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Integrating Literacy Strategies In The Biology Classroom: Using A Generative Vocabulary Matrix To Improve Standardized Test Scores

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INTEGRATING LITERACY STRATEGIES IN THE BIOLOGY
CLASSROOM:
USING A GENERATIVE VOCABULARY MATRIX TO IMPROVE
STANDARDIZED TEST SCORES

by

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DEDICATION

To my grandmother, Ann Elizabeth Casey, who served her community as a high school English teacher and librarian from 1952 until 1987. Her unique teaching methods were ahead of her time. My grandmother's life and her work have inspired me never to stop pursuing greater knowledge.

To my husband, Zachary Morrison, who has provided me with unfailing support and encouragement throughout this process and to whom I owe an immense amount of gratitude.

ABSTRACT

This dissertation focuses on the development and implementation of an action research study that seeks to determine the impact of integrating literacy strategies in the biology classroom on standardized test scores. The teacher-researcher identified the problem of practice in her classroom after four years of observation of ninth-grade biology students. These observations led the teacher-researcher to develop, research, and investigate the following question: What is the impact of Larson's (2014b) Generative Vocabulary Matrix (GVM) in a high school biology course as demonstrated by students' performance on the South Carolina End-of-Course Examination Program? This dissertation orients the research question from a theoretical perspective and provides literature to support the relevance of this work. Additionally, this dissertation provides details associated with the process of planning, developing, acting, and reflecting on this action research study.

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CHAPTER 1

INTRODUCTION AND METHODOLOGY

Topic & Background

The present action research study integrated literacy strategies into the biology classroom using Larson's (2014b) Generative Vocabulary Matrix (GVM). The GVM emphasizes the need for student engagement in academic content through experiences. By using an active learning method for literacy instruction, such as the GVM, students can develop personal connections to the content while simultaneously building science literacy skills.

The teacher-researcher is a high school biology teacher whose students often find it very difficult to learn and retain the concepts taught in the high school biology classroom because of a lack of science literacy skills. Students think of literacy and science as separate entities, never overlapping, while in reality the two are permanently intertwined. Larson (2014a) states that "Over half of the work of scientists involves reading and writing, yet secondary instruction does not typically incorporate the very reading and writing discourses of the subject area domain that develop reasoning and conceptual understanding" (pp. 287-288). To increase student achievement in the sciences, science educators must begin integrating literacy fundamentals into their lessons and build on those principles regularly. This study evaluated the importance of integrating literacy instruction in the science classroom on student performance on the

South Carolina End-of-Course Examination Program for biology. The teacher-researcher utilized action research methods to conduct this study within her classroom. Chapter 2 includes detailed information regarding the historical context of this study and research related to instructional strategies, literacy education, and the SC biology curriculum.

Problem of Practice

The identified Problem of Practice (PoP) involves Rushmore High School (RHS), a pseudonym used to protect the school's identity, where student achievement on the South Carolina End-of-Course Examination Program (EOCEP) for biology needs improvement. The identified PoP was developed after several years of direct observation by the teacher-researcher who was a ninth-grade biology instructor at RHS. Students consistently perform below their potential in ninth-grade biology because their reading ability and writing skills in science collectively referred to as "science literacy skills," are not at the levels necessary for students to effectively memorize and comprehend the vocabulary and concepts evaluated on the SC EOCEP for biology. The teacher-researcher also noted that students do not have identical experiences contributing to their scientific knowledge. If assumptions regarding shared experiences are made in the process of test development, this diversity has the potential to place some students at a disadvantage on standardized tests, such as the SC EOCEP for biology.

The teacher-researcher evaluated the relationship between integrating literacy strategies in the biology classroom and performance on the SC EOCEP for biology. Larson's (2014b) Generative Vocabulary Matrix (GVM) is a literacy strategy that utilizes experiences as part of instruction. The integration of literacy strategies and science is a pedagogical technique that has been effective with ninth-grade biology students in other

areas of the United States using Larson's (2014b) GVM. Before the present action research study, the integration of literacy strategies and biology had not previously been researched using Larson's (2014b) GVM at RHS. The teacher-researcher implemented Larson's (2014b) GVM as a literacy strategy with ninth-grade biology students in the spring of 2018.

The SC EOCEP for biology is a high-stakes test which accounts for 20% of each student's overall course average and consequently has the potential to impact students' overall grade point averages (GPA). Additionally, the passage rate on this test is published in the public domain on the SC Department of Education's website. This information can be used by parents and community members to evaluate a school's merit and achievement level. Based on these factors, the PoP was identified as a need for increased student achievement on the SC EOCEP for biology due to the potential impact this test has on students' overall course averages, their GPAs, and the consequences these results may have on public opinion of the present school. This identified PoP was the subject of the present action research study.

Research Question and Objectives

This study is classified as an action research study and was conducted by the teacher-researcher. According to Mills (as cited in Mertler 2014), action research can be defined as, "any systematic inquiry conducted by teachers...with a vested interest in the teaching and learning process or environment for the purpose of gathering information about...how they teach and how their students learn" (p.4). This study took place at Rushmore High School where the teacher-researcher was employed during the 2016-2017 and 2017-2018 school years. The action research study was conducted in the

teacher-researcher's ninth-grade biology classes during the 2017-2018 school year. The teacher-researcher had a vested interest in improving her students' retention and comprehension of the concepts covered in introductory biology. The teacher-researcher sought to improve her students' scores on the South Carolina End-of-Course Examination Program for biology by implementing Larson's (2014b) Generative Vocabulary Matrix (GVM) as the foundation for literacy instruction.

The design of this action research study was a mixed-methods study. Most of the data were quantitative and the teacher-researcher used descriptive statistics to analyze the results. The teacher-researcher kept an informal observational journal during the study that was used to triangulate the data. In this study, the scores of the teacher-researcher's students on the SC EOCEP for biology were compared to the results of similar students from the previous year. During the 2017-2018 school year, Larson's (2014b) GVM was implemented as the foundation for literacy instruction in both teacher-researcher's biology classes. This instructional strategy was not used in the previous year in the teacher-researcher's classes or by any teacher at Rushmore High School. The study was designed as an action research study with the intent of being suggestive, not probative. The research question at the center of this action research study was:

- 1. What is the impact of Larson's (2014b) Generative Vocabulary Matrix (GVM) in a high school biology course as demonstrated by students' performance on the SC End-of-Course Examination Program?*

The teacher-researcher hypothesized that the biology classes at Rushmore High School where students used Larson's (2014b) GVM would have higher average scores on the SC EOCEP than the scores of similar students from the previous year. Further details on the

research design, including participant selection, statistical analysis, and ethical considerations, are included in Chapter 3.

Purpose Statement

The primary purpose of the present action research study was to integrate literacy strategies into the biology classroom using Larson's (2014b) Generative Vocabulary Matrix (GVM). The secondary purpose was to develop an action plan based on the use of Larson's (2014b) GVM and the South Carolina biology standards for instruction. The tertiary purpose was to describe the relationship between science literacy skills and performance on the SC End-of-Course Examination Program for biology.

Theoretical Framework

The present action research study draws on the theories of Franklin Bobbitt, William F. Pinar, and Wayne Au. Franklin Bobbitt (2013) emphasizes the importance of creating and drawing on students' experiences to meet learning objectives. William Pinar (2013) shares the importance of blending various educational ideologies in developing an effective curriculum. Wayne Au (2013) seeks to combat unwelcome instructional trends associated with the increase of high-stakes testing.

Experience and Education

In far too many instances, science is taught as a series of facts presented in isolation while in the real-world these facts are woven together to create events, systems, and phenomena. It is to the detriment of students that the methods of teaching science do not accurately reflect the real-world applications of the subject. Franklin Bobbitt (2013) suggests,

Education is now to develop a type of wisdom that can grow only out of participation in the living experiences of men, and never out of mere memorization of verbal statements of facts. It must, therefore, train thought and judgment in connection with actual life-situations, a task distinctly different from the cloistral activities of the past. (p.11)

Bobbitt (2013) encourages educators to draw from these “actual life-situations” to support the mastery of learning objectives. In support of Bobbitt’s theology, this action research study used Larson’s (2014b) Generative Vocabulary Matrix (GVM) as the foundation for literacy instruction. Larson’s (2014b) GVM centers on lesson development that utilizes activating experiences (such as labs, demonstrations, or simulations) to facilitate the creation of meaningful connections between learning objectives and real-world applications of the content. Larson (2014b) states, “Generative processes include building rich relationships among concepts, linking prior knowledge to new information, actively constructing meaning, and transferring experience and knowledge to new situations” (p. 113). The blending of experiences and education are foundational components in the present action research study.

Blending Educational Ideologies

William F. Pinar (2013) divides curricularists into three categories: traditionalists, conceptual-empiricists, and reconceptualists. Pinar paints traditionalists as former school teachers, now curricularists, who focus on addressing current issues within schools and their classrooms (2013). Conceptual-empiricists are individuals with varying backgrounds and motives for studying education but ultimately seek to follow a scientific method to develop solutions to educational problems (2013). Pinar (2013) states that

conceptual-empiricists hold, “the view that education is not a discipline in itself, but an area to be studied by the disciplines” (p. 152). Pinar (2013) believes that while each type of curriculumist has a unique view of education, the field of education must blend the ideas of each to prosper and flourish. Reconceptualists take ideas from both traditionalists and conceptual-empiricists but diverge by adding a, “‘value-laden’ perspective and a perspective with a politically emancipatory intent” (Pinar, 2013, p. 153). This action research study seeks to find a middle ground between the reconstructionist views and the ideals of both the traditionalists and conceptual-empiricists. This study addresses a problem in the classroom which is a focus of traditionalists and will use the scientific method to develop an action research plan and collect data that orients the study with the conceptual-empiricists. Pinar (2013) states, “We are not faced with an exclusive choice: either the traditional wisdom of the field, or conceptual-empiricism, or reconceptualization. Each is reliant upon the other” (p. 155).

In South Carolina, standardized testing is required of students at the end of select courses. At the culmination of biology courses, students take the SC End-of-Course Examination Program. Larson’s (2014b) General Vocabulary Matrix (GVM), which is the foundation for the literacy instruction in the present action research study, works within the instructional framework outlined by the government by building upon the core content standards, but also incorporates the focus of reconceptualists by implementing a strategy of interactive learning which is targeted towards the students’ interests and personal experiences.

Educators may work towards changing policies associated with the over-testing of high school students, but while the tests are in place, educators must explore

opportunities to enrich students' educational experiences within the current framework. Educators can use strategies such as Larson's (2014b) GVM, which gives students educational experiences, provides them with "intellectual freedom," and helps them achieve academic success on the standardized tests which currently contribute heavily to their overall course averages (Pinar, 2004, p.10).

High-Stakes Testing

Wayne Au (2013) defines a test as high-stakes, "when its results are used to make important decisions that affect students, teachers, administrators, communities, schools, and districts" (p. 236). According to these guidelines, the South Carolina End-of-Course Examination Program for biology is identified as a high-stakes test. The SC EOCEP directly impacts students by contributing to 20% of their overall course averages for biology. Due to the impact this test can make on a student's overall course average, it also has the potential to impact a student's grade point average (GPA). Additionally, administrators, communities, schools, and districts are affected by the results of the SC EOCEP. The results of this test and EOCEPs in other subject areas are in the public domain and parents may decide to move their students into or out of the district or school zone based on how the schools perform on high-stakes tests such as this one.

The present action-research study seeks to combat the unwelcome trends that have arisen due to the proliferation of high-stakes testing in the United States. In Au's (2013) study, he found that "overwhelmingly, the prevalent theme triplet in the qualitative research was the combination of contracting curricular content, fragmentation of the structure of knowledge, and increasing teacher-centered pedagogy in response to high stakes testing" (p. 245). The structure of Larson's (2014b) Generative Vocabulary

Matrix (GVM) focuses on making connections throughout the curriculum and relating the content to real-world experiences instead of teaching in isolated units. Larson's (2014b) GVM also increases student-centered pedagogy instead of focusing on a teacher-centered lecture. Larson's (2014b) GVM is based on students integrating curricular content through experience-based lessons into their current understanding of the world. By using Larson's (2014b) GVM to increase student achievement on a high-stakes test, like the SC EOCEP for biology, students are benefiting from an unrestricted curricular content, a fluid and continuous structure of knowledge, and increased student-centered pedagogy. Moe (2003) states, "Virtually all organizations need to engage in top-down control, because the people at the top have goals they want the people at the bottom to pursue, and something has to be done to bring about the desired behaviors" (p. 81). While this may be true, the implementation of high-stakes tests such as the SC EOCEP begs the question, how do the goals of the people at the top directly benefit the people (teachers and students) at the bottom who are pursuing them?

The present action research study seeks to help students be successful within the current educational system without losing the benefits of an academically rich and student-centered instructional method. The method used for the present action research study weaves together student experience and perspective within the framework that is currently in place at the school and district of interest for this study.

Potential Weakness

As previously stated, the design of this action research study is a mixed-methods study but is largely quantitative using descriptive statistics to analyze the results. In this study, the scores of the teacher-researcher's students on the South Carolina End-of-

Course Examination Program for biology were compared to the results of similar students from the previous year. One of the limitations of the study was consistency in the specific questions asked on the SC EOCEP for biology. The 2017 and 2018 SC EOCEPs had identical blueprints, but the questions themselves were not necessarily identical from year to year. The significance of this issue may be minimal because the SC Department of Education develops the test with the goal of comparing results from year to year and establishing trends; however, to show consistency and determine any differences, the state mean scores for the 2017 and 2018 SC EOCEP for biology are included and evaluated as part of the reported data for this study.

Significance of the Study

The present action research study took place in an era where students' grades in select high school courses are largely determined by results of high-stakes tests, such as the South Carolina End of Course Examination Program for biology. The SC EOCEP for biology accounts for 20% of each student's overall class average in ninth-grade biology with the semester averages accounting for the other 80% of the final grade. This one assessment could greatly impact a student's grade in the class and potentially affect their overall high school grade point averages (GPA). The teacher-researcher seeks to provide students with instruction that will afford them the best opportunity to score at their maximum ability on this examination. If students feel successful at the beginning of their high school career, they may have more drive to continue putting forth effort in the following years. The present action research study sought to produce statistical relevance related to improving standardized test scores by integrating literacy strategies using Larson's (2014b) Generative Vocabulary Matrix (GVM).

Larson's (2014b) GVM was selected as the literacy strategy for this study because it uses experience-based education as the foundation for instruction. The instructional framework used with Larson's (2014b) GVM centers on four stages: initiate, conceptualize, enrich, and access. In the initiate stage, students participate in an in-class experience (such as a lab, demonstration, or activity) and use that experience to identify important words or terms. In the conceptualize stage, students begin to group words and label categories based on further instructional activities. During the enrich stage, students can continue to add words to the GVM as they expand their knowledge base and rework the matrix to transition from isolated word groups to an interconnected semantic framework. In the access stage, students reference the GVM as they continue to move through the unit, reflect, and enhance their depth of knowledge.

The teacher-researcher educates diverse students. In the present action research study, the teacher-researcher could not control outside factors that influence a student's knowledge, but she could control the experiences she provided within her classroom. If the teacher-researcher were simply to reference an assumed shared experience and then relate it to content, students who had never experienced that event might lose the opportunity to recall or understand the associated material effectively. Using Larson's (2014b) GVM, the teacher-researcher facilitated experiences (such as labs, activities, demonstrations) in the classroom that the students used as a foundation to build science literacy skills. The use of Larson's (2014b) GVM as a literacy strategy provided an opportunity for all students, regardless of their backgrounds, to make connections between experiences and educational material.

Summary and Conclusion

The present action research study focused on the impact of integrating literacy strategies in the biology classroom on standardized test scores. The goal of this research was to implement Larson's (2014b) Generative Vocabulary Matrix (GVM), an experience-based literacy strategy, to increase student performance on the South Carolina End-of-Course Examination Program. The present action research study sought to answer the question: What is the impact of Larson's (2014b) Generative Vocabulary Matrix (GVM) in a high school biology course as demonstrated by students' performance on the SC End-of-Course Examination Program? The teacher-researcher sought to improve the quality of biology instruction for her students using the Larson's (2014b) GVM. The teacher-researcher hoped to demonstrate that this change in instructional methods would increase the students' scores on the SC EOCEP. The literature review in Chapter 2 provides a historical context for the study and in-depth research on instructional strategies, literacy education, the SC biology curriculum. Chapter 3 explains the methodology and research design for this study. Chapter 4 presents and analyzes the data for this study, and Chapter 5 provides conclusions and recommendations for future research.

Keywords Glossary

Generative Model/Process: A model that, “predicts that learning is a function of the abstract and distinctive, concrete associations which the learner generates between his prior experience, as it is stored in long-term memory, and the stimuli” (Wittrock, 2010, p. 41).

Generative Vocabulary Matrix (GVM): A “fluid and interactive concept organizer made of words written on sticky notes and arranged semantically on a large poster by students with teacher guidance during learned activities” (Larson, 2014a, p. 291).

High-stakes Test: A test is deemed this “when its results are used to make important decisions that affect students, teachers, administrators, communities, schools, and districts” (Au, 2013, p. 236).

Literacy: The combination of reading and writing abilities.

Semantic Maps: “Graphic organizers that help students identify important ideas and how those ideas fit together” (Jackson, Tripp, & Cox, 2011, p. 45).

SC End-of-Course Examination Program (EOCEP): A standardized test which counts for 20% of each biology students’ final grade in SC and covers content related to the SC Performance Standards for Biology (South Carolina Department of Education, 2016).

Standardized Test: A test given to measure student growth and achievement. Developed at the county, state or national level.

CHAPTER 2

LITERATURE REVIEW

Introduction

This chapter provides a review of scholarly literature that explains the relevance of integrating literacy strategies in the biology classroom in an era of high-stakes testing in the state of South Carolina. The main topics included in this literature review are: historical context, instructional strategies, literacy education, SC biology curriculum, and methodology. This chapter grounds the study by providing a historical context starting in the early 1800s and extending to the present day. Next, Larson's (2014b) Generative Vocabulary Matrix (GVM) is explained by reviewing the instructional strategies that contribute to its structure and implementation. The instructional strategies addressed are generative knowledge and process, semantic maps and discussion, and experience-based education. The review of literacy education discusses continuing literacy education throughout high school and scientific literacy concerns for subpopulations. Information on the SC biology curriculum provides details about the state standards and the SC End-of-Course Examination Program for biology. Lastly, this chapter concludes with a brief overview of the action research methodology for the present action research study.

