

WRITING TO LEARN STRATEGIES ON STUDENT LEARNING IN BIOLOGY: AN
EXPERIMENT WITH STUDENTS WITH SPECIFIC LEARNING DISABILITIES

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ABSTRACT

Current research has shown that writing to learn strategies have a positive impact on overall student learning. However, previous studies mainly assessed student learning through instruments that have been self-designed by researchers and there is little research examining relations between writing to learn strategies and science related context achievement such as biology measured through standardized testing. In addition, very few studies on writing to learn strategies with students with disabilities measure the potential relations with biology achievement. The purpose of this quantitative study is to address the literature gap by implementing the use of writing to learn strategies to institute growth and achievement in biological science in students with disabilities. The objective of the study is to evaluate content area growth of students with disabilities in biological science through the use of writing to learn strategies embedded in classroom pedagogy. Using experimental research, forty-eight students with high incidence disabilities in grades 9 and 10 received writing to learn strategies in their biology class during the school day. The quantitative instrumentation involved in the study is a pre-test comprehensive biology baseline exam, a mid-treatment biology assessment, and a post-test comprehensive biology exam, an acceptability survey, and an attitude toward biology survey that was administered over a semester's timeline. The exams simulated standardized biology exams that employ the New Jersey Science Standards (NJSS) taught within the curriculum. All exams were slightly different; however, they focused on the same standards in biological science and the same overall content. Results were that the experimental group showed greater growth than the control group in the mid-treatment assessment, posttest and the Attitude Toward Biology Survey. Empirical implications are that writing to learn strategies would have significant impact on biological science standardized testing for students with disabilities.

DEDICATIONS

I dedicate this second dissertation that I have written to my beautiful sons Alexander, Jacob and David who are my gifts from my Lord and Savior, JESUS CHRIST. They have watched me go to class and at Temple University in Philadelphia for the last three years. This was a second doctorate and a ninth degree. With these accomplishments, I want my sons to understand that all things are possible if: 1) you put GOD first in your life and 2) you work hard and do not become satisfied with current levels of success. My sons, you are the best fiends I could ever ask for and you are my everything. My sons, you make this life worth living and every moment I spend with you is a gift from our Creator, JESUS CHRIST.

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CHAPTER 1

INTRODUCTION

The Research Problem

Educators have recognized the importance of writing in learning content, in particular science content. Writing has been used as a method for learning in all content areas and scholars have researched how writing could positively impact the overall performance in all content area learning (Wills, 1993; Zinsler, 1988). This is true for learning biological science, writing enhances critical thinking skills in students which enhances performance in biological science and supports learning through the initiation of a connection with reading, writing, and learning scientific content (Fulwiler, 2007; Holliday, Yore, & Alvermann, 2006; Kurtz & Quitadamo, 2007). Writing and notetaking strategies in all students, particularly in students with specific learning disabilities, progresses analytical thinking skills in biological science and connects understanding of scientific content (Boyle, 2011; Boyle, 2013; Fulwiler, 2007; Holliday, Yore, & Alvermann, 2006; Kurtz & Quitadamo, 2007).

Within the last decade in primary and secondary schools, writing has become secondary to technology. Technology in primary and secondary education has decreased traditional writing in educational classrooms as they can be mutually exclusive in the curriculum. Writing and technology are not fundamentally incompatible, however, traditional writing is not taught to the extent it was in the past due to advanced use of technology in schools. As such, writing is only minimally taught in primary and secondary education anymore and it has been replaced by an increase in technology courses. Although technology is essential in learning, enhanced handwriting in schools would improve letter processing and reading acquisition in students which could be hindered through the replacement of writing with technology (James &

Engelhardt, 2012). Throughout K-12 education, technology has become a primary objective of school districts and writing has been left out of the daily course load (Davis, Fisher, & Forde, 2009). In school districts that use tablets and specified technology that allows students to hand write on the tablet, writing could be implemented within technology, however; Middleboro High School does not have that capability. In Middleboro High School, there are Smart Boards and Promethean Boards that we use for class; however, tablets and specified technology that allows students to hand write on the tablet are not available for the students. More technology would offer learning skills that benefit 21st century learning which would enhance the learning process through writing leading to greater achievement and content understanding in specified content areas (Cooper, 2012).

Although technology is highly beneficial to students in the acquisition of 21st century leaning skills, there is a growing gap in content knowledge, critical/analytical thinking skills, and methodological/reasoning abilities based on more time spent on technology than writing within the curriculum. Writing to learn strategies can provide greater understanding of content knowledge to general education students and also students with disabilities (Danoff, Harris, & Graham, 1993). Writing to learn strategies - defined by writing techniques that catalyze learning of content - have a positive impact on student learning in science, especially students with learning disabilities. Writing to learn strategies are an educational and investigative method to learn specified content such as biological science along with concepts within the content through engaging strategies (Tarchichi, 2017). Dialectical notebooks and strategic notetaking, which are defined below, are two forms of writing to learn strategies that are used in this study to enhance student performance in biological science (Danoff, Harris & Graham, 1993; Fulwiler, 2007; Kurtz & Quitadamo, 2007; Moore, 1994; Prain & Hand, 1999; Tarchichi, 2017). Through

writing, students are able to expand their ability to learn content, develop critical understanding of subject matter, and develop greater reflection capabilities about content they have learned (Kurtz & Quitadamo, 2007). Through writing in educational classrooms, student achievement, especially achievement in students with disabilities, increases in individual content areas, in particular, biological science (Boyle, 2010; Hohenshell & Hand, 2006). Writing to learn strategies enhance the ability of students to organize information that is necessary in the content of biological science. Engaging in writing to learn strategies leads to greater understanding leads to greater understanding in science disciplines and content as well as increasing student knowledge within biological science content for students with disabilities.

Without writing being emphasized in the curricula, the ability of students to think critically and analytically has decreased (Kurtz & Quitadamo, 2007). The writing to learn strategies that I focused on were strategic notetaking and dialectical notebooks. Dialectical notebooks allow students to enhance their critical thinking skills through a double entry journal method where the reader analyzes the information in the text and creates meaning to further their understanding of the content (Tarchichi, 2017). Strategic notetaking is a strategy that teaches students to record specific words and phrases from the content to improve their understanding of the overall subject matter. Strategic notetaking enhances the ability of students to record proficient notes from their learning at a pace where they can make meaning from the content (Boyle, 2011). This is especially essential for students with specific learning disabilities because they are expected to learn and understand the same content as their general education peers, which is very difficult in the content of biological science (Boyle, 2011; 2013; Boyle, Forchelli, & Cariss, 2015).

Boyle examined the effects of notetaking skills on students with disabilities and how strategic notetaking can positively impact the learning in the content and subject matter in both the middle and high school level (Boyle, 2001; 2007; 2010; 2011; 2013; Boyle, Forchelli, & Cariss, 2015). Writing to learn strategies can influence overall science learning in both physical and biological science through examination and analysis; additionally, the writing strategies would have a positive impact in the sciences through motivation and learning through integrating theory and practice (Campbell & Fulton, 2003; Kornyshev, 2010; Tynjala, Mason, & Lonka, 2001).

Writing to learn strategies include both dialectical notebooks and strategic notetaking, which are two examples of writing to learn strategies. Dialectical notebooks are double entry journals which act as interactive notebooks for students that help them to make sense of the content they are learning through pedagogy and their own comprehension. Strategic notetaking helps students to learn concepts within a particular content through the creation of their own notes independently, also through summarization of concepts and activation of prior content understanding (Boyle, 2011; Boyle, Forchelli, & Cariss, 2015). The procedures for the use of dialectical notebooks are interconnected to the processes for the use of strategic notetaking in multiple ways. In both writing to learn strategies, students must summarize specific facts, details, and concepts from the lecture/teaching, use independent learning to understand information being presented, and summarize or create a personal understanding of the content being taught (Tarchichi, 2017; Waldman & Crippen, 2009). A ten-item checklist of the implementation of both dialectical notebooks and strategic notetaking is presented in Appendices E and F.

Problem Statement

Students with specific learning disabilities have difficulties learning advanced content, especially science. This is shown in students with specific learning disabilities' having difficulty in science and their lack of interest in science courses beyond the high school requirements, which is reflected in their standardized test scores in biological and physical science (Espelage, Rose, & Polanin, 2016). Moreover, with the continuous rise in technological advancements in primary and secondary education, there is not much time in the day for writing in the curriculum due to the technology advancements (Davis, Fisher, & Forde, 2009). The rise of technology has had a positive impact on school culture and student learning but came at a price to writing pedagogy in K-12 education; this is especially true for students with specific learning disabilities. Without the ability to write on a continuous basis, students with and without specific learning disabilities will not be as effective when strategically and methodically learning difficult content. Furthermore, writing will catalyze critical thinking when learning difficult content such as biological science (Danoff, Harris, & Graham, 1993; Kurtz & Quitadamo, 2007). The connection needed for learning science embeds both reading and writing. Without writing, it is difficult for students, especially students with disabilities to create the connection needed to learn the difficult scientific content entrenched in biological science (Holliday, Yore, & Alvermann, 2006). Science requires constant experimental writing which must be repetitively used throughout student coursework. This has the overall ability of improving the academic performance of students in content such as biology.

Due to curricular restraints, educators do not have the ability to teach writing daily because they would be off target on the curricular pacing guide. Educators need the freedom to teach writing which will support student learning at the secondary level (Pooch, Burke,

Greenbowe, & Hand, 2007; Ray, Graham, Houston, & Harris, 2016). Teachers use to have the freedom to use writing to enhance literacy in all content areas. For example, teachers use to be able to deviate from curricular restraints and write stories to develop knowledge in specific learning content. Writing stories would be an excellent way for students, especially students with specific learning disabilities, to grow in their science literacy skills needed to learn biological content (Ritchie, Tomas, & Tones, 2010). Writing is seldom used in school districts today because there is little room in the curriculum; however, if writing to learn strategies were able to be incorporated in schools due to their effectiveness in teaching students with disabilities science content, then the effectiveness of writing could be recognized for policy makers and state curriculum writers.

Purpose of the Study

Educational researchers have conducted studies concentrating on notetaking strategies and their effects on students with mild learning disabilities or high incidence learning disabilities such as Learning Language Mild to Moderate students or Inclusion students as a means to measure academic growth in various content areas and disciplines. Yet, there needs to be more empirical evidence for writing to learn strategies as an intervention to cultivate and support biological science advancement and development in students with specific learning disabilities (Boyle, 2001; 2007; 2010; 2011; Boyle, 2013; Boyle, Forchelli & Cariss, 2015). These studies focus on notetaking and this study focuses on both strategic notetaking and dialectical notebooks.

The purpose of this study was to examine the effectiveness of writing to learn strategies, both dialectical notebooks and strategic notetaking in combination on biological science learning for students with specific learning disabilities. I addressed two areas of concentration with this study. I first explored the role writing to learn strategies have on student achievement,

specifically relating to dialectical notebooks and strategic notetaking. By having students with disabilities take standardized science exams in science while receiving writing to learn strategies as a treatment/intervention, this dissertation aimed to contribute to the literature on how writing could catalyze science learning and knowledge in students with disabilities.

The second area of concentration from this study addressed the question of attitude, particularly whether writing to learn strategies have an effect on the desire of the students with disabilities to learn science through writing and if they believe writing had a positive impact on their biological science understanding. By using writing to learn strategies in the form of classroom teaching through small group instruction, students' level of biological science understanding have led to more learning through writing pedagogy. I hypothesized that the increase in writing to learn strategies would catalyze learning in biological science measured using standardized tests and attitude surveys given to students.

The design of the study was an experimental study where students were randomly assigned to the experimental and control group which is the definition of a true experiment as subjects were randomly assigned. The independent variable was that the writing to learn strategies implemented with the students with disabilities in biology class. The dependent variables in this study were the change in biological science knowledge measured through standardized test assessments and the change in attitude toward biology. In addition, the control group consisted of students with disabilities not receiving the writing to learn strategies. Finally, the secondary students with disabilities' knowledge measured through standardized tests helped to facilitate an understanding of the relationship between writing to learn strategies and biology learning in students with specific learning disabilities. Therefore, I explored the impact of

writing to learn strategies (dialectical notebooks and strategic notetaking) on biological science content knowledge in students with disabilities.

Research in this area has the potential to inform educators, both teachers and administrators, how beneficial writing to learn strategies can be in biology achievement. The analysis of research on writing to learn strategies used in science and other content areas is beneficial in the potential impact of writing to learn strategies on students with disabilities in biological science. Additionally, research in this area has the potential to inform state and federal departments of education how to positively impact student biology achievement through incorporation of writing to learn strategies in daily pedagogy for students with high incidence disabilities.

Research Focus and Research Questions

My research focused solely on students with disabilities in biological science and incorporated one more writing to learn strategy than strictly strategic notetaking. The writing to learn strategies used in my research included dialectical notebooks and strategic notetaking. As stated, this study focused on writing to learn strategies that included strategic notetaking and dialectical notebooks and their impact on learning biological science content knowledge of students with specific learning disabilities (Boyle, 2001; Fulwiler, 2007; Hohenshell & Hand, 2006; Moore, 1994; Prain, 2006; Zinsser, 1988). This was a quantitative research design that was pre-determined using instrument-based questions where statistical analysis and interpretation were used to analyze performance data on standardized exams. In biological science, standardized exams are invaluable measures of student understanding of vital biological concepts and theories. The study consisted of a pretest, a mid-treatment assessment and a posttest where data were collected to support or refute the hypothesis. The null hypothesis was

that writing to learn strategies have no effect on academic achievement for students with disabilities in Biology (Creswell & Creswell, 2017).

Students with disabilities in high school are instructed in biology in alignment with the common core standards. My hypothesis was that if writing to learn strategies are incorporated within teacher pedagogy, student biological science achievement would increase because of the positive influence of writing to learn strategies on student cognition (Bangert-Drowns, Hurley & Wilkson, 2004; Fulwiler, 2007). The usage of writing and writing to learn strategies in science has the potential to enhance content understanding and its relationship to student achievement which was measured in this study (Poock, Burke, Greenbowe, & Hand, 2007). This quantitative study addressed the following two research questions:

1. Do the writing to learn strategies of dialectal notebooks and strategic notetaking enhance student achievement in students with disabilities in biological science?
2. Do the writing to learn strategies of dialectal notebooks and strategic notetaking impact the attitude and acceptability of students with disabilities in biological science?

Significance of the Study

A quantitative research study was used to determine whether or not the writing to learn strategies of dialectical notebooks and strategic notetaking had the potential to impact the biological science standardized test scores, the attitude, and the acceptability of students with disabilities in secondary education. Writing to learn strategies have been used by researchers to enhance learning in both primary and secondary students; however, the literature lacks a connection between the writing to learn strategies of dialectical notebooks and strategic notetaking and the biological science learning of students with disabilities (Kurtz & Quitadamo, 2007; Tarchichi, 2017).

This study contributes to the field of special education research through the exploration of writing to learn strategies and may also be used to inform instruction and biological science learning for students with high incidence disabilities. With a growing emphasis on students in special education staying on the same curricular pacing guide as students within the general education population, there is a continuous responsibility being placed on educators to increase the effectiveness of teaching along with overall student understanding of content areas like mathematics and science (Burns, 2004; Moore, 1994).

This responsibility is placed on educators with limited resources and classroom space; therefore, it is the responsibility of educational researchers to develop teaching strategies that are impactful, resourceful, economical, and which create effective student approaches to learning and studying (Biggs, 1987). These teaching strategies can be developed in a system wherein both researchers and educational practitioners contribute to the development and testing of plausibly more effective educational strategies. Creating additional teaching strategies such as writing to learn catalyze student success in the sciences, especially for students with specific learning disabilities, and give them the learning tools that are essential in understanding difficult content. While the use of writing to learn strategies is existent in the literature, the role of writing to learn strategies in biological science for students with specific learning disabilities remains in question. This is especially true using the writing to learn strategies of dialectical notebooks and strategic notetaking. The results of this study have shown that there is a relationship between writing to learn strategies and biological science learning for students with disabilities (Cole, Waldron, & Maid, 2004).

The potential of the writing to learn strategies of dialectical notebooks and strategic notetaking positively impacting performance and attitude of students with specific learning

disabilities in biological science has relevance for both practical and research application in the field of special education. Standardized exams are used to measure the growth and curricular knowledge of students in public education and writing to learn strategies could be used as a measure of closing the achievement gap for students with specific learning disabilities and development of curricular understanding in a difficult content area such as biological science. Furthermore, the use of attitude surveys could inform educators of the interest of students with disabilities in writing to learn strategies, which could mirror their ability to learn a difficult content area such as biological science, chemistry, physics, or mathematics (Campbell & Fulton, 2003; Countryman, 1992).

Conclusion

This quantitative study concentrated on the infusion of writing to learn strategies in biology classrooms in order to facilitate greater biological science content understanding in secondary students with disabilities. There is an absence in the literature regarding writing to learn strategies for students with disabilities to catalyze biological science knowledge and learning in secondary science. The writing to learn strategies of dialectical notebooks and strategic notetaking were aimed at benefiting the Middleboro School District through the inception of biological science learning in students with disabilities.

This study illustrated the need of writing in difficult content areas such as biological science and the benefit writing to learn strategies has on students with specific learning disabilities' science learning and overall knowledge. Through this research study, I demonstrated that existing curriculum pacing guides should contain a daily writing component that help students with disabilities absorb biological science content more thoroughly. This was also shown through their performance on standardized exams and attitude surveys.

Dissertation Organization

This chapter provided an outline of the research problem, the purpose of the study, and the research questions the study addressed along with the introduction of the two specific writing to learn strategies that were used throughout the dissertation. Chapter 2 will provide a more detailed view of the theoretical framework for the study and a review of the current literature on writing to learn strategies and their impact on student assessment. Chapter 3 describes the systematic design, statistics, and methodology that were used to answer the research questions. The results and statistical analysis are shown in Chapter 4. Lastly, Chapter 5 describes conceivable limitations of the study and the suggestions for future research.

CHAPTER 2

LITERATURE REVIEW

In this chapter, I present the literature review. I offer an introduction to the study, the research involved in strategic notetaking, dialectical notebooks, and writing to learn strategies. I offer a theoretical framework, the philosophical epistemology, along with the social practice theory and reciprocal learning. I discuss the conceptual framework in the study which leads into science learning and the impact of writing to learn on biological science. I then offer literature on learning in inclusion classrooms and learning in language mild to moderate classrooms. I conclude with reviewing the literature and the research questions.

Introduction

There is a lack of research on the impact of writing to learn strategies on the biology performance of students with disabilities. Research is limited to notetaking strategies on students with disabilities in biological science and writing to learn strategies in all content areas with a focus primarily on general education students. These studies focus strictly on the notetaking strategies and no other writing to learn strategy. Additionally, these studies do not focus on students strictly in biological science. Research focusing on notetaking strategies and their educational effects on students with mild learning disabilities or high incidence learning disabilities has been attempted as a measure to facilitate academic growth in various content areas of students; however, there is a lack of empirical evidence for writing to learn strategies being used as a treatment to catalyze and promote biological science growth in students with disabilities (Boyle, 2001; 2007; 2010; 2011; 2013; Boyle, Forchelli & Cariss, 2015). The use of the writing to learn strategies of both strategic notetaking and dialectical notebooks has shown to be beneficial in learning biological science for students with disabilities.

