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Why Assess Everyone the Same Way?

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Why Assess Everyone the Same Way?

Exploring Modality of Assessment in Science Education

An Action Research Project

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By

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This action research project, written under the direction of the candidate's master's project advisory committee and approved by members of the committee, has been presented to and accepted by the faculty of the Kalmanovitz School of Education, in partial fulfillment of the requirements for the Master of Arts in Teaching Leadership degree.

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Abstract

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By
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Many students struggle on conventional assessments that do not always reflect their true understanding of science concepts. A possible solution is implementation of multiple modes of assessment. This action research project examines incorporating choice of mode of assessment allowing students to show what they know about a topic. The literature review identified that traditional assessments do not accurately depict the intelligences of the different modes of thinking and performance. So often, there is a very narrow depiction of intelligence and achievement in schools. Results from the action research project support the idea that incorporation of student choice in modality of assessment incorporates a wider conception of intelligence and achievement while allowing students to show what they know by developing their strengths.

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Table of Contents

List of Figures

Figure

List of Tables

Table

Chapter I

Introduction

The students in classrooms across our nation are not the same. They do not live in the same neighborhoods; they do not have the same socioeconomic status; and they do not learn in the same way. In addition, they do not all score equally on assessments. Teachers often differentiate their teaching, but when it comes time for assessing acquisition of concepts and skills, all students are generally given the same assessment. According to Gardner (1983), if teachers treat students as if they all learn the same, teachers are only considering one profile of intelligence. If students are all different and learn in different ways, teachers should assess them in a manner that allows them to show the skills and content they have learned in a manner of their choosing. Students from different cultures and ethnicities value different modes of communication and expression. Some embody musical outlets; others excel in prose or oral response, while others view the world artistically. If the understanding of a concept is key, then these other modes of understanding should be honored as valid forms of expressing ones understanding.

Science achievement scores at the state level are indicative of this dilemma. Students in all sub-groups struggle with comprehension of non-fiction text (CAASP, 2019). These same students are faced with navigating science assessments that expect them to not only understand the text, but to also make connections in the material presented by means of explaining evidence. Furthermore, they are often expected to provide reasons for what they believe to be an explanation of the phenomenon. Unfortunately, science often takes a back burner when teachers are trying to hit the long list of the grade level standards for a given year. In the current educational climate, with students having missed major chunks of instructional time in

classrooms during the 2020-21 and 2021-22 academic years due to the COVID-19 pandemic, this lack of attention to science is even more so prominent. During these years, students were thrust into an online learning environment; and as a result, most students have struggled to meet the grade level benchmarks in English Language Arts and Math. Due to this struggle, many teachers have been focused on math and language instruction, while science standards have largely been abandoned. This trend was already apparent in the most recent California State science assessment data where only 30.8% of all eighth graders earned an "at standard" score on the California Science Test (CAASP, 2019). Similarly, this trend is expected to intensify when new California State science assessment data are available.

By the middle school years, students have often developed an aversion toward science. For many students, science is a jumble of disconnected facts that are memorized and regurgitated when called for on an exam (Miller, 2014). In addition, for many teachers, science is the "extra" subject that is taught when time permits. It is not taught with fidelity and sincerity throughout grade school due to the fact that teachers have pressure to meet accountability goals in Math and English (LHS press release, 2011). As a result, many middle schoolers have succumbed to negative thoughts and an attitude that science class is something they are just not going to do well in (Potvin & Hasnin, 2014). This negative attitude can lead to poor performance on state and district benchmarks. Unfortunately, when science takes the back burner with teachers trying to teach all the standards in a given year, science scores suffer.

Establishing positive attitudes and success in the science classroom is key as this may in turn lead students to be more engaged in class and, in turn, become more confident (Dautrich, 2021). The goal of this action research project is to explore ways to increase student success on science assessments by allowing the students to choose how they are assessed.

Statement of the Problem

Students in the United States are continuing to fall behind in the sciences (Teitelbaum, 2014). As a result, STEM careers in the United States lack skilled personnel to fill the roles needed to compete with other nations. There is a growing need for people with STEM skills; and if students succeed in science education, they may be able to obtain the knowledge needed to secure a job in the STEM fields (Matthews, 2018). At the time of this study, I was a middle school science teacher in a suburban K-8 Title 1 school. I had 190 students, 66% of whom were socioeconomically disadvantaged, 49% were Latinx, 24% were White, 13% were Black/African American, 6% were AAPI, and 6% other. I found that my students have difficulty with comprehension of non-fiction science text. I have tried whole-class instructional strategies such as annotating text, pair/share responses, and class discussions. Of particular concern, my students were not scoring "at standard" on end of topic science assessments of Savvas Pearson Realize curriculum. After further reflecting on teaching practices, I wonder if an incorporation of student choice of mode of response to select questions would improve scores on the end of topic science assessments overall.

Just as students gravitate toward a subject area that is easier for them to understand, these same students will also be drawn to subjects that are taught in a manner that makes sense to them. Researchers such as Emig (1997) assert that "traditionally, school has been directed at verbal- linguistic and logical-mathematical intelligences" (p.72). Some students thrive when subject areas are delivered using the aforementioned intelligences. However, what if a student is not strong in either of these intelligences? What if the student does not perform well on the assessment because it was asked in a manner that is not the strength of the student? In my research study, my goal was to investigate the use of multiple modes of assessment as a means of

allowing inclusion and at the same time make science assessment meaningful and relevant to all learners.

Purpose of the Research

STEM education has become a trend across the nation. The goal of such programs is to guide students into becoming proficient in the skills of science, technology, engineering, and mathematics. Unfortunately, by the time students are in the eighth grade, many of them have an aversion toward science classes and future STEM based careers (Kennedy, Hefferon & Funk, 2018). If students do not excel in STEM based classes, they will not be able to take advantage of the increasing demand for graduates entering careers in science, technology, engineering, and math (STEM). In the coming decades, science occupations are predicted to grow faster than the average rate for all fields (Lacey & Wright, 2012), and a significant amount of science and math training will be required for nine of the 10 fastest growing occupations requiring a bachelor's degree or higher (Wang, 2013). How can teachers make sure students are ready to meet this demand?

This study aspired to examine the relationship between student choice of assessment mode and their science achievement scores. According to the Digest of Educational Statistics (2019), the population of Latinx students has increased from 16 to 27 percent between the fall of 2000 and the fall of 2017. Many of these students do not speak English as their native language; and as a result, they may not be able to read and write in English proficiently. When these students are thrust into science classrooms where the expectation is to read and write fluently with vocabulary that is discipline specific, many flounder. Typically, when students are in the process of acquiring a new language, although they may not be able to express an understanding of big ideas and concepts in writing, they may be able to show their understanding verbally or

visually. Deeper understanding and vocabulary development is often necessary before written language is acquired and perfected. Science classrooms with content specific vocabulary typically are not aligned with this progression of language development.

As the Latinx population at my school site has increased, I have observed that the Science achievement gaps by race and ethnicity have become more prominent. In my classes, we have annotated our text both as a whole group and independently. We have discussed the material whole class and in small groups, and we have worked on small group activities including hands on labs all before the end of unit assessments. Students have appeared to have a grasp of the material and have been able to answer review questions during review activities. These students then take the assessment for the unit we have studied, and to my dismay, their scores are much lower than I thought they would be. Consideration of these data led me to consider the implication of assessing the science content in a manner that better met their academic needs. The chance for a student to explore assessment options that are compatible to their strengths and interests may foster a positive educational experience instead of one that leads them to feel like they cannot excel in science.