Historical Context

Common School Movement (the early 1800s)

Rushmore High School is a public high school in a suburban area in South Carolina. It enrolled approximately 2350 students during the 2017-2018 school year. As a public school, many of the fundamental ideals of the school evolved from the common school movement in the early 1800s. The common school movement was a result of many different groups pushing education in a similar direction, but for vastly different reasons. The common school was created with the intent of being, “administered by state and local governments for the purpose of achieving public goals, such as remedying social, political, and economic problems” (Spring, 2014, p. 78). Throughout the common school movement, the philosophies of political groups continued to move in opposing directions, but the common school movement still managed to prevail (Spring, 2014).

One of the focuses of the common school movement was equality. Today, literacy plays a key role in attaining economic and social equality. While literacy will not solve all equality issues, just as the common school movement could not, a student who has learned to express their thoughts through writing and can attain knowledge through reading can gain power over their future. The concept held today of education leading to future success and power is an extension of the ideals of the of the workingmen’s parties during the common school movement. The workingmen’s parties saw the common school as an opportunity to ensure the sharing power, the protection of their rights, and fair treatment (Spring, 2014).

Post-World War II (1945- early 1960s)

After World War II, the field of education saw a dramatic increase in the role of the federal government. Reminiscent of the educational movements in the early 1800s, education once again took on the burden of being the proposed solution to many of the nation's growing concerns (Spring, 2014). The aftermath of World War II illuminated the need for educational and training opportunities for young American men. The nation required soldiers as well as engineers and scientists. In the 1940s, to rival and ideally surpass the other nations of the world, the federal government along with Vannevar Bush and James B. Conant helped to develop the National Science Foundation (NSF) (2014). The NSF-supported scientific research was devoted to improving science education in public schools (2014). Approximately a decade later, the National Defense Education Act (NDEA) was implemented (2014). The NDEA was developed as a response to the Soviet Union's launch of Sputnik I. As part of this program President Eisenhower, "called for a system of nationwide testing of high school students and a system of incentives to persuade students with high ability to pursue scientific or professional studies" (Spring, 2014, p. 369).

A Nation at Risk (the 1980s)

In the early 1980s, Secretary of Education, Terrel H. Bell, spoke out on the importance of literacy education. Since this time, the call for nationwide testing has been a theme in the American educational system. In 1983, the National Commission on Excellence in Education stated, "our nation is at risk. Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world" (p. 102). One of the recommendations to

combat this challenge was that “standardized tests of achievement (not to be confused with aptitude tests) should be administered at major transition points from one level of schooling to another and particularly from high school to college or work” (p. 116).

Today, the United States government is still arguing for the necessity of standardized testing to propel students toward higher academic achievements and ultimately position the United States as a fierce international academic competitor.

The problem of practice for the present action research study is centered on a standardized test of achievement which was developed from the past and current mandates issued by the federal and local government. The South Carolina End-of-Course Examination Program for biology is one of many standardized tests administered to high school students in the state of South Carolina. In order to attain the associated goals the government has for standardized tests, students must not only participate in testing but are also pushed to achieve specific passing scores. The focus of this research was to implement a literacy strategy, Larson’s (2014b) Generative Vocabulary Matrix (GVM), to improve student achievement on the SC EOCEP for biology.

Common Core and South Carolina Standards (2009-present)

In 2009, the Race to the Top education policy, promoted by President Obama’s administration, was signed into law (Spring, 2014). States developed policies in response to this legislation. One such policy suggested that educational systems should adopt, “standards and assessments that prepare students to succeed in college and in the workplace and to compete in the global economy” (Spring, 2014, p. 445). This policy initiated the creation of the national Common Core State Standards (2014). The Common Core Standards were developed for English Language Arts (ELA) and math with the

intention that the ELA standards could be used as supplemental literacy standards for other subjects such as science and social studies (Common Core Standards Initiative, 2012). The Common Core Standards were initially approved by South Carolina in 2010 but were then repealed in 2014 (Kerr, 2015). The current SC standards are similar in content to the Common Core Standards but are cited as being more specific regarding what elements of each topic should be taught (Kerr, 2015).

Jackson, Tripp, and Cox (2011) assert that a “contextually rich instruction builds basic language comprehension through the use of context clues that include authentic pictures, illustrations, diagrams, graphic organizers, and interactive learning experiences” (p. 45). Larson’s (2014b) Generative Vocabulary Matrix (GVM) is an experience-based literacy strategy that centers on an interactive word wall. The use of this literacy strategy supports the ideology of Jackson et al. (2011) while also building on the fundamentals of the SC Standards for biology (Larson, 2014a). The SC Biology Standards Support Guide (2014b) states that “an important component of all scientists and engineers’ work is communicating their results both by informal and formal speaking and listening, and formal reading and writing” therefore students should be participating in similar experiences in their science classes (p.6).

Spring (2014) expresses concern that our nation’s focus on standardization suggests, “a view that schools would now be, among other things, data collection centers with students being reduced to statistical data” (p. 453). By using Larson’s (2014b) GVM, teachers can work within the confines of the state standards, integrate important literacy strategies, and prepare students for a required standardized test while continuing to use diverse instructional methods to engage students. Larson (2014a) promotes

teaching with a “strong, practical instructional plan that supports both content learning and sustained engagement in the classroom” (p. 289).

Instructional Strategies

The basis for the present action research study arose from a study conducted by Sue C. Larson (2014a) which explored the relationship between use of the Generative Vocabulary Matrix (GVM) and academic literacy engagement among ninth-grade biology students. In her study, Larson utilized a robust literacy intervention tool called the Engagement Model of Academic Literacy for Learning (EngageALL).

The EngageALL instructional design, employed in Larson’s (2014a) study, is based on four steps: (1) situate the inquiry, (2) investigate and construct knowledge, (3) select and synthesize knowledge, and (4) generate and demonstrate knowledge. A key component of the EngageALL intervention is the GVM. Larson (2014a) defines the GVM as a “central placeholder for ongoing thinking and inquiry throughout a unit and to support student engagement in meaning-making discourse through active use of both core vocabulary and academic language” (p. 291). Larson’s (2014a) study showed that students who were taught using the EngageALL intervention method with the GVM, “performed at significantly higher levels of conceptual understanding of biology content, engagement, motivational factors, and academic language/vocabulary use compared to students receiving traditionally organized instruction” (p. 287).

Larson (2014b) also conducted a learning workshop with second-grade students using the GVM to explore information about the wetlands habitat. In this workshop, Larson (2014b) modified the four steps utilized in the EngageALL framework to integrate the GVM for this lesson. The modified steps are listed as initiating the matrix,

conceptualizing the matrix, enriching the matrix, and accessing the matrix. These modified steps provided the framework for the present action research study. The initiation stage included actions such as connecting two words, asking questions and integrating relevant prior knowledge (2014b). The conceptualizing the matrix stage asked student complete tasks such as determining important concept words, labeling categories, and analyzing results of experiments (2014b). The students enriched the matrix by completing tasks such as evaluating additional relevant information and synthesizing information from multiple sources (2014b). Lastly, the students transferred their knowledge to a task in the “accessing the matrix” phase (2014b). Larson (2014b) demonstrated through this workshop that the generative method of learning combined with the matrix structure creates a dynamic and effective learning experience for students. At the present date, Larson’s (2014b) model and use of the GVM has not been widely tested by empirical research in other studies.

Generative knowledge and process

Several studies have determined the positive impact of integrating generative frameworks within an instructional process and provide support and relevance for Larson’s (2014b) work with the Generative Vocabulary Matrix (GVM). The generative process as an instructional tool is not limited to use with vocabulary, but it can be used as a component of literacy instruction. The structure of GVM is considered a generative process because it seeks to create rich and long-term connections in the minds of students between content being studied and prior experiences.

Templeton (2012) describes generative knowledge as, “students’ ability to learn quite literally tens of thousands of words-- words they study explicitly and words they

encounter in their independent reading across all disciplines-- by attending to the combinations of prefixes, suffixes, and roots” (p. 101). Templeton asserts that generative knowledge is supported by an understanding of word morphology. Morphology is defined as, “the domain of language that addresses how meaningful word parts, morphemes, are arranged to create words” (Templeton, 2012, p. 101). When taught the concept of word morphology, students are quickly able to recognize that related words often look similar, for example, ecology/ecosystem. Templeton shares instructional techniques that can facilitate vocabulary expansion. He provides an example of a teacher who used scenes from a book and directed questioning to generate a learning experience where students respond to questions and ultimately create the definition of a term before the teacher shares the new term with them.

Wittrock (2010) studied learning as a generative process by presenting reading materials to a group of sixth graders and examining students’ mean retention scores. Wittrock (2010) states that the fundamental concept of the generative model is that, “people tend to generate perceptions and meaning that are consistent with their prior learning” (p. 41). In Wittrock’s study, approximately half of the students were designated as having above-average reading abilities, and the other half were labeled as having below-average reading abilities (2010). The students were divided into categories: the control with just the reading material, students who received one-word organizers, students who received two-word organizers, and students who were asked to generate a summary of each paragraph (2010). Some students with the organizers were also asked to generate a sentence to summarize the paragraph (Wittrock, 2010). In both the above-average and below-average reading groups, mean retention scores were highest in the

groups that had two-word organizers and were asked to generate a sentence to summarize the paragraph. Furthermore, the generative group with two-word organizers, “double[d] the scores of the control group that had the same stories without generative instructions or organizers” (Wittrock, 2010, p. 41).

Wittrock (2010) believes progress related to instruction, understanding human abilities, development, and learning can be united under one fundamental understanding. The understanding Wittrock (2010) refers to is, “the notion that human learning with understanding involves the process of generating and transferring meaning for stimuli and events from one’s background, attitudes, abilities, and experiences” (p. 43). Johnson and Mrowka (2010) conducted a study based on Wittrock’s research to determine if there was a correlation between quizzes promoting generative processing and performance on summative examinations. Their study showed that students who took quizzes that promoted generative processes performed better on summative examinations than those who were given knowledge and comprehension-based quizzes (Johnson & Mrowka, 2010). Their findings support the positive impact of the generative learning process. Johnson and Mrowka (2010) assert that generative learning can create, “cognitive linkages [that] are likely to stimulate memory, which can facilitate performance on later assignments where concepts are encountered again” (p. 118).

Semantic maps and discussion

Semantic maps are, “graphic organizers that help students identify important ideas and how those ideas fit together” (Jackson, Tripp, & Cox, 2011, p. 45). One example of a semantic map is an interactive word wall. The interactive word wall is a map which provides not only words but also visual aids, that helps students organize terms and

assists in developing more in-depth understanding (2011). Jackson et al. (2011) also found many benefits to using interactive word walls in the classroom. Teachers stated that “organizing unit instruction [was] easier and focused planning meetings” (p. 49). Additionally, the study reports that students could more readily understand connections in the material and, “became self-sufficient during activities and labs, finding information they needed by looking at the word wall rather than asking the teacher” (p. 49).

The Generative Vocabulary Matrix (GVM) used by Larson (2014b) is an extension of a semantic map based on the interactive word wall structure. Larson’s (2014b) GVM was the literacy strategy used in the present action research study. Larson’s (2014b) GVM includes semantic mapping as well as discussion. Discussion was an important factor in the success of this instructional strategy. Stahl and Vancil (1986) found that “vocabulary discussion is the key element in the effectiveness of semantic mapping” (p. 62). Their study divided a collection of sixth-grade students into three groups (1986). One group had discussion only, one group was given a semantic map only, and one group had both the discussion and the map (1986). The data showed that both groups with discussion scored higher on each of the three post-tests administered than the group that received only the semantic map (1986). The group that had the full treatment, both discussion and semantic map, scored slightly higher than the group who had discussion only on two of the three posttests administered, although the difference was not statistically significant (1986).

Experience-based education

The present action research study integrated literacy in science using Larson’s (2014b) Generative Vocabulary Matrix (GVM). Larson’s (2014b) GVM emphasizes the

need for student engagement in the academic content through experiences. Advancing scientific literacy is aided by experiences that help students personally connect to the concepts presented in the science curriculum. The present action research study sought to provide students with quality educational experiences related to literacy and science. By using an active learning method, such as Larson's (2014b) GVM, students can develop personal connections to the content. Larson (2014b) states, "Generative learning is motivating because students control meaning making during active learning experiences" (p. 2).

Larson's (2014b) GVM encourages teachers to develop activities related to content for the students to experience. At the beginning of a unit on cellular transport, a teacher instructs students to take droppers of food coloring and dispense the food coloring into a water bottle to demonstrate the concept of diffusion. After this experience, the students would write key words from their observations and place them on a display board near key terms from the unit that have already been pre-placed. The GVM is a "fluid and interactive concept organizer made of words written on sticky notes and arranged semantically on a large poster by students with teacher guidance during learning activities" (Larson, 2014a, p. 291). In this way, the students can make connections from their shared experience to the vocabulary terms for the unit (Larson, 2014a). Larson's (2014b) GVM supports Bobbitt's (2013) idea that, "education must be concerned with both [undirected and directed experiences], even though it does not direct both" (p.13). By using Larson's (2014b) GVM, a teacher ensures that students have an experience that typically might be considered undirected (putting food coloring in water) to strengthen the understanding of the directed training (the concept of diffusion).

Experience-based education is not only an example of sound pedagogy, but it also has relevance to social justice concerns. Many middle and upper-class Americans would like to assert that individuals in the United States are a heterogeneous group of people that have unique personalities and backgrounds, but collectively we would also prefer that an individual's uniqueness fall within a certain “comfort zone.” It makes many individuals uncomfortable to talk about different social classes in America, but the reality is that students enter the classroom from diverse backgrounds with unique experiences that contribute to their understanding of new information. Gregory Mantsios (2013) provides myths that are common beliefs held regarding life in the United States. One myth is that “everyone has an equal chance to succeed. Success in the United States requires no more than hard work, sacrifice, and perseverance” (p. 151). This myth is far from the truth, but allows individuals to absolve themselves of guilt and responsibility. Teachers must acknowledge that for some students, their difficulties in the classroom may not be due to lack of effort, but instead an absence of common experiences. If a biology teacher gives a lecture on succession in a forest, she may rely on students’ experiences visiting or living near a forested area to create connections and help students retain the new information. Some students may have grown up in the city where their experiences include mostly cars, streets, and buildings. These students’ families might not have had the opportunity to vacation to an area where there was a forest. Due to this lack of experience, those students are now at a disadvantage to recall the information on the topic of succession in a forest.

While there are individuals who hold great wealth in America, there are many more living in poverty. Mantsios (2013) states, “Approximately one out of every five

children (4.4 million) in the United States under the age of six lives in poverty” (p. 151). Hard work, sacrifice, and perseverance are important character traits but do not equate to equal chances for success. Studies have shown that “class standing has a significant impact on chances for educational achievement” (p. 155). Willie Lee Buffington, the founder of the Faith Cabin Library Movement, observed the consequences of class differences and acted to improve the number of educational opportunities available. Buffington believed that “individual and community uplift could be achieved through education” (Powell, 2008, p. 77). Buffington’s story of creating the Faith Cabin Library Movement “is proof that individuals, no matter what their resources, can work to alleviate unjust situations for other people” (p. 91). Integrating experience-based education into instruction is one of many ways to begin alleviating those unjust situations for students.

Literacy Education

Continuing literacy education throughout high school

At Rushmore High School, all students are required to take biology to graduate. Students typically take this course when they are in ninth-grade. The biology curriculum requires students to learn numerous terms, definitions, and concepts at a more accelerated pace than the students were exposed to at the middle-school level. Many ninth-grade students begin high school and quickly realize that they are academically unprepared for high school-level work (Balfanz & Legters, 2006). This lack of academic readiness can cause students to act disengaged at school, try to avoid school entirely, or create disruptions in the classroom. Much of their frustration stems from inadequate reading comprehension and writing levels. Carlson (2014) provides the statistic that,

[A]ccording to the 2009 National Assessment of Educational Progress (NAEP) in reading, only 30% of entering high school freshman read proficiently (NCES, 2009), which means that as the material in the textbooks becomes more challenging, those students who struggle with literacy fall even further behind. (p.3)

High school educators must stop assuming the literacy skills taught in elementary school are effective for reading all forms of texts and for writing in any format, such as lab reports or argumentative essays (Carlson, 2014). In order for students to be successful in upper-level science classes, literacy fundamentals must be woven into the science curriculum. Scaffolding the content-area standards is a common practice of educators, but it takes added planning and preparation to scaffold the reading and writing associated with that content-area curriculum. This added effort is necessary for the success of the students.

Scientific literacy concerns for sub-populations

While scientific literacy is an area of concern for all student groups, research has shown that many sub-populations of the students in the United States have even greater difficulty in reading and writing. The National Center for Education Statistics (NCES) (2010) provides data that demonstrates a significant achievement gap in reading between White students and their Black and Hispanic peers, in addition to differences in performance between genders. The 2009 Nation's Report Card states,

[T]he average reading score for the nation's twelfth-graders in 2009 was 2 points higher than in 2005 but 4 points lower than in 1992. White students, Asian/Pacific

Islander students, and male students all made gains since 2005, but no racial/ethnic or gender groups showed gains since 1992. (NCES, 2010, p.9)

Buckingham (2012) notes the achievement gaps of these subpopulations but also brings to light the disconcerting fact that many teachers, "have traditionally felt unprepared to plan for and instruct" other diverse student groups, such as English Language Learners (ELL) (p.1). This student group is referred to as "Limited English Proficient (LEP)" by the South Carolina Department of Education. Many content area teachers are aware of the need for improvement of student literacy, but they do not feel that they can effectively integrate literacy curriculum into their courses. This concern is not isolated to ELL/LEP students. Westover and Martin (2014) researched literacy instruction for students with significant disabilities and reinforce the importance of this issue. Westover and Martin (2014) state that for students with disabilities, "strong literacy skills provide a gateway to generative communication," but "many educators lack the knowledge to design or implement appropriate evidence-based literacy instruction for students with significant disabilities" (p. 364). Buckingham (2012) reveals that the uncertainty of teachers in integrating literacy instruction is not a consequence of a lack of available resources. Many books and resources are available for teaching literacy in various content areas, like science, to diverse student groups but the resources are not consistently being used.