Strategic Notetaking

All students, especially students with disabilities need assistance with their learning in all forms. One of these forms is notetaking that can have long term effects on strategies to retain learned information and assist students in preparation for required exams. Proper notetaking will catalyze learning in all educational settings and will prepare students to capitalize on previously learned material that has critical components for new content which will be introduced in future lessons and enhance critical thinking (Boyle, 2011). An example of this would be organic chemistry where learning nomenclature would be a requirement for learning specific, more detailed reactions. A student cannot simply acquire the necessary notetaking skills in secondary or post-secondary settings to perform well in a subject of that magnitude, the notetaking skills must be acquired earlier in their academic careers. Learning useful notetaking techniques in primary educational settings will enhance learning in secondary and post-secondary learning environments and prepare students for material that is foreign and requires significant cognitive skills and capabilities. This is especially true of students with disabilities as they require more organizational skills and strategies to effectively learn content (Boyle, 2001; 2007; Boyle, Forchelli, & Cariss, 2015). Boyle (2011) discusses strategic notetaking in more content-oriented settings when he stated:

Strategic notetaking offers students with disabilities a chance to learn effective notetaking skills that they could use independent of teacher assistance and, once mastered, these skills could be used by students as they move on to high school and postsecondary settings. (p.33)

As students get older, their education becomes more content specific (just as in the above organic chemistry example) and strategic notetaking is a method of learning that enhances their ability to absorb new information in a more independent learning manner (Boyle, Forchelli, & Cariss, 2015). However, content specific learning for students in the general education setting

and special education setting requires more than rote learning techniques. Students, particularly students with disabilities, need to become more independent in the content knowledge, particularly in content such as science that requires learning in stages (Boyle, 2011). Students with disabilities require more than lecture, discussions, reading and group work. Content specific lessons, especially science lessons require more organizational skills and accurate learning accommodations for students with disabilities. Notetaking strategies ultimately catalyze processing of learned information which would help students to remember vital material that is needed for testing and further learned material that is dependent on previously learned information (Boyle, Forchelli, & Cariss, 2015). Boyle (2011) pointed out the application of notetaking techniques when he stated:

Notetaking techniques, such as strategic notetaking, can be successfully implemented into a content-area curriculum. Teachers who want to use these techniques in their classes should begin by developing their own set of notes using strategic notetaking. These notes will not only help the teacher help the teacher stick to a script of the lecture, but these notes can also serve as model notes for students. (p.62)

Throughout the reviewed research, Boyle discusses the purpose of his studies as he attempts to answer specific research questions centered on notetaking and student performance in test taking skills and abilities. More to the point, Boyle (2011) is very clear in his research intentions in his fourth research question when he stated, “why would middle school students who used strategic note-taking perform better on a long-term recall measure and a comprehension test?” (p.55). This question could be mirrored for high school students when discussing writing to learn strategies such as strategic notetaking impacting a student’s ability to recall content knowledge for a comprehension exam. Boyle (2011) discusses notetaking through the use of five metacognitive cues that essentially help students to create a connection with previously learned content and the arrangement, classification, labeling, and detail-oriented

notetaking strategies. Essentially, Boyle's research methodology for his studies employed quantitative analysis through the use of experimental and control group design. In Boyle's research, there is a comparison of experimental and control groups where strategic note taking is used as the independent variable or treatment used by the researcher. The result of whether the notetaking strategies/skills were successful in enhancing academic performance was the dependent variable used in Boyle's research.

Using a control group served to act as a limitation in the research as Boyle (2013) stated: Although the use of a no-treatment group is a common procedure that has been used in notetaking research, its use does present a possible weakness because some notetaking of the training of the control subjects may have lessened the difference in the effect of the independent variable. (p.87)

Data were collected in various ways including test scores, quizzes, review of student notes, and writing tasks. Data analysis was mainly conducted using a multivariate analysis of variance (MANOVA) due to multiple dependent variables used in the research (Boyle, 2011; 2013). This is very similar to the data analysis in my study although I used a repeated measures analysis of variance (ANOVA).

Additionally, the studies are very similar in their assumptions that strategic notetaking skills and practices will facilitate growth in student learning and will be quantified on performance measures such as exams. The research is consistent in the assumption that students with disabilities require further assistance taking appropriate notes in their classes, especially content specific coursework. Additionally, the reviewed research methods were consistent in their use of experimental and control groups. The most salient differences in the research were the utilization of different populations of students; specifically, middle school students, inclusion students, students with mild disabilities, students with learning disabilities and students within the general education population. The reviewed articles that employed an experimental design

had varying number of subjects including 76, 90, and 104. They were comprised of both students with disabilities and students within the general education population (Boyle, 2010; 2011; 2013). These studies are excellent in understanding notetaking strategies and their potential impact on students with high incidence disabilities in many content areas including science; however, more research is needed to understand the impact of writing to learn strategies on biology for students with disabilities measured through standardized exams. Learning science requires greater abilities than notetaking strategies and other writing to learn strategies such as dialectical notebooks could catalyze science learning in students with disabilities to a greater degree.

In a study performed by Ruiz-Primo, Li, Tsai and Schneider (2010) the authors found that the manner in which students took notes within their notebooks was tethered to their level of scientific understanding. The authors also found that performance on assessments was directly correlated to students' ability to explain the science content they learned.

The authors stated that

Many researchers have supported writing in science to enhance student understanding of scientific content and processes. It is claimed that the mental representations, strategies, and operations that take place while writing can lead to improved learning... The rationale is that having students present their explanations in written language engages them in a specific type of reflection that is not natural in oral exchanges (p. 584).

A study with a similar objective as previous studies was performed by Danoff, Harris and Graham (1993) where the researchers focused on the effects of strategic writing in classroom content that had both students with disabilities and general education students. This study was beneficial in understanding the impact of strategic writing on more than one content area, but much like the aforementioned studies, there was not a strict focus on biological science or students with disabilities. Specific studies (e.g., Kurtz & Quitadamo, 2007) have focused on

writing strategies and their impact on biological science and the overall effects of writing and its influence on critical thinking skills. Studies have also measured the effects of writing as an educational tool for learning biological science. However, these studies have focused on students strictly in the general education setting and have not included students with disabilities (Hohenshell & Hand, 2006; Kurtz & Quitadamo, 2007; Moore, 1992; 1994). It is essential to employ research that incorporates more writing to learn strategies than simply strategic notetaking that focuses on students with disabilities in biological science.

Dialectical Notebooks

Both strategic notetaking and dialectical notebooks are important writing to learn strategies that have the potential to benefit science learning in students with disabilities as hands on and inquiry-based learning activities. School based science education must have some transferability to actual science learning, which would benefit overall understanding of students and enhance their performance on standardized testing (Roth, 2011). Waldman and Crippen (2009) discuss how transferability can be provided in science through the integration of interactive notebooks during learning. The authors provide an example of the interactive notebook activities where the left side of the paper is based in student directed activities and the right side of the paper is based in teacher directed activities. The authors discuss the educational empowerment for students using the interactive notebooks and how they provide students with active engagement, self-reflection, and organizational abilities in science. Moreover, they provide students with a sense of visual learning, content language understanding, and incorporation of learned content from other science disciplines which helps students to identify weaknesses within the standards they are learning (Waldman & Crippen). Waldman and Crippen further discussed the value of interactive notebooks when they stated “working with the

interactive notebook, students come to value sensemaking and become aware of the knowledge and skills required to control their learning. This, in turn empowers students to become confident and focused, thereby improving their achievement” (p. 55).

Students are empowered in science through the use of more hands-on activities where the learning setting and atmosphere adheres to a positive shift in the learning culture (Hwang & Roth, 2007). In their study, Hwang and Roth developed a teaching environment for secondary students through the use of hands-on curricular activities centered on scientific concepts. The authors showed the importance of hands on activities when learning theoretical concepts and theories within physical and biological science.

Writing to Learn Strategies

There is extensive literature available on writing to learn strategies and their effects on student learning and literacy in science along with other academic disciplines (Moore, 1994; Ritchie, Tomas, & Tones, 2010). What differs in this study from past and current research is the link of writing to learn strategies to specific biology achievement in high school curriculum for students with disabilities. Writing to learn strategies should change biology achievement based on the positive influence on learning created in students; in addition, writing to learn interventions can enhance classroom content knowledge (Bangert-Drowns, Hurley & Wilkson, 2004).

The importance of biological science in secondary education is paramount and well established. Biology is a main science taught to high school students, with most students taking biology in grade 9 and grade 10. By identifying if writing to learn strategies can benefit biology achievement, student biological science understanding in high school could grow; thereby benefitting most students in secondary education. Biology achievement is important for college

and career readiness because it can help students understand the academic content more fluently (Fry & Villagomez, 2012; Hohenshell & Hand, 2006; Kurtz & Quitadamo, 2007). Most students with disabilities in high school are placed in biology courses because the overall requirements for chemistry and physics courses are too demanding for students with disabilities. Therefore, there is a larger number of students with disabilities in biology courses in a secondary setting. Although not as mathematically demanding as chemistry or physics, biology requires a great deal of critical/analytical thinking skills that must be catalyzed and cultivated in students with disabilities. Due to the disparity of students with disabilities in biological science as compared with the physical sciences, this study is needed and will be beneficial in helping special education students learn biology suitably for their educational needs.

In addition, there is potential to use the information learned in this study in other sciences such as chemistry and physics, further benefiting students in secondary education. Biological science content knowledge can help students learn physical science through biological science theory applied usefully in physical science concepts (Kornyshev, 2010). Strategic writing has been shown to positively impact student growth and erudition in multiple content areas both in primary and secondary education. Moreover, writing in science can assist students grow in course content knowledge, positively affecting academic performance in science and all academic content areas (Poock, Burke, Greenbowe, & Hand, 2007; Tarchichi, 2017). Current research shows there is a positive impact of writing and writing to learn strategies and student scientific learning and concept understanding (Friend, 2002; Hand, Hohenshell, & Prain, 2007).

Theoretical Framework

The design of an instructional practice like writing to learn strategies in science content such as biology needs to be rooted in a theoretical framework. Gardener and Belland (2012)

pointed this out when they stated, “to match instructional methods with instructional goals, the design of instructional materials should be grounded in a research-based framework” (p. 468). In learning biological science, and all science for that matter, I have a set of beliefs that guide my teaching, inquiry and research that have led to my philosophical epistemology which affects my ontology, methodology, and research theories. This theoretical framework discusses my philosophical epistemology which leads to two learning theories that I contend shape the use of writing to learn strategies as an intervention in learning. They include Vygotsky’s Sociohistorical Theory and Activity Theory along with Social Practice Theory and Reciprocal Learning (Brown, 1992; Hohenshell & Hand; Wolf-Michael & Yew-Jin, 2007; Holland & Lave, 2009).

Philosophical Epistemology

The theoretical framework for writing to learn strategies to be effective as an intervention in learning biological science is embedded in both a positivist and a constructivist approach to learning. Concerning the positivist framework, the biological science content knowledge is delivered to students through the understanding of core concepts in science and the ability of students to understand the scientific processes embedded within biological concepts. Biological science understanding is rooted in scientific law and/or paradigms, where observation, measurement, and methodology are centered on experimentation and hypotheses. Biological science, much like physical science is objective and focused on deductive logic and inductive reasoning where the results are considered absolute truths. Therefore, the knowledge of biological science is considered to be scientific law (Compte, 2000).

Regarding the constructivist framework to learning, there should be a hands-on and collaborative approach to learning biological science. Biological science learning contains an

active learning component which will create greater engagement of students in biological science and the problem-solving skills needed to comprehend biological science concepts (Gardner & Belland, 2012). The use of a hands-on collaborative approach and the student engagement through active learning is how I approached this study. The writing to learn strategies of dialectical notebooks and strategic notetaking enhance knowledge growth through collaboration and discussion with both the teacher and fellow students in the learning process. Social interaction within a biology classroom catalyzes the facilitation of learning science discussion of core concepts within the discipline (Hohenshell & Hand, 2006).

Kumar (2012) showed the significance of the constructivist approach to learning science through concept maps and how the constructivist methodology showed significantly better results in learning scientific content than traditional individual learning methods. In addition, in their case study, Wang and Buck (2016) were able to show that through the application of argumentation in science pedagogy as a learning objective, student participation would increase in science learning. Argumentation and discussion are necessary in the structure and transformation of meaning and understanding in science education. In opposition to the positivist perspective, a constructivist approach to learning welcomes discussion and communal participation in the understanding of scientific learning through argumentation, dialogue, and debate practices that stimulate science content knowledge (Hohenshell & Hand, 2006; Kim & Song, 2005; Wang & Buck, 2016).

The positivist paradigm should be supplemented through the use of paradigms in special education research that employ hands-on/discovery-based learning, in particular, the constructivist paradigm. Subjective and objective methodologies should both be employed in order to fully understand the fundamental and concrete information within the content, and

constructive approaches to inquiry and knowledge within the field should evolve from the mere use of objective analysis that was employed at the commencement of the positivist learning paradigm. In order for a hands-on intervention such a writing to learn strategies to be successful in the field of special education, the use of strict objective methodology through the positivist paradigm should be tethered to collaborative and subjective data analysis that would catalyze essential knowledge and inquiry in students with specific learning disabilities (Anderson & Barrera, 1995; Hohenshell & Hand, 2006; Lather, 1988; 1991). Inquiry should lead to action and must be guided by universal truths that are accepted across all educational content and concepts, especially science and grounded in universal truth or laws. Research in special education is grounded in a positivist and/or functionalist research viewpoint and philosophy and moves toward a constructivist lens for inquiry-based learning (Anderson & Barrera, 1995; Bhaskar, 1975; Comte, 2000).

Vygotsky's Sociohistorical Theory and Activity Theory

Writing to learn strategies in science are linked to Lev Vygotsky's Sociohistorical Theory and Activity Theory which is a theory that stemmed from the work of Vygotsky (Rowell, 1997; Spinuzzi, 1996). A mechanism for students to enhance their thinking, cognition, impetus and overall learning is through Vygotsky's Activity Theory. Wolf-Michael and Yew-Jin (2007) discussed the benefits of activity theory when they stated "Activity theory holds much promise for sharpening our thinking and praxis across three interrelated topics in learning research: motive or motivation, emotion, and identity. These concepts are, as Vygotsky realized, integral to cognition, knowing, and learning" (p. 213).

Teaching biology is tethered to student engagement, peer collaboration and discussion along with problem solving (Gardener & Belland, 2011). Conversation, discussion, and

argumentation are essential processes in learning biological science and the integration of science in the natural world and society. Biology learning concepts should be aligned with authentic tasks and personal connections for the student which will catalyze engagement in their learning (Gardener & Belland, 2011; Kuhn, 2005). The writing activities in classrooms are undertakings where students can function as a community of learners which engage students to achieve an objective through the use of teaching and learning actions and activities over a time period. Writing activities allow learners to create meaning through social interaction, collaboration, discussion and cooperative relationships (Gardener & Belland, 2011; Hohenshell & Hand, 2006; Spinuzzi, 1996). Vygotsky's Sociohistorical Theory and Activity Theory have a focus on catalyzing knowledge through practices of inquiry, collaboration, connection, praxis and the development of understanding in students and their specific learning (Hohenshell & Hand; Wolf-Michael & Yew-Jin, 2007). Vygotsky's Sociohistorical Theory and Activity Theory are directly linked to social practice theory and reciprocal learning.

Social Practice Theory and Reciprocal Learning

Both the positivist and constructivist theoretical epistemologies are centered on my definition of learning which states that knowledge from a science concept that is considered a law must also be rich in teaching centered in social capital for authentic understanding in the school environment. Learning is a sociocognitive process that requires a social interaction amongst the stakeholders in a learner's education. Based on my belief or theoretical underpinning that social capital must be an instrumental component of the learning process in science education, I contend that for success in science learning to take place, there must be a social context embedded in the educational process. There must be an interchange of resources among the students within an organization for real learning to occur in an educational environment. The idea of social interaction, which I contend is evident in writing to learn

strategies, is a culture of learning which enhances the overall academic growth in students and creates a reciprocal learning process (Brown, 1992; Trainor, 2008, 2010).

Brown's (1992) design of reciprocal learning incorporates the concept of social capital because she views student peers as a resource to better learn the material, content, or subject matter appropriately. Through her practice of reciprocal learning, students could become more accountable for their learning through a social or active learning process which would catalyze their overall content knowledge (Brown, 1992). Bandura (2001) discussed the social causation or context embedded in personal effectiveness or success. There are environmental and social factors which are essential in the growth and development of an individual, both socially and cognitively. The resources available through social capital have the capabilities to catalyze learning, cognition, and personal ambition (Bandura, 2001). Cole and Wertsch (1996) contend that social capital is directly associated with cognition and that social interactions are tethered to individual development. The researchers argue that social developments within the environment catalyze individual growth and actions.

Much like the above researchers, Holland and Lave (2009) discuss the significance of social practice theory within an environment and its impact on culture, values, and individual engagement. The researchers contend that personal identity and knowledge are woven into the environment, culture, and social practice. John-Steiner and Mahn, (1996) discuss how learning, knowledge, and overall growth are fastened to social systems, culture, and community. Through their educational viewpoint, the participation of the community is directly linked to learning and application of academic and real-world knowledge. Secluded learning without the use of social processes would not yield the learning outcomes of sociocultural methods of learning and erudition (John-Steiner & Mahn, 1996). Lai, Wong, and Feng (2015) argue a connection

between social capital and academic growth and achievement in the school environment.

Trainor (2008) argues the lack of social capital in students with disabilities gives rise to subpar academic outcomes and lessened academic accomplishments. My personal epistemology along with the frameworks associated with writing to learn strategies and learning theories associated with writing to learn strategies have been instrumental components to my positionality.

Conceptual Framework

The conceptual framework, shown in Figure 1, was articulated to describe the initial research problem, which was the effect of the writing to learn strategies of dialectical notebooks and strategic notetaking on biological science. The research problem consisted of the lack of performance of students with specific learning disabilities in biological science. Writing enables students, especially students with disabilities, to make an association with the challenging subject of biological science and it would create those connections in other science content areas as well (Holliday, Yore, & Alvermann, 2006; Poock, Burke, Greenbowe, & Hand, 2007; Tarchichi, 2017). The epistemologies that are grounded in this conceptual framework are both positivism and constructivism. Constructivism reveals features of a system that can be partially explained by using Vygotsky's sociohistorical theory, activity theory, social practice theory, and reciprocal learning. Through these theories, authentic tasks, peer collaboration, connection, inquiry and praxis are enhanced (Hohenshell & Hand, 2006; Wolf-Michael & Yew-Jin, 2007). However, science learning still requires a deductive logic and inductive reasoning that will lead to student content knowledge.

Positivism utilizes the belief the biological science is grounded in scientific law and or paradigms and established or agreed upon facts. Through the use of deductive logic and inductive reasoning, students will enhance their content knowledge of biological science which

originated from the positivist philosophy that science is authentic knowledge and that knowledge is gathered through evidence based and observable methodology (Compte, 2000). Through a positivist framework, content knowledge is acquired; however, inquiry, connection and praxis are also required. Through the utilization of writing to learn strategies of dialectical notebooks and strategic notetaking, there is a progression of students in biological science performance and a positive change in student attitude toward biological science (Hohenshell & Hand, 2006; Zinsser, 1988).

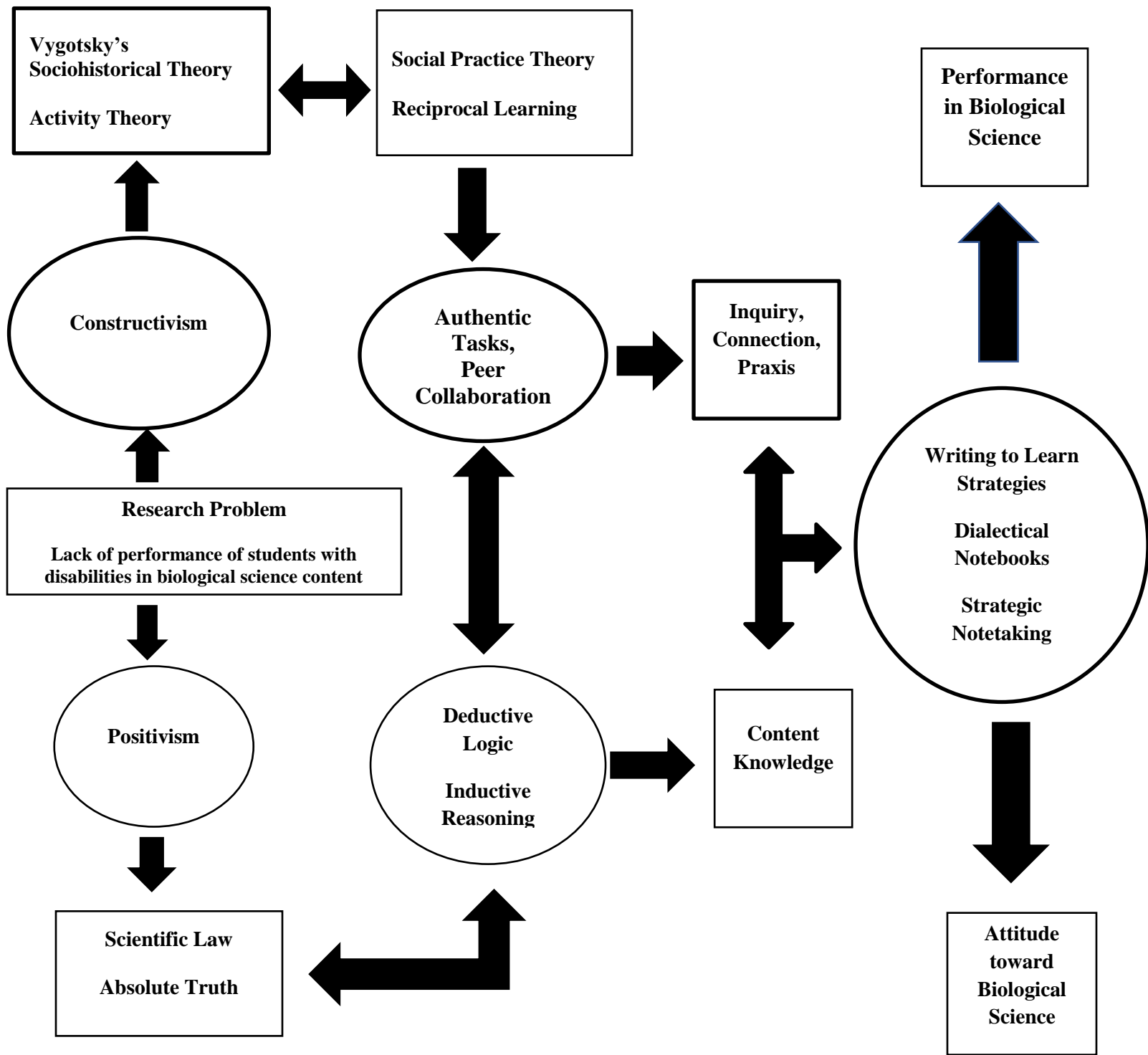


Figure 2.1 Writing to Learn in Biological Science Conceptual Framework.