Gardner (1983) defines intelligence as "the ability to create products and solve problems that are a value to one's culture" (p.83). My research examined the relationship between student choice on mode of assessment and their scores on formative and summative assessments in science. My hypothesis was that when students are given a choice in their mode of assessment, they can draw on their cultural frames of knowledge, and will in turn place value on the product they are turning in for assessment. This is especially important for Latinx learners because as they come to place value on the field of science, their achievement scores may increase over time. In turn, when all students are able to express their knowledge that they have gained in a

variety of modalities, they may feel motivated and encouraged to put forth effort on future assessments.

Action Research Question

The action research question of this study was: *How does the use of student choice in modality of assessment on test responses impact students' scores on end of topic assessments?* My expectation was that if students were given the choice of how they were assessed at the end of a science topic, students would have higher scores on the assessment than students who were not given a choice of how they would be assessed. I also hoped that students would become more aware of their own learning styles and how they perform best as thinkers and learners.

Limitations

There are several limitations that may have affected my research study. One of those limitations is the Covid-19 pandemic. At the time of this study, the world was in a world-wide pandemic. As a result, some students may become exposed to persons that were Covid positive and either contract the virus or be quarantined for all or part of the research study. Another limitation is the factor that the study will be over the course of eight weeks. This is a short timeframe and could have an impact on the results of my study. Additionally, I acted as the teacher and researcher in this study which could have had an impact on the validity of the results. I may have a bias when interpreting the results of the study in favor of my desired outcome.

Positionality of the Researcher

I am a White cisgender woman who researched students who were racially and socioeconomically diverse at a Title I school. My family is biracial, as my husband is Filipino. I live in an affluent neighborhood near my school and must take into consideration my social privilege as I engage in my research study.

I am a logical thinker, and I kept this in mind when offering assessment choices to my students. I also tried to keep in mind all learning styles as to offer choices that suit all learners. I acknowledge that there is implicit bias when grading assessments that are not multiple choice in nature, and I was cognizant of my implicit bias when grading the assessments.

Definition of Terms

Multiple Intelligences Theory (MI)

Gardner introduced eight different types of intelligences consisting of: linguistic, logical/mathematical, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, and naturalist (Gardner, 2000).

Assessment

Assessment is the process of gathering and discussing information from multiple and diverse sources in order to develop a deep understanding of what students know, understand, and can do with their knowledge as a result of their educational experiences; the process culminates when assessment results are used to improve subsequent learning (Huba & Freed, 2000)

CAASP

California Assessment of Student Performance and Progress.

Intelligence

Gardner defines *intelligence* as a "biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture" (Gardner, 2000).

Implications

The purpose of this study was to identify the existence of an increase in science achievement scores of learners given a choice on the mode of assessment that they take at the

end of a science topic. This study will potentially increase students' attitudes toward the field of science and in turn increase their interest in STEM careers. Furthermore, if this study is successful, the results can be applied to other grade levels as well as other fields of study.

Chapter II

Literature Review

The purpose of the action research study was to investigate if the incorporation of student choice regarding the mode of response to test questions would improve scores on the end of topic science assessments. I chose to integrate student choice based on students' individual learning style, allowing students to have the opportunity to "show what they know" at the end of the unit of study. My end of unit assessments were designed with the hope of addressing Gardner's multiple intelligences.

Research suggests that students who have not mastered the English language typically struggle on multiple choice and short answer assessments (Booth & Land, 2007). In middle school science curriculum, the majority of assessments are written in a manner that is a handicap for many students. In the past, my typical science assessment included multiple choice and short answer questions to assess student understanding of a concept. However, research suggested that the ability to comprehend a reading passage may influence student performance on assessments (Scott-James & Clark, 1986). Therefore, I hypothesized that, by giving students a choice in how they were assessed, students would be able to show what they know in a modality that is best for expressing their knowledge of the science concept. By incorporating choice of written response, execution of a hands-on lab activity, creation of a comic, deliverance of an oral presentation, or production of a multimedia video, students were offered different options to demonstrate their proficiency with concepts. Thus, the action research question that guided this study was: *How does the use of student choice in modality of assessment on test responses impact students' scores on end of topic assessments?*

Overview of the Literature Review

This literature review begins with the theoretical rationale, which established the basis and the foundation of my action research study. Specifically, the first section of my literature review presents the theoretical framework that informed this study: Gardner's theory of multiple intelligences (1975). The second part of the literature review includes a discussion of the research surrounding the importance of the implementation of multiple intelligences in the classroom as a means of instruction and assessment. The sources within the second section are divided into the following categories: Multiple intelligences, factors that impact academic performance, and alternative forms of assessment. All research studies were retrieved from databases like ERIC, and EDUSOURCE, using key search terms such as *multiple intelligences, assessment, modality, mode, student choice, multimodalities, and hands-on*. In addition, studies from Google Scholar were also included in this research study.

Theoretical Rationale

The primary theory that was used to frame this action research project was Howard Gardner's (1975) multiple intelligences theory. The work of Gardner was essential to this research project as it laid the foundation for thoughtfully planning lessons that included various ways for students to be able to share their knowledge and understanding of a given topic. Before the work of Gardner (1975), it was thought that all minds were equivalent in their ability to access and absorb information. Gardner challenged this conventional conception of intelligence, asserting that aptitude was not a one-size-fits-all construct. Gardner (1975) furthered the idea that people learn and demonstrate proficiency through different modalities. For example, some individuals learn new information linguistically, while others may learn best by means of hands-on learning.

Gardner's Theory of Multiple Intelligences

The research question in this study was informed by the work and theory of Howard Gardner (1975). Before his thesis and theory of multiple intelligences was published, intellect was identified and measured as a part of a eugenicist movement whose aim was to increase the intellect of the population through proper breeding (Galton, 1870). After this movement, it became the norm for "intelligence" to be tested with attention paid only to linguistic and logical facets. Intelligence was deemed numerical and quantifiable by means of an *intelligence quotient*, or IQ. Remnants of this method are still a part of our lives today and can be seen in higher level testing such as the SAT (Gardner, 2006). This focus bothered Gardner, and he began to envision a different mode of measuring intelligence.

Gardner proposed the idea that if different types of assessments were used, or different kinds of assessment instruments, then students would be able to have higher outcomes on assessments (Gardner, 2004). This thinking deviated from the traditional definition of intelligence. In the traditional uniform way of testing intellect, some score high and do well while others struggle. This approach works well for certain people. Gardner questioned this disparity, curious to know about minds that work differently. He presented an alternate vision, asserting, "recognizing many different and discrete facets of cognition, acknowledging that people have different cognitive strengths and contrasting cognitive styles" (Gardner, 2004, p.172).

It is important to remember that each person is very special. People learn and grow in different ways and at different speeds. As a part of Gardner's research, he studied "special populations," including prodigies, autistic, idiots, savants, and the learning disabled. He also examined the forms of intellect that are valued in other cultures. From this research, he was able

to identify seven intelligences (musical, kinesthetic, logical–mathematical, linguistic, spatial, interpersonal, and intrapersonal) (Gardner, 2006). The theory of multiple intelligences recognizes that all people do not learn in the same manner. An example is that certain skills and strengths may manifest as writing in one culture, and as oratory in another culture. Within Gardner's framework (1983), one set of skills is not superior to the other. His work identifies that mainstream concepts of intelligence are ethnocentric and culturally biased (Gardner, 1983).