South Carolina Biology Curriculum

Biology curriculum

The present action research study was conducted in a biology classroom in South Carolina. Teachers in SC are strongly encouraged to use the SC Biology 1 Standards

(South Carolina Department of Education, 2014a) and the Support Guide for Biology 1 South Carolina Academic Standards and Performance Indicators for Science (South Carolina Department of Education, 2014b) as a framework for developing lesson plans and assessments, both formative and summative. The SC Biology 1 Standards are broken down into the following categories: science and engineering practices, cells as a system, energy transfer, heredity, biological evolution, and ecosystem dynamics (South Carolina Department of Education, 2014a). Each standard also has sub-categories that the SC Department of Education refers to as “performance indicators” (South Carolina Department of Education, 2014a). These performance indicators provide specific information regarding what a student should be able to do to demonstrate their knowledge of the standard. Teachers are instructed to integrate the indicators for the standard on science and engineering practices within the other five core standards instead of teaching it in isolation. Each core standard has a range of five to twelve performance indicators. Table 2.1 provides a description and number of performance indicators for each standard (South Carolina Department of Education, 2016).

The units that were taught during the present action research study were B5: Biological Evolution and HB6: Ecosystem Dynamics, but the SC EOCEP for biology covered material from the entire school year. The CP biology instructors slightly amended the pacing guide published by the school district in which the teacher-researcher is employed due to various factors, such as the loss of days due to testing or inclement weather. The biology teachers at Rushmore High School planned to spend three weeks on standard B5: Biological Evolution and four weeks of instruction dedicated to the HB6: Ecosystem Dynamics standard.

Table 2.1

South Carolina Biology I Standards and Number of Performance Indicators

Standard	Description	Number of Performance Indicators
HB1	The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.	9
HB2	The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells.	12
HB3	The student will demonstrate the understanding that all essential processes within organisms require energy which in most ecosystems is ultimately derived from the Sun and transferred into chemical energy by the photosynthetic organisms of that ecosystem.	5
HB4	The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes.	8
B5	The student will demonstrate an understanding of biological evolution and the diversity of life.	7
HB6	The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment.	6

Adapted from "South Carolina end-of-course examination: Test blueprint for biology," by the South Carolina Department of Education, 2016, Retrieved from the South Carolina Department of Education website: <http://ed.sc.gov/tests/tests-files/eocep-files/2016-17-biology1-test-blueprint/>

Table 2.2

HB5: Biological Evolution Performance Indicators

Performance Indicator	Description
B5.1	Summarize the process of natural selection.
B5.2	Explain how genetic processes result in the continuity of life-forms over time.
B5.3	Explain how diversity within a species increases the changes of its survival.
B5.4	Explain how genetic variability and environmental factors lead to biological evolution.
B5.5	Exemplify scientific evidence in the fields of anatomy, embryology, biochemistry and paleontology that underlies the theory of biological evolution.
B5.6	Summarize ways that scientists use data from a variety of sources to investigate and critically analyze aspects of evolutionary theory.
B5.7	Use a phylogenetic tree to identify the evolutionary relationships among different group of organisms.

Adapted from “South Carolina biology 1 standards,” by the South Carolina Department of Education, 2014a, Retrieved from the South Carolina Department of Education website:

<http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Biology1-Standards-Printable%20.pdf>

Table 2.2 describes the seven performance indicators that compose the HB5: Biological Evolution standard (South Carolina Department of Education, 2014a). Table 2.3 describes the six performance indicators that compose the HB6: Ecosystem Dynamics standard (South Carolina Department of Education, 2014a). Rushmore High School, the site of the present action research study, is on a traditional schedule. Students take seven classes each day, and the classes run throughout the entire academic year.

Table 2.3

HB6: Ecosystem Dynamics Performance Indicators

Performance Indicator	Description
HB6A1	Analyze and interpret data that depict changes in the abiotic and biotic components of an ecosystem over time or space and propose hypotheses about possible relationships between the changes in the abiotic components and the biotic components of the environment.
HB6A2	Use mathematical and computational thinking to support claims that limiting factors affect the number of individuals than an ecosystem can support.
HB6B1	Develop and use models of the carbon cycle, which include the interactions between photosynthesis, cellular respiration and other processes that release carbon dioxide, to evaluate the effects of increasing atmospheric carbon dioxide on natural and agricultural ecosystems.
HB6B2	Analyze and interpret quantitative data to construct an explanation for the effects of greenhouse gases on the carbon cycle and global climate.
HB6C1	Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.
HB6D1	Design solutions to reduce the impact of human activity on the biodiversity of an ecosystem.

Adapted from “South Carolina biology 1 standards,” by the South Carolina Department of Education, 2014a, Retrieved from the South Carolina Department of Education website:
<http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Biology1-Standards-Printable%20.pdf>

Standardized testing

In South Carolina, upon completion of a biology course, all students are required to take the SC End of Course (EOC) examination. The test is given at the end of the academic year, typically in mid-May. The SC EOCEP accounts for 20% of the students’

final grades and covers content related to the SC Biology 1 Standards (South Carolina Department of Education, 2016). The SC EOCEP consists of approximately 60 questions. Students are not limited to a specific timeframe in which to complete the assessment. The test blueprint states that it “will include two scenario sets. A scenario set consists of a scenario (scientific text, graph, or data) with three test items related to the scenario” (South Carolina Department of Education, 2016, p.1). The test blueprint also says the examination will have two to six technology-enhanced items. The questions vary in their levels on the Depth of Knowledge (DOK) scale. All levels of questions require basic literacy skills, but as the levels increase so does the expectation for both content knowledge and literacy abilities. If a student does not have the literacy skills necessary to process the facts, the student will not be able to accurately answer the question independent of their level of content knowledge.

An achievement gap among various subpopulations on standardized tests, such as the SC EOCEP for biology, is a large concern. In SC, the 2017 EOC state score report scores show that the mean score for males was 74.2% and for females it was 76.4% (South Carolina Department of Education, 2017). A more significant difference is shown in the mean scores for disabled students. The mean score for disabled students was 54.8% compared to 77.8% for non-disabled students (South Carolina Department of Education, 2017). Looking at Limited English Proficient (LEP) students, the mean score for LEP students in SC was 67.3% while non-LEP students had a mean score of 75.7% (South Carolina Department of Education, 2017).

At Rushmore High School, the location of the present action research study, the score reports show that the mean score for males was 79.0% versus 80.7% for females (South Carolina Department of Education, 2017). Looking at students with disabilities, the mean score was 55.5% versus 82.9% for non-disabled students (South Carolina Department of Education, 2017). Data on Limited English Proficient (LEP) students show a mean score of 67.5% versus 80.9% for non-LEP students (South Carolina Department of Education, 2017). There are clear achievement gaps for students with disabilities and LEP students at the state level and at Rushmore High School in addition to potential areas for investigation between gender groups at both levels.

By the time that students enter ninth-grade, they have started to become pre-conditioned to ask questions such as, “Will this be for a grade?” or “Will this be on the test?” These students have been regularly tested since elementary school and through that process have adopted the idea that if it is not for a grade or if the concept is not an exact mirror of what is on a test, then the assignment or activity is not worth doing. Eisner (2013) summarizes this ideology by stating that our rationalized approach to education which relies heavily on testing, “promotes an orientation to practice that emphasizes extrinsically defined attainment targets that have a specified quantitative value. This, in turn, leads students to want to know just what it is they need to do to earn a particular grade” (p. 282). This approach to learning eliminates the joy of mastering a new concept. Our current educational structure does not often allow the flexibility for students to explore new concepts because the topic is interesting to them personally or because the topic may have a connection to the student’s daily life. Teachers design their lessons by presenting and reinforcing information that will be assessed on the test. The United

States' focus on high-stakes tests, such as the SC EOCEP, removes student interest from the educational equation. Eisner (2013) emphasizes this by stating, "Prediction is not easy when what the outcome is going to be is a function not only of what is introduced in the situation but also of what a student makes of what has been introduced" (p. 280). As more teachers follow the trend and narrow their curriculum to match the precise content of each high-stakes test, students' positive experiences and connections with the material become less frequent.

Unfortunately, school districts will not easily change these policies. Eisner (2013) sheds light on the sad fact that, "Education has evolved from a form of human development serving personal and civic needs into a product our nation produces to compete in a global economy. Schools have become places to mass produce this product" (p. 282). Not only are students unique in their interests and learning styles, but teachers also have varying personalities and strengths. Analysis of test scores leads schools to lock teachers into certain teaching formats because the methods are "proven." The influx of high-stakes testing in the United States may have the goal of producing a certain product, but the road to reaching that goal must allow room for individuality for it to be successful for both teachers and their students. This design of the present action research study was structured to work within the confines of the current education system while continuing to promote the importance of individuality for students and teachers.

Action Research Methodology

The present action research study took place at Rushmore High School during the spring of 2018. The teacher-researcher introduced Larson's (2014b) Generative Vocabulary Matrix (GVM) after students took a benchmark test to assess student mastery

of all standards required to be taught in a ninth-grade biology course. Larson (2014b) promotes the use of four major steps to integrate the GVM into any content area: initiating the matrix, conceptualizing the matrix, enriching the matrix, and accessing the matrix. These steps were implemented throughout the study.

Larson's (2014b) GVM was used in both the teacher-researcher's ninth-grade biology classes. The data for the present action research study was both quantitative and qualitative. The core data came from a test that is currently administered to all high school biology students, the South Carolina End-of-Course Examination Program (EOCEP) for biology. This test was conducted approximately eight weeks after the benchmark test. The benchmark test, unit tests, and a teacher-researcher observation journal were used to triangulate the standardized test data. Data were compared to the results of similar students on the SC EOCEP for biology from the previous year.

Summary of Research

The present action research study is based on principles of respected educational theorists and grounded within a historical context. Support for the use of Larson's (2014b) Generative Vocabulary Matrix (GVM) is provided by research that substantiates the positive impact of generative knowledge and the generative process, semantic maps and discussion, and experience-based education. Larson's (2014b) GVM builds on research related to the importance of continuing literacy education throughout high school and addresses concerns associated with scientific literacy among sub-populations. The action research methodology outlines a comprehensive process to address the present research question. This review of the literature demonstrates evidence for the merit of this study.

CHAPTER 3

RESEARCH DESIGN

Introduction

The primary purpose of the present action research study was to integrate literacy strategies into the biology classroom using Larson's (2014b) Generative Vocabulary Matrix (GVM). The secondary purpose was to develop an action plan based on the use of Larson's (2014b) GVM and the SC biology standards for instruction. The tertiary purpose was to describe the relationship between science literacy skills and performance on the South Carolina End-of-Course Examination Program for biology. The research question at the center of this action research study was:

- 1. What is the impact of Larson's (2014b) Generative Vocabulary Matrix (GVM) in a high school biology course as demonstrated by students' performance on the SC End-of-Course Examination Program?*

The purpose of this chapter is to provide an overview of the methodology for the present action research study. This chapter includes a summary of the research context and details related to the action research design.

Research Context

Participant Selection

The participants in the present action research study were biology students of the teacher-researcher at Rushmore High School during the 2017-2018 school year. The students selected for this study were classified as ninth-grade students at the high school level. There was no recruitment process for this study. The participants were placed in the teacher-researcher's classes by the school's guidance department. The participants in the teacher-researcher's classes were enrolled in College Prep (CP) biology. At Rushmore High School the term "college prep" is used for courses that are part of the standard academic requirement for students who plan to graduate high school and then attend college. Courses identified as honors or advanced placement (AP) would be considered more academically rigorous versions of a specific course.

In the present action research study, the participants were students enrolled in the teacher-researcher's third and fourth-period classes. The teacher-researcher's third-period class was a traditional College Prep (CP) biology course. The teacher-researcher's fourth-period class was an inclusion College Prep (CP) biology class. This section was instructed by the teacher-researcher and supported by a co-teacher who was certified in special education. The inclusion class was created due to the number of students with Individual Education Plans (IEPs) in that class and their specific accommodations. The co-teacher provided instructional support during the class period based on the specific accommodations of the students in the class. These accommodations included, but were not limited to, small group testing, extended time on assignments, and oral administration of tests. The teacher-researcher's comparison classes from the 2016-2017 school year

were both non-inclusion, CP biology courses. The teacher-researcher's 2017-2018 class data was disaggregated by class period to evaluate any possible differences between the two types of classes. Additionally, the population differences introduced with the inclusion CP biology class were further accounted for in a breakdown of subpopulation data, specifically students with disabilities. The demographic composition of the teacher-researcher's classes is noted in Table 3.1. Larson's (2014b) Generative Vocabulary Matrix (GVM) was used in both teacher-researcher's biology classes during the 2017-2018 school year.

Research Site

Rushmore High School is a public high school that enrolled approximately 2350 students, grades nine through twelve during the 2017-2018 school year. The demographic breakdown of the RHS student body during the 2017-2018 school year was approximately: 61.7% Caucasian, 20.6% African-American, 9.6% Hispanic, 3.3% Asian, 0.2% American Indian/Alaskan Native, 0.1% Hawaiian Native/Pacific Islander, and 4.6% Multi-Racial. Approximately 25.7% of the student body was enrolled in the free and reduced lunch program, 9.7% of the student body had an Individualized Education Plan (IEP), and 4.0% had a 504 plan.

Participants

Table 3.1 provides detailed demographic information for the participants from each of the teacher-researcher's College Prep (CP) biology courses during the 2017-2018 school year. The third-period class was a traditional CP biology course, and the fourth-period class was an inclusion CP biology course. Scores of students in these classes who were classified as grades 10-12 were not included in the study. There was a ninth-grade

student in the teacher-researcher’s fourth-period class who did not take the South Carolina End-of-Course Examination Program (EOCEP) so that student’s scores and demographic information were removed from all the following tables and data sets. Additionally, there was a ninth-grade student in the teacher-researcher’s third-period class who did not take the comprehensive benchmark assessment, the baseline measure, so that student’s scores and demographic information were removed from all the following tables and data sets.

Table 3.1

Participant Demographic Information by Class Period

Characteristic	TR3P-9 th	TR4P-9 th
N of Students	17	21
Gender		
Female	10	11
Male	7	10
Disabled	3	7
Limited English Proficient	0	2
Race/Ethnicity		
Caucasian	10	11
African-American	4	6
Hispanic	2	3
Multi-Racial	1	1

Note. TR3P-9th = Teacher-Researcher’s Class, third period, ninth-grade students. TR4P-9th = Teacher-Researcher’s Class, fourth period, ninth-grade students. The category “disabled” is made up of students with Individualized Education Plans (IEPs) or 504 plans. This label is consistent with what is used by the SC Department of Education (South Carolina Department of Education, 2018).

Action Research Design

The action research design outlined by Mertler (2014) suggests a four-stage process: planning, acting, developing, and lastly, reflecting. The planning stage for the present action research study was addressed in-depth in Chapters 1 and 2. The acting stage is described in detail in this chapter and the developing and reflecting stages are addressed in Chapters 4 and 5.

Research Design

The present action research study began with the administration of a district-mandated benchmark test created by an education company contracted by the district where the teacher-researcher was employed. The district provided a window for this benchmark test to be administered. The window for the 2017-2018 school year was between March 12th and March 30th. The teacher-researcher administered the test on March 19th-20th, 2018. After the benchmark test was administered in both teacher-researcher's biology classes, integration of the Larson (2014b) Generative Vocabulary Matrix (GVM) began. See Appendix A for the Research Design Flowchart.

Hypothesis

The teacher-researcher hypothesized that the biology classes at Rushmore High School where students used Larson's (2014b) Generative Vocabulary Matrix would have higher average scores on the South Carolina End-of-Course Examination Program (EOCEP) than the scores of similar students from the previous year.

Intervention

Larson's (2014b) Generative Vocabulary Matrix (GVM) was implemented as the foundation for literacy instruction in both teacher-researcher's classes. The use of Larson's (2014b) GVM was limited to two classes because during the time of the data collection the teacher-researcher also served as an instructional coach at RHS and only taught two periods each day. The implementation of Larson's (2014b) GVM as an instructional strategy was not used in the previous year at RHS by the teacher-researcher or by any other biology teacher at the school. Additionally, the teacher-researcher was the only teacher utilizing Larson's (2014b) GVM as an instructional strategy at RHS during

the 2017-2018 school year. The core data for this study comes from the South Carolina End-of-Course Examination Program for biology and is supported by data from other sources including a benchmark test, unit tests, and a teacher-researcher observation journal.

Larson (2014b) suggests a specific protocol for implementing the GVM. This protocol was implemented in two cycles throughout the duration of the present action research study. The teacher-researcher followed Larson's (2014b) GVM implementation method which is described in detail in Figure 1. Larson's (2014b) GVM protocol was implemented in two cycles over the course of five weeks, March 21st-May 1st, 2018.

The topic for the first unit was Biological Evolution. To initiate the implementation of Larson's (2014b) GVM, the students participated in a trigger experience. In this unit, the trigger experience was a lab titled "Bird Beak Adaptations." This lab simulated the use of four bird beaks and demonstrated how variation among character traits allows certain species to be better suited for competition for different food sources. The students selected key terms from the background information and the lab itself to begin creating their GVM. The students wrote the words on sticky notes and placed them on chart paper. As part of the lab reflections, students were instructed to select a minimum of two terms from the GVM to answer the question "How does this lab simulation provide support for the theory of evolution?" The following day, the students continued to build the GVM and make connections between key vocabulary terms. The teacher-researcher led her classes in reading an article on a study of Darwin's finches. During the reading, there was discussion, and the students continued to select key terms for the GVM. The teacher-researcher was absent for several days attending an

educational conference, so the students watched pre-recorded video lectures and completed guided notes to enrich their understanding of the topic.

Upon the teacher-researcher's return, the students worked to conceptualize and enrich the matrix. The teacher-researcher took the terms from the chart paper and typed them into a digital format that could be manipulated using the class Promethean board. The teacher-researcher shared the main topic, inquiry questions, and learning goals. The teacher-researcher guided the students in using their prior knowledge and guided notes to discuss and create categories for the words. Students also used their guided notes to add additional words to the digital GVM. At the end of the lesson, the students were asked to apply their understanding of the topic to a worksheet on evolutionary patterns. The students accessed the GVM several times in the following days. The students completed short writing assignments, multiple-choice assessments, a project, and discussions that referenced the GVM.

The topic for the second unit was Ecosystem Dynamics. In the unit on Ecosystem Dynamics, the trigger experience was an activity called “Oh Deer” that simulated the impact of limiting factors on an ecosystem. In this activity, students are assigned the task of being deer, food, water, or shelter. The deer stand on one side of the designated activity area and the resources stand on the other side. The deer and resources turn their backs to one another. The deer decide what resource they need during each round. Once the decision has been made, the deer and resources face each other and try to pair up. If the deer do not find the resource they were looking for, they die and become a resource. If the resources do not find a deer, they stay a resource. If the deer find their selected resource, they stay a deer and the resource also becomes a deer.