Science Learning

Prain (2006) stated “writing for learning in science should focus mainly on traditional school science genres because these genres represent the enduring specific representational practices of the science community” (p.184). Learning in science has been the same throughout many content areas in multiple different countries. In science, in particular biological science, the content has been taught using identical methodology and in some cases one prescribed syllabus and textbook (Xiaohui, 1991). Xiaohui (1991) discussed the teaching methods of biology in the county of China along with the limited textbooks and syllabi used to teach an entire county a difficult science in one fashion. The author discussed the need for a variety in teaching methods based on the differences and complexities of learners throughout the country (Xiaohui, 1991). This long-standing method of teaching science exists in many countries throughout the world and more hands-on approaches such as writing to learn strategies when teaching science are needed for students, especially students with disabilities (Scruggs & Mastropieri, 2007). Scruggs and Mastropieri (2007) discussed the relevance of both instructive and constructive knowledge when learning science and the importance of hands on/discovery-based approaches that would benefit the learning of students with disabilities. The authors discuss the importance of mnemonic instruction that is vital in the study of science because it is based in increasing vocabulary achievement where writing is essential. In addition, the authors discussed the importance of text structure analysis and the assessment of science text writing and processing. The authors postulated that the processing of science text leads to growth in science learning and understanding for students with disabilities through enhanced critical and analytical thinking skills (Scruggs & Mastropieri, 2007).

Earlier in their research, Mastropieri and Scruggs (1994) analyzed the science learning of four different school districts where two school districts employed textbook based science learning in a more long-standing method of teaching science for students with disabilities and the other two school districts employed more hands on/discovery based science learning for students with disabilities. Through the use of the different approaches, the authors looked at the vocabulary, activities, illustrations, comprehensible text, and formative and summative evaluation of learning. The authors contend that a hands/on activities-based approach is beneficial for students with disabilities and discussed the important components that are essential in the activities-based approach (Mastropieri & Scruggs). They stated that:

If schools elect an activities-based approach, then peer mediation, special education support, supported inquiry instruction, specific coaching to facilitate thinking, specific cooperative learning instruction and modifications, and activity-specific adaptations will be necessary. In both cases, test formats and assessment procedures may need to be modified to include more curriculum-based and performance-based components (p. 84).

Learning science must have in instructive knowledge; however, constructive knowledge is essential for content understanding for students, especially students with disabilities. More of an emphasis needs to be placed on hands/on, discovery based, and activity-based learning in science for students with disabilities to develop the critical thinking skills needed in understanding scientific content (Mastropieri & Scruggs, 1994; Scruggs & Mastropieri, 2007). Researchers contend that students with disabilities both in primary and secondary education need to acquire the logical, critical, and analytical thinking skills that are associated with scientific learning and reasoning needed for science assessment. McGrath and Tejero Hughes (2018) confirm my point when they stated, “researchers note that inductive thinking and deductive thinking, inherent in scientific reasoning, present difficulties that might hinder the science learning of students with LD” (p. 132).

To acquire these thinking and reasoning skills associated with learning science, it is imperative that both students with disabilities including both inclusion classrooms and Learning Language Mild to Moderate (LLMM) classrooms learn the content appropriately through the principles of scientific reasoning. Critical inquiry is imperative in learning science appropriately for students with disabilities and essential for helping special education students stay grow in the content in comparison with their general education peers. In a study performed by Leshowitz, Jenkins, Heaton and Bough (1993) the researchers enhanced critical thinking skills of secondary students with disabilities through scientific reasoning and critical inquiry and their results were directly compared to their general education peers showing enhanced improvement in the students with disabilities.

Inquiry and critical thinking directly benefit assessment for students with disabilities which is how school districts measure performance of all students. In a study initiated by Stephenson, Miller and Sadler-Mcknight (2019), the authors investigated the effect of scientific writing and peer lead team learning on the critical thinking skills of secondary science students and showed through a similar pre and posttest quasi-experimental design as the one used in this study that science learning infused with peer learning have positive impacts on the academic growth of students along with catalyzing their critical thinking skills. This study shows that the impact of writing is tethered to critical thinking enhancement in students in science learning which has a direct impact on biological science where memorization ability and analytical/thinking capabilities are essential to growth within the content.

Impact of Writing to Learn on Biological Science

Writing can positively influence memorization ability of students and help with the reorganizing of prior knowledge with recently learned information (Friend, 2002). Additionally, specific studies have focused on instructional support when learning science through the use of writing and writing strategies. Researcher used writing strategies as methods of helping their students make connections in reading and learning science content in more of a hands/on and activities-based manner. Additionally, researchers have measured how writing strategies could impact overall science content literacy and understanding (Fulwiler, 2007; Holliday, Yore, & Alvermann, 2006; Prain & Hand, 1999; Prain, 2006; Tarchichi, 2017). These studies were beneficial in understanding the impact of writing strategies on science content, but these studies did not focus on the content of biology and did not apply their research to students with disabilities. Campbell and Fulton (2003) and Ritchie, Tomas and Tones, (2010) have completed studies that have used writing to enhance literacy and inquiry in science for general education students through stories and notebooks. Lastly, researchers have measured the overall impact of teaching writing in all content areas in order to support student learning in the general education population (Ray, Graham, Houston & Harris, 2016; Urqahart & McIver, 2005; Wills, 1993; Zinsser, 1988).

The aforesaid studies have addressed the impact of writing strategies in learning overall content areas, writing strategies in learning science, writing used as tool for learning biology, how writing could impact critical thinking skills, how writing could improve performance in overall content areas, or how notetaking strategies could impact the performance of students with and without disabilities in multiple content areas. There are deficiencies in these studies that will be addressed in the research I conducted for this dissertation. These specific deficiencies were

remedied by specific writing to learn strategies such as dialectical notebooks and strategic notetaking in learning biological science for students with disabilities.

Specific researchers have examined the effect of writing to learn strategies on learning in students. Zinsler (1988) discussed in his early work, the influence of writing and writing to learn strategies on the way students think about content and learned material. Kurtz and Quitadamo (2007) discuss the effects of writing on critical and analytical thinking skills on learning subject matter and how this augments students' ability to grow as a learner. Bangert-Drowns, Hurley, and Wilkinson (2004) researched the effectiveness of writing to learn strategies on student academic achievement in their academic content conceptual understanding of learned material. Researchers have used writing as a tool for learning biology in secondary education to engage student understanding and support learning in biological science (Bangert-Drowns, Hurley, & Wilkinson, 2004). The enhancement of these critical and analytical thinking skills is especially essential to students with disabilities in inclusion classrooms and learning language moderate classrooms.

Learning in Inclusion Classrooms

Students placed in inclusion classrooms are defined as students that are participating in the general education setting with support from a special education teacher. Students placed in inclusion classrooms within Middleboro High School are placed in general education settings and also fall under the Specific Learning Disability category of disability under IDEA.

Inclusion learning supports the ability of students to succeed and achieve academic understanding in any content as they are provided with an equal opportunity education in comparison with their general education peers. In education for numerous reasons we still use methods of pullout instruction for students within special education and if their IEP requires,

students are placed in self-contained classrooms (which will be discussed in the next section of this paper).

Some students with disabilities, if their IEP permits, are placed in inclusion settings where they are educated in the same classroom environment as their general education peers and receive in class support from a teacher of students with disabilities. The special education teacher acts as secondary teacher within the classroom and offers extra assistance to the students with disabilities as they learn specific content such as science (Obiakor, Harris, Mutua, Rotatori, & Algozzine, 2012). In teaching science to students with disabilities in inclusion classrooms, researchers suggest that it is important that students learn in a cooperative model, take advantage of important classroom practices such as peer tutoring and notetaking that will enhance assessment of the students (Scott, 2002). Moreover, in the case study by Scott (2002) the author noted that “students with disabilities sometimes became distracted when not involved in listening and note taking during lectures and class discussions” (p. 18).

In her research, Biddle (2006) discussed the importance of educating students with learning disabilities in manner that is most conducive to their learning. The author discussed the significance of students with disabilities, in particular inclusion students to be educated by teachers that are most qualified to offer effective science instruction and offer students the appropriate accommodations and resources for them to learn effectively in science. The author discussed an expansion of the gamut of instructional strategies for science teachers in order to augment student interest in science, construct an encouraging learning experience in science and enhance achievement in the learning of science content for students with disabilities. The education of literacy skills such as writing are imperative in learning science for students with disabilities. Many students with disabilities do not have the literacy skills required to learn

science content in a textbook driven format that is a more traditional way of learning science content. For students with disabilities that do not possess the appropriate literacy skills to learn science in a more traditional or long-standing textbook driven methodology, a more hands/on or discovery-based approach to instruction would be beneficial (Cawely, 1994; Cawley & Parmar, 2011).

Cawley and Parmer (2011) pointed out that:

Many students may know a great deal about science, but may not be able to read or write well enough to demonstrate this knowledge. For example, a teacher who wants to measure vocabulary might ask the student to write a sentence containing a specific term. The student may know the term, but may not be able to write. (p. 123)

In their study, Hand, Yang, and Bruxvoort (2007) found that the use of writing to learn strategies assisted students' science understanding through the use of language acquisition and created enhanced science understanding and knowledge of students in the content of science. This study which used writing to learn strategies as an intervention promoted writing which assisted in the demonstration of knowledge and vocabulary growth of students in the discipline of science. The study employed a mixed method methodology that included a pretest/posttest design and interviews to gauge the academic growth and understanding of students. Students were able to write about the content that is generally learned in a traditional or long-standing textbook driven methodology with a goal of helping them further understand a difficult scientific concept.

Through the use of these writing to learn strategies, the authors were able to show in their results that student test scores increased significantly, and students' analytical thinking skills were heightened with the use of this intervention (Hand, Yang, & Bruxvoort, 2007). More to the point, the researchers stated "the students indicated clearly that they had to think much more about what they were doing as a consequence of being involved with the writing activity. They

had to move past just explaining the definitions” (p. 140). Although the authors were not able to show the importance of writing to learn strategies used as a hands/on activity in learning science in the content of chemistry, they discussed the relevance of writing to learn strategies within biological science. Additionally, they argued that the task of writing to learn strategies is a valuable teaching tool that enhances science terminology and vocabulary, assists in the understanding of science content and makes the meaning of scientific content more authentic for students (Hand, Yang, & Bruxvoort, 2007).

Learning in Learning Language Mild Moderate Classrooms

Learning Language Mild to Moderate (LLMM) students are defined as students with specific language difficulties in auditory input and expressive output impacted by their language barrier. This classification is based on the New Jersey Special Education Code, N.J.AC. 6A:14 where it states “special class programs for students with learning and/or language disabilities may be organized around the learning disabilities or the language disabilities or a combination of learning and language disabilities” (p. 105). Under the New Jersey Special Education Code, LLMM students can have a class size of 10 without an special education teacher assistant, however, once the class size reaches 11, an assistant is required. LLMM students within Middleboro High School are placed in self-contained classrooms and fall under the Specific Learning Disability category of disability under IDEA. Learning science content for students with disabilities that are placed in learning language moderate classrooms would require the same hands/on activity-based instruction offered to students placed in inclusion classrooms. This is because a learning language mild to moderate classroom supports students that are below grade level, have language barriers, require individualized instruction based on their levels or follow an alternate pacing guide of the general education curriculum. Students could be below

grade levels across all content levels or have a reading deficiency based on their language barriers. In addition, learning language mild moderate classes are smaller in number than general education classes because students struggle to maintain their learning within a pacing guide of the curriculum.

In the classroom, teachers work with students in individual instruction, peer instruction and small group instruction to assist with their current reading/language levels and catalyze learning within English, reading or other content areas (Gelzheiser, Meyers, & Pruzek, 1992). In their study, Gelzheiser, et al., pre-tested and post-tested students with disabilities in pull-in and pull-out instruction to measure growth in the reading achievement of students. The authors discussed how the study was flawed based on teacher preference and would have more positive results if the teachers were mandated to use one intervention or treatment in order to increase the reading achievement of the students with disabilities (Gelzheiser, Meyers, & Pruzek, 1992).

Kourea, Gibsoin, and Werunga (2018) performed a study where researchers used writing as a treatment to enhance reading instruction for students with disabilities. The researchers added necessary cultural components to the curriculum and enhanced student learning through guided notes during pedagogy, and helping students engage in the writing process through meaningful writing processes. The authors took the cultural background of the students into consideration, which is necessary for teaching students in learning language moderate classrooms. The researchers discussed how writing for students with disabilities is beneficial for all of their literacy content learning and discussed benefits of writing strategies such as collaborative writing, writing narratives, or cultural writing.

Collins, Lee, Fox, and Madigan (2018) postulated that inclusion of the writing process during reading benefits low performing students in literacy. In their study, the authors argue that

writing and reading are universal in education and should mirror each other if low academically performing students are to grow in their literacy skills. More to the point Collins, et al. made their thoughts of the tethering of reading and writing clear when they stated

Low-performing students may have difficulty with using writing to make sense of their reading, and at the same time, research on reading comprehension and research on writing have made little mention of validated interventions for helping students develop abilities for writing about text. (p. 312)

The authors hypothesized that assisted writing instruction would catalyze growth in reading comprehension skills of low performing students to a greater degree than if writing was not included in the reading comprehension instruction. The study used a relatively large sample size (N=1062) and used a randomized pretest/posttest control group design. The results of the study indicate that the students that were exposed to writing in their reading comprehension pedagogy have greater potential to perform better on assessments based on their exposure to the writing intervention, thereby enhancing their literacy development (Collins, Lee, Fox, & Madigan, 2018). Despite the empirical evidence shown in these articles in support of writing and writing to learn strategies for students with disabilities and low performing students, there are many gaps in the literature that need to be addressed.

Reviewing the Literature

Numerous studies have been done by researchers that have implicated the importance of writing in learning in numerous content areas, especially in science. Writing in science and other content areas has had positive results on literacy, communicating their learned information, the role of language in learning and writing, writing summarization, and the construction of sequences and explanations during the writing process (Faller, 2017; Gilgun, 2005; Hylton & Allen, 1993; Klein, 2000; Mateos, Martin, Villalon & Luna, 2008).

For example, Mateos, Martin, Villalon and Luna, (2008) used a multiple case study approach to observe the cognitive activities of secondary students in writing and informational texts in order to construct meaning and informational processing from writing in the erudition process. Hylton and Allen, (1993) discussed the importance of writing to learn strategies, such as journal writing, as a teaching tool for students to explore learning and higher order thinking for discovery-based learning. Faller (2017) examined the role of literacy practices in accordance to specific text genres in hands-on science to foster a relationship between literacy and science through the writing. Dyson (2008) discussed the importance of instructional relationships tethered to literacy and writing practices through contextualization of the learning process. These studies have discussed a relationship between writing and science. However, more quantitative research is needed to explore the relationship between writing and science performance in students, especially biological science in secondary students.

Students with disabilities need to receive more empirically supported education that is based on evidence-based practices in all content areas that fosters critical thinking skills and inquiry-based learning in science (Leshowitz, Jenkins, Heaton, & Bough, 1993; McGrath, Tejero Hughes, 2018). Students with disabilities are given an education that does not mirror the education given to their general education peers, which is both student and teacher driven (Gable, Tonelson, Sheth, Wilson & Park, 2012). Students with disabilities, across grade levels have been known as inactive or sedentary learners and this has been more evident when direct instruction is used as a main teaching method for these students. Students with disabilities greatly benefit from more of a hands-on learning approach in science where the curriculum and pacing guide are tethered to activity-centered science learning. Students with disabilities cannot be expected to retain science content in the same manner as their general education counterparts,

therefore it would be essential that they are able to apply the information they are taught and potentially retain the knowledge through exploratory analysis and study (Caseau & Norman, 1997). Standardized assessment growth is essential for all students, including students with disabilities, and for them to grow in their science assessments, direct instruction is not the best method of instruction.

Educators need to change the way they think about assessing our students with disabilities and move toward more inquiry based/hands on science learning and assessment for both primary students and secondary students (Cawley, 1994; McGrath & Tejero Hughes, 2018). Inquiry based and hands/on learning activities such as dialectical notebooks and strategic notetaking through guided investigation will help to enhance cognitive processing in science and overall memory skills. Through inquiry-based learning, students with disabilities will effectively be able to learn the science curricula in both primary and secondary education and teachers will be able to offer effective learning pathways to students with disabilities. Teachers of these students will need to be better prepared to teach students the curriculum in a way that best prepares them for mandated assessments (Lynch, Taymans, Watson, Ochsendorf, Pyke, & Szesze, 2007).

Cawley (1994) pointed out that:

Hands-on programs force a different approach to instruction and evaluation provided that the hands-on activities are conducted by the students and not simply used as demonstrations by the teachers. In this regard, there must be a degree of equivalence in the use of hands-on activities for instruction and evaluation. (p. 69)

There is a chance some school districts within specific states of the country may not feel as though science assessments are important or relevant to a child's education, especially students with disabilities, however, they will still need to be educated efficiently by prepared teachers. More to the point, Lynch, Taymans, Watson, Ochsendorf, Pyke, and Szesze (2007)

discussed this point when they stated “even though states may choose not to use the science assessments as a means to demonstrate annual yearly progress, clearly the requirement for science assessments will draw increased attention to science education and to the performance of students with disabilities” (p. 221). Assessments are necessary to gauge student knowledge in science for students, especially students with disabilities and the writing to learn strategies of dialectical notebooks and strategic notetaking could be a teaching intervention to catalyze scientific knowledge growth in special education students.

Epistemological Underpinnings

Writing to learn strategies are based on the cognitive development of students and the development of critical thinking skills needed to apply the writing to learn strategies to learning specific scientific content such as biology. The development of scientific thinking is paramount for students to apply the strategies of dialectical notebooks and strategic notetaking which are hands-on approaches to learning fundamental concepts within all content, in particular biological science (Moore, 1992).

Kuhn, Cheney, and Weinstock (2000) discussed the levels of epistemological knowledge where knowledge is definite and there is a certainty in understanding and learning, especially in scientific learning. In scientific learning, assessments and evaluations are the primary way we evaluate student growth and erudition. Students grow in their critical thinking and analytical ability to associate, as well as link and evaluate knowledge obtained through scientific evidence. This growth in science knowledge begins through essential textbook learning; however, it manifests itself through more hands-on/discovery-based learning as the student grows within the content. Through traditional science learning, students learn fundamental concepts that provide learners with a solidified methodology in problem solving that creates building blocks of

knowledge needed by scientists and that knowledge is solidified through hands-on approaches to solidifying scientific content knowledge (Kuhn, 1963).

In scientific thinking, there needs to be a concrete source of knowledge that is linked to a notion of certainty and an objective reality in order to grow as a science learner. Nonetheless, that does not justify how that learner fully comprehended the content (Kuhn & Pearsall, 2000). More to the point, Kuhn and Pearsall (2000) stated “the epistemological achievement of awareness of the sources of one’s knowledge is, of course, critical in scientific thinking. One needs to know and be able to justify exactly how one knows something to be the case” (p. 120). The sources of scientific knowledge and learning are a necessity for the epistemological understanding required for scientific growth and erudition, as are the methods for solidifying that knowledge for learners (Kuhn & Pearsall, 2000; Kuhn, Cheney, & Weinstock, 2000). I am supportive of this epistemology as it lends itself to the positivist and constructivist interpretive framework.

Worldview of the Researcher

This study is based on a positivist worldview. This worldview is essential for this study and research because it has a cause and effect element and an experimental study must have reliability for there to be a relationship or link between variables in positivism. The positivist perspective on the tenet of scientific law is rooted in observation and measurement and is not biased based on society or traditions. In positivism, knowledge is valid because of its extraction from scientific law and methodology in research/experimentation is universal throughout all content or subject matter such as biology. Facts are exposed thorough experimentation based on science and the results are absolute truths (Compte, 2000).

Additionally, this study is under a positivist label because it is linked to the notion of certainty. Within the positivist position, there is an objective reality that a researcher can directly observe through the scientific method and the results can be shown in an experimental study. The idea behind logical positivism is deductive logic and is applied to experimentation, which is the case in this research study. Moreover, in this study, there is inductive reasoning in the observation and the experimentation is objective based on inductive reasoning (Bhaskar, 1975; Compte, 2000).