I wanted to examine how educators could apply the research of Gardner by offering multiple modes of assessment in the classroom as a means of honoring the intelligences that exist in the classroom. Not all students can or will score well on traditional linguistic and logical-mathematical styled assessments. By offering multiple modes of assessment tailored to multiple intelligences, my hope was to honor and embrace the various intellects that students possess. Through the provision of varied assessment measures, I can capture a more authentic understanding of student learning and provide meaningful feedback to students that parallels their learning styles and strengths.

Review of Related Research

The review of related research is organized into three sections: multiple intelligences, factors that impact academic performance, and alternative modes of assessment. Each of these three sections includes a summary of relevant literature and a discussion of the implementation of multiple intelligences in the classroom setting. Moreover, this section also presents studies that discuss the connections between race, ethnicity, poverty, and science performance. Lastly, this review of related research included findings on the effectiveness of student choice on assessment scores.

Multiple Intelligences in the Classroom Setting

In the school setting, assessments are often uniform, and every student is tested in the same manner. These assessments are written and administered in a manner that was established hundreds of years ago. Generally, the emphasis of these assessments favors linguistic and logical- mathematical intelligences, while the other intelligences are overlooked (Gardner, 1989). As a result, many students do not score well on assessments. This section examines the use of multiple intelligences in the classroom setting. Reviewing research of how multiple intelligences have been infused into classroom assessments, as well as which multiple intelligences have been most widely used, may offer insight into how multiple intelligences can best be utilized to ensure student success on science assessments.

Multiple Intelligence Instruction. This subsection includes studies that examined the impact of instruction geared toward the application of multiple intelligence theory in the classroom. This research establishes the foundation for the premise that when students are exposed to instruction in multiple modalities, it may allow the students to increase their understanding of a concept in comparison to traditional teaching methods.

Ozdemir, Gueysu, and Tekkaya (2006) investigated the difference in students' understanding of concepts when the students were taught with traditional science instruction vs. multiple intelligences instruction. The researchers analyzed the student scores at the end of unit assessment. The study included a control group of students that were taught with traditional teaching methods and the remainder of the students were taught according to their multiple intelligences as determined by use of the Teele Inventory of Multiple Intelligences.

One of researchers' key findings was that before the study there was no statistical difference between in performance levels between the control and experimental groups. After

treatment (in which the experimental group was taught according to their MI), Ozdemir, Gueysu, &Tekkaya (2006) found that the experimental group had an increase of scores greater than that of the control group. In addition, the researchers tested both groups two months after the end of unit test with an identical end of unit test and found that the experimental group scored higher on this test than the control group. This study demonstrates that implementation of multiple intelligence as a modality of instruction has a positive correlation to the assessment scores of the students.

In a related mixed methods study, Winarti, Yuanita and Nur (2019) investigated the effectiveness of MI-based learning strategies in enhancing the multiple intelligences and science process skills of 124 junior high school students chosen from a high performing school and a low performing school. Two classrooms were chosen at each school site, as one at each school acted as the control group. Researchers tracked student achievement, recorded observations, and performed statistical analysis of student preferences of learning styles with the use of Likert scale questionnaires. The researchers included participants from a high performing school in addition to a lower performing school. Each school site had a control group for comparison.

One of their significant findings was that when there is a focus on multiple intelligence, then the potential for each student can be achieved. Students in the experimental group were allowed to create games, poems, songs, and research projects to practice their MI skills while the control group was given traditional lectures, discussions, and demonstrations. After analyzing the data, Winarti and colleagues concluded that participants' multiple intelligence scores increased in five of the intelligences. The findings of this study show that if there is a focus on multiple intelligences, then the potential for each student can be achieved.

Similarly, a third study that investigated the effectiveness of MI instruction focused on students' learning and attitudes is that of Ucak, Bag & Usak (2006). This mixed methods study aimed to examine student attitudes toward science as well as scores on the Chemistry Achievement Test (CACT). In the same manner as the aforementioned studies, seventh graders were divided into a control group which received traditional lessons and teaching methods, and the experimental group that received MI instruction. The pre/post test scores of the control and an experimental group of seventh graders were then compared.

As a result of this study, Ucak et al. (2006) found a positive correlation between the use of the MI methods and an increased positive attitude toward science. In addition, as a result of this study, the researchers were able to also see a positive correlation between use of the MI methods and increased test scores. The mean difference between pre/post test scores on the CACT were higher in the experimental group than they were in the experimental group. The researchers concluded that with the implementation of the MI strategies, students gained confidence and scored higher on assessments. These findings show that as students have success on assessments in a subject area, that the students may have an increased positive attitude toward that subject area and as a result have continued successes.

These studies each investigate the connection between the use of MI strategies and student performance. These sources distinctly speak to the positive impact of multiple intelligence instruction on student achievement and in some cases like Ucak et al. (2006), an increase in attitude toward science as well. As this study aimed to investigate the effectiveness of student choice of assessment, the next step was to explore additional factors that influence multiple intelligence teaching strategies employed in the classroom setting.

Additional Factors Affecting Multiple Intelligences in the Classroom Setting. This subsection investigates the impact of the Multiple Intelligences of the teacher and textbooks on student achievement.

The research study conducted by Alsahi (2020) wanted to explore multiple intelligence representations in the intermediate stage Science textbook in Jordanian schools. Two hundred sixty middle school teachers were given the task of identifying and tallying the use of multiple intelligences in the lessons of the Jordanian middle school textbook. The results were tabulated, and researchers found verbal/linguistic intelligence (VL) in the textbooks in general had the highest frequency in lesson plans (288, 38.8 %), followed by visual/spatial intelligence (VS) with 159 appearances 21.4 %. The other multiple intelligences were underrepresented.

Alsahi (2020) found that only two of Howard Gardner's seven identified multiple intelligences were represented in the Jordanian textbooks. This study further supports the evidence that if multiple intelligences exist, then students should have access to curriculum and assessments that allow them to learn according to their identified multiple intelligence. If the textbook is only presenting information in two formats, there are learners that are not able to fully access the curriculum.

Sulaiman and Abdurahman (2010) conducted another study that aimed to examine the correlation between the multiple intelligences of teachers and the manner in which the same teachers deliver the content of their discipline to their students. Researchers used a questionnaire to investigate the teaching styles of 174 Malaysian math and science teachers. These results were then compared to responses to the same questionnaire that identified their own MI learning style. The researchers found that there was a positive correlation between the individual MI of the teachers and their instructional methods.

Researchers found that a majority of the teachers were themselves strong in intrapersonal, interpersonal, and logical-mathematical intelligences. These three intelligences were also the three most frequent teaching strategies that were used in the classroom. Sulaiman and Abdurahman (2010) concluded that if teachers became aware of the multiple intelligence spectrum, that teachers may be able to address the learning gaps of the student population.

Factors That Impact/ Influence Academic Performance

Gardner (2006) asserts that in the school setting everyone is treated equally, when in reality all minds work differently. Assessments are written in one modality, which often does not suit all learning styles. In addition, Becares and Priest (2015) illustrate that there are multiple factors such as ethnicity, socioeconomic status and gender that influence student assessment scores. The following studies exemplify the factors that contribute to academic performance.