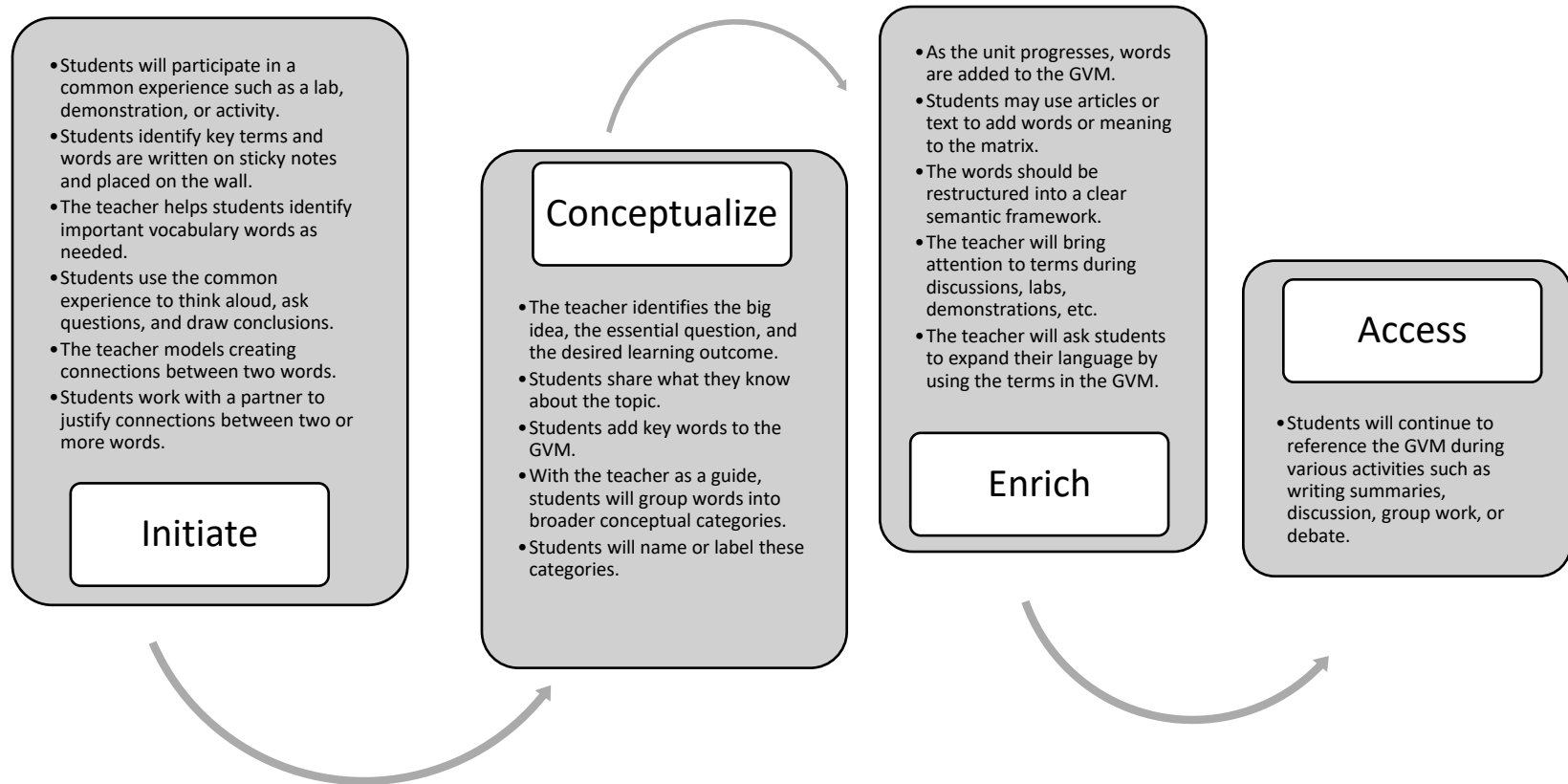


Figure 3.1 Protocol for using the Generative Vocabulary Matrix. Adapted from “Using a generative vocabulary matrix in the learning workshop,” by S.C. Larson, 2014, *The Reading Teacher*, 68(2), 113-125.

Following this activity, the students used key terms from the activity to begin creating their GVM. The teacher-researcher provided the students the main topic and guiding questions. The students used this information to identify keywords on sticky notes and place them on chart paper. In this unit, the students seemed to feel more comfortable with the process of creating the GVM. The students worked to initiate and conceptualize the GVM almost simultaneously. The students began grouping key terms as they supplied them. In the following days, the teacher-researcher converted the GVM into a digital format. The teacher-researcher guided the students in discussion and lecture. During this time the students continued to conceptualize and enrich the matrix. The students accessed the GVM to complete reflections forms, create concept maps on small segments of information, and participate in discussions. See Appendix B for images and diagrams created during the implementation of the GVM.

Following two complete GVM cycles, the teacher-researcher's classes participated in a mini-unit on the remaining indicators for the Ecosystem Dynamics standard and then completed a brief review of most of the Biology 1 Standards before the South Carolina End-of-Course Examination Program (EOCEP) for biology. This mini-unit and review were not specifically evaluated as part of this study because Larson's (2014b) GVM was not used during this instructional period. The time constraints at this point in the year did not allow for the implementation of Larson's (2014b) GVM during the mini-unit and review, but there were still some indicators that needed to be addressed, and the teacher-researcher wanted to provide a review of concepts from earlier in the year before the SC EOCEP. The SC EOCEP was administered in the teacher-researcher's classes on May 23rd and May 24th, 2018.

Data Collection

The data collection for this action research study was both qualitative and quantitative. The quantitative data is presented using descriptive statistics to analyze the results. The qualitative data is presented in a narrative format. In this study, the scores of the teacher-researcher's students on the South Carolina End-of-Course Examination Program (EOCEP) for biology are compared to the results of similar students from the previous year. The scores from the 2017 and 2018 administrations of the SC EOCEP are reported for all ninth-grade students enrolled in College Prep biology at Rushmore High School (RHS) and used as comparison data. Students in the tenth, eleventh, and twelfth-grade were eliminated from the analysis of the SC EOCEP due to the small sample population and the potential for conflicting variables such as repeating the course or previous enrollment in preparatory coursework (e.g., Environmental Studies). The teacher-researcher categorized the data from the SC EOCEP into subpopulations to examine potential correlations. The core data for this study comes from the SC EOCEP for biology but is supported by data from other sources including a comprehensive benchmark test, unit tests, and a teacher-researcher observation journal. Additionally, the SC state averages on the SC EOCEP for biology from the 2017 and 2018 administrations are reported to determine if there were significant variances across the state between the two administrations of this assessment.

Variables

The independent variable in the present action research study was the use of Larson's (2014b) Generative Vocabulary Matrix (GVM). The dependent variable was students' performance on the South Carolina End-of-Course Examination Program

(EOCEP). The teacher-researcher had two class periods, third and fourth. On a traditional day, third period took place from 10:40am-11:30 am and fourth period took place from 11:35am-12:30 pm. The students participating in the present action research study were ninth-grade students enrolled in the teacher-researcher's biology classes. Data was not used for students in tenth, eleventh, or twelfth-grade who were enrolled in the teacher-researcher's classes.

Assessments

Benchmark Assessment

The benchmark test was generated by an education company contracted by the district where the teacher-researcher was employed. The benchmark test was designed to mimic the South Carolina End-of-Course Examination Program (EOCEP) for biology. The education company that created the benchmark test utilized the SC state-released blueprint for the SC EOCEP for biology and the SC standards for biology to generate their assessment. The education company that created the benchmark test boasts of high accuracy in predicting scores on SC standardized assessments using their benchmark tests. The benchmark test covered all the standards included in the SC Biology 1 curriculum. The test was composed of 60 selected-response questions. The test was administered through an online platform. The students took the assessment utilizing school provided devices (Chromebooks). The teacher-researcher's classes had two, 50-minute class periods to complete the assessment. The assessment was given to both classes on March 19th-20th, 2018.

Unit Tests

The unit tests were created by the teacher-researcher using a question bank provided by the same company that made the benchmark assessments. The first unit test covered content on SC Standard B5: Biological Evolution (Performance Indicators 1-5) and the second test covered content on SC Standard HB6: Ecosystem Dynamics (Performance Indicators A1, A2, and C1). The Biological Evolution (Performance Indicators 1-5) test consisted of 35 selected response questions. The Ecosystem Dynamics (Performance Indicators A1, A2, and C1) test consisted of 30 selected response questions. The tests were given on paper, and each student was provided with a bubble sheet to record their answers. Students could write on the test as needed, but only responses recorded on the bubble sheet were graded (unless an IEP has other requirements). The unit tests were designed to be completed in one, 50-minute class period. The Biological Evolution unit test, performance indicators 1-5, was given on April 10th, 2018. The Ecosystem Dynamics unit test, performance indicators A1, A2, and C1, was given on May 1st, 2018.

Observations

The teacher-researcher completed an observation journal. The observation journal included unstructured, narrative reflections generated throughout the study. Additionally, the journal was supplemented with images of the various stages of creation and revision of the Generative Vocabulary Matrix (see Appendix B). Journal entries were made a minimum of four times during each unit. The format of these observations allowed the teacher-researcher to gather data about student behaviors and helped clarify results on

summative assessments (benchmark exam, unit tests, and the South Carolina End-of-Course Examination Program).

South Carolina End-of-Course Examination Program

The South Carolina End-of-Course Examination Program (EOCEP) for biology was created by the SC Department of Education. The state utilized the released blueprint for the SC EOCEP for biology and the SC standards for biology to generate their assessment. The SC EOCEP covered content related to all the SC Biology 1 Standards. The SC EOCEP consisted of 66 questions. According to documents released by the SC Department of Education, the test “include[d] two scenario sets. A scenario set consists of a scenario (scientific text, graph, or data) with three test items related to the scenario” (South Carolina Department of Education, 2016, p.1). The test also had two to six technology-enhanced items. The questions varied in their levels on the Depth of Knowledge (DOK) scale. Students took the assessment using their Chromebooks through a secure, online platform. Students were not limited to a specific timeframe in which to complete the assessment.

The SC EOCEP was given to the teacher-researcher’s third-period class on May 23rd and her fourth-period class on May 24th, 2018. Some students took the exam on make-up days after these assigned dates. For comparison purposes, data from the 2016-2017 administration of the SC EOCEP was used, which was administered May 15th through May 18th.

Data Analysis

The analysis for the present action research study includes the use of descriptive statistics. Mean scores for the comprehensive benchmark assessment, unit tests, and the

South Carolina End-of-Course Examination Program (EOCEP) were calculated and reported. The goal of using these statistics was to demonstrate the performance of a group of students in addition to identifying trends in subpopulations (Mertler, 2014). The teacher-researcher utilized Microsoft Excel to calculate the data. The results are presented in Chapter 4 using narrative, tables, and graphs.

Comprehensive Benchmark Assessment

The teacher-researcher collected and analyzed data from the March 2018 administration of the comprehensive benchmark assessment for all students at Rushmore High School (RHS) enrolled in College Prep (CP) biology. The teacher-researcher received a report from the education company that created the benchmark test that provided the average scores, projected percent proficient, and average suggested marks for each class period. The average score is a raw score on the benchmark assessment, in other words, the percentage of questions answered correctly. The projected percent proficient is calculated from each student's projected achievement level which is reported on a scale from one to five. Level five denotes superior command, and level one denotes limited command of the standards and performance indicators being assessed. The projected percent proficient is given for the class and is calculated from the number of students who scored at a level three or above. The suggested marks are a prediction, based on performance on the benchmark assessment, of students' scores on the South Carolina End-of-Course Examination Program for biology.

The mean scores for these three measures on the comprehensive benchmark assessment were calculated and reported for each of the teacher-researcher's class periods and all students at RHS enrolled in CP biology. The teacher-researcher also calculated the

percent difference between the teacher-researcher's class averages for each data point, and the averages for all students at RHS enrolled in CP biology. This assessment served as a baseline to compare the teacher-researcher's class performance with students at the same school with different teachers, before the introduction of Larson's (2014b) Generative Vocabulary Matrix.

Unit Tests

The unit test data were used to compare how well individual students did on the unit test in relation to their performance on the same standards on the comprehensive benchmark assessment. This data was then used to calculate mean class performance for each measurement and demonstrate the class growth on each of the units taught as part of the present action research study. These steps were followed:

1. The teacher-researcher randomly assigned each student a three-digit number to protect their identity. The key to this code was not publicly shared.
2. The company that created the benchmark assessment provided an item analysis that showed which standard and performance indicator were assessed by each question on the benchmark assessment. The teacher-researcher identified the questions that were associated with the standards and performance indicators assessed on each unit test.
3. The teacher-researcher created a Microsoft Excel spreadsheet that included a column for students' coded IDs and two columns for reporting each of the students' data points from the benchmark assessment.

4. Using the data from the item analysis, the teacher-researcher calculated a percent correct for each student for the standard and indicators addressed on each of the unit tests.
5. The teacher-researcher inserted a column for each unit test in the Microsoft Excel spreadsheet that was created for analysis after the comprehensive benchmark assessment. The column for the unit test was inserted next to the data from the comprehensive benchmark assessment that corresponded to the same standards.
6. The teacher-researcher inputted each student's percent correct for each of the unit tests.
7. The teacher-researcher calculated and compared the average percent correct on the selected questions from the comprehensive benchmark assessment and the average percent correct for the corresponding unit test for each class.
8. The two data points for each unit and each class were reported to demonstrate growth (or a lack of growth) after the implementation of Larson's (2014b) Generative Vocabulary Matrix.

Observations

The teacher-researcher's observations provided descriptions of events taking place in the classroom during the creation and use of Larson's (2014b) Generative Vocabulary Matrix. The teacher-researcher utilized the inductive analysis model outlined in Mertler's (2014) book: *Action Research: Improving Schools and Empowering Educators*. The following steps were followed:

1. When reading through the observational notes, the teacher-researcher looked for patterns and themes. Based on these themes, the teacher-researcher began creating coding categories.
2. After developing the coding categories, the teacher-researcher re-read the observational journal and assigned code labels to various parts of the observation journal keeping in mind the original research question. This process was repeated and re-evaluated multiple times until the teacher-researcher was content with the system and its product.
3. The teacher-researcher separated the information from each category by typing the information into different sections of a table, titled for each category.
4. The teacher-researcher drew connections between the themes and patterns that emerged and how those topics related to the original research question.
5. The teacher-researcher examined the notes to see if there were any patterns or themes that conflicted with other results or analysis.
6. The teacher-researcher explored the significance of the connections between the observations and the research question. Additionally, the teacher-researcher evaluated the significance of any observational themes that provided conflicting data. The teacher-researcher wrote a summary reflection of this information.

South Carolina End-of-Course Examination Program

The teacher-researcher collected the test scores for all teachers at Rushmore High School (RHS) from the 2017 and 2018 administrations of the South Carolina End-of-

Course Examination Program (EOCEP). This data was provided by the school district's Department of Accountability and Quality Assurance. The teacher calculated the mean scores for the following groups and subpopulations for the 2017 and 2018 administrations of the SC EOCEP:

1. All ninth-grade students at RHS enrolled CP biology
2. All ninth-grade students at RHS enrolled in CP biology with an IEP or 504 plan
3. All ninth-grade students at RHS enrolled in CP biology with an ELL plan
4. All ninth-grade male students at RHS enrolled in CP biology
5. All ninth-grade female students at RHS enrolled in CP biology
6. Ninth-grade students at RHS enrolled in the teacher-researcher's CP biology class
7. Ninth-grade students at RHS enrolled in the teacher-researcher's CP biology class with an IEP or 504 plan
8. Ninth-grade students at RHS enrolled in the teacher-researcher's CP biology class with an ELL plan
9. Ninth-grade male students at RHS enrolled in the teacher-researcher's CP biology class
10. Ninth-grade female students at RHS enrolled in the teacher-researcher's CP biology class

The teacher-researcher also calculated the percentage of students in the following categories who received a passing score on the SC EOCEP (60-100%):

11. All ninth-grade students at RHS enrolled in CP biology
12. All ninth-grade students at RHS enrolled in CP biology with an IEP or 504 plan
13. All ninth-grade students at RHS enrolled in CP biology with an ELL plan

14. All ninth-grade male students at RHS enrolled in CP biology
15. All ninth-grade female students at RHS enrolled in CP biology
16. Ninth-grade students at RHS enrolled in the teacher-researcher's CP biology class
17. Ninth-grade students at RHS enrolled in the teacher-researcher's CP biology class with an IEP or 504 plan
18. Ninth-grade students at RHS enrolled in the teacher-researcher's CP biology class with an ELL plan
19. Ninth-grade male students at RHS enrolled in the teacher-researcher's CP biology class
20. Ninth-grade female students at RHS enrolled in the teacher-researcher's CP biology class

The teacher-researcher used this data to determine trends or correlations among the data sets and used that information to evaluate the impact of the use of Larson's (2014b) Generative Vocabulary Matrix on the students' standardized test scores. The teacher-researcher also included the SC state mean scores for the 2017 and 2018 SC EOCEP for biology for the following populations:

1. All students
2. Disabled
3. Limited English Proficient (LEP)
4. Male
5. Female

The SC state category "disabled" encompasses students with Individualized Education Plans (IEPs) and 504 plans. The SC state category "Limited English Proficient" would

include students with ELL plans. The SC state scores were compared from one year to the next to determine if there were any significant changes in scores between the two administrations of the examination. The difference in scores between the two administrations was taken into consideration when evaluating the scores from RHS.

Ethical Considerations

In an action research study, it is important to consider the participants involved and the ethical obligations the teacher-researcher owes to participants. This action research study was conducted with students in the teacher-researcher's biology classes at Rushmore High School. As the instructor, the teacher-researcher was privy to the test scores of each of her students. This data was a central part of the study, and therefore it is important to note that ethically, the teacher-researcher was permitted to use these test results as data in the present action research study. While this study used the test results of students, the privacy of individual students was protected. To protect the confidentiality of the students, the teacher-researcher, "limit[ed] detailed descriptions [and] remov[ed] explanations of characteristics that are not essential to the nature of the research" (Metler, 2014, p.233). Additionally, the teacher-researcher sent home a parent notification letter before the start of the data collection period. This letter provided an overview of the study, potential risks, and benefits to participants, and the option for parents to withdraw their student from participating in the study. See Appendix C for Parent Notification Letter.

