good sources of glucose. Glucose is the simple sugar that living things use to store and transport energy. Glucose is taken up by all of your cells. However, cells don't use the energy in glucose directly. They first need to release the energy and store it in ATP, or adenosine triphosphate. The much smaller amount of energy stored in ATP is just right for fueling cell processes. How do your cells change glucose to ATP? It happens during cellular respiration.

Using Glucose to Make ATP

Cellular respiration is the process in which cells break down glucose, release the stored energy, and use the energy to make ATP. For each glucose molecule that undergoes this process, up to 38 molecules of ATP are produced. Each ATP molecules forms when a phosphate is added to ADP, or adenosine diphosphate. This requires energy, which is stored in the ATP molecule. When cells need energy, a phosphate can be removed from ATP. This releases the energy and forms ADP again.

What Happens During Cellular Respiration?

Cellular respiration involves many biochemical reactions. However, the overall process can be summed up in a single chemical equation:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy (stored in ATP)}$$

Cellular respiration uses oxygen in addition to glucose. It releases carbon dioxide and water as waste products. Cellular respiration actually "burns" glucose for energy. However, it doesn't produce light or intense heat like burning a candle or log. Instead, it releases the energy slowly, in many small steps. The energy is used to form dozens of molecules of ATP.

Biology Reading Assessment
Cellular Respiration

Where Does Cellular Respiration Take Place?

Cellular respiration takes place in the cells of all organisms. It occurs in autotrophs such as plants as well as heterotrophs such as animals. Cellular respiration begins in the cytoplasm of cells. It is completed in mitochondria. The mitochondrion is a membrane-enclosed organelle in the cytoplasm. It's sometimes called the "powerhouse" of the cell because of its role in cellular respiration.

Aerobic vs. Anaerobic Respiration

Both aerobic and anaerobic respiration have certain advantages.

- Aerobic respiration releases far more energy than anaerobic respiration does. It results in the formation of many more molecules of ATP.
- Anaerobic respiration is much quicker than aerobic respiration. It also allows organisms to live in places where there is little or no oxygen, such as deep under water or soil.

Flexbooks 2.0 > CK-12 Life Science for Middle School > 2.9 Cellular Respiration CK-12 Foundation 2019

Appendix E

Unit Reading Comprehension Assessment Questions (Sample)

Retell

1	*What are the molecules used during cellular respiration?* *a) Oxygen and carbon dioxide* *b) Oxygen and glucose* *c) Oxygen and ATP*
2	*What are the molecules released by cellular respiration?* *a) Carbon dioxide and water* *b) Carbon dioxide and glucose* *c) Carbon dioxide and ADP*
3	*What are the three parts of the cellular respiration process?* *1.* ______________________ *2.* ______________________ *3.* ______________________
4	*Since cells don't use the energy in glucose directly then why do they need glucose?* ______________________ ______________________ ______________________ ______________________

Main Idea

	Where in the cell does cellular respiration begin?
5	*a) mitochondria*
	b) cell membrane
	c) cytoplasm
	Where in the cell is cellular respiration completed?
6	*a) mitochondria*
	b) cell membrane
	c) cytoplasm
	Name two organisms that use cellular respiration:
7	*a) autotrophs and heliotropes*
	b) autotrophs and heterotrophs
	c) heterotrophs and pterotrophs

Prediction

	Predict what type of respiration does the cell do in the presence of oxygen.
8	*a) anaerobic respiration*
	b) aerobic respiration
	c) cellular respiration

	Predict what type of respiration does the cell do in the absence of oxygen.
9	*a) anaerobic respiration*
	b) aerobic respiration
	c) cellular respiration

	Predict what will happen to the structure of ATP when a cell needs energy.
10	

Appendix F

Modified Self-Efficacy Questionnaire for Children (SEQ-C)

(Lofgran, Whiting, & Smith, 2015)

Modified Self-Efficacy Questionnaire for Children (SEQ-C)

(Lofgran, Whiting, & Smith, 2015)

1) How well can you study biology when there are other interesting things to do?

   1 not at all 2 not very well 3 somewhat well 4 pretty well 5 very well

2) How well can you study for a biology test?

   1 not at all 2 not very well 3 somewhat well 4 pretty well 5 very well

3) How well do you succeed in finishing all of your biology homework every day?