Researchers Kohlhaas, Lin and Chu (2010) wanted to investigate the relationship between gender, ethnicity and poverty levels and science achievement scores of fifth grade students. The researchers conducted a quantitative study of the raw data contained in the 8,741 extant fifth grade data files (2003-2004), from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K). The findings of this research study were that males performed better than females. In addition, the study showed that children from at or above poverty performed better than those from below poverty. White "at/above poverty" males had the highest test scale score, while African American "below poverty" females had the lowest mean score.

The researchers found that there were many false negative results in the test results of students who were ELLs and from low-income backgrounds. These false negatives were explained to be answers that were marked as incorrect on the test, however when the student was

asked the question orally the student was able to answer the question correctly. In addition, they found that this discrepancy was not due to differences in knowledge or ability, it was due to the students not understanding what the test question was asking of them. The researchers concluded that students answered differently due to different understandings of the questions they were being asked. Researchers concluded that ethnicity and socioeconomic status have a strong negative correlation with student performance.

Noble and colleagues (2012) conducted another research study that evaluated how individual science test items function differently for students of different communities. Researchers interviewed 36 students about their responses to six multiple choice science test items from the Massachusetts state science assessment for fifth grade. The students were recruited from volunteers chosen from eleven schools in three urban school districts in Massachusetts. This study was conducted using low income, English Language Learners, and middle class native English speakers as the variables to be considered. They compared the results of the science assessment to their findings during interviews about the student's explanation of why they chose an answer to a question and their rationale.

The results of this study indicated that there were many false negative results in the students who were ELLs and from low-income backgrounds. As reported in a previous study, Noble and others (2012) found that this discrepancy was not due to differences in knowledge or ability. They concluded that students answered differently due to different understandings of the questions they had been asked.

Shepherd (2020) conducted a related study focusing on evaluation of White and male students' responses in comparison to their evaluation of equivalent responses given by racial/ethnic minority students and female students. In this mixed method study involving 128

secondary science teachers, teachers were asked to evaluate pre-recorded responses to grade for content on the scale of 1-8. These responses were pre-recorded by students of all ethnicities/ genders (Black, White, Latino, male, female) and played back as recorded. All of the recorded responses were the same as the written response which had been generated by combining responses of random students.

The findings of the researchers identified that identical responses were given higher points if the recording was perceived to be a White male, and less points of the voice were perceived to be racial/ ethnic and or/ female responses. The results of this study suggest that direct biases against underrepresented and underperforming groups are holding them back from achieving higher marks in STEM classes and on assessments.

The study conducted by Shepherd (2020) investigated the existence of obstacles that inhibit students of color and socioeconomic status from achieving comparable marks on assessments in relation to their White native English-speaking counterparts. A common theme from each source was that bias exists when grading assessments, as well as in the construction of test questions. The research from this subsection informed the action research project by illustrating the importance of integrating multiple modalities into assessment. Students of diverse backgrounds should be able to excel and not be hindered by test question or teacher bias.

Alternative Assessment Modalities

As I developed this research project, I looked for research that testified to the effectiveness of multiple modalities of assessment on student achievement. It is with the incorporation of multiple modalities and opportunities to show what students have learned that educators may be able to see an improvement on standardized tests. (Gardner, 2006, p.62) This

section explores three such studies that were published between 2010 and 2021, which specifically investigate the incorporation of student choice in modality of assessment.

Buyukkarci and Sahinkarakas (2021) wanted to find out if the assessment preferences of freshman college students would change after being introduced to an alternate mode of assessment which included learning goals, peer assessment, and verbal and written feedback. The participants of the study were 86 college freshmen aged 18-20, all of whom were students in the English Language Teaching (ELT) program at the University. The researchers used a combination of surveys, informal interviews, and observations as modes of data collection.

The findings of the study were that the students who were exposed to the hands-on formative assessment began to prefer that mode of assessment over the traditional methods. Buyukkarci and Sahinkarakas (2021) observed that the initial hesitation of the students may have been due to the participants' unfamiliarity with the new assessment. The researchers concluded that if college students were exposed to the hands-on formative assessment methods, that the students would typically prefer these methods to traditional formative assessment methods.

Bakula (2010) conducted a research study using one of her seventh-grade science classes to track the scores of formative and summative assessments on a unit of study. The researcher wanted to see if the creation and implementation of quality formative assessments improved student learning and helped students be more successful on summative assessments. Student assessment scores were tracked as well as well as their reflections on their errors. The researcher incorporated surveys into the design of the study to get student feedback on how they felt they did on the formative assessments.

Of the 19 mixed gender seventh graders, Bakula (2010) concluded that many of the students participating in the study moved from a partial understanding of the material covered on the test to an accurate understanding by the time of the summative assessment. This study clearly depicts the importance of feedback on student performance. Analysis of the feedback allowed the researcher to identify content areas of deficiency while also informing them about the content of future lessons based upon where students were struggling. There was a significant increase in the number of students who answered questions correctly on the summative assessment compared to the number on previous assessments.

Bakula (2010) found that on average the students in the study scored higher on the summative assessment than they did on the formative assessments. There was a substantial increase in the number of students able to answer the questions on the summative assessment. Students were able to progress from a partial understanding to an elevated level of understanding. This study reinforces the importance of student feedback. If students do not know where they can improve or the teacher does not know the specific skills that need honed, less student progress is materialized. Some limitations may exist with the findings as there was no control group with which to definitively compare the results.

In a blog titled, “Should multimodalities be incorporated into testing and assessment of multilingual learners?” Gottlieb (2021) discussed the connection between the increase of access to the content by presenting content to learners in modalities that are a combination of visual, spatial, oral, and written sources. It is by the incorporation of multiple modalities that students can be given the opportunity to show what they have learned. This blog reinforces the idea that when students are exposed to content that is presented in a modality that is accessible to their learning style, students are more likely to be able to and express their knowledge.

Summary

Theoretical research included in Gardner's theory of multiple intelligences provided the foundation for this study. Gardner (2006) asserted that intelligence is not finite, but rather all minds can express their thinking in different ways. The review of relevant research explored the incorporation of multiple intelligences in the classroom, discussion of additional factors that impact/influence academic performance, and alternative assessment modalities. The major findings were indicative of an increase of student understanding and positive attitudes toward science when the curriculum was taught by means of multiple intelligence instruction. In addition, many studies exemplified the importance of feedback after assessment, allowing students to know what they needed to work on. However, there was little research on how to better allow students to show what they know about a topic at the end of a unit of study.

While this action research project could not fill in all the gaps, it addressed the occurrence of false negatives. Many students in previous studies knew the answers to assessment questions but were just not sure what the assessment was asking. Many of the previous studies introduced various forms of implementation of multiple intelligences into the instructional strategies of the classroom setting; however, the modes of assessment remained traditional assessments. Therefore, I designed an action research project that would incorporate multiple modalities of assessment to focus on student understanding by allowing students to show what they know.

The next chapter describes the methodology used to implement the study. Exit tickets, researcher field notes, and student assessment scores were used to exemplify the effects of choice in mode of assessment as a means of evaluation of student learning.

Chapter III

Methods

Middle school is a time of transition for students. Not only are they struggling to fit in socially, but they are also thrust from a single teacher and self-contained classrooms to navigating a schedule full of classes with different teachers who have differing academic criterion and expectations. This transition in and of itself can be difficult for all students, but it is even more difficult for those who are not native speakers of the English language. The transition of *learning to read* in the elementary grades, to *reading to learn* in the middle elementary grades is exacerbated for those whose reading level is below grade level expectation. The pace and reading levels of compulsory textbooks further complicates this already difficult transition into middle school.