The literature review in Chapter 2 of this dissertation includes information on student subpopulations that include racial, ethnic, and gender differences. As

recommended by Metler (2014), when analyzing and reporting data on these topics, the teacher-researcher made every effort to eliminate any inherent biases she might have. The results of this study hold the most meaning if data related to ethnic, racial, and gender differences are presented in a factual, unbiased format that is respectful of all students and people groups represented.

Summary and Conclusion

It might be uncommon for a teacher with an undergraduate degree in biology and a master's degree in teaching science to plan an action research study centered on integrating literacy in science. However, the teacher-researcher believes that her background and extensive research provide compelling evidence to support the importance of this study. As a conscientious educator, the teacher-researcher cannot turn a blind eye to what her experience has conclusively shown. The teacher-researcher has observed an obvious lack of literacy skills among high school students and has seen the detrimental effect that gap of knowledge has on their achievement in the biology classroom. The present action-research study integrated literacy fundamentals with the biology curriculum with the goal of increasing students' scores on the South Carolina End-of-Course Examination Program. The goal is that students not only benefit from the improved test scores but also improve their literacy abilities and develop greater confidence in their academic capabilities as they progress through their high school career.

CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

Overview

Problem of Practice

After four years of teaching College Prep (CP) biology, the teacher-researcher felt that her students were not performing at their optimal ability on the state-mandated standardized test for biology. The teacher-researcher observed that her students often found it very difficult to learn and retain the concepts taught in the high school biology classroom because of a lack of science literacy skills. Science literacy skills refer to a student's ability to read and interpret scientific text and write about science-related concepts. To address these concerns, the teacher-researcher utilized Larson's (2014b) Generative Vocabulary Matrix (GVM) as a literacy strategy to determine the relationship between integrating literacy strategies in the biology classroom and performance on the South Carolina End-of-Course Examination Program (EOCEP) for biology. The teacher-researcher implemented Larson's (2014b) GVM as a literacy strategy with ninth-grade biology students in the spring of 2018.

The SC EOCEP for biology is a high-stakes test which accounts for 20% of each student's overall course average and consequently has the potential to impact students' overall grade point averages (GPA). Additionally, the passage rate on this test is published in the public domain on the SC Department of Education's website. This

information can be used by parents and community members to evaluate a school's merit and achievement level. Based on these factors, the Problem of Practice (PoP) is identified as a need for increased student achievement on the SC EOCEP for biology due to the potential impact this test has on students' overall course averages, their grade point averages (GPA), and the consequences these results may have on public opinion of the present school. This identified PoP is the subject of the present action research study.

Significance of Study

The teacher-researcher developed the present action research study with the goal of providing students with science instruction that supports students in achieving an optimal score on the South Carolina End-of-Course Examination Program (EOCEP). The present action research study seeks to produce statistical relevance related to improving standardized test scores by increasing scientific literacy skills using Larson's (2014b) Generative Vocabulary Matrix.

Data Collection Methods

The data collection for this action research study was both qualitative and quantitative. The quantitative data are presented using descriptive statistics to analyze the results. The qualitative data are presented in a narrative format. In this study, the scores of the teacher-researcher's students on the South Carolina End-of-Course Examination Program (EOCEP) for biology are compared to the results of similar students from the previous year. The scores from the 2017 and 2018 administrations of the SC EOCEP are reported for all ninth-grade students enrolled in College Prep (CP) biology at Rushmore High School (RHS) and used as comparison data. The teacher-researcher categorized this data into subpopulations to examine potential correlations. The core data for this study

comes from the SC EOCEP for biology but is supported by data from other sources including a benchmark test, unit tests, and the teacher-researcher's observation journal. Additionally, the SC state averages on the SC EOCEP for biology for the 2016-2017 and 2017-2018 academic years are reported to show the variances across the state between the two administrations of this examination.

Sample Characteristics

The research site is a public high school that enrolled approximately 2350 students, grades nine through twelve during the 2017-2018 school year. Table 3.1 in Chapter 3 provides detailed demographic information for the participants from each of the teacher-researcher's College Prep (CP) biology classes during the 2017-2018 school year. The teacher-researcher's third-period class was a traditional CP biology class, and her fourth-period class was an inclusion CP biology class.

Intervention Strategy

Larson's (2014b) Generative Vocabulary Matrix (GVM) was implemented as the foundation for literacy instruction in both teacher-researcher's classes. Larson (2014b) suggests a specific protocol for implementing the GVM (see Figure 1). This protocol was implemented in two cycles throughout five weeks.

General Findings and Results

The following tables, graphs, and narratives summarize the data collected for the present action research study. This study seeks to answer the research question:

1. *What is the impact of Larson’s (2014b) Generative Vocabulary Matrix (GVM) in a high school biology course as demonstrated by students’ performance on the SC End-of-Course Examination Program?*

The teacher-researcher established three purposes for conducting the present action research study. The primary purpose was to integrate literacy strategies into the biology classroom using Larson’s (2014b) Generative Vocabulary Matrix (GVM). The secondary purpose was to develop an action plan based on the use of the GVM and the South Carolina biology standards for instruction. The tertiary purpose was to describe the relationship between science literacy skills and performance on the SC End-of-Course Examination Program for biology. The primary and secondary purposes were addressed in Chapter 3, and the tertiary purpose is discussed in this chapter.

Comprehensive Benchmark Assessment

The comprehensive benchmark assessment served as the baseline measure for this study. The teacher-researcher used this measurement to compare her students’ performance to all Rushmore High School (RHS) students enrolled in CP biology during the 2017-2018 school year. The comprehensive benchmark assessment was administered to biology students in the teacher-researcher’s classes on March 19th-20th, 2018, before the implementation of Larson’s (2014b) Generative Vocabulary Matrix (GVM). The comprehensive benchmark assessment was composed of 60 selected-response questions and was designed to evaluate students’ understanding of all Biology I standards.

Table 4.1

Comprehensive Benchmark Assessment Results

Group	N of Students	M % Correct	Projected % Proficient	M Suggested Marks
TR3P-G9	17	46.7	47.1	71
TR4P-G9	21	37.8	23.8	64
RHS Bio CP	331	48.4	56.4	76

Note. TR3P-G9 = Teacher-Researcher's class, third period, ninth-grade students. TR4P-G9 = Teacher-Researcher's class, fourth period, ninth-grade students. RHS Bio CP = All students at Rushmore High School enrolled in CP biology except for tenth, eleventh, and twelfth-grade students in the teacher-researcher's classes and any student who did not take the SC EOCEP. There were five students in classes outside the teacher-researcher's classes that were in the tenth, eleventh, or twelfth-grade or that did not take the SC EOCEP but are included in calculations for "RHS-Bio CP." *N*= number. *M*=mean.

Table 4.1 demonstrates that on all measures, the teacher-researcher's third and fourth period performed lower than the general population of College Prep (CP) biology students at RHS.

Table 4.2

Teacher-Researcher's Classes Compared to General Population at RHS

Group	M % Correct	Projected % Proficient	M Suggested Marks
TR3P-G9	-3.5%	-16.5%	-6.4%
TR4P-G9	-21.9%	-57.8%	-15.6%

Note. TR3P-G9 = Teacher-Researcher's class, third period, ninth-grade students. TR4P-G9 = Teacher-Researcher's class, fourth period, ninth-grade students. *M*=mean.

The teacher-researcher used the data presented in Table 4.1 to calculate the percent difference between her students' performance on the comprehensive benchmark assessment and the general population of CP students at RHS on each of the measured categories. This data is shown in Table 4.2. Table 4.2 shows that at the time of the baseline assessment, the teacher-researcher's classes performed below the general

population in all measures. Based on the design of the data provided by the education company that created the benchmark test, the measure that most closely aligns with the mean score on the South Carolina End-of-Course Examination Program is “*M Suggested Marks*” on the comprehensive benchmark assessment. The data in Table 4.2 indicates that prior to the implementation of Larson’s (2014b) Generative Vocabulary Matrix in the category of “*M Suggested Marks*”, the teacher-researcher’s third period traditional CP biology class performed 6.4% below the general population of ninth-grade students at Rushmore High School (RHS) and the teacher-researcher’s fourth period inclusion CP biology class performed 15.6% below the general population of ninth-grade students at RHS.

Unit Tests

The unit tests administered as part of the present action research study served to demonstrate the growth of each teacher-researcher’s classes from the time of the comprehensive benchmark assessment to the administration of the unit tests. The administration of each unit test followed the implementation of Larson’s (2014b) Generative Vocabulary Matrix (GVM). The Biological Evolution unit test (Performance Indicators 1-5) was administered on April 10th, 2018. The Ecosystem Dynamics unit test, (Performance Indicators A1, A2, and C1) was administered on May 1st, 2018.

Biological Evolution

There were nine questions on the comprehensive benchmark assessment that addressed the standard and performance indicators evaluated on the Biological Evolution unit test. The percent correct for these nine questions was calculated for each student. Each student’s percent correct on their unit test was also recorded. The individual student

data was used to calculate average scores for each of the teacher-researcher's class periods on each measure.

Table 4.3

Biological Evolution (Performance Indicators 1-5) Benchmark and Unit Test

Group	Comprehensive Benchmark M Score	Unit Test M Score	% Growth
TR3P-G9	52	64	23%
TR4P-G9	35	52	48%

Note. TR3P-G9 = Teacher-Researcher's class, third period, ninth-grade students. TR4P-G9 = Teacher-Researcher's class, fourth period, ninth-grade students. *M=mean.*

Table 4.3 shows the average growth of students in each of the teacher-researcher's classes from the comprehensive benchmark assessment to the Biological Evolution unit test. Both class periods demonstrated growth after the implementation of Larson's (2014b) Generative Vocabulary Matrix (GVM). The data indicates that the implementation of Larson's (2014b) GVM resulted in more growth in the teacher-researcher's fourth-period class than the teacher-researcher's third-period class.

Ecosystem Dynamics

There were five questions on the comprehensive benchmark assessment that addressed the standard and performance indicators evaluated on the Ecosystem Dynamics unit test. The percent correct for these five questions was calculated for each student. Each student's percent correct on their unit test was also recorded. The individual student data was used to calculate average scores for each of the teacher-researcher's class periods on each measure.

Table 4.4

Ecosystem Dynamics (Performance Indicators A1, A2, and C1) Benchmark and Unit Test

Group	Comprehensive Benchmark M Score	Unit Test M Score	% Growth
TR3P-G9	51	70	37%
TR4P-G9	43	54	26%

Note. TR3P-G9 = Teacher-Researcher's class, third period, ninth-grade students. TR4P-G9 = Teacher-Researcher's class, fourth period, ninth-grade students. *M=mean.*

Table 4.4 shows the average growth of students in each of the teacher-researcher's class from the comprehensive benchmark assessment to the Ecosystem Dynamics unit test. Both class periods demonstrated growth after the implementation of Larson's (2014b) Generative Vocabulary Matrix (GVM). The data indicates that the implementation of Larson's (2014b) GVM resulted in more growth in the teacher-researcher's third-period class than the teacher-researcher's fourth-period class.

Observations

The teacher-research used a researcher journal throughout the implementation of Larson's (2014b) Generative Vocabulary Matrix (GVM). Codes were identified through Mertler's (2014) inductive analysis model. This model involves the teacher-researcher reading the observational notes multiple times, looking for patterns and themes, creating coding categories, separating the information by category, drawing connections between categories and exploring their significance (Mertler, 2014). Table 4.5 shows the coding categories and themes that emerged as the teacher-researcher analyzed her observational journal. Table 4.5 also includes specific notes and quotations that support the creation of these categories and themes.

Table 4.5

Teacher-Researcher's Observation Journal Coding Categories, Themes, and Notes

Coding Category	Theme(s)	Notes from Observational Journal
Engagement	Students enjoyed the hands-on lab, the activity that incorporated movement and getting to share their thoughts out loud in a semi-structured environment.	<p>About the Bird Beak Lab and beginning stages of creating the GVM: "Overall students seemed engaged in the activity and seemed to understand its purpose."</p> <p>"In both classes, there was a variety of students participating in identifying terms."</p> <p>"Their enthusiasm was exciting, but I was concerned about their focus and retention."</p> <p>About the "Oh Deer" Activity: "We went to the hall to play. I felt that the students liked getting up to move around."</p>
Distractibility	Students enjoyed the lab, activity, and discussions, but had trouble focusing on the instruction that corresponded with these instructional strategies.	<p>"Students in fourth period seemed to have trouble focusing on all the instruction because they were so excited for the lab."</p> <p>"I was concerned that the open discussion may need to be supported by some general guidelines in the future. My fourth period especially was so eager to identify and write terms that they didn't always hear how another student defined and justified his/her word choice."</p>
Need for Support	Students found it difficult to begin tasks that involved critical thinking. When encountering these tasks, students often requested an example or asked the teacher to model what was expected.	<p>"At first the students struggled to figure out what kind of terms to select."</p> <p>"The students struggled a bit to get started, but in the end created some great responses...one student said, 'Where are the answers?' I said, 'You have to create it!'"</p> <p>"[The students] struggled to generate a big picture category."</p> <p>I asked the students to generate a concept map using terms from a short video they watched on Ecological Succession and an</p>

activity they did on the same topic. Students responded by stating, “This is too hard” or “I don’t know how.” I noted, “They struggled, and many refused to begin fearing failure.” I added a basic concept map drawing to the board which helped many begin. I started the next period by showing the students the drawing and the process was smoother, “but overall the process in both classes was grueling.”

Discussion

Semi-structured discussion allowed students to feel comfortable sharing their ideas and thoughts out loud. This format encouraged students to ask questions.

“As they share the terms, we discussed their meaning and then wrote them on sticky notes to add to the chart paper.”

“When [I was] reading, [a] student stopped me and asked, ‘Who is Darwin?’”

When reading an article titled “Study of Darwin’s Finches”: “We discussed what they [the students] thought the term meant, what it actually means, how it relates to the GVM.”

“We had amazing discussion about the meaning of the words and how they fit into the conceptual categories.”

Referring to the initial stages of creating the GVM for the ecology unit: “This went much smoother than when we completed this part of the GVM for evolution. The students had a better grasp of what kinds of keywords I was looking for. We were even able to start discussing categories.”

“I am realizing that as part of this process I have started asking my students to think more critically, generate their own ideas, and answer WHY they selected an answer. They still fight me on this. I wish I had started this from day one.”

Reflection

The teacher-researcher shifted from primarily using selected

“We reviewed the terms selected from the previous class. I asked the students [to complete the following sentence]: The

response questions to more open-ended, short-answer questions (both verbal and written).

connection between _____ and evolution is _____.”

“The students had to apply their knowledge...After approximately 10 minutes working, students shared answers and explained their logic.”

“I asked the students to complete a short writing assignment...students were instructed to write in complete sentences and use at least ONE term from the GVM in each of the two answers.”

A note after reviewing a multiple choice and short answer reflection: “I feel like my students would be able to better articulate their answers verbally, based on previous class discussions, then they were able to do in a written format.”

An overarching theme that emerged from the journal was the teacher-researcher’s desire to modify certain aspects of the implementation of Larson’s (2014b) GVM and its associated protocol. The teacher-researcher encountered areas of great success, in student engagement and discussion, but in other areas, the teacher-researcher felt that the students needed more structure to prevent unnecessary distractions and required practice developing their critical thinking skills. The teacher-researcher questioned if certain components of Larson’s (2014b) GVM protocol should have been implemented more intentionally throughout at academic year instead of attempting to introduce them all during a five-week period. Scaffolding this type of instructional method might have improved the ability of this literacy strategy to increase students’ scores on the South Carolina End-of-Course Examination Program.

South Carolina End-of-Course Examination Program

The South Carolina End-of-Course Examination Program (EOCEP) for biology provides the data central to this study. The SC EOCEP was created by the SC Department of Education and addressed content related to all the SC Biology 1 Standards. The 2017 SC EOCEP was administered May 15th through May 18th, 2017. The 2018 SC EOCEP was given to the teacher-researcher's third-period class on May 23rd and her fourth-period class on May 24th, 2018. Some students took the exam on make-up days after these assigned dates.

Table 4.6 displays the mean scores for all ninth-grade students enrolled in College Prep (CP) biology at Rushmore High School at the time of the 2017 and 2018 administration of the SC EOCEP and the mean scores for all ninth-grade students enrolled in the teacher-researcher's CP biology classes during the 2017 and 2018 administration of the SC EOCEP. The mean scores were calculated for whole groups and four subpopulations.

The teacher-researcher's hypothesis for the present action research study was that the biology classes at Rushmore High School (RHS) where students used Larson's (2014b) Generative Vocabulary Matrix would have higher average scores on the SC End-of-Course Examination Program than the scores of similar students from the previous year. The teacher-researcher's hypothesis was supported in two subcategories in specific class periods. Table 4.6 shows that the teacher-researcher's fourth-period students in the 2017-2018 school year performed higher than similar students from the previous year in the subpopulation "Limited English Proficient." The sample size was $n=8$ for the teacher-researcher's subpopulation "Limited English Proficient" in the 2016-2017 school

year. The sample size was $n=2$ for the teacher-researcher's subpopulation "Limited English Proficient" in the 2017-2018 school year. The sample size for subpopulation "Limited English Proficient" $n=40$ for all ninth-grade students at RHS during the 2016-2017 school year and was $n=18$ for all ninth-grade students at RHS during the 2017-2018 school year. Table 4.6 also shows that the teacher-researcher's third-period students in the 2018 school year performed higher than similar students from the previous year in the subpopulation of "Males." The sample size was $n=7$ for the teacher-researcher's subpopulation "Males" in her third period during the 2017-2018 school year. The sample size was $n=35$ for the teacher-researcher's subpopulation "Males" in both of her class periods during the 2016-2017 school year. The sample size for subpopulation "Males" was $n=222$ for all ninth-grade students at RHS during the 2016-2017 school year and was $n=169$ for all ninth-grade students at RHS during the 2017-2018 school year.