   1 not at all 2 not very well 3 somewhat well 4 pretty well 5 very well

4) How well can you pay attention during biology class?

   1 not at all 2 not very well 3 somewhat well 4 pretty well 5 very well

5) How well do you succeed in passing biology class?

   1 not at all 2 not very well 3 somewhat well 4 pretty well 5 very well

6) How well do you succeed in satisfying your parents with your biology schoolwork?

   1 not at all 2 not very well 3 somewhat well 4 pretty well 5 very well

7) How well do you succeed in passing a biology test?

   1 not at all 2 not very well 3 somewhat well 4 pretty well 5 very well

8) Gender M/F

9) Ethnicity: American Indian, Asian, Black, Caucasian, Hispanic, Pacific Islander, Other

Appendix G

Pre-PALS Focus Student Biology Self-Efficacy Interview Questions

Pre- PALS Focus Student Biology Self-Efficacy Interview Questions

1. How do you feel about biology? Explain.
2. Do you think you will be able to pay attention in biology class? Why or why not?
3. Do you think you will be able to study for biology tests this year? Why or why not?
4. Do you think you will be able to pass a biology test in this class? Why or why not?
5. How do you think you will do in biology class this year? Explain.
6. What grade do you think you will earn in biology class? Is this grade higher or lower than your other classes?
7. Is there anything else you want to add about how you feel about taking biology this year?

Appendix H

Post-PALS Focus Student Biology Self-Efficacy Interview Questions

Post-PALS Focus Student Biology Self-Efficacy Interview Questions

1. How do you feel about biology after PALS? Explain.
2. Do you think it has been easier or harder to pay attention in biology class after using PALS? Explain.
3. Do you think it has been easier or harder to study for biology tests after PALS? Explain.
4. Do you think it has been easier or harder to pass a biology test in this class after PALS? Explain.
5. How do you think you will do in biology class this year since using PALS?
6. What grade do you think you will earn in biology class after using PALS? Is it higher or lower than your other classes?
7. Is there anything else you would like to add about how you feel about biology since using PALS?

Appendix I

Semistructured Teacher Interview Protocol

Semistructured Teacher Interview Protocol

1. Tell me what you observed about the dyads when reading the biology text in the classroom using PALS.
2. What differences did you notice in the dyads?
3. How would you describe student participation? Did you notice any differences in participation from the previous unit?
4. How do you think scores from the unit reading comprehension assessments align with what you are seeing in the classroom?
5. Are there any other observations regarding the intervention that you would like to share?

Appendix J

Final Semistructured Teacher Interview Protocol

Final Semistructured Teacher Interview Protocol

1. Tell me what you observed about the difference in reading biology text in the classroom using PALS than reading the biology text during the baseline unit?
2. What differences did you notice from the beginning of the intervention until now?
3. How would you describe student participation? Did you notice any differences in participation from the baseline unit at the beginning of the intervention?
4. Are there any other observations regarding the intervention that you would like to share?

Appendix K

Permission to use the SEQ-C (Lofgran,Whiting & Smith, 2015)

From: **Leigh Smith**
Subject: Re: SEQ-C Modifications
Date: December 17, 2018 at 7:49 AM
To: K Lea Priestley
Cc: Sarah Clark

Dear K. Lea,

I have attached the modified Self-Efficacy Questionnaire for Children (SEQ-C) that you requested (see attached). As you can see, one document includes the modifications made to the original; the other document includes both an English and Spanish version which we used in the study due to the population we were investigating.

We wish you well in your work!
Best,
Leigh Smith

****

Leigh K. Smith, Ph.D.

Associate Professor, Science Education

Associate Chair, Department of Teacher Education

205-B MCKB

Brigham Young University

Provo, UT 84602-5099

On 12/14/18, 5:19 AM, "K Lea Priestley wrote:

Hello Dr. Smith,

My name is K. Lea Priestley and your colleague, Dr. Sarah Clark, was my advisor when she was at Utah State University. I am currently working on my proposal and was wondering how to gain permission to use your modified SEQ-C in my study. I am looking at the possible gains in science self-efficacy of students with learning disabilities using Peer-Assisted Learning Strategies (PALS) with science text (biology specifically) as one variable in my mixed methods study.