Many of the students at the school who were participants in my research project struggled with a command of academic language skills. I observed a number of students who were engaged in classroom discussions, partner activities, and labs scoring lower than expected on written assessments despite their competency with answering questions orally in the classroom setting. I began to wonder if the way that the students were being assessed was a true reflection of their understanding and competency with science content. As a result of these observations, this research study was designed to investigate: *How does the use of student choice in modality of assessment on test responses impact students' scores on end of topic assessments*?

Science achievement scores are indicative of the difficulty that numerous students have being able to "show what they know." This research study was designed to allow student choice in how they were assessed based upon their personal preference and learning style. Many of my students do not speak English as their native language, and they are not yet able to read and write in English proficiently. When these students are thrust into science classrooms where the

expectation is to read and write fluently with domain-specific vocabulary, many flounder. As discussed in the related literature, many students often stumble when given an assessment due to not knowing what the questions on the assessment are asking of them (Noble et al., 2012). In addition, many tests are written in a linguistic and logical manner, which causes students who are strong in other modalities to falter and not score as well as if the questions were given in an optional modality (Kohlhass et al., 2010). I hoped that when the students had choice in how they were assessed at the end of a science topic, students would be able to demonstrate their learning and have higher scores on the assessment than students who were not given a choice. My hope was that students would be able to focus on the science content knowing they have a choice in how they will communicate that understanding. When given a choice of their mode of assessment, my hypothesis was that students would be more likely to demonstrate their understanding and, consequently, would stay engaged while allowing their academic language to progress over time.

The work of Gardner (2006) supports the hypothesis that students would benefit from diverse means of assessment. Gardner argues that in the United States, many assessments are set up to treat all students the same while not allowing for students from various backgrounds and skill sets to thrive (p. 187). As a result, English language learners frequently score lower than their peers. For example, students at the school I chose for my research project had on average 43% of their student population scoring at or above the grade level standard in English Language Arts (ELA) in comparison to only 10% of the English language learners scoring at or above the grade level standard. (CAASP, 2019) In addition, none of the English Language Learner subgroup reported at or above the grade level standard on the science portion of the same California assessment.

The California Assessment of Student Performance and Progress is an example of a test that is set up to evaluate all students in the same manner. The results are indicative of the struggle that English Language Learners face when accessing assessments that are administered with one modality. In this research project, I investigated in what ways student achievement at the end of unit science assessments might be affected if students were able to choose an assessment that suited their learning style.

Setting

This study took place in a suburban K-8 Title I school. For this project, *suburban* was defined as an area outside of the central city, but within a metropolitan area (huduser.gov, 2022). The school is unique in that it was built on the border between two cities, and the zone of attendance is separated by a highway and a set of railroad tracks. The school site is not easily accessible by bike or by foot due to the lack of sidewalks on the streets adjacent to the school. The school site was once a vineyard, and is neighbored by a farm, a large apartment complex, and an expansive shipping hub. Students are primarily dropped off and picked up by private vehicles, while approximately 10% of students walk to and from school.

At the time of the study, the total enrollment of the school was approximately 800 students, and these students reside in the two neighboring cities. The demographics of the school were as follows: 66% were socioeconomically disadvantaged, 49% Latinx, 24% White, 13% Black/ African American, 6% Asian American and Pacific Islander, and 6% self-defined as "other." Approximately 17% of the students were classified as English Language Learners (School Accountability Report Card, 2019). At the time of this study, there were approximately 30 ELL students enrolled in the middle school grades. In addition, there were 31 teachers at this

school site, all of whom were fully credentialed. At the time of this study, there were no vacant teaching positions.

There were no current CAASP scores for the participating students. CAASP testing was suspended in the 2019/2020 and 2020/2021 school years due to the COVID-19 pandemic. The most recent 2018-2019 CAASP scores for the school were below the state average. Only 42% of the students were at or above the grade level standard grade level standard in English Language Arts in comparison to the California State average of 50% at or above grade level English Language Arts. Similarly, only 43% of the students were at or above the grade level standard in math in comparison to the California State average of 51%.

Demographics of the Classroom

The participants of this study were drawn from two general education seventh grade Science classes that I taught during the 2021-22 academic school year. A majority of these students had been sixth grade Science students during the prior school year at the same school and were taught via distance learning due to COVID-19 pandemic. All 67 students opted to have their data included, after a letter discussing the research project was sent home to all seventh-grade families.

Of the 68 participants, 29 were boy-identified (43%) and 39 were girl-identified (57%). Their ages ranged from 12 to 13 years old at the time of the study. Twelve participants (18%) were classified as ELLs. Of the 12 students, the English proficiency of 17% were at level 1, 50% at level 2, and 33% were at level 3. Five students were identified as SPED at the time of this study.

I chose my two classes of seventh graders because I knew what they were taught during the previous year and had a good understanding of student proficiencies before the

implementation of the research project. During the previous year, I observed that some students were able to excel in the online environment while others floundered. Having these same students in the classroom setting after being online for an entire school year allowed me to see their strengths and weaknesses in the way that they score on assignments and assessments in multiple settings. I saw that some students, who did not score well on standardized tests, were the leaders during hands-on experiments. I also saw that several students were amazing at articulating what they had learned in an oral presentation. It made me ponder how I could incorporate these methods of learning into the end of the unit assessment process allowing all students to "show what they know."

Data Collection Strategies

To determine the impact of offering multiple assessment modalities at the end of the unit, a variety of data collection strategies were used throughout this study. Specifically, data were analyzed both quantitatively and qualitatively. Four assessment alternatives were practiced by all students and collected prior to the end of the unit assessment. Each method of assessment was introduced, practiced, and discussed during the lessons and worked on in class with partners. The students were then given feedback on the content of their work so that the students knew how well they performed on the practice of that type of assessment and what they could do better in the future. The assessment types that were practiced were: comic strips, hands-on lab, traditional multiple choice including short answers, and oral/multimedia presentations.

Comic Strips

Students produced comic strips during week 2 after the culmination of Lesson 1: Chemical Change. This assessment option allowed students the opportunity to use the vocabulary from the unit of study in a comic strip story. Students used the vocabulary to explain

the phenomena of physical and chemical changes. Their comic strip story was given points for proper use of vocabulary and explanation of the phenomena through art and dialogue on the comic strip storyboard. Points were awarded for neatness, use of vocabulary, and ability to express the concepts in the story. All scoring was applied according to the rubric (Appendix B).

Hands-On Lab

Students participated in a hands-on lab during week 4 after the culmination of Lesson 2: Modeling Chemical Reactions. This assessment option was a combination of an end of unit lab that included in the seventh grade adopted science curriculum and a template/rubric for grading that I designed to determine if a student was able to identify why or why not their hypothesis was correct/incorrect, as well as explain whether a chemical reaction had taken place. Their explanation allowed me to determine if they understood the science concepts that were taught in the unit of study. In addition, students were expected to summarize the procedures that they followed as well as an explanation of the results of the lab (Appendix C).

Oral/Multimedia Presentation

Students participated in an oral presentation/ multi-media presentation during week 6 after the culmination of Lesson 3: Producing Useful Materials. This assessment option allowed students to use the unit vocabulary in an oral presentation after creating an infographic or PowerPoint presentation. Students created an infographic poster to explain the phenomena of chemical change. Students then presented the information in an oral presentation that was graded according to the rubric (Appendix E).