Table 4.6
2017 & 2018 SC EOCEP Mean Scores

Group	All Students	Disabled	Limited English Proficient	Males	Females
RHS Bio CP-G9 '17	74.1*	60.7	65.0	73.9	74.5
TRAP-G9 '17	71.4	59.6	63.5	69.5	75.1*
RHS Bio CP-G9 '18	69.6	61.1*	62.7	72.0	67.1
TRAP-G9 '18	66.5	58.1	67.5*	69.6	64.0
TR3P-G9 '18	70.9	51.3	-	74.1*	68.6
TR4P-G9 '18	63.0	61.0	67.5*	66.4	59.8

Note. RHS Bio CP-G9 '17=All ninth-grade students at Rushmore High School enrolled in CP biology in the 2016-2017 school year. TRAP-G9 '17= All ninth-grade students enrolled in the teacher-researcher's classes in the 2016-2017 school year. RHS Bio CP-G9 '18=All ninth-grade students at Rushmore High School enrolled in CP biology in the 2017-2018 school year. TRAP-G9 '18= All ninth-grade students enrolled in the teacher-researcher's classes in the 2017-2018 school year. TR3P-G9 '18 = Teacher-Researcher's ninth-grade students, third period, in the 2017-2018 school year. TR4P-G9 '18 = Teacher-Researcher's ninth-grade students, fourth period, in the 2017-2018 school year. Bolded scores with * indicated the highest score for all groups in that population.

Table 4.7 displays a comparison of the passage rates (60 and above) for all ninth-grade students enrolled in College Prep (CP) biology at RHS at the time of the 2017 and 2018 administration of the SC EOCEP and the passage rates for all ninth-grade students enrolled in the teacher-researcher’s CP biology classes during the 2017 and 2018 administration of the SC EOCEP. The mean scores were calculated for whole groups and four subpopulations.

Table 4.7

2017 & 2018 SC EOCEP Passage Rates

Group	All Students	Disabled	Limited English Proficient	Males	Females
RHS Bio CP-G9 '17	77%*	44%*	65%	74%	81%
TRAP-G9 '17	72%	38%	63%	63%	89%*
RHS Bio CP-G9 '18	72%	44%*	67%	75%*	70%
TRAP-G9 '18	58%	20%	100%*	65%	52%
TR3P-G9 '18	65%	0%	-	71%	60%
TR4P-G9 '18	52%	29%	100%	60%	45%

Note. RHS Bio CP-G9 '17=All ninth-grade students at Rushmore High School enrolled in CP biology in the 2016-2017 school year. TRAP-G9 '17= All ninth-grade students enrolled in the teacher-researcher’s classes in the 2016-2017 school year. RHS Bio CP-G9 '18=All ninth-grade students at Rushmore High School enrolled in CP biology in the 2017-2018 school year. TRAP-G9 '18= All ninth-grade students enrolled in the teacher-researcher’s classes in the 2017-2018 school year. TR3P-G9 '18 = Teacher-Researcher’s ninth-grade students, third period, in the 2017-2018 school year. TR4P-G9 '18 = Teacher-Researcher’s ninth-grade students, fourth period, in the 2017-2018 school year. Bolded scores with * indicated the highest passage rate for all groups in that population.

Table 4.7 demonstrates that the teacher-researcher’s fourth-period students in the 2017-2018 school year had higher passage rates than similar students from the previous year in the subpopulation “Limited English Proficient.” The sample size was $n=2$ for the teacher-researcher’s subpopulation “Limited English Proficient” in the 2017-2018 school year. The sample size was $n=8$ for the teacher-researcher’s subpopulation “Limited English Proficient” in the 2016-2017 school year. The sample size for subpopulation “Limited English Proficient” $n=40$ for all ninth-grade students at Rushmore High school

during the 2016-2017 school year and was $n=18$ for all ninth-grade students at Rushmore High school during the 2017-2018 school year. Table 4.7 also shows that the teacher-researcher's students in the 2017-2018 school year performed higher than similar students from the previous year in the subpopulation of "Males." The sample size was $n=17$ for the teacher-researcher's subpopulation "Males" during the 2017-2018 school year. The sample size was $n=35$ for the teacher-researcher's subpopulation "Males" during the 2016-2017 school year. The sample size for subpopulation "Males" was $n=222$ for all ninth-grade students at Rushmore High school during the 2016-2017 school year and was $n=169$ for all ninth-grade students at Rushmore High school during the 2017-2018 school year.

Table 4.8 shows a comparison of South Carolina State End-of-Course Examination Program (EOCEP) mean scores from the 2016-2017 and 2017-2018 administrations. These two exam administrations are central to the data collection for the present action research study. Table 4.8 also shows the difference in the teacher-researcher mean scores for the same populations from the 2016-2017 and 2017-2018 school years. The data shown in Table 4.8 help to explain trends seen in Table 4.6.

Table 4.8 shows that the SC statewide scores dropped in all five noted categories from the 2016-2017 administration to the 2017-2018 administration of the SC EOCEP. The teacher-researcher's class data showed decreased mean scores in three of the five noted categories and an increase in mean scores in two categories, "Limited English Proficient" and "Male." In two of the categories where the teacher-researcher's classes had decreased mean scores, the difference was less than what was seen at the state level.

The categories where the teacher-researcher’s students show a smaller decrease in mean scores than the state were “All students” and “Disabled.”

Table 4.8

South Carolina Statewide EOCEP Mean Scores

Group	2016-2017	2017-2018	Difference in statewide <i>M</i> scores	Difference in TRAP-G9 <i>M</i> scores
All Students	75.3	69.5	-5.8	-4.9
Disabled	54.8	52.0	-2.8	-1.5
Limited English Proficient	67.3	54.3	-13.0	4.0
Male	74.2	68.7	-5.5	0.1
Female	76.4	70.3	-6.1	-11.1

Note. TRAP-G9= All ninth-grade students enrolled in the teacher-researcher’s classes during the 2016-2017 and 2017-2018 school years. Data files retrieved from the South Carolina Department of Education (2017) and the South Carolina Department of Education (2018).

Supplemental Analysis

The teacher-researcher’s original hypothesis and associated data provided in Table 4.6 and Table 4.7 focused on the comparison between the teacher-researcher’s students from the 2017-2018 school year and similar students from the previous school year. After analyzing the results of the four assessments for the present action research study, the teacher-researcher determined that additional analysis was warranted. The data in Table 4.9 and analysis that follows examines the teacher-researcher’s students’ performance on the South Carolina End-of-Course Examination Program (EOCEP) compared to similar students at Rushmore High School (RHS) who took the examination in the same year. This analysis method eliminates the necessity of looking at differences between the two administrations of the SC EOCEP and looks solely at how the teacher-

researcher's students performed compared to similar students at RHS on the same administration of the test.

Table 4.9
Teacher-Researcher's Mean Scores Compared to School from Same Year

Group	All Students	Disabled	Limited English Proficient	Males	Females
TRAP-G9 '17	-3.7	-1.7	-2.3	-5.9	0.8
TRAP-G9 '18	-4.5	-4.9	7.7*	-3.3	-4.6
TR3P-G9 '18	1.8*	-16.0	-	3.0*	2.2*
TR4P-G9 '18	-9.6	-0.1	7.7*	-7.8	-10.9

Note. TRAP-G9 '17= All ninth-grade students enrolled in the teacher-researcher's classes in the 2016-2017 school year. TRAP-G9 '18= All ninth-grade students enrolled in the teacher-researcher's classes in the 2017-2018 school year. TR3P-G9 '18 = Teacher-Researcher's ninth-grade students, third period, in the 2017-2018 school year. TR4P-G9 '18 = Teacher-Researcher's ninth-grade students, fourth period, in the 2017-2018 school year. Bolded scores with * indicate that group/subgroup of the teacher-researcher's students performed better than the average ninth-grade student at RHS on the same administration of the SC EOCEP.

The data in Table 4.9 indicates that the teacher-researcher's students in the 2017-2018 school year, in specific class periods, performed better than the general population of ninth-grade students at RHS in several subpopulations. In the 2017-2018 school year, the students in the teacher-researcher's third-period, traditional CP biology class out-performed the general population of ninth-grade students at RHS in three of the measured categories. In the 2017-2018 school year, the teacher-researcher's fourth-period, inclusion CP biology class out-performed the general population of ninth-grade students at RHS in one category.

The results shown in Table 4.9 increase in value when connected with the baseline data provided in Table 4.2. Prior to the implementation of Larson's (2014b) Generative Vocabulary Matrix (GVM), the teacher-researcher's third-period, traditional CP biology class performed 6.4% below the general population of ninth-grade students at Rushmore High School (RHS) and the teacher-researcher's fourth-period, inclusion CP

biology class performed 15.6% below the general population of ninth-grade students at RHS. After the implementation of Larson's (2014b) GVM, the teacher-researcher's third period, traditional CP biology class performed 1.8% higher than the general population of ninth-grade students at RHS and the teacher-researcher's fourth period, inclusion CP biology class only performed 9.6% below the general population of ninth-grade students at RHS. Both classes demonstrated improved performance compared to the general population of ninth-grade students at RHS after the implementation of Larson's (2014b) GVM.

Summary

The teacher-researcher used four assessments to evaluate the impact of Larson's (2014b) Generative Vocabulary Matrix (GVM) on students' scores on the South Carolina End-of-Course Examination Program (EOCEP). The comprehensive benchmark assessment results provided a baseline measurement that demonstrated that both teacher-researcher's classes were performing below the general population at Rushmore High School (RHS) before the implementation of Larson's (2014b) GVM. The unit tests demonstrated that both classes demonstrated growth in knowledge related to the standards on Biological Evolution and Ecosystem Dynamics after the instruction that included the use of Larson's (2014b) GVM. The teacher-researcher's observational journal reflected two key areas of success, student engagement and discussion, with the use of Larson's (2014b) GVM, but also indicated a desire to modify some aspects of the protocol and scaffold and extend its implementation over a longer instructional period.

The teacher-researcher hypothesized that the biology classes at RHS where students use Larson's (2014b) GVM would have higher average scores on the SC

EOCEP than the scores of similar students from the previous year. The hypothesis was only supported in two subpopulations within specific class periods: the mean scores for the teacher-researchers fourth-period students in the subpopulation “Limited English Proficient” and the mean scores for the teacher-researcher’s third-period students in the subpopulation “Males.” The data also reflected that the teacher-researchers fourth-period students in the subpopulation “Limited English Proficient” during the 2017-2018 school year had higher passage rates than similar students of the previous year. It is important to note that these two subpopulations both had small sample sizes (Limited English Proficient, $N=2$, and Males, $N=7$). Due to the small sample size of these two subpopulations, the teacher-researcher determined that the data is inconclusive regarding the effectiveness of Larson’s (2014b) GVM with these students and further research was warranted.

The teacher-researcher determined there was a need for supplemental analysis of the results from the SC End-of-Course Examination Program. This analysis method examined how the teacher-researcher’s students performed compared to similar students at RHS on the same administration of the test. The results of this analysis demonstrated the teacher-researcher’s third-period class’ mean SC EOCEP scores were 1.8% higher than all ninth-grade students at RHS during the 2017-2018 school year and her fourth-period class’ mean SC EOCEP scores were 9.6% below all ninth-grade students at RHS during the 2017-2018 school year. This information was compared to the baseline measurement which showed that the teacher-researcher’s students in both classes showed improved performance compared to the general population of ninth-grade students at RHS after the implementation of Larson’s (2014b) GVM.

The results of this study provide support for further research using Larson's (2014b) Generative Vocabulary Matrix (GVM) in CP biology classes. The data analysis of the four measures in the present action research study demonstrate areas of success in improving standardized test scores, but also illuminate areas of weakness which warrant further examination and research. The teacher-researcher plans to explore the strengths and weaknesses of this implementation of Larson's (2014b) GVM and make necessary adjustments to the protocol before future implementations. The teacher-researcher hopes that these adjustments will continue to improve the efficacy of this tool and provide more conclusive evidence of the ability of Larson's (2014b) GVM to improve students' scores on the SC End-of-Course Examination Program.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Overview of Study

Problem of Practice

After four years of teaching biology, the teacher-researcher felt that her students were not performing at their optimal ability on the state-mandated standardized test for biology. The teacher-researcher observed that her students often found it very difficult to learn and retain the concepts taught in the high school biology classroom because of a lack of science literacy skills. Science literacy skills refer to a student's ability to read and interpret scientific text and write about science-related concepts. To address these concerns, the teacher-researcher utilized Larson's (2014b) Generative Vocabulary Matrix (GVM) as a literacy strategy to determine the relationship between integrating literacy strategies in the biology classroom and performance on the South Carolina End-of-Course Examination Program (EOCEP) for biology. The teacher-researcher implemented Larson's (2014b) GVM as a literacy strategy with ninth-grade biology students in the spring of 2018.

The SC EOCEP for biology is a high-stakes test which accounts for 20% of each student's overall course average and consequently has the potential to impact students' overall grade point averages (GPA). Additionally, the passage rate on this test is published in the public domain on the SC Department of Education's website. This

information can be used by parents and community members to evaluate a school's merit and achievement level. Based on these factors, the Problem of Practice (PoP) is identified as a need for increased student achievement on the SC EOCEP for biology due to the potential impact this test has on students' overall course averages, their grade point averages (GPA), and the consequences these results may have on public opinion of the present school. This identified PoP is the subject of the present action research study.

Significance of Study

The teacher-researcher developed the present action research study with the goal of providing students with science instruction that supports students in achieving an optimal score on the South Carolina End-of-Course Examination Program (EOCEP). The present action research study sought to produce statistical relevance related to improving standardized test scores by increasing scientific literacy skills using Larson's (2014b) Generative Vocabulary Matrix.

Theoretical Framework

The present action research study drew from the theories of Franklin Bobbitt, William F. Pinar, and Wayne Au. Franklin Bobbitt's (2013) work emphasizes the importance of integrating "actual life-situations" when delivering instructional content (p. 11). He proposes that educators should combine experiences with content instead of solely requiring students to memorize isolated facts and processes. William Pinar (2013) writes about the importance of blending various educational ideologies in the pursuit of developing curriculum. Pinar (2013) believes in the necessity of looking to traditionalist, conceptual-empiricists, and reconceptualists to devise the best way to educate students. Pinar (2013) states that each type of curricularist "is reliant upon the other" and no

philosophy must be eliminated in the exploration of another (p. 155). Wayne Au (2013) seeks to combat unwelcome instructional trends associated with the increase of high-stakes testing such as the “contracting [of] curricular content, fragmentation of the structure of knowledge, and increasing teacher-centered pedagogy” (p. 245). The theories of all three individuals were central to the development of the research design for the present action research study.

Research Site and Participant Selection

The present action research study took place at Rushmore High School (RHS), a public high school that enrolled approximately 2350 students, grades nine through twelve, during the 2017-2018 school year. The demographic breakdown of the RHS student body during the 2017-2018 school year was approximately: 61.7% Caucasian, 20.6% African-American, 9.6% Hispanic, 3.3% Asian, 0.2% American Indian/Alaskan Native, 0.1% Hawaiian Native/Pacific Islander, and 4.6% Multi-Racial. Approximately 25.7% of the student body was enrolled in the free and reduced lunch program, 9.7% of the student body had an Individualized Education Plan (IEP), and 4.0% had a 504 plan.

The participants in the present action research study were biology students of the teacher-researcher at RHS during the 2017-2018 school year. The students selected for this study were classified as ninth-grade students at the high school level. There was no recruitment process for this study. The participants were placed in one of two of the teacher-researcher’s classes by the school’s guidance department. The participants in the teacher-researcher’s classes were enrolled in College Prep (CP) biology. The teacher-researcher’s third-period class was a traditional CP biology course, and the fourth-period class was an inclusion CP biology course. Larson’s (2014b) Generative Vocabulary

Matrix (GVM) was used in both teacher-researcher's biology classes during the 2017-2018 school year.

Data Collection Methods

The data collection for this action research study was both qualitative and quantitative. The quantitative data are presented using descriptive statistics to analyze the results. The qualitative data is presented in a narrative format. In this study, the scores of the teacher-researcher's students on the South Carolina End-of-Course Examination Program (EOCEP) for biology are compared to the results of similar students from the previous year. The scores from the 2017 and 2018 administrations of the SC EOCEP are reported for all ninth-grade students enrolled in College Prep biology at Rushmore High School (RHS) and used as comparison data. The teacher-researcher categorized this data into subpopulations to examine potential correlations. The core data for this study comes from the SC EOCEP for biology but is supported by data from other sources including a benchmark test, unit tests, and a teacher-researcher observation journal. Additionally, the SC state averages on the SC EOCEP for biology for the 2016-2017 and 2017-2018 academic years are reported to show the variances across the state between the two administrations of this examination.

Results

The teacher-researcher used four assessments to evaluate the impact of Larson's (2014b) Generative Vocabulary Matrix (GVM) on students' scores on the South Carolina End-of-Course Examination Program (EOCEP). The comprehensive benchmark assessment results provided a baseline measurement that demonstrated that both teacher-researcher's classes were performing below the general population at Rushmore High

School (RHS) before the implementation of Larson’s (2014b) GVM. The unit tests showed that both classes demonstrated growth in knowledge related to the standards on Biological Evolution and Ecosystem Dynamics after the instruction that included the use of Larson’s (2014b) GVM. The teacher-researcher’s observational journal reflected two keys areas of success with the use of Larson’s (2014b) GVM, student engagement and discussion, but also indicated a desire to modify some aspects of the protocol and scaffold and extend its implementation over a longer instructional period.

This study sought to answer the research question:

1. *What is the impact of Larson’s (2014b) Generative Vocabulary Matrix (GVM) in a high school biology course as demonstrated by students’ performance on the SC End-of-Course Examination Program?*

The teacher-researcher hypothesized that the biology classes at RHS where students used Larson’s (2014b) Generative Vocabulary Matrix would have higher average scores on the SC End-of-Course Examination Program than the scores of similar students from the previous year. The hypothesis was only supported in two subpopulations within specific class periods: the mean scores for the teacher-researcher’s fourth-period students in the subpopulation “Limited English Proficient” and the mean scores for the teacher-researcher’s third-period students in the subpopulation “Males.” It is important to note that these two subpopulations both had small sample sizes (Limited English Proficient, $N=2$, and Males, $N=7$). As stated in Chapter 4, due to the small sample size of these two subpopulations, the teacher-researcher believes that the data is inconclusive regarding the effectiveness of Larson’s (2014b) GVM with these subpopulations and further research is warranted.

The teacher-researcher determined there was a need for supplemental analysis of the results from the SC End-of-Course Examination Program. This analysis method examined how the teacher-researcher's students performed compared to similar students at RHS on the same administration of the test. The results of this analysis demonstrated the teacher-researcher's third-period's mean SC EOCEP scores were 1.8% higher than all ninth-grade students at RHS during the 2017-2018 school year and her fourth-period's mean SC EOCEP scores were 9.6% below all ninth-grade students at RHS during the 2017-2018 school year. This information was compared to the baseline measurement which showed that the teacher-researcher's students in both classes showed improved performance compared to the general population of ninth-grade students at RHS after the implementation of Larson's (2014b) GVM.