Research Questions

Providing students more hands-on instruction in the form of writing to learn strategies addresses many of the questions posed by researchers on how to enhance student knowledge in science. Writing strategies have enhanced student understanding in science and improved reading, writing, and science connections for students (Hand, Yang, & Bruxvoort, 2007; Hohenshell & Hand, 2006; Holliday, Yore & Alvermann, 2006). Strategic notetaking has been used as a treatment in students with disabilities in the form of notetaking interventions in specified content areas (Boyle, 2010; 2011; 2013; Boyle, Forchelli, & Cariss, 2015). However, the deficiencies of biological science need to be addressed in students with disabilities through the use of more than notetaking interventions. Strategic notetaking and dialectical notebooks, when tethered together are writing to learn strategies that could catalyze a gain in biological knowledge in students with disabilities and improve science assessment scores of special education students. Moreover, students in both inclusion classrooms and learning language mild moderate classrooms could become more cognitively engaged in biological science, which could lead to more improved learning for all students with disabilities in secondary science. To further explore these ideas, I developed the following research questions to guide this study.

1. Do the writing to learn strategies of dialectal notebooks and strategic notetaking enhance student achievement in students with disabilities in biology?

From prior research (Hohenshell & Hand, 2006; Tarchichi, 2017), we can expect students who participate in writing to learn strategies to grow in their content knowledge of Biological science. I expect that students who participate in the writing to learn strategies of dialectical notebooks and strategic notetaking to grow minimally in their biological content knowledge and have minimal growth on their biology assessments. Moreover, I expect that the writing to learn strategies will also increase the confidence and overall biological science understanding of students with disabilities which will mirror the growth on their assessments.

2. Do the writing to learn strategies of dialectal notebooks and strategic notetaking impact the attitude and acceptability of students with disabilities in biological science?

From prior research (Kennedy, Quinn, & Taylor, 2016), we can expect students to fall into one of five categories for each question on the attitude survey which include strongly agree, agree, neither agree or disagree, disagree, or strongly disagree. I expect that after the implementation of the writing to learn strategies, students will have a more positive attitude about biological science based upon their enhanced proficiencies and abilities in learning the science. Furthermore, I expect students with disabilities to have a more positive disposition when learning biological science after receiving the writing to learn strategies of dialectical notebooks and strategic notetaking based upon the intervention's positive influence on learning science. Because both strategies will be offered simultaneously, differential effects of notetaking versus dialectical notebooks will be unknown.

CHAPTER 3

METHODOLOGY

In this chapter, I present the methodology used to answer the research questions. I discuss the intervention and location of the study, the students participating in the study, the instruments and materials used in the study, research procedures, data collection and analysis, the study's validity and reliability, along with the anticipated results. The research study, procedures, and processes are outlined in the methodological design of the study as well.

Intervention and Location

In Middleboro High School (Pseudonym for an urban high school in a suburb of a major city in the northeastern region of the United States), located in the northeastern region of the United States, I implemented writing to learn strategies for 9th and 10th grade high school biology students. The two writing to learn strategies were only implemented for students in the experimental group of the study. The intervention took place five days a week for approximately 30 minutes each time the secondary students were in their classroom. This intervention was beneficial for biology teachers because it provided individualized, small group instruction for the high school students. The intervention was conducted for seven weeks from mid-January to the end of February, excluding the days when the school district is closed.

The timeline of this study spanned across one semester as the students in the study had biology in the spring semester of 2020. There were two groups participating in the study, an experimental and a control group. Students were randomly assigned to either the experimental or control group. I administered the supplemental writing to learn strategies to the experimental group. The control group received equal time learning biological science content even though they did not receive the two writing to learn strategies. There was a standardized condition

(separate classrooms for experimental and control groups) for the control groups as they were not exposed to the writing to learn interventions as it could confound their scores. All students (both experimental and control) were pretested in January, then the experimental group was introduced writing to learn strategies throughout the seven weeks of the research; both the experimental and control groups received a mid-treatment assessment and a posttest in February (Table 3.1).

Table 3.1 Participants: Experimental and Control Pre Test, Mid-Treatment Assessment & Post Test

Participants	1/13/20		2/4/20	2/27/20
Experimental	Pre Test & Attitude Toward Biology Survey	X	Mid-Treatment Assessment	Post Test & Attitude Toward Biology Survey
Control	Pre Test & Attitude Toward Biology Survey		Mid-Treatment Assessment	Post Test & Attitude Toward Biology Survey

Furthermore, the timeline of this study was 34 days. In week one, I pretested both the experimental and control students and writing to learn strategies (both dialectical notebooks and strategic notetaking) began for the experimental group in week one as well. The experimental group received the treatment Monday through Friday for the duration of the study. Students in the control group did not receive the writing to learn strategies but did receive the curricular prescribed mandatory instruction. During day 16, all students took their mid-treatment assessment and during day 34, all students were administered the posttest. In addition, all students took the acceptability survey (AS), and attitude toward biology survey (ATBS) at day 34. After their posttest, all writing to learn strategies commenced and data was analyzed (Table 3.2). Over the 34 days, the writing to learn strategies were incorporated in all biology topics within the high school biology curriculum, and students used both strategic notetaking and

dialectical notebooks as the writing to learn exercise for each topic. For example, if week 1 covered Mitosis, students used both strategic notetaking and dialectical notebooks as the writing to learn exercise for Mitosis. This practice was consistent across all topics in biological science. The control group covered the same topics in biological science except through other methods of learning. There was not a knowledge difference in biology between the two instructors in the study as they had the same state certification in biological science, and both hold a bachelor's degree in biology.

Table 3.2 Study Timeline

Participants	1-13-20	1-14-2020 to 2-3-2020	2-4-20	2-5-20 to 2-26-20	2-27-20	2-28-20
Experimental	Pre Test & ATBS	Writing to Learn Strategies	Mid-Treatment Assessment	Writing to Learn Strategies	Post Test, AS, & ATBS	Data Analysis
Control	Pre Test & ATBS	N/A	Mid-Treatment Assessment	N/A	Post Test, AS, & ATBS	Data Analysis

Participants and Setting

The study took place at Middleboro Public Schools District, specifically Middleboro High School which houses grades nine through twelve with an 85% graduation rate. The demographics of Middleboro High School are 40% Hispanic, 35% African American, 14% Caucasian, and 11% Asian. In addition, they include a special education population of 22% and there are 75% economically disadvantaged students who receive free and reduced lunch. Figure 3.1 below summarizes the demographics of Middleboro High School.

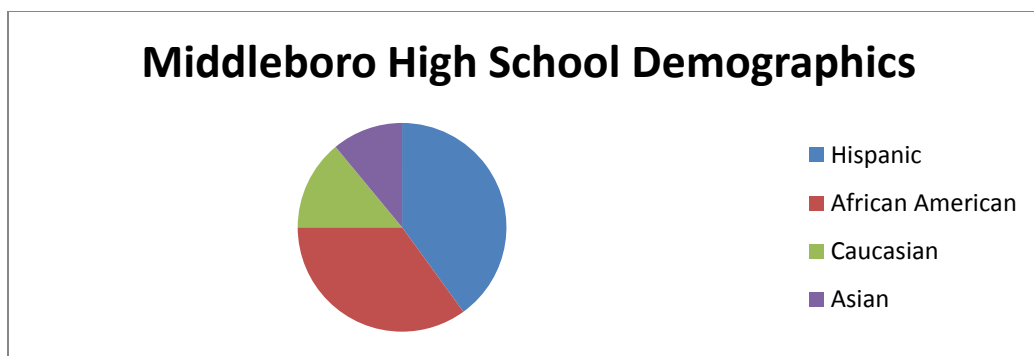


Figure 3.1 Middleboro High School Demographics: 2019-20.

In Middleboro High School, there are a total of 1,356 students, 354 grade 10 students and 298 grade 9 students. All students with disabilities enrolled in biology were invited to participate in the study. I, as the researcher invited the students to participate in the study, and as Superintendent of Schools, I addressed unequal power between the researcher and the participants by the development of a trust relationship with all the participants in the study and assured all the students that regardless of the outcomes of the study, I would always act in their best interests as they are students within the school district (Ferguson, Yonge, & Myrick, 2004). Furthermore, I addressed the unequal power between the researcher and the participants through continuous human contact of the researcher with the participants of the study as the relationship grew into reliance, rapport, and amity which overcompensated for the generalized administrator to student dichotomy. As the researcher, I worked with these students daily which facilitated a dichotomy of trust and confidence which acted to reduce the unequal power implanted by the administrator and student relationship (Haigh, 2005).

Students had the freedom to participate or not participate in this study. Many grade 9 students take biology; however, there are students in grade 10 in the course as well. Middleboro High School is on 82-minute block scheduling with a range of 29 students with Learning Language Mild to Moderate (LLMM) disabilities in two classes, 15 in one and 14 in the other.

There are 19 other special education students enrolled in Biology Inclusion Classrooms and they receive support in the general education setting.

Both the LLMM and Inclusion students were invited to participate in the study. The sample size is 48 students and I randomly assigned these 48 students to experimental and control groups. There were 25 students within the experimental and 23 students within the control. I was limited to the number of students that were available in the study based on the population of students with specific learning disabilities in the high school. The power analysis reported a 17% power based on the limited number of subjects in the study; however, a repeated measures analysis of variance has a significant increase in power due to the fact that the dependent variable is correlated. Students were randomly assigned to the experimental and control clusters. This study followed a true experiment model, and in the high school it is routine to randomly assign students to groups. I anticipated that all students would participate in the study and I was correct. Moreover, all of the parents/guardians provided permission for their children to participate in this study. It has been the practice of the Middleboro School District that all parents/guardians allow their children who are asked to participate in a research study to partake. As stated, this study took place during daily biology classes for all students.

Twenty-nine students with disabilities, specifically Learning Language Mild to Moderate (LLMM) students, were registered for biology in the spring of 2019 along with nineteen other students with disabilities in inclusion classes. The LLMM students were split in two different classes 15 in one and 14 in the other. The LLMM students included 15 students in grade 9 and 14 students in grade 10. The Inclusion students included 11 students in grade 9 and 8 students in grade 10. There were two groups participating in the study, an experimental (the class with the 15 students and 10 Inclusion students) and control group (the class with the 14 students and 9

Inclusion students). Because there were two types of students participating in the study, I accounted for these students in my analytic model through treating the groups as a between subjects factor in the analysis of variance. If there was no significant difference between the groups, the groups would be combined.

The experimental group received writing to learn strategies (dialectical notebooks and strategic notetaking strategies) daily in their biology class and the control group did not receive writing to learn strategies in their biology instruction. All students received at baseline, the ordinary standard of instruction in biology for the school district. Participants were all enrolled in biology class at Middleboro High School. No other inclusion criteria existed. The only reasons for exclusion from this study were that they were not enrolled in biology class at Middleboro High School and/or they had not completed the assent and consent forms.

Table 3.3 Study Participant Breakdown

Total Subjects =48	Students	LLMM	Inclusion
	<i>Experimental</i>		
9 th Grade	13	8	5
10 th Grade	12	7	5
	<i>Control</i>		
9 th Grade	13	7	6
10 th Grade	10	7	3
Total	48	29	19

Research Design

Middleboro High School offered a unique opportunity for this study. There were significant numbers of students in the Leaning Language Mild to Moderate (LLMM) and students in the inclusion classes that made this study possible. I conducted a pilot study in the summer session of 2019 school year to gain some insights into the questions for the writing to learn strategy interventions for this dissertation study. The pilot study was eight weeks long where students who were entering biology for the next school year could learn the fundamental

concepts of the subject. The writing to learn strategies of dialectical notebooks and strategic notetaking were used as a treatment for all students when learning concepts such as Mitosis and Meiosis. Students were observed and interviews were conducted to gauge students' feelings about the effect of writing to learn strategies on learning biological science. Additionally, students were pretested, and post tested in order to measure growth of content knowledge in a pretest/posttest design, similar to this study.

This study used a quasi-experimental design, with half of each biology class for students with disabilities (i.e., LLMM and Inclusion) randomly assigned to the experimental group and the other half assigned to the control group. Additionally, this study followed a pretest/posttest design where the growth of the scores on the posttest was used to assess the effect of the writing to learn intervention on biology test scores. The research methods included predetermined biological science testing instruments and writing to learn attitude survey.

Students answered questions from the Attitude Toward Biology Survey (ATBS) to measure their approaches and outlooks of learning biology before and after the intervention of writing to learn strategies. This was a researcher made survey that was designed to gauge the face validity of the writing to learn strategies in biological science. The basis of why I chose these questions were that they offer a subjective assessment of students' feelings towards biological science and the impact of writing to learn strategies in further understanding the content. The survey included ten statements covering topics of the usefulness of biological science; desire to learn biological science, teaching methods, the satisfaction of learning biology, and understanding the concepts of biological science. The survey also included the influence of writing when learning biology and biological concepts (see Appendix D).

In order to track changes in the approaches and outlooks of learning biology of students with disabilities, students completed the survey before the intervention and immediately after the intervention. In summarizing the research study design, students in both the control and experimental groups were administered the Attitude Toward Biology Survey (Pre-Treatment) and then given a Pre-Test. Following, the ATBS, all students took a biological science pre-test (Appendix A). The experimental groups then began to receive the writing to learn strategies of dialectical notebooks and strategic notetaking. All students in both the control and experimental groups then took the biological science mid-treatment assessment. The experimental groups continued to receive the writing to learn strategies of dialectical notebooks and strategic notetaking. All students in both the control and experimental groups then took the biological science posttest. Once the writing to learn strategies intervention were completed, the students in both the control and experimental groups were administered the Attitude Toward Biology Survey (Post-Treatment) (Figure 3.2). The research design incorporated a pretreatment phase, a quasi-experimental phase and a post treatment phase.

Pre-Treatment Phase

On day one of the study, I explained the study procedures with each class. Students responded to statements on the Attitude Toward Biology Survey and took the biological science pretest. All survey responses were recorded, and students did not receive any feedback on their responses. The pre-instruction phase took one block period (82 minutes) to complete.

Experimental Phase

On day two of the study, the experimental phase began where students in the experimental group received the writing to learn strategies of dialectical notebooks and strategic notetaking in addition to their standard biology instruction in their classes. Writing to learn

strategies were infused in the learning of the students in the experimental groups daily in small group activities. Students were given a mid-treatment assessment twenty-two days after the pretest. After the mid-treatment assessment, the writing to learn strategies of dialectical notebooks and strategic notetaking continued for students in the experimental groups within small group settings. Students were given a posttest twenty-four days after the mid-treatment assessment and forty-six days after the pretest. After the posttest, students in the experimental group were no longer given the writing to learn strategies of dialectical notebooks and strategic notetaking.

Post-Treatment Phase

The following day after the posttest, students responded to the identical statements on the Attitude Toward Biology Survey and responded to a Acceptability Survey as well. All survey responses were recorded, and students did not receive any feedback on their responses. All data for the pretest, the mid-treatment assessment, and the posttest were then analyzed. The instrumentation and materials of the study were thoroughly discussed to ensure instrument validity and the overall intervention's use of materials.

Instrumentation and Materials

All students were pretested using administrator made instruments. The instrument used in this study was a simulated biology exam that mirrors the New Jersey Biology Competency Exam (NJBCT). The steps I took to ensure that that my tests reflected the NJBCT was to create questions that were standard specific to the questions offered on the state exam. The biology content standards in the state exam were reflected in the researcher made assessments. I prepared three versions of this simulated exam in the forms of a Pretest, Mid-Treatment Assessment, and a Posttest that focused on the same biological science standards (Appendix A,

Appendix B, and Appendix C). As stated, all students both in the experimental and control group took a biology pretest that mirrored the New Jersey Biology Competency Exam (NJBCT). In the middle of the writing to learn intervention (Day 23), all students (experimental and control groups) took the Mid-Treatment Assessment. At the end of the intervention (Day 46), all students (experimental and control groups) took Post Test 2. The pretest consisted of 15 multiple choice questions that constitute a summative understanding of high school biological science. Both the Mid-Treatment Assessment and Post Test 2 also consisted of 15 multiple choice questions that constitute a summative understanding of high school biological science. All three exams tested the same biological standards and objectives in order to ensure instrument validity. The instrument's validity was ensured for each test through discussion and description of all instruments with participants before the commencement of the study and through pilot testing not involving the participants (Creswell & Creswell, 2017).

Procedures

One classroom at the high school was randomly assigned to the experimental group and ten inclusion students were also randomly assigned to the experimental groups of the study. The assignment of the inclusion students and the LLMM students were all assigned randomly based on the limited number of students with specific learning disabilities within the secondary setting. Clusters of students were assigned based on available students in the school setting. In addition, one classroom in the high school and nine inclusion students were assigned to the control group of the study. There were 25 students in the experimental group and 23 students in the control group. All students completed assent forms and received parental consent forms to participate in the study. If parents/guardians did not want their students participating in writing to learn strategies or taking part in the pretest, mid-treatment assessment or posttest, their pretests, mid-

treatment assessments, and posttest would not have been analyzed, and their data would not be used. However, this was not the case as all parents/guardians gave consent for their students to participate in the study.

High school biological science teachers were informed if students were in the experimental or control groups at the beginning of January. After being informed, the teachers of the experimental and control groups underwent an orientation and learned what should take place during the study and the writing to learn intervention. The teachers of the control groups were made aware of all the writing to learn interventions using both dialectical notebooks and strategic notetaking that the students in the experimental groups would undertake. No teacher received any training for the implementation of the writing to learn strategies as I administered the strategies to the students. Procedural fidelity measures on both the treatment and control conditions included daily field notes of the writing to learn intervention. There was a daily checklist on what was done each day of the intervention for dialectical notebooks (Appendix E) and strategic notetaking (Appendix F). The students used the intervention properly because I continuously monitored the methods in which they used the writing to learn strategies on a daily basis. Students were documented using the writing to learn strategies of dialectical notebooks and strategic notetaking as they learned different biological concepts to ensure the proper use of the intervention and also to observe the interest of one strategy versus the other.

The teacher in the control group holds the same biological science teaching certification as me and the teacher in the experimental group. The level of biological science knowledge was the same. In the LLMM classroom, all students in the experimental group received writing to learn strategies at the same time. In the Inclusion classroom, there were only five to eight students with disabilities in that classroom. Therefore, within the Inclusion classroom, all

writing to learn strategies were administered in small group instruction for the experimental group with groups of five to eight students as the general learning took place in the classroom. As stated previously, the control groups, both in the LLMM and Inclusion classroom covered the same topics in biological science except for through other methods of learning.

Data Collection and Analysis

Data collection took place in two phases. As discussed, there was one pretest and two posttests. Additionally, there was a survey administered and collected through the use of a science attitude survey geared toward biological science and a acceptability survey that measures the appropriateness and relevance of the intervention for the students. Repeated measures ANOVA, Independent Samples T-test and Paired Samples T-test were used to analyze the data (Creswell & Creswell, 2017; Kennedy, Quinn, & Taylor, 2016).

Pre Test, Mid-Treatment Assessment and Post Test

One phase of data collection took place at the pretest, midterm assessment, and posttest. I administered the assessments to students in their classroom locations. This study was a pretest-posttest control group design (Creswell & Creswell, 2017). The pretest, mid-treatment assessment and posttest were administered for both the experimental and control groups but only the experimental group received the writing to learn intervention. The unit of analysis was the individual high school students. The pretest was conducted one day prior to the initiation of the writing to learn strategy intervention. To determine that the two groups (experimental and control) were statistically similar, I compared the student's means scores on the pretest prior to the writing to learn intervention. In order to determine the impact of the writing to learn strategies on student's biological science content knowledge, I used a Repeated Measures

ANOVA on the scores collected at Pretest, Mid-Treatment Assessment, and Posttest as I compared the three scores for each student.

Data analysis consisted of repeated measures pre, mid and post exam performance of students in order to determine whether relations existed between writing to learn strategies and student achievement. Mean scores of biology assessments were measured in both January and February in order to measure the effectiveness of writing to learn strategies on student achievement. Additionally, the repeated measures determined whether student scores on biology assessments changed through the implementation of the writing to learn strategies which established an association between the two variables (Sampson, Enderle, Grooms, & Witte, 2013).

The Repeated measures ANOVA was used because I employed only one independent variable (writing to learn strategies), I compared three group means where the group participants did not change in the study, and the study participants' growth was measured while utilizing the writing to learn strategies treatment three times during the study (Pre-test, Mid-Treatment Assessment, and Post-test 2). As previously stated, Figure 3.2 below summarizes the data collection and analysis of the study with a pre-treatment survey, initial pretest, mid-treatment assessment, posttest, a post-treatment survey, and a concluding data analysis.