Traditional Multiple Choice and Short Answer

This assessment option was the end of unit assessment, which took place during week 7 of the study at the culmination of the unit of study (three lessons). The assessment administered

was a component of the district adopted curriculum. The assessment contained a total of 23 questions, including three short answer responses, 10 multiple choice responses, and 10 true-false responses (Appendix F).

Researcher Field Notes

I took notes weekly in my notebook and then transferred the entries to a Google Drive document (Appendix G) each week. In total, I captured 20 entries. I tallied the number of students engaged on the task of the day, made note of any comments made by students, as well as how well I thought the lesson of the day was comprehended. My seventh-grade classes were after lunch in the afternoon; therefore, after school was the best time to sit down and add my notes to Google Drive. Notes were taken after the students left the classroom, except for meeting days and one day a week when I had afterschool yard duty. On the dates of other activities, notes were written later in the day at school or at home. Typing my notes allowed me to access and add to the prior notes at any time during the day, as necessary.

Exit Tickets

Exit tickets were utilized to check-in on student understanding of lessons for the duration of this action research project (Appendices H/I). Students reported their understanding of the current science content as well as descriptions of their feelings and feedback on the interventions. There were 15 exit tickets in total. The exit tickets varied in length from 1-15 questions, the longest being at the end of the series of interventions.

Procedures

The study took place over eight weeks from late-January to mid-March. The study consisted of two phases: the intervention phase (six weeks), and the post-intervention phase (two weeks). During the intervention phase, the science lessons were taught, and the multiple

assessment modalities were practiced. Once the alternative assessment modalities were practiced and the unit was complete, the alternative assessment phase was implemented.

The intervention consisted of teaching three lessons from *Topic Three: Chemical Reactions* (Pearson Realize seventh grade science curriculum). At the end of each of the three lessons, the standard quiz was administered, and one modality was taught and introduced. At the culmination of the each of the three lessons, students practiced comic books, a hands-on lab, and oral/multi-media presentations.

Over the course of this study, students were taught a unit of study using their district-adopted textbook, online activities, quizzes, and tests. Each lesson consisted of two weeks. One week of the lesson was devoted to learning the new science standards, and the following week students took the standard lesson quiz provided by the publisher and practiced the modalities of the alternative assessments.

Week 1

Lesson 1: Chemical Change was taught over the first week. Students read the text independently as well as whole class, took notes and answered check point questions in their text. In addition, students participated in class discussions, completed warm-up activities, and exit tickets (Appendix H).

Week 2

Week 2 included a review of the first lesson. Students completed a lesson 1 quiz which included four multiple choice questions and one short answer response. The comic strip expectations and procedure were introduced and practiced. Students were given the task of creating a comic s strip that included vocabulary from Lesson 1. The comics were completed in pairs and graded based on a rubric (Appendices A/B) and feedback was given to each student.

Week 3

In the third week of the intervention, students were introduced to Lesson 2: Modeling Chemical Reactions. Students read the text independently as well as a whole class, took notes and answered designated questions in their text. In addition, students participated in class discussions, completed warm-up activities and exit tickets.

Week 4

Week 4 included a review of Lesson 2. Students completed the lesson 2 quiz which included five multiple choice questions and one short answer response. The hands-on lab procedures and protocol were explained and practiced. Students answered follow up questions related to the indicators of chemical reactions. The lab was graded according to a rubric (Appendix D), and feedback was given to each student.

Week 5

Lesson 3: Producing Useful Materials was investigated during week 5. Students read the text independently as well as a whole class, took notes and answered designated questions in their text. In addition, students participated in class discussions, completed warm-up activities, and exit tickets.

Week 6

Week 6 included a review of Lesson 3. Students completed the Lesson 3 quiz which included three multiple choice questions and one short answer response. The oral presentation rubric and instructions were practiced. Students completed an infographic, explaining the concepts introduced in Lesson 3. Graphic organizers and oral presentations were assessed using a rubric (Appendix E). Feedback was given to each student.

Week 7

A review of Lessons 1, Lesson 2 and Lesson 3 was conducted in Week 7. At the culmination of the review, I administered the traditional written test provided by the district approved curriculum. This assessment included a total of 23 questions. Ten questions were multiple choice, two questions were fill in the blank, and three questions were short answer responses (Appendix F). The test was administered over two days.

Week 8

Week 8 allowed students to review their feedback from each modality that had been introduced over the course of the intervention. Prior work samples were collated into student folders. Students completed an exit ticket (Appendix I) that inquired as to which type of assessment the student felt that they were best able to "show what they know." The exit ticket included several questions asking about each individual assessment piece. Students were subsequently given the opportunity to choose one final assessment piece that would be used to evaluate their understanding of the unit. Students were given the choice of a comic strip, a culminating hands-on lab, an infographic/PowerPoint and oral presentation, or another version of the traditional written assessment.

Plan for Data Analysis

All data sources were collected to answer the research question, *How does the use of student choice in modality of assessment on test responses impact students' scores on end of topic assessments*? Students were given a choice in the mode that they were assessed at the end of the unit of study. Participants were given an opportunity in class to practice using the options for assessment. At the end of the unit, each student chose that method of assessment that they felt would allow them to "show what they know." In addition, I kept a field journal to record

field observations. Lastly, I gave exit tickets periodically to assess student understanding of the unit of study. These data sources were used to provide multiple measures of student learning.

Scores on the assessments were analyzed quantitatively, and these results were compared to each other to deduce the impact of student choice in modality of assessment on the participant's ability to show what they know about the topic being assessed. The scores of all assessments were coded for anonymity. A total score was given for each assessment, and these scores were then analyzed using statistical measures of central tendency, by calculating the mean for the ELL subgroup as well as for all participants as whole.

Qualitative analysis was conducted on the responses from the exit tickets and researcher field notes. These data were analyzed for common themes and trends. When reviewing the researcher field notes, I looked for data that showed student understanding of the science concepts. I examined the data to see how particular students were able to express their understanding of the concepts. I searched for similarities in student responses as well as common misconceptions.

Summary

The purpose of this study was to investigate the association between student choice of modality of assessment and student performance on an end of unit science assessment. Previously, I had noticed that some students were participating in class and able to answer questions orally about group work and in class activities, but then faltered at the end of unit assessment. I hoped that by practicing alternative assessment methods and by giving students a choice that their scores would increase. The study lasted a total of eight weeks. The students explored the concepts of electricity and magnetism by participating in lectures, class discussions, hands-on labs, creation of comic strips and oral/multimedia presentations. I assessed student

performance by means of field notes (Appendix G), exit tickets (Appendices H/I) and the end of unit assessment (Appendix F).

Chapter IV

Findings

The purpose of this action research project was to study the impact of introducing student choice with the mode of assessment on end of unit assessment. I also aspired to investigate if the choice would improve student scores. Hence, the action research question was: *How does the use of student choice in modality of assessment on test responses impact students' scores on end of topic assessment?*

As a science teacher, I had noticed that students often were able to demonstrate understanding of a science topic when engaged in partner activities or when answering questions orally. These same students frequently falter when given a traditional assessment. I attributed this disconnect to students often not understanding what the questions asked of them on traditional assessments. This was especially true with my ELL students who struggled with reading and writing with domain specific vocabulary.

A review of literature suggests that when students are instructed with Gardner's (1975) multiple intelligences in mind, students can better understand the content presented as not all learners are linguistic and logical thinkers (Ozdemir et al., 2006). Conventional assessments favor logically minded scholars. When students are exposed to the multiple modes of content acquisition, they are able to better understand the concepts. However, when the assessment does not touch upon different learning styles, many students then fail to demonstrate mastery. In my study, I wanted to explore how educators could allow all students to show what they know about a topic as not all students score well on traditional linguistic and logical styled assessments. By offering multiple modes of assessment tailored to multiple intelligences, I hoped to see improvement in my students' assessment scores.