Your subscale is perfect for the variables that I am looking to measure but wanted to seek permission before proceeding with writing my proposal. Thank you in advance!

K. Lea Priestley

Modified SEQ-C feedback.docx

Modified SEQ-C English...h.docx

Appendix L
Curriculum Vitae

K. Lea Priestley

5825 E. Harmony Ave. Mesa, AZ 85206 | 801.682.6023 | kleapriestley@gmail.com

Education and Certifications

PhD Curriculum and Instruction; emphasis Literacy | *Utah State University – Logan, UT* | May 2020

MEd Special Education/Postgraduate Work |*East Tennessee State University – Johnson City, TN*| May 1985

BA Psychology, Minor: Special Education |*East Tennessee State University – Johnson City, TN*| December 1983

Certifications

Arizona Department of Education
Standard Professional Exp. 9.15.2030
Mild/Moderate Special Education, K-12
Standard Professional Elementary, K-8

The Utah State Board of Education
Level 2 Licensure Exp. 2022
Special Education (K-12+)
Endorsement: Mild/Moderate Disabilities

Elementary Education (1-8)

Montessori Educational Programs International (MEPI)
Lower Elementary Field Supervisor
Lower Elementary Montessori Certification 6-9

Teaching

Higher Education

***Director of Elementary Field Experiences* | – *Utah State University* – Logan, UT | Fall 2015-2018**

ELED 5250 Advanced Behavior Management and Student Teaching Seminar
Fall 2015, Spring 2016, Fall 2016, Spring 2017 (hybrid format)
Fall 2017, Spring 2018 (online delivery format)

Student Outcomes

- Apply content area knowledge from previous coursework to develop and deliver lesson and unit plans which supports students in meeting rigorous learning goals drawing upon content areas, Utah Core Standards, and instructional best practices.

- Develop skills, competencies, and points of view needed by professionals in the field of teaching by designing positive learning environments, instruction based on approved content standards and research using a variety of instructional strategies for diverse learners collaborating with learners, families and the community while demonstrating the highest standard of legal, moral, and ethical conduct.
- Foster collaboration with other student teachers by interacting with classmates via Canvas via an online guided discussion model format to solve problems faced by pre-service teachers.

TEAL 5630 Study Abroad Student Teaching
Fall 2016, Spring 2017, Fall 2017

Student Outcomes

- Plan and teach a variety of lessons in the curriculum in a Dual Language Immersion English classroom in Milan, Italy while modeling effective pedagogy.
- Forge and maintain professional and collaborative relationships with students, families, and teachers
- Develop a respect for and understanding of another country's education system while also reflecting on the differences between American and Italian culture and the tenets that influence educational thought, instructional practices, assessment, and the concept of the learner.
- Represent and share the best of American culture and ideals to the students, families, and teachers.

***Adjunct Professor | Walters State Community College* –Morristown, TN | Fall 1994, Fall 1995**
CDVT 1060 Exceptional Children

Student Outcomes
Develop knowledge of the history of special education as a field and Special Education Law
Understand disability categories and the characteristics of each
Understand educational and psychological outcomes of disability categories
Develop strategies to differentiate curriculum in reading, writing, and math for students with disabilities

***Graduate Assistant | East Tennessee State University* –Johnson City, TN | Fall 1984, Spring 1985**
Introduction to Special Education

Student Outcomes
Develop knowledge of the history of special education as a field and Special Education Law
Understand the categories of disabilities and the characteristics of each
Understand the educational and psychological outcomes for the categories of disabilities
Develop strategies to differentiate curriculum in reading, writing, and math for students with disabilities

Professional Affiliations

Association for Literacy Educators and Researchers (2018-current)
International Literacy Association (2019-current)
Literacy Research Association (2019-current)
Northern Rocky Mountain Education Association (2019-current)

Publications

Teachers College Record, Date Published: December 03, 2018
http://www.tcrecord.org ID Number: 22588, Date Accessed: 12/3/2018 5:55:30 PM

Mohr, K. A. J., Ding, G., Strong, A., Branum, L., Watson, N., **Priestley, K. L.,** Juth, S., Carpenter, N., & Lundstrom, K. (2017). Reading the past to inform the future: 25 years of *The Reading Teacher*. *The Reading Teacher, 71*(3), 251-264

Presentations

Priestley, K. L. (2019, December). *Disciplinary literacy and students with LD.* Literacy Research to Practice Forum at LRA, Tampa, FL.