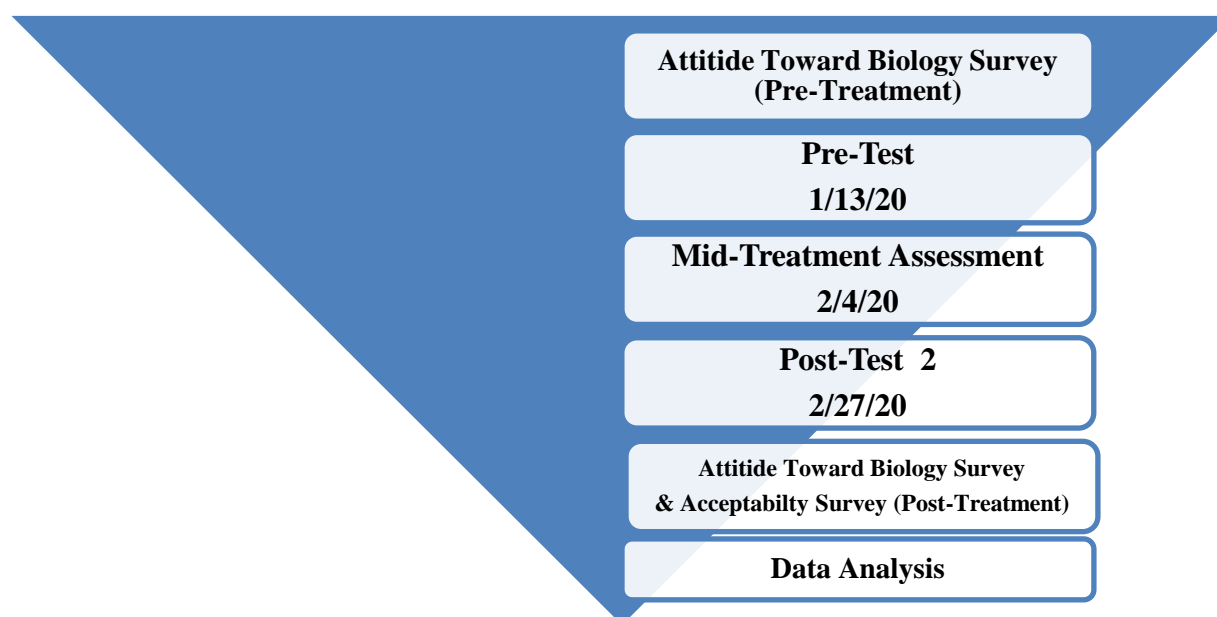


Figure 3.3. Data Collection: 2020.

Attitude Toward Biology Survey

A survey was created for this study that measured the attitudes of students with disabilities toward school science, in particular biological science. In this study, the aim was to capture students' general attitude toward biology, their motivation in learning biological science, classroom practices and methodologies in learning the science, their capabilities in learning the science, the delight of learning biological science, and the aptitudes of students learning the concepts of biological science (Kennedy, Quinn, & Taylor, 2016).

Prior administration of the Attitude Toward Biology Survey was offered to students in the summer of 2019 in a preliminary study where they were asked to answer the ten statements covering topics of the usefulness of biological science, their desire to learn biological science, and the influence of writing when learning biology and biological concepts, etc. (see Appendix

D). As mentioned previously, during the summer enrichment school of 2019, a preliminary study was conducted with students with disabilities entering biological science.

The goal of the study was to examine the impact of writing to learn strategies on student learning in biological science, in particular the writing to learn strategies of strategic note taking and dialectical notebooks. A secondary goal of this study was to examine the influence of writing to learn strategies on the pedagogy of biology teachers. Students were given a pretest, a mid-treatment assessment, and a posttest as writing to learn strategies were implemented during their biology class. After the eight-week summer enrichment ended, I asked the students that received the writing to learn strategies to take the identical Attitude Toward Biology Survey that is used in this study. After analyzing the results for this study, it was shown that writing to learn strategies had a positive effect on student learning in biological science and students had a more positive view on learning biological science because of the writing to learn strategy intervention.

Acceptability Survey

Students were given an acceptability survey that measured their satisfaction with the writing to learn intervention of dialectical notebooks and strategic notetaking. This was a researcher developed instrument which measured the satisfaction, practicality, appropriateness of the writing to learn strategies when learning biological science. Furthermore, the survey measured the student preference of either dialectical notebooks or strategic notetaking when learning biological science and how these strategies impacted the outcomes of intervention. The appropriateness and relevance of the writing to learn intervention along with the complexity of the intervention was gathered from the acceptability survey. After the posttest, students that participated in the experimental portion of the study were offered a acceptability survey that gaged the procedures, expectations, and outcomes associated with the dialectical notebooks and

strategic notetaking (Carter, 2010; Tomasini, Martinez-Basurto, Garcia, & Villegas, 2015) (Appendix G).

Validity and Reliability

Student maturation was the main threat to validity in this study. High school is a time of growth, development and progress both academically and socially through maturation. To avoid this, the control group consisted of students in the same content level and the same level of biological science pedagogy as the experimental group. Mortality was also a threat as students could have left school for a variety of reasons such as transfer or dropping out and may also could have had their schedule switched from their guidance counselor. An additional threat to validity was selection because some students might have chosen to not participate in this study; this could have catalyzed lower motivation for authentic participation in the study. The study was limited to Middleboro High School in school district located in the northeastern section of the United States, which limited the generalizability of the results. Another limitation to the study was the small sample size of 48; however, this was moderate to large sample size in special education research. Furthermore, it was difficult to measure the long-term effects of the study as students would have only two to three years left in high school and would not take another biological science course during their high school career.

Anticipated Results

It was anticipated that the students in the experimental group would perform significantly better on the mid-treatment assessment, and the posttest as compared to students in the control group. There are many studies that show positive results for writing to learn strategies in overall student learning. Also, research has shown that writing to learn strategies have had a positive impact on student learning in science (Friend, 2002; Fulwiler, 2007; Hand, Yang, & Bruxvoort,

2007). Additionally, the influences of writing to learn strategies on biological science have also had a positive relationship on content growth and development (Hohenshell & Hand, 2006; Moore, 1994). Furthermore, science writing has impacted student learning and positively affected student achievement (Fulwiler, 2007; Prain, 2006). It was anticipated that this study would have significant results with a small to moderate effect size for students that received writing to learn strategies in the experimental group in comparison with students in the control group that did not receive writing to learn strategies. It was hypothesized that students with disabilities that received writing to learn strategies would show greater growth in biological science than their peers who did not receive writing to learn strategies.

Conclusion

This chapter was focused on the methodology used to plan and assess how writing to learn strategies impacted the biological science learning of students with disabilities in the Middleboro School District. Moreover, this study sought to gain insight on the effects of writing to learn strategies and biology achievement through the improvement of biological science content knowledge through writing to learn strategies. The objective of the study was to institute a greater level of writing in high school students and measure the potential correlation to biology achievement. This study aimed to determine whether or not writing to learn strategies have a positive impact on student achievement. This quantitative study aimed to identify a correlational relationship between writing to learn strategies and student achievement. However, there was very little research examining writing to learn strategies and biology achievement measured through standardized testing. This study significantly contributed new information to the field of special education by depicting the importance of the two writing to learn strategies of dialectical notebooks and strategic notetaking to achievement in biological science.

CHAPTER 4

RESULTS

This chapter will present the analysis of the data used to address the two research questions in the study. As presented previously, these questions are:

1. Do the writing to learn strategies of dialectal notebooks and strategic notetaking enhance student achievement in students with disabilities in biological science?
2. Do the writing to learn strategies of dialectal notebooks and strategic notetaking impact the attitude and acceptability of students with disabilities in biological science?

The chapter will be presented in three parts. The first section will present descriptive data on the sample. Part 2 will present the results relevant to the major research questions. The final part will present some additional analyses that were used to extend and elaborate the results.

Descriptive Data on the Sample

Descriptive data on the sample are presented in Table 4.1.

Table 4.1: Descriptive Data on the Sample

	Experimental	Control Group
Gender:		
Female	12	12
Male	12	4
Race:		
African American	7	8
Hispanic	17	11
Multi-Racial	0	4
White	1	0
Student Type:		
LLMM	14	10
Inclusion	14	9

The main objective of this study was to compare the differences of the control and experimental groups. The design of the study for student achievement involved a pre-test, a mid-

treatment assessment, and then a final post-test. For attitude the design involved a pre-test and a post-test. In both cases, repeated measures analysis of variance (ANOVA) was used to analyze the differences between the two groups. Repeated measures ANOVA involves a number of assumptions including the typical assumptions of any ANOVA (e.g., homogeneity of variance). There are two major additional assumptions for repeated measures ANOVA. The first is that the correlations between the levels of the repeated assessment should be approximately equal, which is called the sphericity assumption. Since this assumption is typically violated, the Greenhouse-Geisser correction is usually applied, a process that was used in the analyses that will be reported below.

The second assumption is that the groups are not significantly different at the pre-test. This assumption was tested by separate samples t-tests. If the groups are found to be significantly different, then the pre-test is used as the covariate. For the ANOVAs presented, partial eta squared is provided to indicate the effect size or the ratio of variance associated with or accounted for by the main effects or interaction. The benchmarks for Partial eta squared, based on conventions for defining effect sizes in social science research and adapted from Murphy and Myors (2004) are presented in Table 4.2.

Table 4.2. Benchmarks for Partial Eta Squared

<i>Benchmarks for Partial Eta Squared</i>	
Rating	Description
$0.01 \leq \leq 0.05$	Small
$0.051 \leq \leq 0.13$	Medium
≥ 0.14	Large

Student Achievement

The means and standard deviations for the pre-test, midterm assessment and the post-test for the control and experimental groups are presented in Table 4.3,

Table 4.3 Descriptive Statistics for the Comparison of the Effects of the Writing to Learn Strategies on the Experimental v Control Groups in Pretest, Mid-Treatment Assessment and Posttest

	Treatment Assignment	Mean	Std. Deviation	N
Pretest	Experimental	34.16	10.691	25
	Control	37.35	10.936	23
	Total	35.69	10.814	48
Mid-Treatment Assessment	Experimental	42.76	9.968	25
	Control	39.43	11.281	23
	Total	41.17	10.636	48
Posttest	Experimental	55.56	9.265	25
	Control	42.13	11.868	23
	Total	49.13	12.479	48

As mentioned previously, repeated measures ANOVA assumes that the groups are not significantly different at the pretest. This assumption was met ($t = 1.01$, $p = .313$). These data are displayed in Figure 4.1

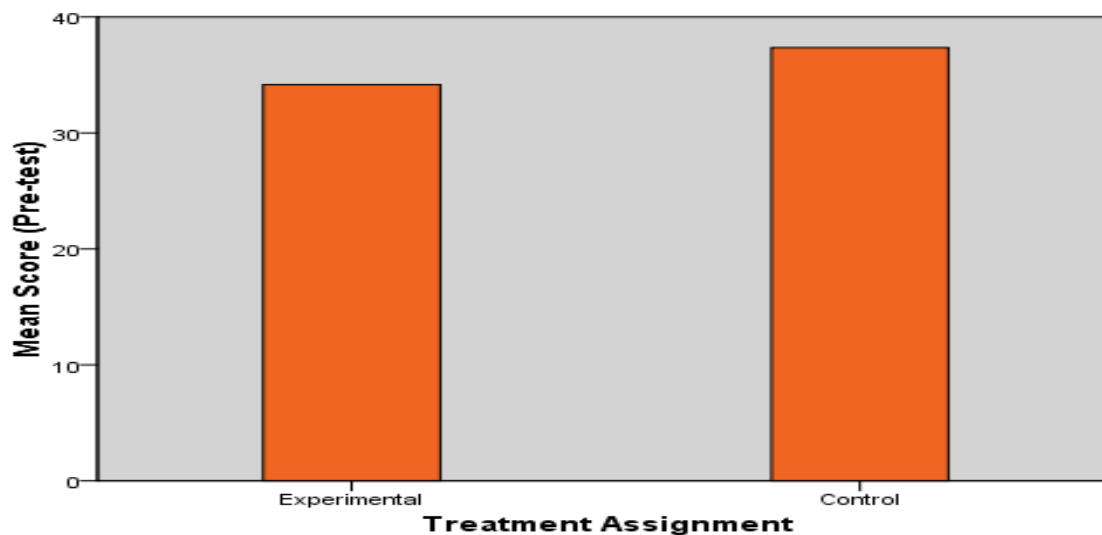


Figure 4.1 Bar Graph of Experimental and Control Group Pretest Scores

Consequently, the repeated measures used the pre-test, the mid-treatment assessment and

post-test as the repeated factor. These results are presented in Table 4.4

Table 4.4: Repeated Measures Summary of Results

Between Subjects Effects				
Source	Mean Square	F	Sig.	Partial Eta Squared
Group (Experimental/Control)	734.97	2.189	.145	.046
Error Between	334.23			
Within Subjects Greenhouse-Geisser				
Source	Mean Square	F	Sig.	Partial Eta Squared
Time (Pre/Mid/Post)	2699.95	557.06	.000	.924
Group * Time	1092.22	225.35	.000	.830
Error Within	4.947			

As shown in Table 4.4 there was a significant main effect for time and a significant interaction. Both effects are large. A graph of the interaction is presented in Figure 4.2.

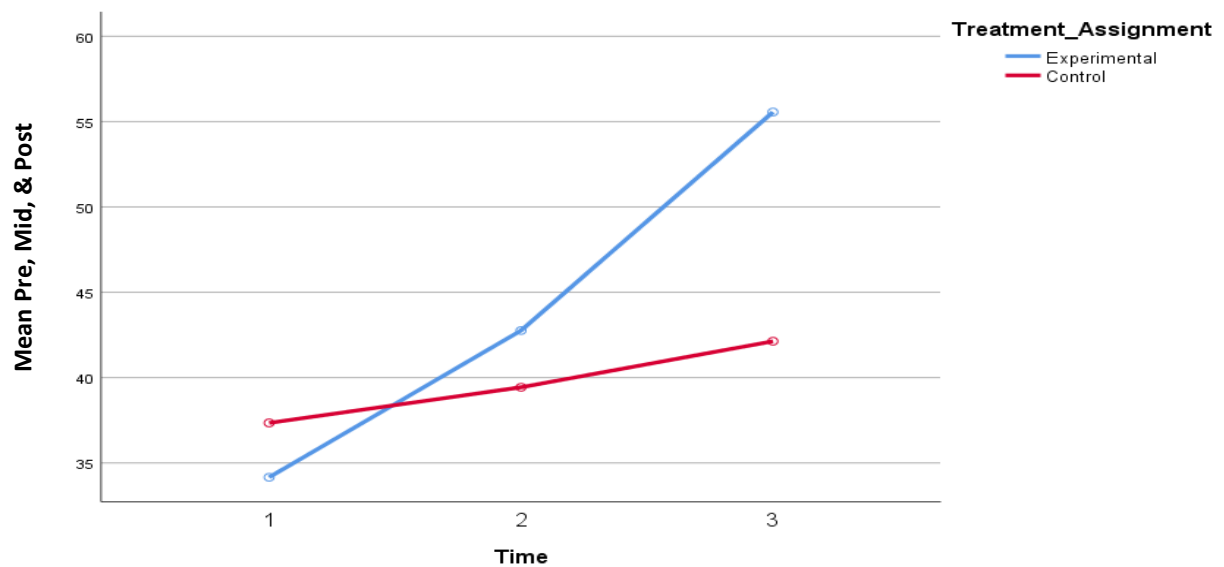


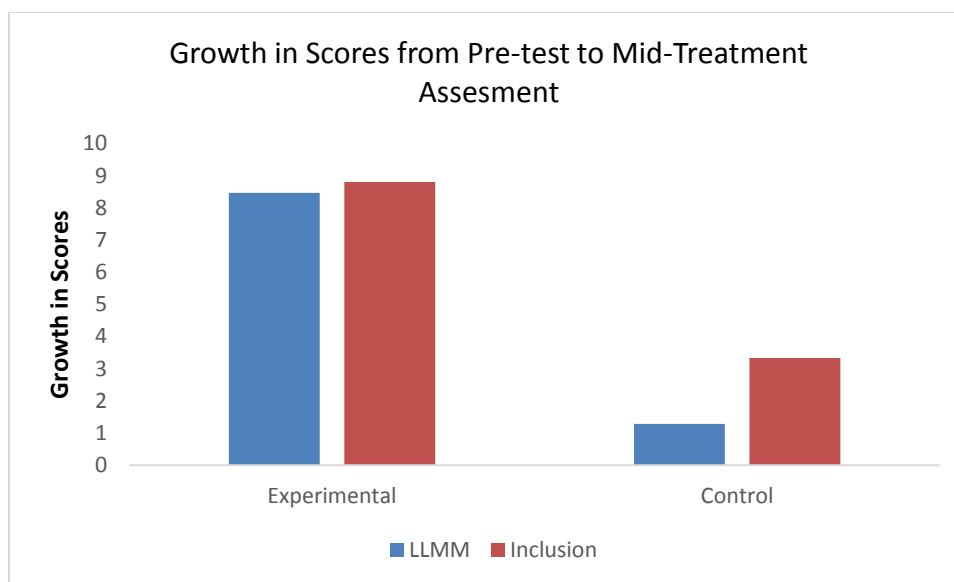
Figure 4.2 Line Graph of Experimental and Control Group Growth

A simple effects analysis was conducted on the interaction. These results are presented in Table 4.5.

Table 4.5. Simple Effects Analysis for the Interaction for Student Achievement

Comparison	F	P Value	Partial Eta Squared
Group at Pre-Test	1.04	.313	.022
Group at Mid-Treatment Assessment	1.175	.284	.025
Group at Post-Test	19.265	.000	.295
Experimental Group Across Time	805.90	.000	.931
Control Group Across Time	34.184	.000	.608

As shown in Table 4.5, the experimental and control groups did not differ at the pre-test (as shown previously) and did not differ at the mid-treatment assessment. The groups did differ significantly, however, at the post-test with a large effect size. Table 4.5 also shows that both groups significantly improved from the pre-test to the post-test with the larger gain being made by the experimental group. The differences in growth for the experimental and control groups are presented graphically in Figures 4.3 and 4.4.

*Figure 4.3 Pre-Test to Mid-Treatment Assessment Growth*

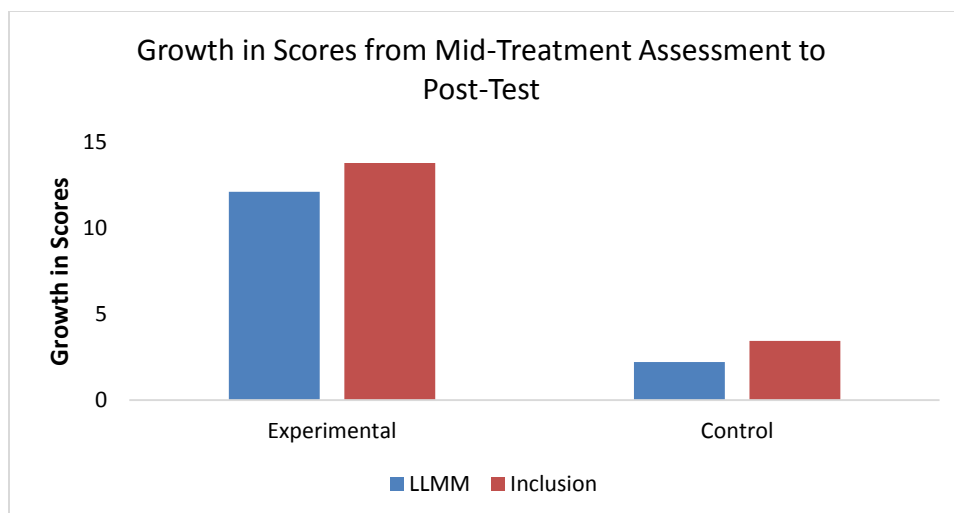


Figure 4.4 Mid-Treatment Assessment to Post-Test Two Growth

Attitude toward Biology Survey

As presented in Chapter 3, attitudes toward biology were assessed by a ten-item survey using a five-point Likert scale where a higher score indicates a more favorable attitude toward biology. As an initial analysis, these ten items were summed to produce a pre-test and post-test score. Cronbach's alphas were computed on these two scores and were found to be acceptable (Alpha at the pre-test = .937; at the post-test Alpha = .834). The means and standard deviations for the total attitude score for the experimental and control groups are presented in Table 4.6

Table 4.6. Descriptive Statistics for the Pre and Post Attitude Survey

	Group	Mean	Std. Deviation	N
PreTestAttitude	Experimental	18.5200	4.47325	25
	Control	17.6957	3.59842	23
	Total	18.1250	4.05612	48
PostTestAttitude	Experimental	28.3600	1.07548	25
	Control	20.0870	3.59182	23
	Total	24.3958	4.90653	48

As before, the two groups were compared at the pre-test and the difference was not significant ($t = 1.34, p = .488$). The results of the repeated measures ANOVA are presented in Table 4.7.