Results Related to Existing Literature

The following section serves as an opportunity to share the results from the present action research study as they relate to the teacher-researcher's findings in the existing literature that formed the framework for this study.

Comprehensive Benchmark Assessment

The comprehensive benchmark assessment served as the baseline measure for this study. The teacher-researcher used this measurement to compare her students' performance to all Rushmore High School (RHS) students enrolled in College Prep (CP) biology during the 2017-2018 school year. The comprehensive benchmark assessment was administered to biology students in the teacher-researcher's classes before the implementation of Larson's (2014b) Generative Vocabulary Matrix (GVM). The

comprehensive benchmark assessment was composed of 60 selected-response questions and was designed to evaluate students' understanding of all Biology I standards.

The results in Chapter 4, Table 4.1, show that on all measures (mean percent correct, projected percent proficient, and mean suggested marks) the teacher-researcher's third and fourth-period classes performed lower than the general population of CP biology students at RHS. The teacher-researcher's fourth-period inclusion class, which had nine students with IEPs, 504 plans, or ELL plans, showed more significant deficiencies in content knowledge when compared to the general population of students at RHS than the teacher-researcher's third-period traditional CP biology class. Table 4.2 in Chapter 4 shows that in the category "Mean Suggested Marks", which most closely aligns with the predicted South Carolina End-of-Course Examination Program (EOCEP) test score, the teacher researcher's third-period class was 6.4% below the general population of CP students at RHS, and her fourth-period class was 15.6% below the general population of CP students at RHS.

The teacher-researcher has a vested interest in the impact of Larson's (2014b) GVM for students that fall within specific subpopulations, students with IEPs, 504s, and ELL plans. The subpopulation labels for these students assigned by the South Carolina Department of Education are "Disabled" and "Limited English Proficient" respectively. In Chapter 2, the teacher-researcher cited studies conducted by Buckingham (2012) and Westover and Martin (2014) regarding the insufficient use of effective instructional strategies to assist diverse student groups, such as students English Language Learners (ELL) and students with disabilities, in mastering scientific content. The baseline measures for the study indicate that the class with a high population of students with

IEPs, 504s, and ELL plans performed significantly below the general population of CP biology students at RHS.

Unit Tests

The unit tests served to demonstrate the growth of each of the teacher-researcher's classes from the time of the comprehensive benchmark assessment to the administration of the unit test. The administration of each unit test followed the implementation of Larson's (2014b) Generative Vocabulary Matrix (GVM). There were nine questions on the comprehensive benchmark assessment that addressed the standard and performance indicators evaluated on the Biological Evolution unit test. The percent correct for each of these nine questions was calculated for each student. Each student's percent correct on their unit test was also recorded. The individual student data was used to calculate average scores for each of the teacher-researcher's class periods on each measure.

Table 4.3 in Chapter 4 indicates that the teacher-researcher's third-period class showed 23% growth from the baseline measure to the unit test and the teacher-researcher's fourth-period class showed 48% growth. The amount of growth that the fourth-period inclusion CP biology class accomplished from the time of the baseline assessment to the administration of the unit test is significant. The fourth period class, with a high percentage of students with IEPs, 504 plans, and ELL plans, grew two times as much as the teacher-researcher's traditional CP biology class. This data provides evidence of the effectiveness of using Larson's (2014b) GVM with this specific population on this specific content.

There were five questions on the comprehensive benchmark assessment that addressed the standard and performance indicators evaluated on the Ecosystem Dynamics

unit test. The percent correct for these five questions was calculated for each student. Each students' percent correct on their unit test was also recorded. The individual student data was used to calculate average scores for each of the teacher-researcher's class periods on each measure. Table 4.4 in Chapter 4 indicates that the teacher-researcher's third-period class showed 37% growth from the baseline measure to the unit test and the teacher-researcher's fourth-period class showed 26% growth.

This data provides evidence that both class periods demonstrated measurable growth on both unit tests after the implementation of Larson's (2014b) Generative Vocabulary Matrix (GVM). The teacher-researcher believes that the amount of growth shown in both classes can be contributed in part to the common experiences provided at the onset of each unit, a strategy that is outlined as part of the "initiate" phase of Larson's (2014b) GVM. This common experience provides a level of equity to each student in the class which has been a goal of public schools since the Common School Movement in the early 1800s (Spring, 2014).

Observations

The teacher-research kept a researcher journal throughout the implementation of Larson's (2014b) GVM. Codes were identified through Mertler's (2014) inductive analysis model. This model involves the teacher-researcher reading the observational notes multiple times, looking for patterns and themes, creating coding categories, separating the information by category, drawing connections between categories and exploring their significance (Mertler, 2014). There were five coding categories that emerged: engagement, distractibility, need for support, discussion, and reflection. Each category had associated themes generated by the notes taken in the observation journal.

Coding categories, themes, specific notes and quotations that support the creation of these categories and themes are included in Chapter 4, Table 4.5.

The teacher-researcher noted that in the category “engagement” the students enjoyed the hands-on lab, the activity that incorporated movement and getting to share their thoughts out loud in a semi-structured environment. This instructional strategy is supported by the theories of Franklin Bobbitt (2013) who was cited in Chapter 1 as part of the teacher-researcher’s theoretic framework. Bobbitt (2013) proposes that education should be relatable to real life situations instead of simply asking students to memorize facts and procedures. The teacher-researcher observed in her previous years of teaching biology that her male students tended to be more vocal about their appreciation of labs, activities involving movement, and class discussion. The teacher-researcher questions if the intentional integration of this type of activity as part of Larson’s (2014b) GVM contributed to her male students receiving higher scores than her female students on the South Carolina End-of-Course Examination Program (EOCEP). Further exploration of the causes of differences in achievement between males and females on the SC EOCEP is an area of future research interest for the teacher-researcher, specifically as it relates to the use of Larson’s (2014b) GVM.

In the category “distractibility,” the theme emerged that students enjoyed the lab, activity, and discussions, but had trouble focusing on the instruction that corresponded with these instructional strategies. The theme in the category “need for support” showed that students found it difficult to begin tasks that involved critical thinking. When encountering these tasks, students often requested an example or asked the teacher to model what was expected.

The theme for the category “discussion” showed that semi-structured discussion allowed students to feel comfortable sharing their ideas and thoughts out loud. This format encouraged students to ask questions. The discussion portion of the implementation of Larson’s (2014b) GVM aligns with Templeton’s (2012) theory that instructional techniques can facilitate the expansion of a student’s vocabulary. In one of the discussion sessions, the teacher-researcher used an instructional format similar to an example Templeton (2012) includes in his writing. Templeton (2012) shares a strategy where a teacher used a book to engage students in guided questions where the students ultimately define a key term before the teacher even shares the term with the class. Stahl and Vancil (1986) provide evidence that students who were given instruction that paired discussion with semantic maps scored slightly higher than groups with only the semantic map or only discussion. The teacher-researcher believes that in her study, the discussion component was an important part of the implementation of Larson’s (2014b) GVM.

Lastly, in the category “reflection,” the theme showed that the teacher-researcher shifted from primarily using selected response questions to more open-ended, short-answer questions (both verbal and written). Wittrock (2010) noted the importance of pairing instructional organizers with discussion. As stated in Chapter 2, Wittrock (2010) states, “the notion that human learning with understanding involves the process of generating and transferring meaning for stimuli and events from one’s background, attitudes, abilities, and experiences” (p. 43).

South Carolina End-of-Course Examination Program

The teacher-researcher stated in the review of literature that the goal of utilizing Larson’s (2014b) Generative Vocabulary Matrix (GVM) as the literature strategy for the

present action research study was to help students be successful within the current educational system without losing the benefits of an academically rich and student-centered instructional method. The teacher-researcher stated that this format provided the opportunity to weave together student experience and perspective within the framework that is currently in place at the school and district of interest for this study. This methodology sought to combat the concerns presented in Au's (2013) study, which stated that, "overwhelmingly, the prevalent theme triplet in the qualitative research was the combination of contracting curricular content, fragmentation of the structure of knowledge, and increasing teacher-centered pedagogy in response to high stakes testing" (p. 245).

Additionally, the teacher-researcher sought to investigate the relevance of this instructional strategy on specific subpopulations: disabled, Limited English Proficient, and between genders. In Chapter 2, the teacher-researcher reported that in South Carolina (SC), the 2017 End-of-Course Examination Program (EOCEP) scores show that the mean score for males was 74.2% and for females, it was 76.4% (South Carolina Department of Education, 2017). A more significant difference was shown in the mean scores for disabled students. The mean score for disabled students was 54.8% compared to 77.8% for non-disabled students (South Carolina Department of Education, 2017). Looking at Limited English Proficient (LEP) students, the mean score for LEP students in SC was 67.3% while non-LEP students had a mean score of 75.7% (South Carolina Department of Education, 2017). At Rushmore High School (RHS), the location of the present action research study, data shows that the mean score for males was 79.0% versus 80.7% for females (South Carolina Department of Education, 2017). Looking at students with

disabilities, the mean score was 55.5% versus 82.9% for non-disabled students (South Carolina Department of Education, 2017). Data on Limited English Proficient (LEP) students shows a mean score of 67.5% versus 80.9% for non-LEP students (South Carolina Department of Education, 2017).

Table 4.6 in Chapter 4 displays a comparison between the teacher-researcher's South Carolina End-of-Course Examination Program (EOCEP) scores from the 2016-2017 and 2017-2018 school years. The data shows that the teacher-researchers students performed better on the SC EOCEP after the implementation of Larson's (2014b) Generative Vocabulary Matrix (GVM) in the subcategories of Limited English Proficient (LEP) and Males. Table 4.8 in Chapter 4 shows that the statewide scores in these categories decreased across the two administration of the exam. In the present action research study, the sample size for students identified as Limited English Proficient was small ($n=2$); however, it is notable that both students passed the South Carolina End-of-Course Examination Program after implementation of Larson's (2014b) GVM. The teacher-researcher believes that the generative structure, which is a key component of Larson's (2014b) GVM, provided the necessary scaffolding for her LEP students to comprehend and retain information related to the Biology 1 standards. The teacher-researcher supports further exploration of the correlation between the scores of LEP students on the SC EOCEP and the use of Larson's (2014b) GVM.

Limitations of Study

In the present action research study, there were three key limitations. While all the limitations were beyond the teacher-researcher's control in the present action research study, it is possible that one limitation be resolved in future studies. The three key

limitations for this study were: variability in comparisons groups, access to the South Carolina End-of-Course Examination Program (EOCEP), and sample size.

In educational research, it is unethical to establish a true control group. The teacher-researcher could not select one of the class periods in which to implement Larson's (2014b) Generative Vocabulary Matrix (GVM) and not the other if the teacher-researcher believed that the implemented strategy would help improve the standardized test scores of the students. Therefore, the comparison groups from the same year were students taught by teachers other than the teacher-researcher. The comparison group from the previous year included students taught by the teacher-researcher, but those students may have had different experiences due to a variety of factors such as classroom location, number of days the teacher was absent, or school events. This limitation cannot be eliminated, but in the future, the teacher-researcher recommends limiting data collection to a single-year to minimize variables.

The second limitation for the present study is the lack of transparency provided by the South Carolina Department of Education regarding the SC EOCEP. The SC Department of Education does not release any previously administered EOCEPs to the public, unlike other states such as New York. Due to this policy, the teacher-researcher does not definitively know how many questions on the 2018 SC EOCEP were directly related to the units taught using Larson's (2014b) GVM or their levels of difficulty. The SC Department of Education releases a blueprint with ranges regarding the number of questions on the examination for each Biology 1 standard, but there is no item analysis released after the examination dates with exact details. This information could have

improved the teacher-researcher's ability to evaluate possible correlations between the implementation of Larson's (2014b) GVM and improved scores on the SC EOCEP.

The final limitation for this study was the small sample size, specifically for some subpopulations including students with disabilities and students who are labeled "Limited English Proficient." The teacher-researcher serves both as a school-based instructional coach and a biology teacher. Due to this dual role, she only teaches two periods a day and only had these two class periods for which to implement the use of the Larson's (2014b) GVM. The small sample size, especially for certain subpopulations, limits the weight that is placed on the conclusions drawn from this study; therefore, the teacher-researcher feels that future research is warranted. This limitation could be minimized if the teacher-researcher returned to the classroom full time and taught more sections of CP biology or continued to collect data related to these subpopulations over multiple years.

Action Plan

The teacher-researcher developed an action plan based on her results and analysis of the data. The teacher-researcher plans to implement the use of Larson's (2014b) GVM with her CP biology classes in the future. As part of this implementation, the teacher-researcher intends to integrate semi-structured discussion during class instruction regularly. The teacher-researcher's observational journal notes reflected that this component of Larson's (2014b) GVM played a central role in the students' learning processes. The teacher-researcher believes that asking students follow-up questions, such as "why" and "expand on your response," should be a practice integrated throughout the academic year to enhance the effectiveness of class discussion and to improve students' ability to generate meaningful connections between concepts. This practice should also

be implemented in other core content areas, specifically English and Social Studies, to reinforce the proper ways to have a discussion, which includes citing evidence and using critical thinking skills to explore new ideas.

The teacher-researcher also plans to integrate Larson's (2014b) GVM throughout an entire academic year instead of limiting it to two units as done in the present action research study. The teacher-researcher believes that this year-long implementation will increase student comfort levels with the process and increase the potential for raising standardized test scores. Part of the year-long implementation process should include scaffolding the introduction of semantic maps and free response writing. Semantic map scaffolding can be accomplished by sharing completed semantic maps with the students, followed by the teacher and students working together to fill in a pre-made blank semantic map, then having students fill-in a semantic map template, and ultimately leading to students generating their semantic maps from scratch. Free response writing can be scaffolded as well. At the start of the year, the teacher should provide sentence stems that teach students how to connect ideas and concepts effectively. As the year progresses, the teacher should ask for short writing samples without providing sentence stems. At the end of the year, the expectation is that students should be able to write extended responses that communicate the linkage of concepts and ideas without support. The teacher-researcher believes that these action plans can be accommodated at the present research site and other high schools in the United States.

Recommendations for Future Research

The present study is classified as an action research study and was conducted by the teacher-researcher. The action research design for this study was outlined by Mertler

(2014). The action research design had four-stages: planning, acting, developing, and reflecting (Mertler, 2014). The teacher-researcher recommends the use of Mertler's action research design for future research on this topic. The instructional framework for this study also had four stages: initiate, conceptualize, enrich and assess (Larson, 2014b). These stages were central to the effectiveness of this study and crucial to the instructional planning needed to implement the Generative Vocabulary Matrix (GVM).

One of the key components of this study is the blending of experiences and education. Teachers of science often begin new units by presenting facts and then they follow up these presentations with practice problems, formative assessments, labs, and other activities. Based on this study's findings, the teacher-researcher recommends starting each new unit of study with a unifying experience, such as a lab, game, demonstration, or story, that the teacher can reference during the lesson and which all students understand. Teaching can be thought of like a play. If actors started a play in the middle with all the details and no context, the viewers would be lost. It is necessary to start the play with an introduction to set the stage for the detailed information that will follow. The actors would not want to assume that the viewers had read the plot of the play before arrival or had seen the play before. It is crucial that all viewers have a common experience at the beginning of the production, so they can all understand the whole story. This principle holds when delivering information to students.

The teacher-researcher also recommends the development and use of in-house measures (pre-test, mid-year, post-test) given at the beginning, middle, and end of the school year to be used by all college-prep (CP) biology teachers at the school of study. This structure would provide the opportunity to show year-long growth of students in

comparison to other students at the same school during the same school year instead of only focusing on a five-week period. This method would provide a more comprehensive picture of the effectiveness of Larson's (2014b) Generative Vocabulary Matrix (GVM) in the biology classroom and ultimately, on the South Carolina End-of-Course Examination Program (EOCEP), than shown in the present action research study.

The teacher-researcher strongly suggests shifting to a single-year comparison of results of the SC EOCEP instead of evaluating change across two different administration years. Single-year data was provided for the present action research study in the supplemental analysis portion of Chapter 4. This suggestion is made based on the understanding that evaluating differences between two different administrations of the exam can introduce variables that would be eliminated by shifting to a single-year structure.

The teacher-researcher advocates for the implementation of the Larson (2014b) GVM, especially with these recommendations, in other tested areas in South Carolina that involve a significant amount of reading and writing. Additionally, the teacher-researcher recommends the use of Larson's (2014b) GVM be extended to subject areas that require students to synthesize large amounts of information, such as Social Studies and English courses. The teacher-researcher also suggests implementing Larson's (2014b) GVM in educational support classes for students with learning disabilities to help scaffold reading and writing principles associated with specific content-area classes. Implementation of Larson's (2014b) GVM in these areas would increase the opportunity for collecting subpopulation data and establishing more concrete conclusions.

Summary

This summative chapter provides an overview of the present action research study, the results of this study as they relate to existing literature, limitations of the study, and recommendations for future research. In the present action research study, the teacher-researcher evaluated the relationship between integrating literacy strategies in the biology classroom and performance on the South Carolina End-of-Course Examination Program for biology. The data related to the effectiveness of Larson's (2014b) Generative Vocabulary Matrix as a literacy strategy to improve standardized test scores shows areas of strength and weakness. The teacher-researcher deems the results of this study inconclusive, but firmly supports further research and data collection using this methodology with the recommendations from this chapter taken into consideration.

REFERENCES

- Au, W. (2013). High-stakes testing and curriculum control. In D.J. Flinders & S.J. Thornton (Eds.), *The curriculum studies reader* (pp. 235-251). New York: Routledge.
- Balfanz, R. & Legters, N. (2006). Closing “dropout factories”: The graduation rate crisis we now and what can be done about it. *Education Week*, 25(42), 42-43.
- Bobbitt, F. (2013). Scientific method in curriculum-making. In D.J. Flinders & S.J. Thornton (Eds.), *The curriculum studies reader*. New York: Routledge.
- Buckingham, T. (2012). Every teacher and English teacher? Literacy strategy teaching and research in the content area of science education. Retrieved from ProQuest Digital Dissertations. (AAT 3509894)
- Carlson, C.L. (2014). Dropout factories and the vaccination approach: the impact of the dropout rate on the economy and the need for effective literacy instruction. *SRATE Journal*, 23(2), 1-7.
- Common Core State Standards Initiative. (2012). *Common Core State Standards for English language arts and literacy in history/social studies, science and technical subjects*. Retrieved from <http://www.corestandards.org/>
- Eisner, E. (2013). What does it mean to say a school is doing well? In D.J. Flinders & S.J. Thornton (Eds.), *The curriculum studies reader* (pp. 279-287). New York: Routledge.