Priestley, K. L. (2019, October). *Formative experiments.* Roundtable at the Northern Rocky Mountain Educational Research Association Annual Conference, Denver, CO.

Mohr, K. A. J., Ding, G., Strong, A., Branum, L., Watson, N., **Priestley, K. L.,** Juth, S., Carpenter, N., & Lundstrom, K. (2017, November). *Reading the Past to Inform the Future: 25 Years of The Reading Teacher*. Session presentation at the Association of Literacy Educators and Researchers Annual Conference, St. Petersburg, FL.

Priestley, K. L. (2017, November). *Literacy Strategies for Learning Disabled Students.* Session presentation at the semiannual workshop for CLIL/BEI teachers, Milan, Italy.

Priestley, K. L. (2017, October). *Literacy Strategies for Learning Disabled Students*. Session presentation at the Utah Chapter of the International Reading Association, Ogden, UT.

Priestley, K. L. (2017, September). *Model for Effective CLIL Practice.* Session presentation at a special education professional development workshop for CLIL/BEI teachers, Milan, Italy.

Priestley, K. L. (2017, March) *Special Education Children's Needs.* Session Presentation at the semiannual workshop for CLIL/BEI teachers, Milan, Italy.

Kelley, K. L., & Fields, R. H. (2015, February). *Beyond Observation: Strategies to Overcome Behavior Obstacles.* Session Presentation at the annual Montessori Education Programs International Hands for Peace Conference, Kiawah Island, SC.

Kelley, K. L., & Fields, R. H. (2014, January). *Beyond Observation: Strategies to Overcome Behavior Obstacles.* Session Presentation at the annual Utah Montessori Council Conference, Salt Lake City, UT.

Research

Utah State University

Graduate Researcher | School of Teacher Education and Leadership | June 2019-Present
Exploring the Influence of Peer-Assisted Learning Strategies (PALS) in Increasing Reading Comprehension of Grade-Level Biology Text and Biology Self-Efficacy in Students with Learning Disabilities: A Formative Experiment

East Tennessee State University

Graduate Researcher | Department of Human Development and Learning | Apr 1985
Independent Study: "Resilient Children"

- Researched current literature on topic and presented findings in a research paper

Undergraduate Researcher | Psychology Department | Dec 1981
Independent Study: "Drug Self-Administration by Mice"

- Performed intravenous cannulation of mice to determine if given the means, the mice would self-administer pain-killing drugs.
- Monitored and recorded times and doses of the self-administered drugs
- Assisted in translating the raw data into reports for the final research paper

Classroom Teaching Experience

Special Education Reading Teacher | Mountain View High School – Mesa, AZ | July 2018-present

- Design and implement reading and writing curriculum for ESL, MIID, MOID, and SLD students to access the general education curriculum
- Administer informal reading assessments to aid in class placement decisions as well as measure progress on IEP reading goals
- Design reading and writing strategies to support diverse learners in a co-taught biology classroom
- Draft and implement IEP goals to aid students in accessing the general education curriculum

Lower Elementary Teacher | Maria Montessori Academy – North Ogden, UT | August 2010 to May 2015

- responsible for individualized Montessori Curriculum implementation for each student to achieve individualized learning plan

- DIBELS Coordinator of thrice yearly K-3 testing (2011-2015) to monitor student reading achievement
- State EYE Mentor Coordinator who coordinated and mentored building teachers in their first three years of teaching (2011-2015)
- Data Coach who mentored teachers on the RtI data-gathering process (2011-2015) to facilitate IEP process
- Montessori Field Supervisor who observed and gave feedback to beginning Montessori teachers as well as reported trainee progress to the accrediting agency

Special Education Teacher |E. G. King Elementary School – Layton, UT | August 2006-May 2007

- Responsible for implementing reading and writing instruction to K-3 case load for resource and self-contained students
- Increased parent participation at IEP meetings and progress meetings in the regular classroom by developing relationships with parents by regular phone and written contact
- Collaborated with educators to improve regular classroom performance
- Provided mediation between special educators and regular educators on program implementation issues
- Shared supervisory/mentoring load of 1 assistant with the 4-6th grade special educator

Special Education Teacher | Family Enrichment Center – Kaysville, UT | August 2005-May 2006