Table 4.7. Repeated Measures Summary of Results for Attitude

<i>Repeated Measures Summary of Results for Attitude</i>				
Between Subjects Effects				
Source	Mean Square	F	Sig.	Partial Eta Squared
Group (Experimental/Control)	495.71	26.122	.000	.362
Error Between	19.98			
Within Subjects Greenhouse-Geisser				
Source	Mean Square	F	Sig.	Partial Eta Squared
Time (Pre/Post)	896.07	202.63	.000	.805
Group * Time	332.23	75.149	.000	.620
Error Within	4.422			

As shown in Table 4.7, both main effects and the interaction are significant with large effects. A graph of the interaction is presented in Figure 4.5

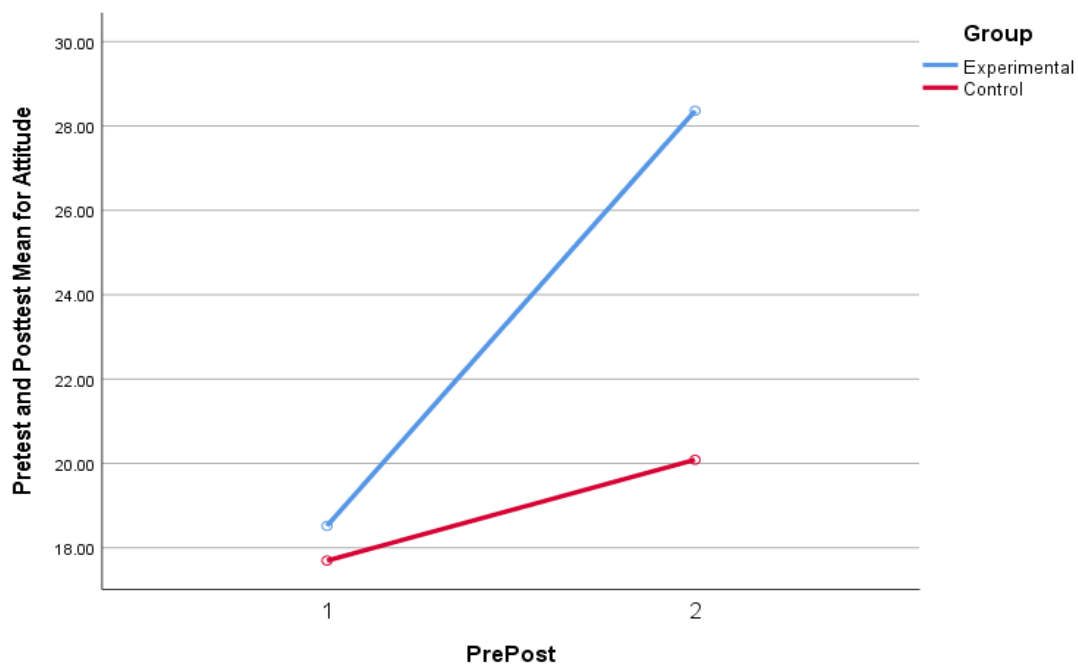


Figure 4.5 Line Graph of Pre and Post Means for Attitude

Table 4.8. Simple Effects Analysis for the Interaction for Student Achievement

Comparison	F	P Value	Partial Eta Squared
Group at Pre-Test	.489	.488	.011
Group at Post-Test	290.71	.000	.863
Experimental Group Across Time	188.97	.000	.887
Control Group Across Time	79.20	.000	.789

As shown in Table 4.8, the groups were not different at the pre-test but did differ at the post-test with a large effect. As before, both groups significantly increased in attitude between the pre-test and the post-test with a larger gain for the experimental group. An analysis of the individual items on the survey is presented in Appendix X.

Additional Analyses

Several additional analyses were conducted to extend and elaborate the results presented for the two research questions. These are summarized below.

Gender

Both of the repeated measures ANOVAs presented above were run again with gender added as an additional between subjects factor. It should be mentioned that all of the analyses presented in this section of the chapter have the limitation that some of the cells have unequal sample sizes with some of these samples being small. As such, these analyses should be interpreted with caution. For achievement there were no differences as a function of gender. For attitude there was a significant main effect for gender (Female mean = 24.903; Male mean = 20.89; $F = 38.21$, $p = .000$, partial eta squared = .470). There was also a significant interaction with females gaining slightly more than males. The pattern of the data, however, was essentially the same for both males and females.

Race

There were only two racial groups with enough subjects to make the analysis meaningful: African Americans and Hispanics. No differences were found for either achievement or attitude.

Student Type

As mentioned above, there were two different type of students in the sample: LLMM and inclusion. The means and standard deviations for achievement for these groups for the three testing periods are presented in Table 4.9.

Table 4.9. Achievement by Student Type

	Group	Mean	Std. Deviation	N
Pretest	Experimental LLMM	35.53	11.313	15
	Experimental Inclusion	32.10	9.893	10
	Control LLMM	35.79	9.978	14
	Control Inclusion	39.78	12.498	9
	Total	35.69	10.814	48
Mid-Treatment Assessment	Experimental LLMM	44.00	10.135	15
	Experimental Inclusion	40.90	9.938	10
	Control LLMM	37.07	10.284	14
	Control Inclusion	43.11	12.374	9
	Total	41.17	10.636	48
Posttest	Experimental LLMM	56.13	9.296	15
	Experimental Inclusion	54.70	9.650	10
	Control LLMM	39.29	11.684	14
	Control Inclusion	46.56	11.370	9
	Total	49.13	12.479	48

The ANOVA summary table is presented in Table 4.10.

Table 4.10. Repeated Measures Summary of Results for Achievement by Student Type

<i>Repeated Measures Summary of Results for Achievement by Student Type</i>				
Between Subjects Effects				
Source	Mean Square	F	Sig.	Partial Eta Squared
Group (LLMM Experimental & Control; Inclusion Experimental & Control)	469.51	1.405	.254	.087
Error Between	334.116			
Within Subjects Greenhouse-Geisser				
Source	Mean Square	F	Sig.	Partial Eta Squared
Time (Pre/Mid/Post)	2587.216	609.09	.000	.933
Group * Time	287.25	84.528	.000	.852
Error Within	3.398			

As shown in Table 4.10 there is a significant main effect for Time (as already shown) and a significant interaction. A graph of the interaction is presented in Figure 4.6.

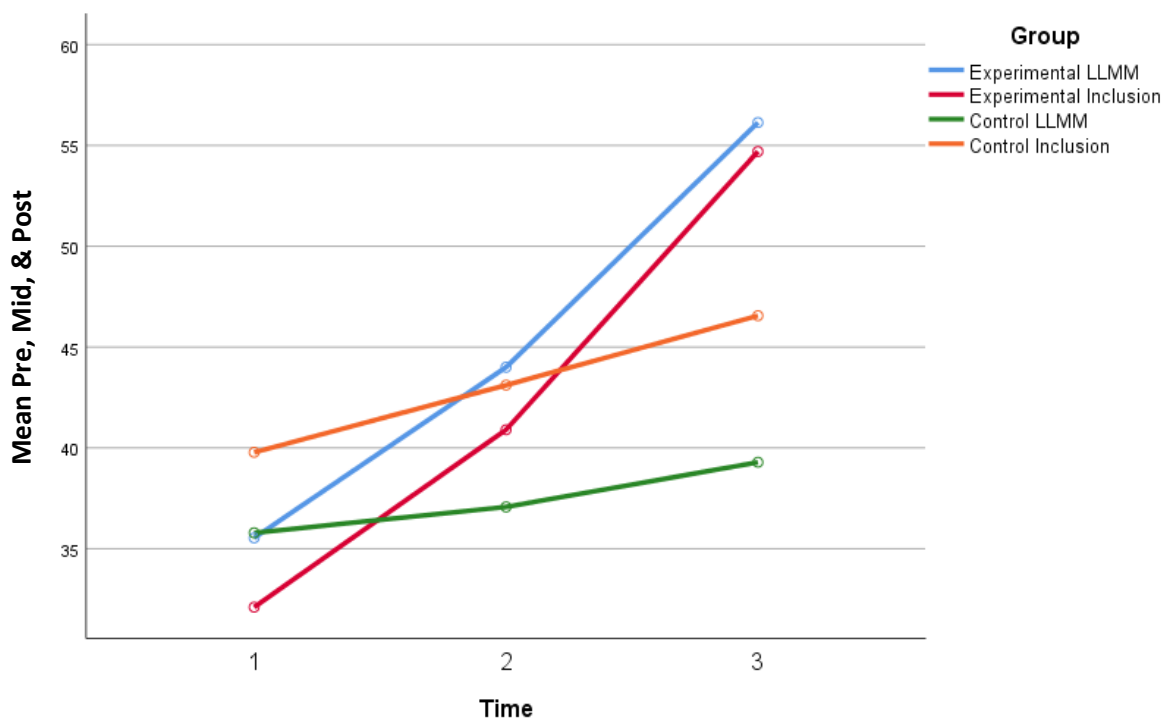


Figure 4.6 Line Graph of Experimental and Control Group Growth LLMM and Inclusion

As shown in Figure 4.6 the experimental LLMM group and the experimental Inclusion groups outperformed their control group counterparts on the post-test. It was shown that in the midterm assessment to the post-test, there was a more significant growth for the experimental group in comparison to the control groups for both the LLMM and Inclusion students.

The means and standard deviations for attitude are presented in Table 4.11 and the ANOVA summary Table in 4.12.

Table 4.11: Means and Standard Deviations for Attitude by Student Type

	Group	Mean	Std. Deviation	N
PretestAttitude	Experimental LLMM	16.3333	4.09994	15
	Experimental Inclusion	21.8000	2.69979	10
	Control LLMM	16.0714	3.45219	14
	Control Inclusion	20.2222	2.10819	9
	Total	18.1250	4.05612	48
PosttestAttitude	Experimental LLMM	40.8000	2.24245	15
	Experimental Inclusion	36.5000	2.54951	10
	Control LLMM	18.5714	2.31099	14
	Control Inclusion	25.0000	3.12250	9
	Total	30.4583	9.77613	48

Table 4.12. Repeated Measures Summary of Results for Attitude by Student Type

<i>Repeated Measures Summary of Results for Attitude by Student Type</i>				
Between Subjects Effects				
Source	Mean Square	F	Sig.	Partial Eta Squared
Group (LLMM Experimental & Control; Inclusion Experimental & Control)	8910.511	98.99	.000	.875
Error Between	8.189			
Within Subjects Greenhouse-Geisser				
Source	Mean Square	F	Sig.	Partial Eta Squared
Time (Mid/Post)	3088.56	333.53	.000	.883
Group * Time	688.63	74.365	.000	.835
Error Within	9.26			

The significant interaction is presented in Figure 4.7.

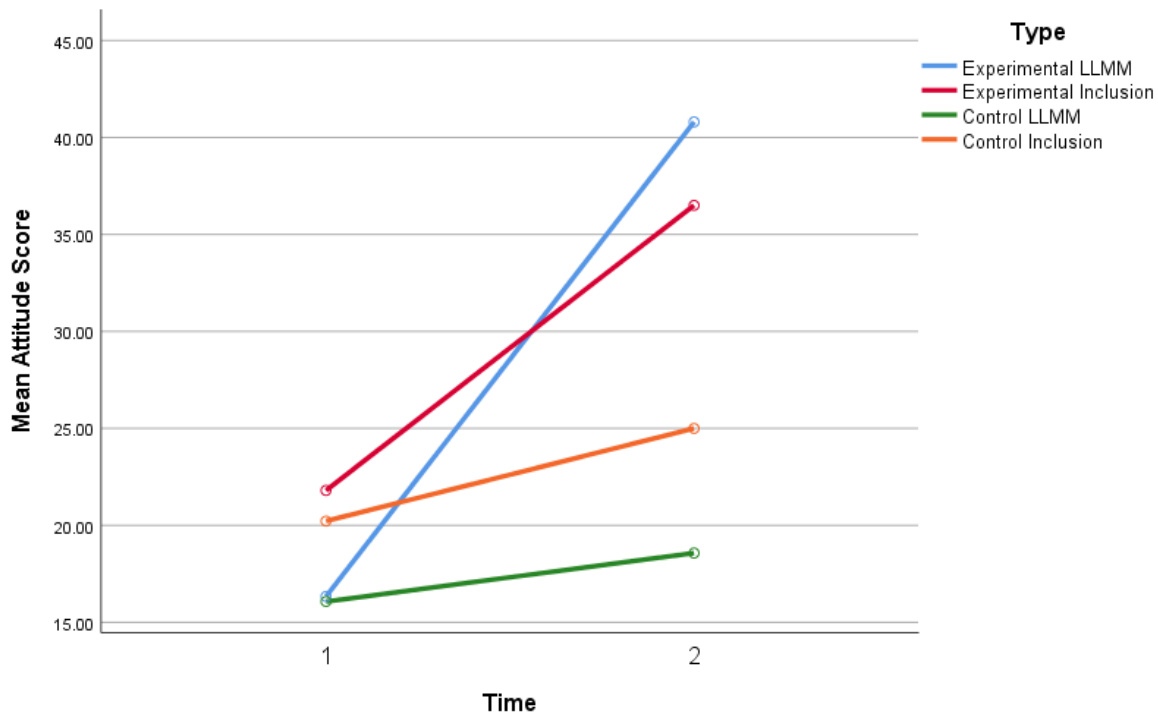


Figure 4.7 Line Graph of Experimental and Control Group Growth LLMM and Inclusion for Attitude.

Similar to the results for achievement the Experimental LLMM and Inclusion groups increased at a great rate than the control students.

Acceptability Survey

Students that received the writing to learn strategies were given an acceptability survey after the post-test. The survey contained 10 questions in a 5-point Likert format where a higher score indicates a higher level of acceptability. This survey was administered to gauge the perception of effects of the writing to learn strategies on student learning, in particular, the differences between the dialectical notebooks and strategic notetaking. The means, standard deviations and t-test results are presented in Table 4.13.

Table 4.13. Differences in Student Satisfaction between Dialectical Notebooks and Strategic Notetaking

	Mean	Variance	t-test	Probability	Partial Eta Squared
Dialectical	104.6	15.3	6.41	.000	.147
Strategic	83.6	38.3			

The results in Table 4.13 show that students were content with the writing to learn strategies and believed the dialectical notebooks to have a more impactful effect on their learning. A table with the means of responses to each item on the survey are included below in Table 4.14. This depicts the descriptive statistics for each question on the Acceptability Survey.

Table 4.14. Mean Responses to Acceptability Survey Statements

Acceptability Statements	Mean	Standard Deviation
I was satisfied with the dialectical notebooks as method to learn biology	4.16	0.37
I was satisfied with the strategic notetaking as method to learn biology	3.28	0.89
Dialectical notebooks was an appropriate intervention for learning biology	4.04	0.20
Strategic notetaking was an appropriate intervention for learning biology	3.24	0.97
Dialectical notebooks made learning biology easier for me as a student	4.20	0.41
Strategic notetaking made learning biology easier for me as a student	2.92	0.28
Dialectical notebooks were useful as a practice to prepare for a biology test	4.44	0.51
Strategic notetaking was useful as a practice to prepare for a biology test	3.56	0.71
I would use dialectical notebooks on my own when I study a subject like biology	4.08	0.28
I would use strategic notetaking on my own when I study a subject like biology	3.52	0.65

Summary

An analysis of the findings in this study showed the effectiveness of the writing to learn strategies on students with disabilities in biological science, as the purpose of this study was to investigate the impact of the writing to learn strategies of dialectical notebooks and strategic notetaking on student achievement. Furthermore, this study investigated if writing to learn

strategies of dialectal notebooks and strategic notetaking impacted the attitude and acceptability of students with disabilities in biological science. The scores of the biological science standardized tests were collected from 25 students in the experimental group (15 LLMM students and 10 Inclusion students) and the 23 students in the control group (14 LLMM students and 9 Inclusion students). The major findings of this study are:

1. A statistically significant effect on student achievement for the use of the writing to learn strategies was found. The students in the experimental group outperformed the control group with a large effect size. Moreover, the effect indicated that impact of the writing to learn strategies was more evident from the mid-treatment assessment to the post-test versus the pre-test to the mid-treatment assessment. The ANOVA showed that there was a significant difference in achievement for biology for all students but that the achievement gains for students in the experimental group was greater.
2. A statistically significant effect on attitude for students administered the writing to learn strategies was found. The students in the experimental group showed a significant improvement in attitude toward biological science in comparison to the control group.
3. While there was a difference between males and females in achievement, with females having a higher mean, there was no evidence that the treatment was differentially effective for females as compared to males.
4. No effect for race was found for either achievement or attitude.
5. There was a slight difference between LLMM and inclusion students although the difference was not great.
6. The acceptability of the writing to learn strategies was measured and the writing to learn strategies of dialectal notebooks and strategic notetaking were shown to be useful and

an appropriate intervention for students with disabilities learning biological science. The students were satisfied with the intervention/treatment used in the study.

CHAPTER 5

DISCUSSION

In this chapter, I discuss the summary of the findings, the limitations of the study, and the implications of the findings on future research along with their implications on teaching biological science to students with specific learning disabilities. Lastly, I conclude the chapter with recommendations on future research based on the results obtained along with summarizing thoughts on the study.

Summary of the Findings

In this study, I examined the advantages of the writing to learn strategies of dialectical notebooks and strategic notetaking on biological science learning for students with disabilities. The goal of the study was to increase scientific content knowledge and affinity for biological science through standardized test scores attitude surveys, and acceptability surveys. Furthermore, I wanted to incorporate strategic instruction through the use of the writing to learn strategies to show their positive effects on students with learning disabilities (Danoff, Harris, & Graham, 1993). Therefore, I will discuss the findings in terms of answering the research questions.

In terms of the first research question “*Do the writing to learn strategies of dialectal notebooks and strategic notetaking enhance student achievement in students with disabilities in biological science,*” the data analysis showed specific findings. The study showed that while there was only a significant difference in achievement scores for the experimental group versus the control on the post-test, the growth in scores for both the mid-treatment assessment and the post-test were significantly higher in the experimental group. The quantitative data from the standardized exams showed increases in the scores of students in the treatment groups that

received the dialectical notebooks and strategic notetaking which demonstrated their effectiveness in promoting academic achievement in biological science for students with specific learning disabilities. Writing in science has been shown to have positive effects on learning for students which catalyzes skills that enable students to obtain science content knowledge through a different learning process which augments their learning capabilities (Kurtz & Quitadamo, 2007; Prain, 2006; Zinsser, 1988). More to the point, Cawley and Parmar (2011) stated:

Opportunity to learn in science may be defined as providing students with a set of experiences that include important science concepts, processes, and skills as well as presenting lessons in a manner that allow the student to acquire knowledge, process, and skill capability (p. 106).

In terms of the second research question “*Do the writing to learn strategies of dialectal notebooks and strategic notetaking impact the attitude and social validity of students with disabilities in biological science,*” the data analysis also showed specific findings. The study results showed that there was a significant difference between the attitude toward biological science of the students in the experimental group versus the control group. As stated, after the posttest, all the students were given a post Attitude Toward Biology Survey. In comparison to the control group, the experimental group’s data showed that they grew in their agreement that biology was more useful in problem solving and was more enjoyable to learn. Furthermore, they grew in their appreciation for the method of learning biological science, the way the science was presented and developed admiration for biology learning. Additionally, the students in the experimental group grew in their appreciation for the use of writing when learning biology and the specific concepts within the science. Lastly, and perhaps most significantly, they reported an increased ability to remember specific concepts within biological science in comparison to the control group (Table 4.7).

These findings were the result of the treatment/independent variable of the writing to learn strategies used in the study which included both dialectical notebooks and strategic notetaking. Both dependent variables (change in biological content knowledge and the change in attitude toward biology) were positively influenced by the treatment. Therefore, the null hypothesis which was that writing to learn strategies would have no effect on academic achievement for students with disabilities in biological science was shown to be incorrect (Creswell & Creswell, 2017). These results were evident in the groups that participated in the study, the experimental (the class with the 15 students and 10 Inclusion students) and the control group (the class with the 14 students and 9 Inclusion students). The pretest results were similar for the forty-eight students that participated in the study, which made the results of the study more impactful for the effects of the treatment of writing to learn strategies (Figure 4.1).

Similar results were found in a study conducted by Boyle (2013) that utilized strategic note-taking for inclusive middle school science students and the results indicated that the treatment had a greater impact on student performance than students that were not offered the strategic notetaking. An additional study conducted by Hohenshell and Hand (2006) showed the benefits of writing to learn strategies for secondary students in biological science also had a positive impact on student performance. Hohenshell and Hand's (2006) results indicated that the use of writing to learn strategies had a positive effect on students' ability to answer abstract questions in biological science. The results align with this study as students in both the experimental and control groups were asked to answer conceptual questions in biological science for the pretest, midterm assessment, and posttest. The study showed that there was a relationship between writing to learn strategies and biology learning in students with specific learning disabilities and the standardized tests helped to facilitate an understanding of the overall impact

of dialectical notebooks and strategic notetaking. Writing to learn strategies have been shown to positively impact critical thinking skills for students, which could have played a vital role in this study.