Overview of Methods and Data Collection

Data were collected over an eight-week period for this action research project. The study consisted of four assessment alternatives that were practiced by all seventh-grade science students over the course of a unit of study. The assessment alternatives were introduced, practiced, discussed, and then feedback was given to each student on the products. The assessment types that were practiced were: comic strips, traditional multiple choice and short answer, hands-on lab, and oral/multimedia presentations. At the culmination of the unit of study, students were given the opportunity to choose one modality that would be used to evaluate their understanding of the science unit. The data from the chosen modality were then analyzed and recorded.

For the duration of the study, all student work was collected and collated into a student work folder. Students were given the opportunity to review teacher feedback and choose a final mode of assessment at the end of the unit of study that would best demonstrate what they learned about the science unit of study. In addition, researcher field notes inclusive of student engagement, notable quotes, and teacher-researcher observations were collected for the duration of this study (Appendix E) and kept in a Google Drive. Exit tickets assessing student understanding of a concept were used periodically to continually review and check-in with students and their understanding of the lessons and the unit of study. At the culmination of this study, students were asked to reflect upon each assessment method and how it reflected their understanding of the unit of study (Appendix E).

Demographics of the Participants

The participants for this study were seventh graders during the 2021-2022 school year. They were approximately 12-13 years old at the time of this study, and they attended a Title I

kindergarten through eighth grade school. Of the 68 students included in this study, 29 were boy-identified (43%) and 39 were girl-identified (57%). Twelve of the 68 students were classified as English Language Learners of varying levels of proficiency. Moreover, five participants received services from the Special Education Department.

Analysis of Exit Tickets

Exit tickets (Appendix F) were given to students for the duration of the study to student understanding of lessons. Students reported their understanding of the current science content as well as descriptions of their feelings and feedback on the interventions. There were 15 exit tickets in total. The exit tickets varied in length from 1-15 questions, the longest ticket being at the end of the series of interventions. The responses were coded so that qualitative data could be extrapolated and used to investigate the action research question. Upon evaluation, five themes emerged: feelings about traditional tests, feelings about tests that included multiple modalities, feelings toward test choice, attitudes toward science and perceived effort levels.

Table 1 reports examples of the themes that emerged in the analysis of the exit tickets. The examples demonstrate the common attitudes and feeling of the students toward traditional tests and the testing opportunities presented that included multiple modalities of assessment. Students reported their feelings as well as attitude and effort levels in both scenarios. When students wrote about their experience with traditional tests, they reported feelings of stress and frustration. For example, one student who expressed, “I want to give up when it is hard.” Students explained that on traditional assessments “the way that the questions are worded makes it harder for me to know what to do.” In juxtaposition, students discussed feelings of confidence and comfort when given the opportunity to choose their mode of assessment. Students reported they would invest more effort into the alternate modality of assessment because it was something

they were good at. The students also expressed sentiments of feeling less stressed and able to focus on the test when offered different options of assessment. For example, one student stated that the assessment modalities "make me feel more comfortable and work less." Another replied, "I know what I am getting myself into and there maybe will be a way that I can shine" (Table 1). Exit tickets gave valuable feedback regarding the emotions that students endure throughout the testing process. These data allowed this action research project to achieve perspective into the rationale behind why some students are able to express themselves orally in class, but struggle on the end of unit assessments.

Table 1

Excerpts from Exit Tickets

Theme	Example 1	Example 2	Example 3
1. Feelings about traditional tests	"Gives me questions that I don't understand even though I probably know the answer."	"I want to give up when it is hard."	"The way that the questions are worded makes it harder for me to know what to do".
2. Feelings about tests that included multiple modalities	"It makes me feel more confident. I know what I am getting myself into and there maybe will be a way I can shine."	"I can do better when I do something I am good at."	"My brain would know how to do it."
3. How does choosing your assessment make you feel about the test?	"I would put more effort because it is probably something that is best for me!"	"I would give more effort simply because I got to choose and I might actually have a chance."	"Helps me to focus and not stress."
4. What is the hardest part about science class?	"Taking the tests because they are confusing."	"It's boring and stressful."	"There are no creative elements that let me express what I know."
5. Would you put forth more effort if you got to choose your assessment type every topic?	"I would work hard on it because I would enjoy it, so it's a win/win situation."	"Make me feel more comfortable and worry less."	"I would give more effort simply because I can choose."

At the culmination of the action research study, students were asked to reflect upon their teacher feedback and graded assessments that were housed in their portfolios. On the final exit ticket, students chose the modality of assessment that was best at showing what they knew about the *Chemical Reactions* unit of study. As reported in Figure 1, 36.2% of students chose the traditional multiple choice and short answer form of the unit assessment, 15.5% chose the comic strip intervention, 19% chose the infographic and oral presentation intervention, and 29.3% chose the hands-on lab intervention for their end of unit assessment of Chemical Reactions.

When students were given the opportunity to choose their end of unit assessment modality, 63.8% chose a modality that was untraditional. As students were given the opportunity to express themselves in a manner that they thought would best exhibit their understanding of the science unit of study, the majority chose alternative modes of assessment. Analysis of this data in conjunction with the resulting mean scores may be used to analyze the effects of allowing student choice in modality of assessment. Next, I will provide additional qualitative data in the form of an examination of my researcher field notes.

Analysis of Researcher Field Notes

The researcher field notes (Appendix G) were recorded periodically on a Google Drive file two to three times a week throughout the duration of the action research study. I recorded quotes, engagement frequencies, as well as general observations. There were 20 entries of varied length recorded over the course of the study. The entries were coded so that the qualitative data could be used to inform the research. Notable themes included: engagement on traditional assessments, engagement on multiple modality assessments, and quotes that spoke to the power of the intervention.