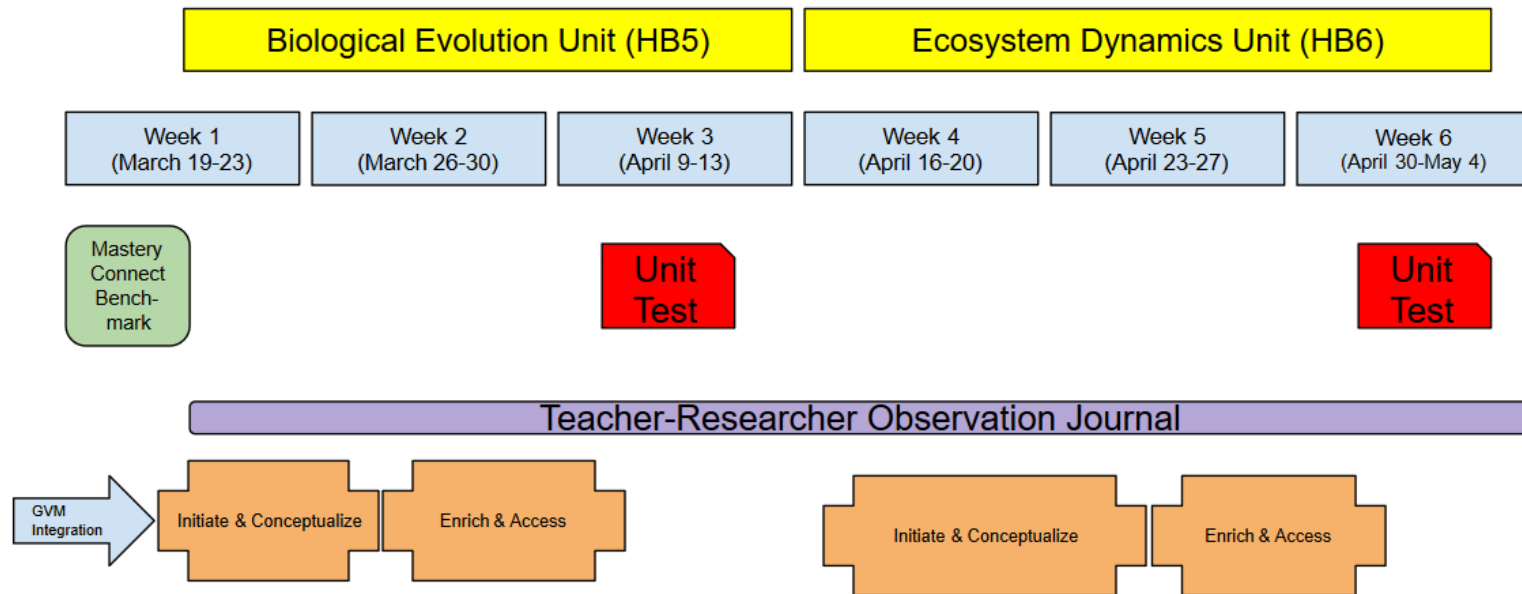
- Jackson, J., Tripp, S., & Cox, K. (2011, May). Interactive word walls: Transforming content vocabulary instruction. *Science Scope*, 35(3), 45-49.
- Johnson, D. I., & Mrowka, K. (2010). Generative Learning, Quizzing and Cognitive Learning: An Experimental Study in the Communication Classroom. *Communication Education*, 59(2), 107-123.
- Kerr, A. (2015, May 14). How will learning change in S.C.?. *The Post and Courier*. Retrieved from http://www.postandcourier.com/politics/how-will-learning-change-in-s-c/article_2d78ec99-b226-57d1-8624-a328b5457f9e.html
- Larson, S. C. (2014a). Exploring the roles of the generative vocabulary matrix and academic literacy engagement of ninth-grade biology students. *Literacy Research and Instruction*, 53(4), 287-325.
- Larson, S. C. (2014b). Using a generative vocabulary matrix in the learning workshop. *The Reading Teacher*, 68(2), 113–125.
- Mantsios, G. (2013). Class in America-2006. In M. Adams, W. J. Blumenfeld, C. Castañeda, H. W. Hackman, M. L. Peters, & X. Zúñiga (Eds.), *Readings for diversity and social justice* (3rd ed., pp. 150-156). New York, NY: Routledge.
- Mertler, C.A. (2014). *Action research: Improving schools and empowering educators*. Thousand Oaks, California: Sage Publication, Inc.
- Moe, T. M. (2003). Politics, control, and the future of school accountability. In P.E. Peterson & M.R. West (Eds.), *No child left behind? The politics and practice of school accountability* (pp. 80-106). Washington, DC: Brookings Institution Press.
- National Center for Education Statistics (2010). *The nation's report card: Grade 12 reading and mathematics 2009 national and pilot state results* (NCES 2011-455).

- National Center for Education Statistics, Institute of Education Sciences, U.S.
Department of Education, Washington, D.C
- National Commission on Excellence in Education. (1983). A nation at risk: The imperative for educational reform: a report to the Nation and the Secretary of Education, United States Department of Education. Washington, D.C.: The Commission.
- Pinar, W. (2013). The reconceptualization of curriculum studies. In D.J. Flinders & S.J. Thornton (Eds.), The curriculum studies reader. New York: Routledge.
- Powell, T. (2008). Willie Lee Buffington and Faith Cabin Libraries. In S. Schramm-Pate & R. B. Jeffries (Eds.), Grappling with diversity: Readings on civil rights pedagogy and critical multiculturalism (pp. 75-95). Albany, NY: State University of New York Press.
- South Carolina Department of Education. (2014a). South Carolina biology 1 standards [PDF]. Retrieved from South Carolina Department of Education website:
<http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Biology1-Standards-Printable%20.pdf>
- South Carolina Department of Education. (2014b). Support guide for biology 1 South Carolina academic standards and performance indicators for science [PDF]. Retrieved from South Carolina Department of Education website:
http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Science_Biology1Support.pdf
- South Carolina Department of Education. (2016). South Carolina end-of-course examination: Test blueprint for biology [PDF]. Retrieved from South Carolina

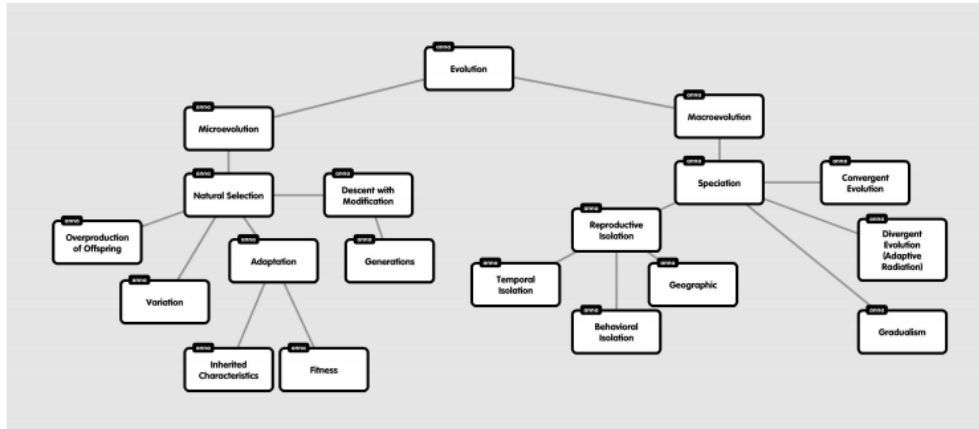
- Department of Education website: <http://ed.sc.gov/tests/tests-files/eocep-files/2016-17-biology1-test-blueprint/>
- South Carolina Department of Education. (2017). End-of-Course Examination Program (EOCEP) 2016-17 [Data file]. Retrieved from <https://ed.sc.gov/data/test-scores/state-assessments/end-of-course-examination-program-eocep/>
- South Carolina Department of Education. (2018). End-of-Course Examination Program (EOCEP) 2017-18 [Data file]. Retrieved from <https://ed.sc.gov/data/test-scores/state-assessments/end-of-course-examination-program-eocep/>
- Spring, J. (2014). *The American school, a global context: From the Puritans to the Obama administration* (9th ed.). New York: McGraw-Hill Education.
- Stahl, S. & Vancil, S. (1986). Discussion is what makes semantic maps work in vocabulary instruction. *The Reading Teacher*, 40(1), 62-67.
- Templeton, S. (2012). Teaching and Learning Morphology: A Reflection on Generative Vocabulary Instruction. *Journal of Education*, 192(2-3), 101-107.
- Westover, J. M., & Martin, E. J. (2014). Performance feedback, paraeducators, and literacy instruction for students with significant disabilities. *Journal of Intellectual Disabilities*, 18(4), 364-381.
- Wittrock, M.C. (2010). Learning as a generative process. *Educational Psychologist*, 45(1), 40-45. Au, W. (2013). High-stakes testing and curriculum control. In D.J. Flinders & S.J. Thornton (Eds.), *The curriculum studies reader* (pp. 235-251). New York: Routledge.

APPENDIX A

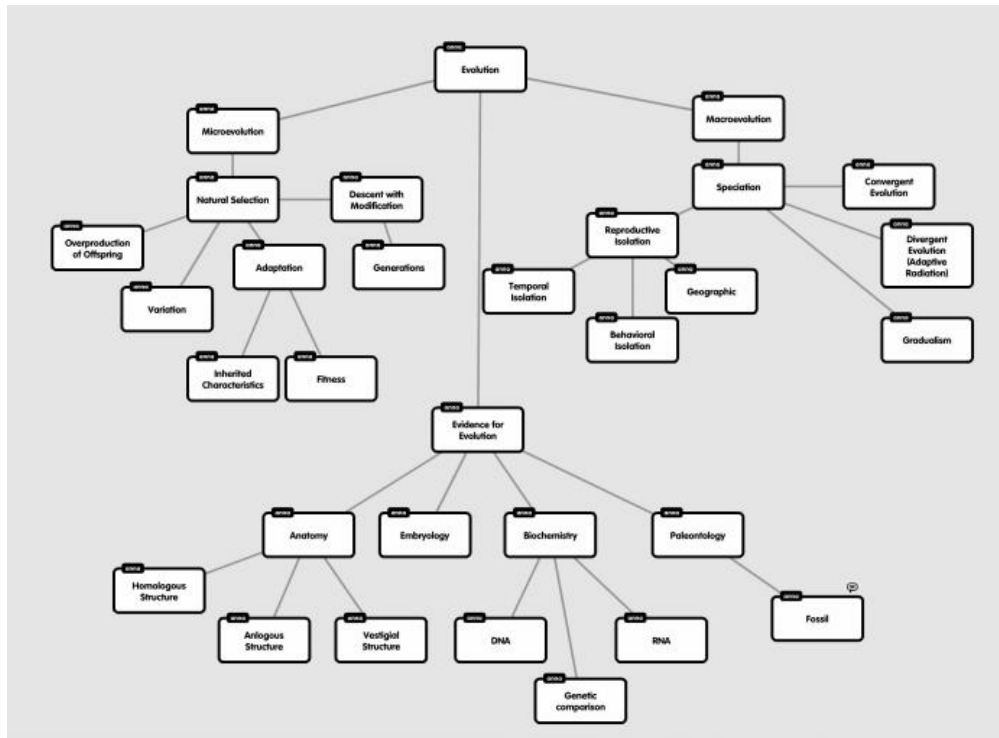
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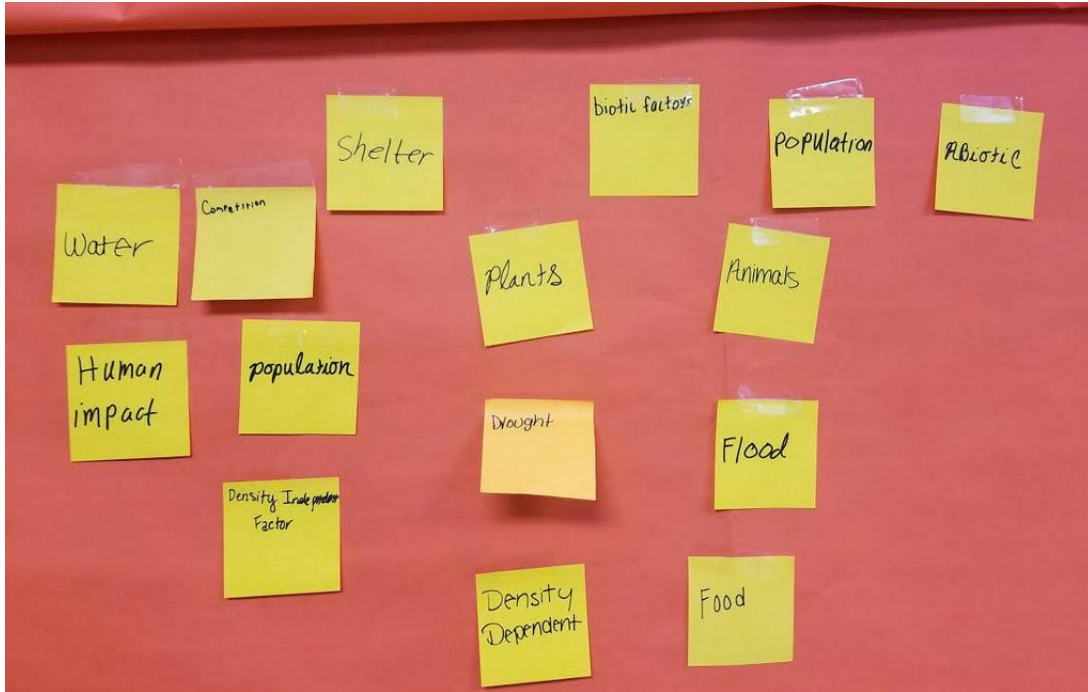
Evolution Unit Stage Three



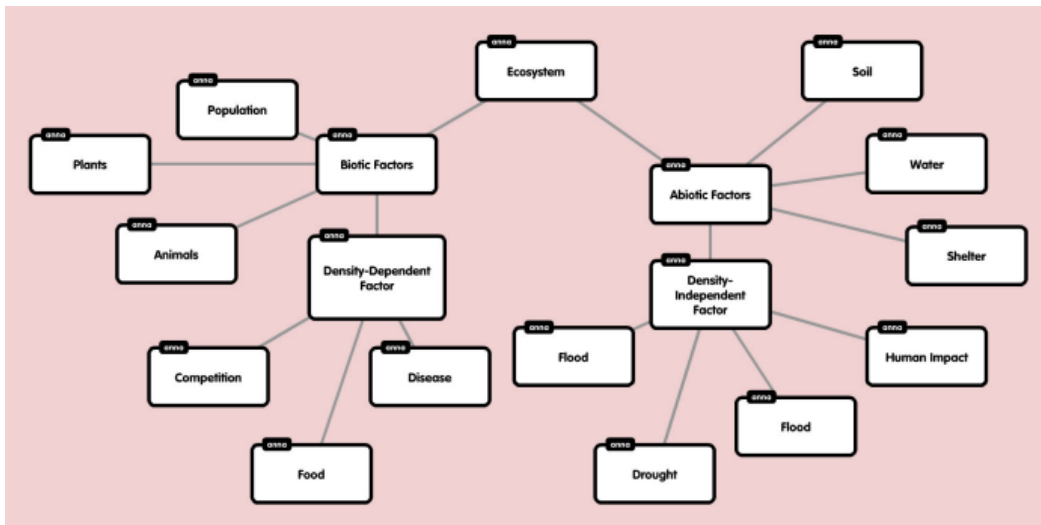
Evolution Unit Stage Four



Ecology Unit Stage One



Ecology Unit Stage Two



APPENDIX C

PARENT NOTIFICATION LETTER

Parents and Guardians,

My name is Anna Morrison and I am your student's biology teacher this year. This year, I am conducting a research study in your student's class as part of my doctoral dissertation process as I pursue my EdD in Curriculum and Instruction at the University of South Carolina. I am interested in studying the impact of integrating literacy strategies in the biology classroom. This research study will span seven to eight weeks starting in March. As part of this research study, the class will use a generative vocabulary matrix (interactive word wall) to connect terms and concepts to experiences (labs, demos, etc.) with the goal of increasing understanding and retention of biology concepts.

I have noticed that students often find it very difficult to learn and retain the concepts taught in the high school biology classroom because of a lack of science literacy skills. Students think of literacy and science as separate entities, never overlapping, while in reality the two are permanently intertwined. I believe that to increase student achievement in the sciences, science educators must begin integrating literacy fundamentals into their lessons and build on those principles regularly. This study will evaluate the importance of integrating literacy instruction in the science classroom on student performance on the South Carolina End-of-Course Examination Program for biology.

The potential risks for the participants in this study are the same as they would be whenever a teacher introduces a new strategy in the classroom. It is always possible that the new strategy, although well-researched, will be less successful than the previously used method. However, I have selected this instructional method after extensive research and firmly believe this strategy will be in the best interest of my students and will ultimately improve their scores on the SC EOCEP examination for biology.

The potential benefits for the participants in this study are that the students may improve their science literacy skills which may result in improved test scores on the SC EOCEP examination for biology. Since this test accounts for twenty percent of students' overall course averages, their course average and possibly also their grade point average (GPA) could improve over the outcome with traditional instructional methods. There is no guarantee of this outcome.

The data collected during this study will be benchmark and test data, student surveys, a teacher observational journal (during class activities), and EOCEP test scores.

The data collected from this study will be included in my dissertation proposal and will be submitted to a committee at the Education Department at the University of South Carolina. Your student will have anonymity and personal identifiers will not be published as part of this research study.

University of South Carolina Sponsor

Dr. Leigh D'Amico

Research Assistant Professor

damico@mailbox.sc.edu

803-777-8072

There is no penalty for not participating in this study. The school's and individual's identities will remain strictly anonymous and confidential. Participants may withdraw from the study at any time without penalty. If you would like to withdraw your student at this time, please check on the line below, fill in your student's name, and have your student return this form to me or scan and email me the document.

_____ I do not wish my student (_____) to participate.

If you have any questions or concerns about the study, please contact me.

Sincerely,

Anna Morrison