In a study conducted by Kurtz and Quitidamo (2007), writing to learn strategies were used in secondary biological science for academic improvement as well. The researchers discussed a national incentive to augment critical thinking skills for students in science. The study was similar to this study as it was a quasi-experimental pretest/posttest control group design that used a treatment of writing to learn strategies as a treatment for effects on biological science learning. The researchers' results indicated that the students in the experimental group had more growth in their critical thinking than the students in the control. The researchers conducted their study with general education students; therefore, it was logical to pose if these strategies could also have a positive influence on the critical thinking of students with specific learning disabilities in science (Kurtz & Quitidamo, 2007).

Leshowitz, Jenkins, Heaton, and Bough (1993) conducted a similar study to Kurtz and Quitidamo (2007) where they looked to evaluate the efficiency of an instructional treatment such as dialogues for catalyzing critical thinking skills for special education students. The study had a low number of participants (similar to this study) and looked for different methods to enhance student performance through alternative instructional approaches.

Dialogues are an essential component when teaching writing to learn strategies for students and dialogues used in the study were incorporated in both strategic notetaking and dialectical notebooks in this study as the hypotheses were that the writing to learn strategies of dialectical notebooks and strategic notetaking could positively enhance student achievement and attitude toward learning biological science.

For this study, the first null hypothesis (H_0) was that writing to learn strategies would not have an impact on achievement of students with disabilities in biological science. The first alternative hypothesis (H_a) was that writing to learn strategies would have an impact on academic achievement of students with disabilities in biological science. The second null hypothesis (H_0) was that writing to learn strategies would not have an impact on attitude of students with disabilities in biological science. The second alternative hypothesis (H_a) was that writing to learn strategies would have an impact on attitude of students with disabilities in biological science. Students that received the treatment of both dialectical notebooks and strategic notetaking had a more positive outlook on learning biological science. Additionally, student responses to the acceptability survey indicated that that the students preferred the dialectical notebooks over the strategic notetaking.

Based on the findings in the study, I rejected the first and second null hypothesis as there was shown to be a statistically significant relationship between the independent variable of the writing to learn strategies and the dependent variables of student achievement and attitude toward biological science. The researcher concluded that the treatment of writing to learn strategies positively benefited and impacted students with disabilities for both attitude and achievement as the P Values fell below the (0.05) significant cut off level.

Limitations

There were a few limitations in this study. Primarily, there were only forty-eight participants total, which limited the generalizability of the results. Secondly, this study took place in the northeastern section of the United States of America and results could have varied depending where else the study would take place, either on a national or global level. Thirdly, although I performed all of the writing to learn strategies, there were different teachers in the

classroom for the students in the study, which could have created differences in biological content learning even though teachers had the same education and teaching certification. Lastly, I, as the Superintendent of Schools administered the writing to learn strategies in this study, which is also a limitation as this would not be as effective in daily educational practice. It would be more beneficial for the researcher to educate the teachers to implement the writing to learn strategies in their classrooms as this would be more impactful on a daily basis for students and offer more tangible results that can be used as a measure of the effectiveness of the writing to learn strategies used in practice.

Implications

Tynjala, Mason, and Lonka, (2001) discussed the importance of the integration of writing as a learning tool from both a theoretical and practical lens. This study infused writing to learn strategies as a practical tool to catalyze student achievement and increase student affinity for biological science. The findings from this study are useful to teachers, administrators, and educational researchers in both science education and special education. Overall, the findings are useful to all educators that are interested in using writing strategies for teaching science at the secondary level for students with specific learning disabilities or general education students. Furthermore, because the writing to learn strategies improved both test scores and overall attitude in biological science, other school districts could benefit from using this evidence-based method for teaching biological science at the secondary level for students with disabilities. This is particularly true for school districts with a higher percentage of special education students that do not typically take biological science classes.

This research has the potential to inform educators, both teachers and administrators, how beneficial the writing to learn strategies of dialectical notebooks and strategic note taking can be

in science learning for students with specific learning disabilities. Also, research in this area has the potential to inform state and federal departments of education how to positively impact student biological science achievement through the importance of writing in the daily pedagogy for students with and without learning disabilities.

Lastly, this study informs educators that the use of the writing to learn strategies of dialectical notebooks and strategic notetaking has the potential to positively impact students' attitude toward biological science which could impact their science affinity and performance in primary, secondary, and post-secondary education. The overall effectiveness of science learning for students with specific learning disabilities has been a continuous issue in education at the secondary level (Donohoe & Zigmond, 1988; Scott, 2002). Donohoe and Zigmond (1988) discussed a high percentage of students with disabilities with testing issues in secondary science for decades. They further stated that an activity-based learning approach which infuses vocabulary development and constructs meaning from text equates growth in science testing. Writing to learn strategies infuse activity-based learning, constructs meaning from text, and enhances vocabulary enhancement (Tarchichi, 2017). Constructed learning for students with disabilities is more beneficial for achievement than simply using traditional instruction for acquiring knowledge (Scruggs & Mastropieri, 2007).

Recommendations of Future Research

Multiple changes can be made in future studies that could expand on the findings of the study. Student achievement scores were significantly different for experimental and control groups and the trends in mean scores showed that students that received the writing to learn strategies grew more significantly in their biological science content knowledge and positive attitude toward learning biological science. The incorporation of strategic notetaking and

dialectical notebooks have been shown to be appropriate if used in biological science classes for students with disabilities.

Future studies could focus on larger groups of students to participate in a similar study for a longer time frame. The larger sample size would add to the generalizability of the results. Furthermore, this study was conducted during the spring semester in a short time frame and it would be beneficial to be over a one-year period (two full semesters). It would be beneficial to incorporate regular education students along with special education students in the same study and analyze the differences in the growth of the experimental and control groups. Future quasi-experimental pretest/posttest control group designs should be used on a reasonably large sample of students with control of extraneous variables across the experimental and control groups. Confounding or extraneous variables that impacted the results of this study would include different grade levels of students or different conditions of learning disabilities which could be accounted for in future studies. For example, future studies could include only students in grade 10 that were explicitly inclusion students or exclusively LLMM students.

The results of this study in biological science could inspire new learning methods for students in other content areas such as physical science (Kornyshev, 2010). Similar studies conducted using writing to learn strategies for students with specific learning disabilities in other subjects besides biological science could be beneficial across the curriculum in secondary education. The use of writing to learn strategies in scaffolded instruction in other areas of science such as chemistry, physics, and mathematics could lead to beneficial results in learned content knowledge in physical science, arithmetic, and inquiry needed to be successful in the secondary content areas (Counrtyman, 1992; Fulwiler, 2007; Hand, Yang, Bruxvoort, 2007; Russek, 1998; Zinsser, 1988).

Future studies should also begin at the elementary level for learning science. Teaching students writing strategies could have a positive effect on students' academic learning abilities which would lead to greater abilities to learn science at the secondary level with amplified problem-solving abilities (Klein, 2000). Klein (2000) pointed out the benefits of student learning through writing when he stated "further benefit of such instruction is that these strategies improve the quality of students' writing, so that even if they do not lead students to construct new knowledge in every case, learning them will nonetheless have some educational value" (p. 344). Writing to learn strategies generally invoke dialogue and group discussion among the teacher and the students. Dialogue and group discussion have considerable educational benefits such as improving critical/analytical thinking skills for students with disabilities which would be very beneficial to students' learning (Leshowitz, Jenkins, Heaton, & Bough, 1993).

Furthermore, future studies could include using writing to learn strategies as professional developments as well as professional learning communities for special education teachers and infusing those strategies into the pacing guide of the curriculum. Pretest and posttest scores of students could still be measured and used as the dependent variable within the study. The independent variable would be the different writing to learn strategies used in separate classrooms in order to gauge the overall effectiveness of individual strategies along with the success of the utilization of the strategies in science curricula.

Additionally, it would be prudent to assess the level of writing ability of students prior to the treatment of writing to learn strategies, measure the level of writing as a mid-assessment of the treatment, and then evaluate the level of student writing after the treatment of writing to learn strategies was complete. This could further gauge the overall effect of the writing to learn intervention.

Lastly, it would be important to use a larger sample size to be able to analyze the changes in growth for categories such as race. It was shown that race was not significant variable because the lower number of participants in this study (Table 7). A future study with more participants would provide more robust statistics for racial differences for students with disabilities learning biological science and meaningfully contribute to statistical analysis. A greater sample size would also lead to more robust statistics for gender differences that would assist the researcher to understand the overall benefits of writing to learn strategies for male and female students. Although this study did show that there were more significant changes in the answers in the female students in comparison to the male students, there were only 17 males in the study, yet there were 31 female participants in the study (Table 10). A larger sample size would lead to more accurate results and offer the results with a lower margin of error (Creswell & Creswell, 2017).

Positionality

My positionality is defined by roles as an administrator, teacher, researcher, and as a member of the Child Study Team (CST) in Middleboro Public Schools. As an administrator and a Learning Disability Teacher Consultant (LDTC), I interact with students with specific disabilities on a daily basis. In fact, as a member of the CST, I perform educational testing of many students with disabilities in Middleboro High School. Additionally, I also have tested both inclusion students and LLMM students in the high school and lower elementary students that are thought to be students of disabilities based on their inability to score proficiently on standardized exams. The tests I generally administer to the students are educational exams such as the WIAT, Woodcock Johnson, Jerry Johns, Batelle, etc. that would determine a student's eligibility for special education services. In my position, I recognize on a daily basis the lack of needed hands-on learning and social capital that is apparent in specific students with disabilities in their science

learning. My positionality impacted what I looked for within the study in a few ways. As a science teacher and administrator, I expected to see growth based on the writing to learn strategies; however, as a member of the child study team, I knew the growth will be marginal due to the specific learning disabilities of the students. I interpreted the academic growth in the students through the intervention of the writing to learn strategies of dialectical notebooks and strategic notetaking as a success because of the specific learning disabilities of the students.

Bias

In this study, there were three forms of bias that could impact the findings of the study. Primarily, there was selection bias that was identified by the participants in the study based on the lack of students with specific learning disabilities within Middleboro High School. There were less than 50 learning language mild moderate and inclusion students within the high school which was considered a small sample size that is not truly representative of the intended population of students with specific learning disabilities. Secondly, there was also confirmation bias where my hypothesis regarding the use of writing to learn strategies in biological science would influence the interpretation of my findings as a validation of my theories on the positive effects of writing to learn strategies on science performance (Cox & Popken, 2008). Lastly, there could have been bias in data interpretation because I have a specific view of the impact of writing to learn strategies on student learning in science and I could have interpreted the data to support my hypotheses if there was minimal growth in student performance. This could have led to overgeneralization of the findings in the study, even though the study was limited to students with specific learning disabilities (Simundic, 2013).

Strategies used to mitigate the above three biases were 1) ensuring that the control group is selected correctly and is representative of the population of students within the study and the

external validity of the study along with its generalizability of the results which accounted for the selection bias, 2) including rigorous statistical procedures that accounted for the confirmation bias as this type of bias often leads to statistical errors and the use of rigorous statistical procedures could have negated the ability of the researcher to selectively interpret the findings toward their hypothesis, 3) ensuring the appropriate statistical tests were used when analyzing the findings along with ensuring the appropriate interpretation/analysis of the results which could account for the bias in data interpretation. It was important in this study not to overgeneralize the findings as the participants are representative of students with specific learning disabilities which consisted of students in inclusion classrooms and learning language mild to moderate students. Moreover, as the repeated measures ANOVA was used to analyze the results which were statistically significant, important pragmatic dissimilarities and relations were also reported that mitigated the potential bias in data interpretation (Creswell & Creswell, 2017; Simundic, 2013).

Summary

This chapter discussed the statistical results of the study in terms of the two research questions, the limitations, and implications for the professionals in both general education and special education, along with the recommendations for future research. This study produced statistically significant results for students that received the writing to learn strategies which showed more vigorous progress for the mean achievement scores and the attitude analysis for the experimental group over the control group. This study was important for educational professionals in science and special education interested in implanting writing to learn strategies at the secondary level.

The importance of active versus passive learning and enhanced problem-solving skills are a priority for students with disabilities to learn science. Hands on activities in science help students to absorb information, construct scientific knowledge, and develop an inquiry-based approach to learning needed in science (Cawley, 1994). Literacy proficiency is also essential for promoting scientific understanding for students with learning disabilities (Cawley & Parmar, 2001). Writing to learn strategies enhance problem solving skills, promote hands on activities, develop inquiry-based knowledge, stimulate literacy proficiency, and promote student learning which led to the objective of the study being achieved (Danoff, Harris, & Graham, 1993; Fry & Villagomez, 2012).

The aim of this study was to contribute to the knowledge of how writing to learn strategies impact the achievement and overall interest of both Inclusion and Learning Language Mild to Moderate special education students in biological science. Writing to learn strategies offer students with specific learning disabilities accommodative approaches in learning, which are essential in secondary science erudition (Biddle, 2006; Tarchichi, 2017). Writing used as a learning tool for biological science moves away from the inconsequential way science is traditionally learned and offers students a method to learn the content more effectively and appropriately for retention (Moore, 1994). The research questions asked in this study were answered with adequate statistical data within the limitations of the study. In conclusion, the results of the study showed improved learning, achievement, and attitude of students with specific learning disabilities in biological science. The writing to learn strategies of strategic notetaking and dialectical notebooks lead to improved learning and achievement along with having a positive influence on student attitudes toward biological science. This was demonstrated in this study as post-test scores were almost identical for the LLMM and Inclusion

groups which further demonstrated that the writing to learn strategies are effective regardless of class type. Students with specific learning disabilities can all learn biological science effectively with the proper writing to learn strategies implemented in instruction such as dialectical notebooks and strategic notetaking.

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APPENDIX A**PRE-TEST**

1. (HS-LS2-3; HS-LS1-2) When a giraffe eats leaves from a tree, it incorporates the leaves into its own _____.
 - a. niche
 - b. biome
 - c. biomass
 - d. community

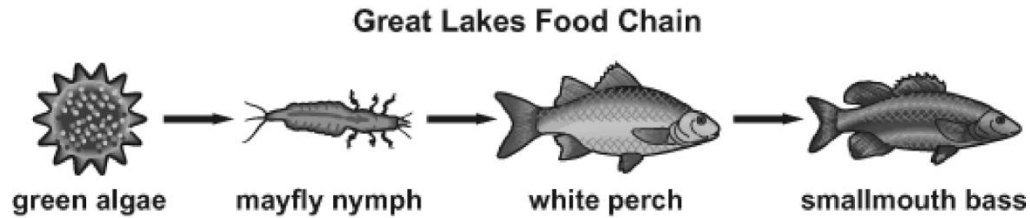
2. (HS-LS2-3; HS-LS1-2) The term biomass refers to the total _____.
 - a. producer-to-consumer ratio
 - b. mass of all living things on Earth
 - c. unused material excreted as waste
 - d. mass of the organisms in a given area

3. (HS-LS2-3; HS-LS1-2) Which provides most of the energy in ecosystems?
 - a. carnivores
 - b. producers
 - c. generalists
 - d. keystone species

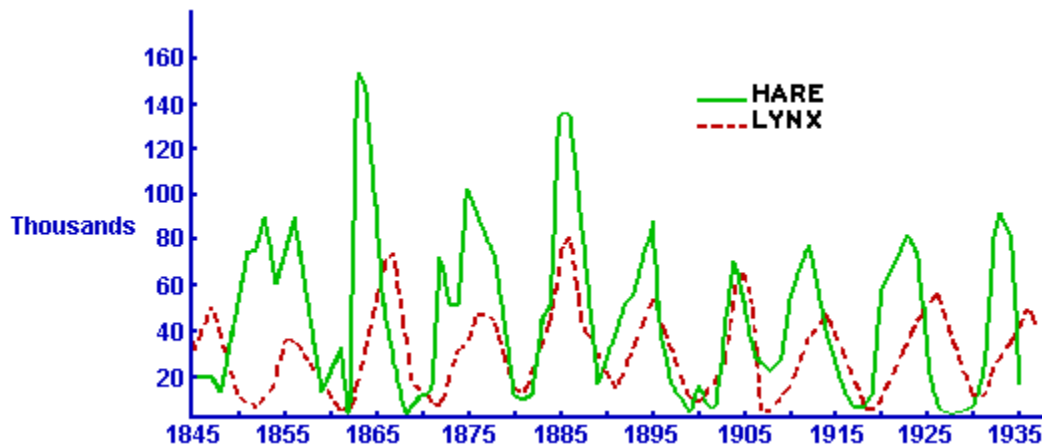
4. (HS-LS1-5; HS-LS1-2) Almost all autotrophs get their energy from _____.
 - a. sunlight
 - b. producers
 - c. decaying matter
 - d. hydrothermal pools

5. (HS-LS1-5; HS-LS1-2) Which of these can be found in trophic level 4?
 - a. herbivores
 - b. carnivores
 - c. omnivores
 - d. detritivores

6. (NGSS-HS-LS2-4; HS-LS2-5) Lake Erie is a freshwater lake located in the Great Lakes region that borders Michigan, Ohio, Pennsylvania, and New York. The food chain shows an example of some of the relationships within this ecosystem.

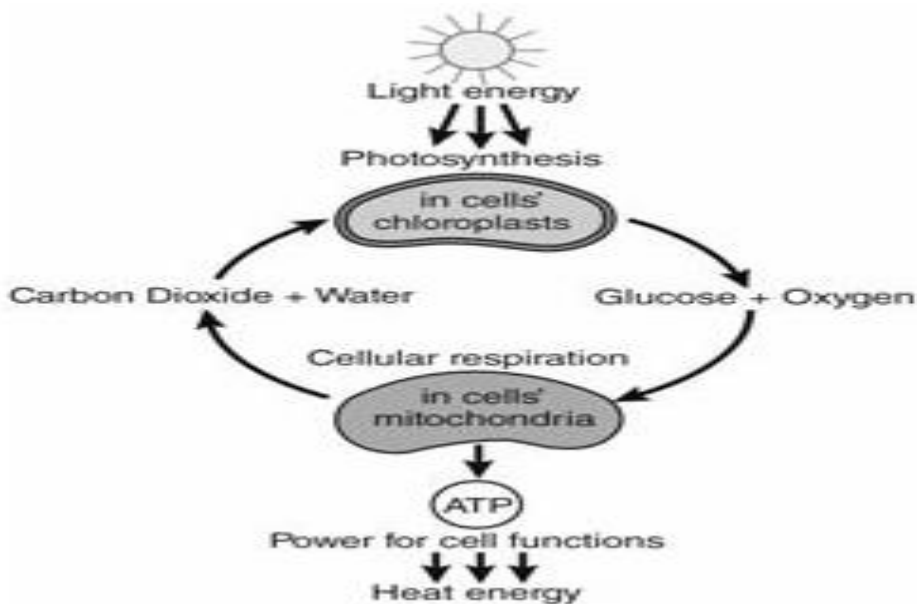


- a. Describe how carbon enters and exits this specific food chain. (3 points)
 - b. In the 1950s, Lake Erie experienced very low levels of oxygen, which resulted in the disappearance of mayflies from the ecosystem. Predict 3 outcomes describing how this would alter the flow of carbon in the food chain (3 points)
7. (NGSS-HS-LS2-1; HS-LS2-2) View the following graph that describes the hare-lynx relationship over time:



- a. Give 1 biotic and abiotic factor that can alter this pattern on the graph (2 points). Give an example how this would alter the pattern for each factor listed (2 points).
8. (HS-LS1-7) A marching band saxophonist is severely dehydrated during practice. The band director should tell her to sit and have a drink to maintain constant cellular respiration during practice. The drink should contain:
- a. ATP
 - b. Lipids
 - c. Glucose
 - d. Proteins

9. (HS-LS1-7; HS-LS1-5; HS-LS1-6) Plants can provide the materials that animals use in cellular respiration, and animals can provide some of the materials that plants use for photosynthesis. This image below shows the relationship between photosynthesis and cellular respiration.



According to the diagram, ATP is known as a _____ of the mitochondria?