- Implemented a self-contained autism unit with a caseload of 20 preschool aged children (3-5 years old)
- Developed and implemented alternative means of communication and reading for caseload
- Collaborated with Family Enrichment Center personnel on FSP (Family Service Plan) program implementation and with the Early Intervention Team to provide an effective transition into the classroom setting
- Supervised 2 assistants in program implantation and instruction
- Ongoing parent collaboration included home visits before beginning the school year and at other times as needed to help with program implementation, parent nights during the year, daily home notes and frequent phone contacts
- Attended IEP meetings to collaborate with regular educators throughout the district for the program's transitioning kindergarteners

Related Teaching Experience

Consultant | Shepherd's Hill Christian School– Talladega, AL | August 2002-June 2003

- Designed and implemented curriculum for elementary, junior and senior high classes for homeschooled students with learning disabilities to provide better access to the general education curriculum

- Collaborated with other homeschool teachers to solve challenges in instructing children with learning problems in the homeschool setting
- Responsible for working with the local school district to ensure compliance and program completion
- Collaborated with other homeschool teachers to provide art and music instruction

Consultant |Valley Christian School–Jacksonville, AL |August 2000-June 2001, August 2001-June 2002

- Designed and implemented curriculum for elementary and junior high classes for homeschooled students with learning disabilities
- Collaborated with other homeschool teachers to solve challenges in instructing children with learning problems in the homeschool setting
- Responsible for working with the local school district to ensure compliance and program completion
- Collaborated with local YMCA to provide physical education instruction for homeschooled students
- Provided support for local homeschool drama group

Long-Term Substitute | Bridgeport Elementary School– Newport, TN | February 1995-April 1995

- Implemented programs and instruction in a resource setting during the extended absence of the hired special educator
- Collaborated with regular classroom teachers on the implementation of IEPs in the classroom
- Supervised one assistant in implementing IEPs and classroom behavior management program

Special Education Teacher | Scera Park Elementary School – Orem, UT | January 1994-May 1994

- Implemented K-3 half-time resource reading and writing program
- Collaborated with reading specialist in implementing Dr. Alan Hofmeister's Reading for All Learners and the Writing Road to Reading in the classroom
- Collaborated with regular educators in effective literacy techniques for implementing IEP goals in the classroom
- Supervised 1 assistant in implementing IEPs and classroom behavior management programs

Special Education Teacher | Greenwood Elementary School – American Fork, UT | August 1993-December 1993

- Responsible for reading and writing program implementation in the half-time resource classroom
- Collaborated with regular educators to provide support for classroom behavior management of students with learning disabilities

Special Education Teacher | Heritage Schools – Provo, UT | March 1991-November 1991

- Designed programs of study based on student deficits for grades 7-12
- Collaborated with residential treatment personnel on implementation of behavior management programs in the classroom
- Team taught courses to meet individual needs
- Coordinated with outside agencies to provide real world experiences via field trips

Long-Term Substitute | Dixon Junior High School – Provo, UT | January 1988-May 1988

- Implemented resource program in the capacity of long-term substitute
- Team-taught biology in the regular education classroom
- Collaborated with regular educators in the implementation of IEPs and behavior management programs

Special Education Teacher | Timberlane Regional High School – Plaistow, NH | August 1987- October 1987

- Implemented resource program for grades 9-12
- Coordinated with regular educators concerning IEP implementation

Long-term substitute | Fayette County Public Schools – Lexington, KY | August 1985-June 1986, August 1986- June 1987

- Served in several K-3 Resource reading classroom settings throughout the district
- Instructed inmates in reading and writing at Fayette County Juvenile Detention Center for grades 7-12

Special Education Teacher | Science Hill High School – Johnson City, TN | August 1984-June 1985

- Co-taught 9-12 resource class for fall semester
- Hired as a long-term substitute for spring semester in the same classroom
- Prepared special education files for Federal audit
- Collaborated with regular educators on behavior management programs and IEP implementation
- Supervised one assistant in implementing IEPs and classroom behavior management programs

Student Teacher | Gunnings School – Blountville, TN | June 1984-August 1984

- Student taught in secondary severe/ profound setting
- Responsible for developing and implementing IEPs and behavior management programs
- Coordinated with employers for work-based learning experiences