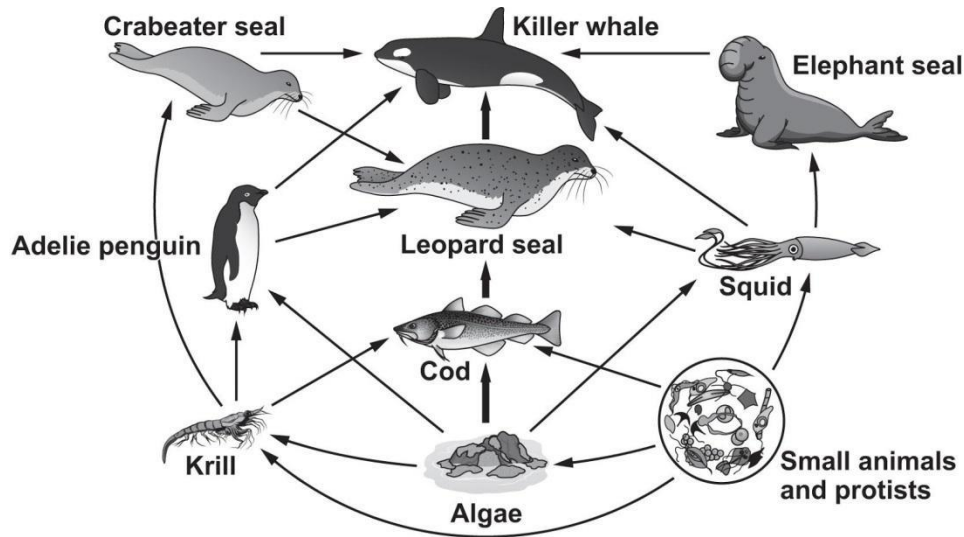
- Product
 - Reactant
 - Nucleotide
 - Peptide
10. (HS-LS1-7; HS-LS1-5; HS-LS1-6) Cellular Respiration is useful in the production of which energy source?
- ATP
 - DNA
 - Glucose
 - Oxygen
11. (HS-LS1-2; HS-LS1-3) Which of the following is a function of the cell membrane?
- breaks down lipids, carbohydrates, and proteins from foods
 - stores water, salt, proteins, and carbohydrates
 - keeps the cell wall in place
 - regulates which materials enter and leave the cell

12. (HS-LS1-2) Which organelle would you expect to find in plant cells but not animal cells?
- mitochondrion
 - ribosome
 - chloroplast
 - smooth endoplasmic reticulum
13. (HS-LS1-2) Which organelle stores food and water for the cell?
- chloroplasts
 - vacuoles
 - nucleoli
 - centrioles
14. (HS-LS1-1) Under which of the following conditions would you expect to find a cell with a predominance of free ribosomes?
- cell that is secreting proteins
 - cell that is producing cytoplasmic enzymes (proteins)
 - cell that is constructing its cell wall or extracellular matrix
 - cell that is digesting food particles
15. (HS-LS1-2) A cell has the following molecules and structures: enzymes, DNA, ribosomes, plasma membrane, and mitochondria. It could be a cell from a:
- bacterium, an animal, but not a plant.
 - a plant, but not an animal.
 - a plant or an animal.
 - any kind of organism.

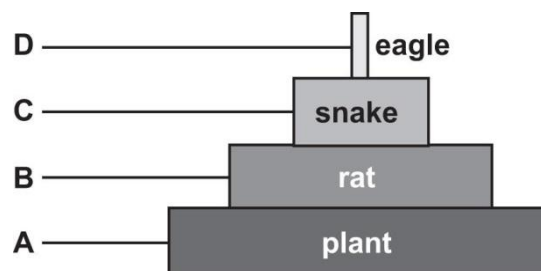
APPENDIX B

MID-TREATMENT ASSESSMENT

Refer to the diagram below to answer questions 1-2



- (HS-LS1-5; HS-LS1-2) At what trophic level do the killer whales primarily feed?
 - the third trophic level only
 - the second trophic level only
 - the third and fourth trophic levels
 - the first and second trophic levels
- (HS-LS1-5; HS-LS1-2) How much energy is available to the organisms in level C?



- all of the energy in level A plus the energy in level B
- all of the energy in level A minus the energy in level B
- 10 percent of the energy in level B
- 90 percent of the energy in level B

1. (HS-LS2-3; HS-LS1-2) Elements such as carbon can move through the environment and organisms in a cycle because living and nonliving things interact in _____.
 - a. cells
 - b. species
 - c. organisms
 - d. ecosystems

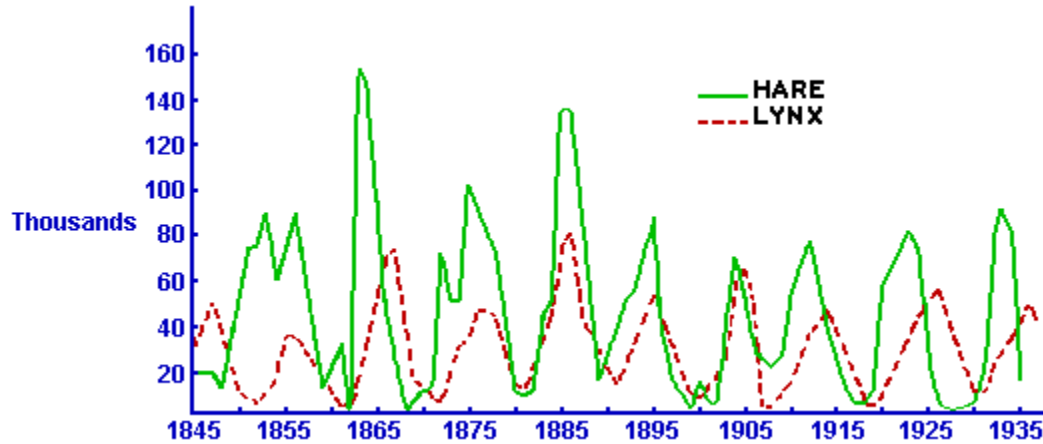
2. (HS-LS1-5; HS-LS2-3) Which process is part of the water cycle?
 - a. nitrification
 - b. transpiration
 - c. sedimentation
 - d. decomposition

3. (HS-LS1-6) Which of these is common to the carbon cycle, the nitrogen cycle, and the water cycle?
 - a. The largest reserves of the substance, such as water, are always stored in organisms in the biosphere.
 - b. The substance, like water, must pass through organisms in order to complete its cycle.
 - c. The substances are considered biotic factors of an ecosystem.
 - d. The substance is required by all living things and is involved in many processes that occur in all living things.

4. (NGSS-HS-LS2-1; HS-LS2-2) Provide 2 examples of a system within this ecosystem? Include all components of a system in your answer and include evidence and examples.

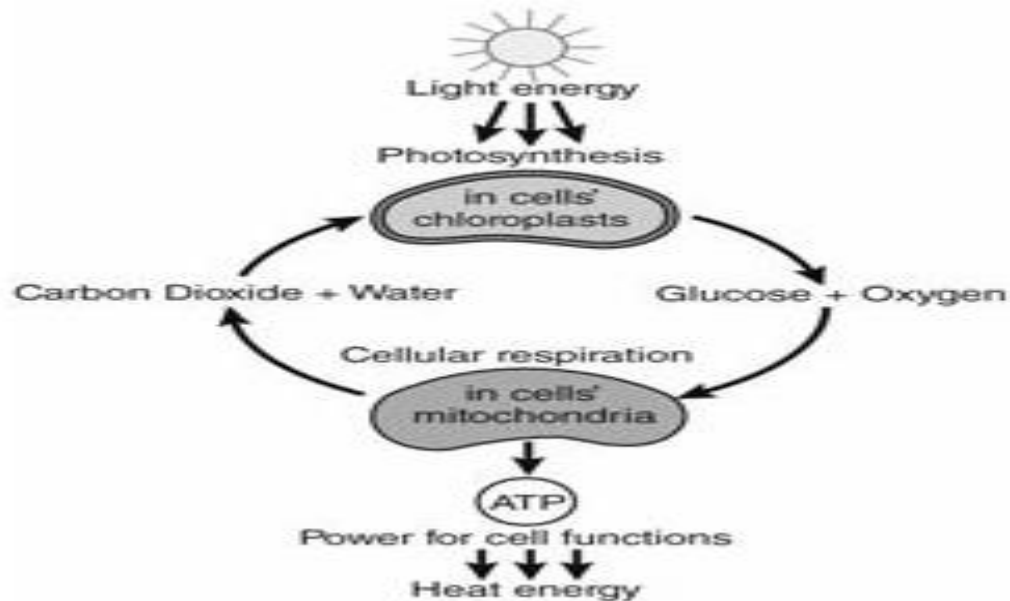


5. (NGSS-HS-LS2-1; HS-LS2-2) View the following graph that describes the hare-lynx relationship over time:



- a. What is the relationship between the hare and the lynx? (1 point)
6. (HS-LS1-7) Drinks made to hydrate an athlete must be able to maintain the athlete's cellular respiration. The drink should contain:
- ATP
 - Lipids
 - Glucose
 - Proteins

7. (HS-LS1-7; HS-LS1-5; HS-LS1-6) Plants can provide the materials that animals use in cellular respiration, and animals can provide some of the materials that plants use for photosynthesis. This image below shows the relationship between photosynthesis and cellular respiration.



- According to the diagram, the production of ATP is directly from which process?
- Cellular Respiration
 - Photosynthesis
 - Glycolysis
 - Electron Transport Chain
8. (HS-LS1-6, HS-LS1-7) The mitochondria directly impacts which of the following processes?
- ATP production
 - DNA replication
 - Photosynthesis
 - Glucose production
9. (HS-LS1-2) Which of the following is a function of the cell membrane?
- breaks down lipids, carbohydrates, and proteins from foods
 - stores water, salt, proteins, and carbohydrates
 - keeps the cell wall in place
 - regulates which materials enter and leave the cell

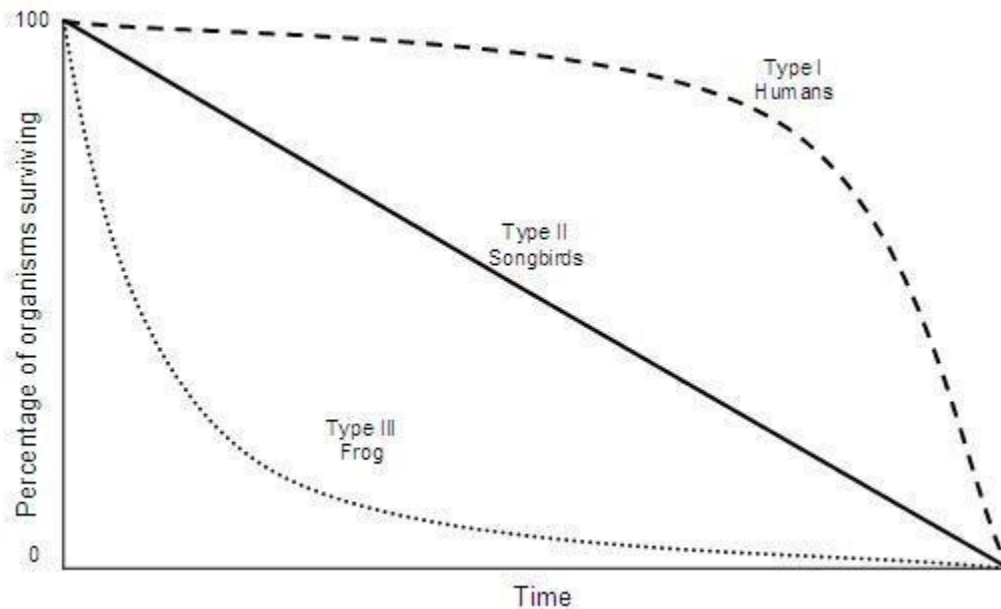
10. (HS-LS1-3) Which of the following organelles are found in prokaryotes?
- ribosomes
 - Golgi apparatus
 - endoplasmic reticulum
 - lysosomes
11. (HS-LS1-3) Which of the following is an example of a prokaryotic cell?
- chloroplast
 - fungus
 - bacterium
 - muscle cell
12. (HS-LS1-2) A cell has the following molecules and structures: enzymes, DNA, ribosomes, plasma membrane, and mitochondria. It could be a cell from a.
- bacterium.
 - an animal, but not a plant
 - a plant, but not an animal.
 - a plant or an animal.
13. (HS-LS1-2) What level of organization is the small intestine?
- cell
 - tissue
 - organ
 - organ system

APPENDIX C**POST TEST**

1. (HS-LS2-2) A pyramid of numbers is used to show _____.
 - a. a chain of feeding relationships
 - b. a network of feeding relationships
 - c. the distribution of biomass in an ecosystem
 - d. the distribution of organisms in an ecosystem
2. (HS-LS1-5; HS-LS1-2) Leopard seals eat only meat. What are leopard seals?
 - a. carnivores
 - b. herbivores
 - c. omnivores
 - d. producers
3. (HS-LS1-5; HS-LS1-2) _____ release carbon dioxide into the atmosphere when they break down organic compounds.
 - a. autotrophs
 - b. plants
 - c. photosynthesis
 - d. decomposers and heterotrophs
4. (HS-LS2-4) Bobby was asked to predict the trophic levels in a specific ecosystem. When he drew his energy pyramid, he included 7 trophic levels. Why is this not a good example of trophic level model:
 - a. because as the energy transfer is always 100%
 - b. because as you increase trophic levels, biomass decreases
 - c. because as you increase trophic levels, energy transfer decreases
 - d. both b and c are correct
5. (NGSS-HS-LS1-2; HS-LS6) All living things have numerous characteristics in common. Could the robot below be considered “living”? Why or why not? Use the characteristics of living things to justify your answer.



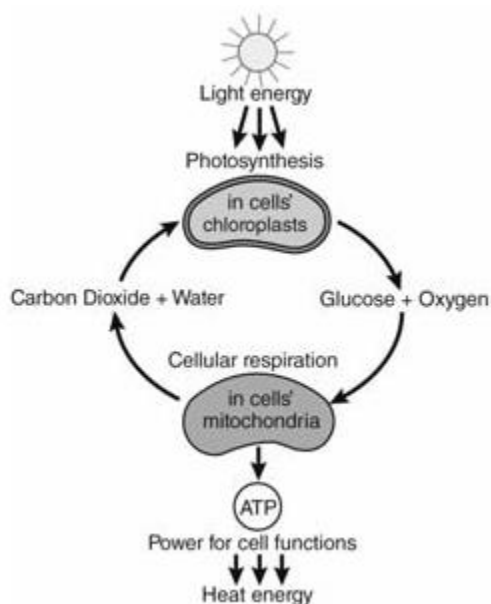
6. (HS-LS2-6) The cellular activity of organisms that are carbon or non-carbon based. Living or non-living can be biologically affected by _____.
- environments
 - other species
 - ecosystems
 - both a and c are correct
7. (HS-LS2-2) View the following survivorship curve



Describe what the graph is describing in terms of survivorship with

- Type I curve:
 - Type II curve:
 - Type III curve:
8. (HS-LS1-7) ATP is essential in order to maintain energy during physical situations. Which of the following situations where a drink containing ATP would be least beneficial?
- A football player running the 40-yard dash more than once
 - A basketball player jogging around the court
 - A marching band student practicing for an hour with the team
 - A coach walking around the practice field instructing the team

9. (HS-LS1-7; HS-LS1-5; HS-LS1-6) Plants can provide the materials that animals use in cellular respiration, and animals can provide some of the materials that plants use for photosynthesis. This image below shows the relationship between photosynthesis and cellular respiration.



According to the diagram, the following statement is not true:

- Light energy is the catalyst in the photosynthetic reaction
 - Heat energy is the product in the reaction
 - ATP is a direct product of photosynthesis
 - Glucose and oxygen are direct products of photosynthesis
10. (HS-LS1-7) Which cellular process begins glucose metabolism in all cells?
- Respiration
 - Fermentation
 - Cellular respiration
 - Glycolysis
11. (HS-LS1-2) Which of the following is NOT a principle of the cell theory?
- Cells are the basic units of life.
 - All living things are made of cells.
 - Very few cells reproduce.
 - All cells are produced by existing cells.

12. (HS-LS1-3) Which of the following membrane activities does NOT require the expenditure of energy by the cell?
- active transport
 - osmosis
 - endocytosis
 - exocytosis
13. (HS-LS1-3) A plant cell placed in a hypertonic solution will:
- remain unchanged.
 - undergo lysis.
 - undergo plasmolysis.
 - swell slightly.
14. (HS-LS4-2) The ultimate source of genetic variation within a population is:
- mutations in DNA.
 - adaptation of a species to environmental changes.
 - homeostatic mechanisms that compensate for environmental changes.
 - a sensory system that can detect an environmental change.
15. (HS-LS1-3; HS-LS1-2) Which organelles contain enzymes and is involved in digestion and waste removal?
- chloroplasts
 - lysosomes
 - nucleus
 - mitochondria

APPENDIX D

BIOLOGY ATTITUDE SURVEY

Demographic Data

Please tell us your Gender and Race/Ethnicity. Note that your name will not appear anywhere on the survey.

Gender:

Male_____

Female _____

Ethnicity:

African American/Black_____

Caucasian/White_____

Asian American_____

Hispanic/Latino_____

Multi-Racial_____

Other_____

The following are statements about the study of biology. Please read each statement carefully. Respond to the statements by circling the numbers that correspond to you level of agreement to the statement. It is important that you respond to every question and that you circle only one number per question.

Attitude Toward Biology Survey

ATB Statements	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. Biology is useful for solving the problems of everyday life.	1	2	3	4	5
2. I enjoy learning Biology; I have a real desire to learn biology.	1	2	3	4	5
3. I enjoy the method I am taught Biology.	1	2	3	4	5
4. Biology is easy for me	1	2	3	4	5
5. When I hear the word "biology" I have a feeling of dislike	1	2	3	4	5
6. No matter how hard I try, I cannot understand biology.	1	2	3	4	5
7. Biology teachers present materials in a way I cannot understand.	1	2	3	4	5
8. Writing does not help me when learning biology.	1	2	3	4	5
9. Writing in biology does not help me learn the concepts in the science.	1	2	3	4	5
10. I remember most of the concepts I learn in biology class.	1	2	3	4	5

APPENDIX E

CHECKLIST FOR DIALECTICAL NOTEBOOK IMPLEMENTATION

- I. Students must use a composition or spiral bound one subject notebook
- II. Each notebook or composition book will be used for only one subject
- III. One standard or concept should be used for one page
- IV. Students are to separate the page by drawing a straight line down the center of the page
- V. Teacher lecture the students on the content that is standard specific (e.g. biology)
- VI. Students record specific information on the left side of the page on one specific concept
- VII. Students record their understanding of the content or the standards on the right side of the column
- VIII. Students compare their information on both the left-hand side and right-hand side of the column
- IX. Students discuss both the left-hand side and right-hand side of the column in small group instruction
- X. In a small group discussion, the researcher/educator discusses the information in the lecture in detail and what the students wrote on the right side of the column in correspondence to the facts and details on left side of the column. The researcher/educator assists the students with the organizational skills needed for dialectical notebooks to be implemented with fidelity.

APPENDIX F

CHECKLIST FOR STRATEGIC NOTETAKING IMPLEMENTATION

- I. Students must use a composition or spiral bound one subject notebook
- II. Each notebook or composition book will be used for only one subject
- III. One standard or concept should be used for one page
- IV. The researcher/educator demonstrates the proper notetaking procedure and specific organizational skills needed in strategic notetaking
- V. Teachers lecture the students on the content that is standard specific (e.g. biology)
- VI. Students record their understanding of the critical components of the content
- VII. Students summarize their understanding of the of the content or standards
- VIII. Students compare their recordings of the critical components of the content to their summarization of the content
- IX. Students discuss both the critical components of the content to their summarization of the content and take down vital information presented by their classmates in small group instruction
- X. In a small group discussion, the researcher/educator discusses the information in the lecture in detail and what the students wrote down as critical components and their summarization and discusses what was vital information and the necessary information that should be retained from the content. The researcher/educator assists the students with the organizational skills needed for strategic notetaking to be implemented with fidelity.

APPENDIX G

ACCEPTABILITY SURVEY

Demographic Data

Please tell us your Gender and Race/Ethnicity. Note that your name will not appear anywhere on the survey.

Gender:

Male_____

Female _____

Ethnicity:

African American/Black_____

Caucasian/White_____

Asian American_____

Hispanic/Latino_____

Multi-Racial_____

Other_____

The following are statements about the social validity of the writing to learn strategies of dialectical notebooks and strategic notetaking. Please read each statement carefully. Respond to the statements by circling the numbers that correspond to you level of agreement to the statement. It is important that you respond to every question and that you circle only one number per question.

Acceptability Survey

SV Statements	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. I was satisfied with the dialectical notebooks as method to learn biology	1	2	3	4	5
2. I was satisfied with the strategic notetaking as method to learn biology	1	2	3	4	5
3. Dialectical notebooks were an appropriate intervention for learning biology	1	2	3	4	5
4. Strategic Notetaking was an appropriate intervention for learning biology	1	2	3	4	5
5. Dialectical notebooks made learning biology easier for me as a student	1	2	3	4	5
6. Strategic Notetaking made learning biology easier for me as a student	1	2	3	4	5
7. Dialectical notebooks were useful as a practice to prepare for a biology test	1	2	3	4	5
8. Strategic Notetaking was useful	1	2	3	4	5

as a practice to prepare for a biology test					
9. I would use dialectical notebooks on my own when I study a subject like biology	1	2	3	4	5
10. I would use strategic notetaking on my own when I study a subject like biology	1	2	3	4	5