Figure 1

Student Choice of Modality of Assessment

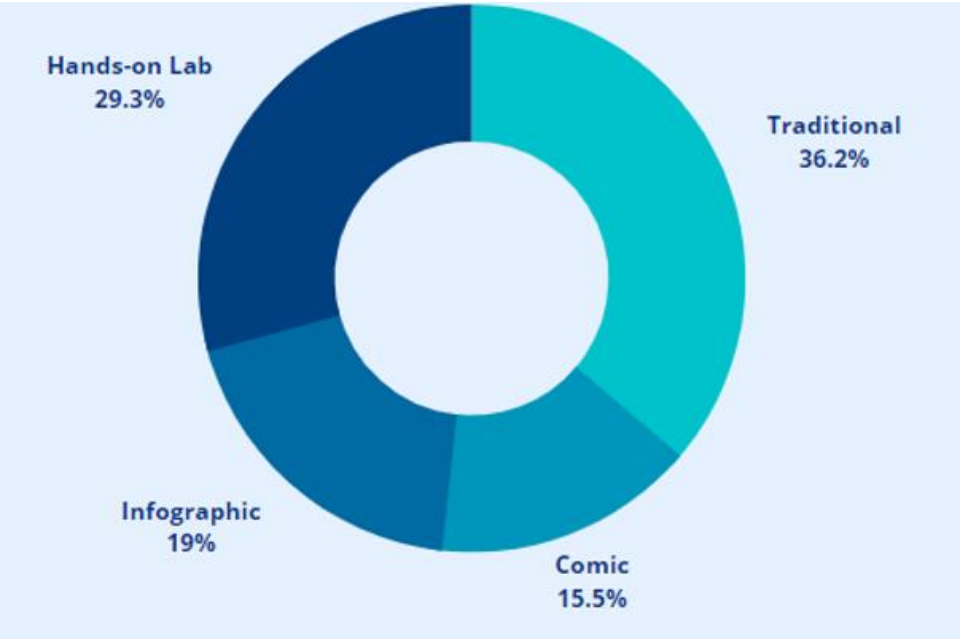


Table 2 displays the themes that emerged from the analysis of the researcher field notes. The examples provided demonstrate the student engagement in the duration of the action research project. For example, students needed multiple redirects during a traditional assessment, and student assessment responses included 16/67 scored lesson one quizzes that were inclusive of blank responses. These observations can be compared to students displaying confidence and enjoyment during the implementation of the assessments using multiple modalities. This enjoyment was evidenced by comments such as, “I really like being able to draw today.” This sentiment was echoed in observations inclusive of students who struggled on past written responses excelling on an assignment that encompassed multiple modalities (See Table 2). An increase in student engagement was evidenced in student work, student attitudes and student voice.

In addition, students also expressed excitement when writing about the prospect of the implementation of the multiple modalities on future units of study. Multiple students reported ideas for additional categories that could be added to the multiple modality choices. These future additions included children's story books and song lyrics. In the following section, I will provide a quantitative analysis of the end of unit assessment chosen by each student at the end of the unit of study.

Table 2

Excerpts from Researcher Field Notes

Theme:		Example 1	Example 2	Example 3
1.	Engagement on traditional assessments (tests/quizzes)	Today 16/67 students wrote IDK or left a question blank on lesson one quiz.	I noticed a student today off task during the quiz. They completed 2/4 quiz questions after 6 redirects.	Observed student staring into space. I asked if I could help and read the question aloud. They stated, "it makes so much more sense when you read it to me."
2.	Engagement on multiple modality assessments (intervention)	"Mrs. Caguyong, this option is way too easy for my brain (infographic). I think I will do the lab so I can write a lot to explain all of the things I have learned."	"I really liked being able to draw today."	I observed an ELL student present his infographic to the class today in a confident manner. This same student usually struggles with written open response questions.
3.	Quotes that speak to the power of the intervention	"Can I write a children's story book for my assessment next time if I use all of the essential vocabulary?"	"Will we be able to do this every time we take a test from now on?"	"I have an idea. What if I used the infographic instructions, but wrote a song instead? I don't think I would want to perform it in front of the class, but could I record it?"

Analysis of Multiple Modality Assessment Choices

Throughout the duration of this study, students practiced and received feedback on multiple modality assessments inclusive of traditional multiple choice/ short answer assessments, creation of a comic strip, an oral presentation of an infographic, or written responses discussing phenomena presented in a hands-on lab. At the culmination of each of the three lesson segments inclusive of the chapter titled *Chemical Reactions*, students practiced the assessment choices.

The graded completed assignments were returned to students in their student portfolio. In addition, teacher feedback on student work was included in the portfolio as a means for students to see where they did well on the assessment/ activity and where they could continue to improve.

The end of unit assessment was given at the end of an eight-week period. Participants reviewed their portfolios which contained lesson quizzes, comic strip, the infographic, and the hands-on lab assignments that were introduced and practiced in class. After review of their portfolios, participants were asked to complete an exit ticket in which they were given the opportunity to evaluate each modality of assessment that was practiced and how it enabled them to show what they had learned about the unit of study. After reflection on all student work, participants were then asked to make a final choice of the modality of assessment they would like to use for their end of unit assessment.

Figure 2 demonstrates the overall mean of responses for each modality of assessment. This figure shows that the mean score for those students that chose the traditional multiple choice or/ short answer assessment was 70%. The overall mean for the comic strip option was 76%. The mean score for participants that chose the infographic or /oral presentation as their modality of assessment was 78%. Additionally, the hands-on lab option an overall mean of 84%. These quantitative data report the results of allowing student choice in modality of assessment, in turn allowing them to show what they know. The mean scores for all additional modes of assessment were higher than the mean score of the traditional assessment.

Figure 2

Student Score (N=68) vs. Modality of Assessment

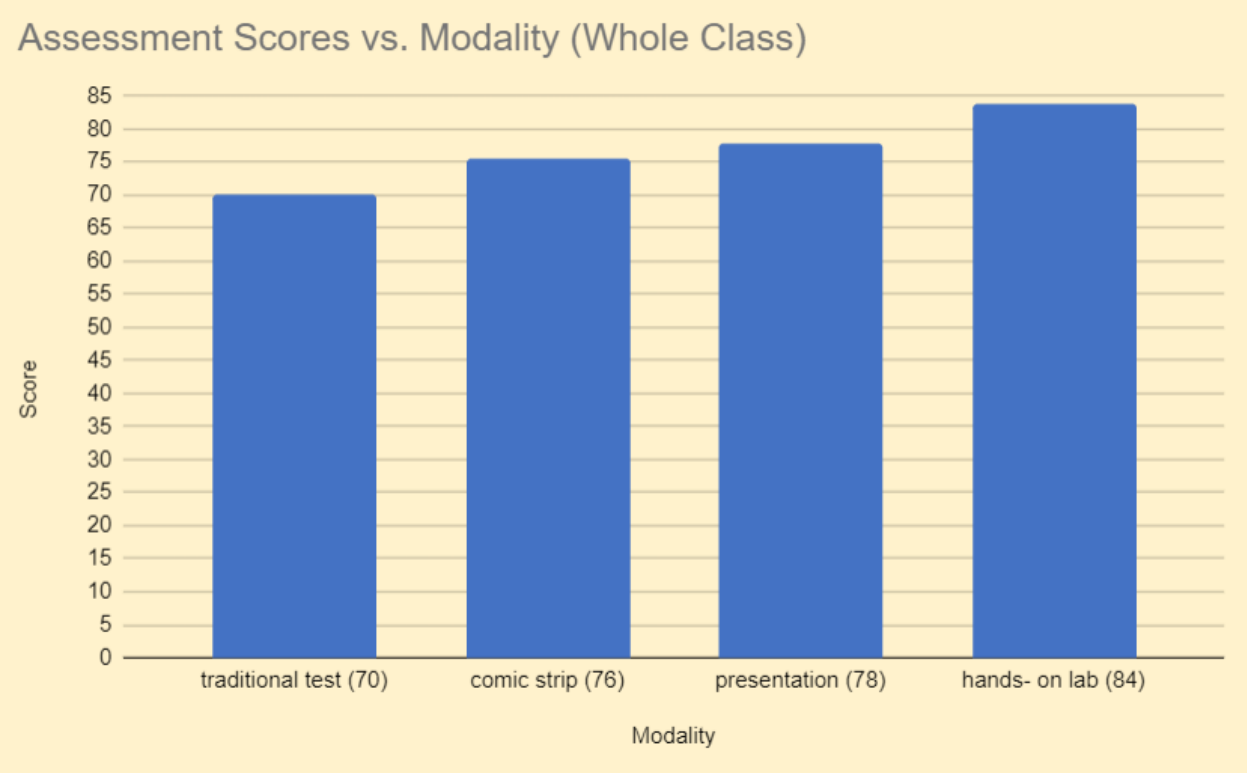
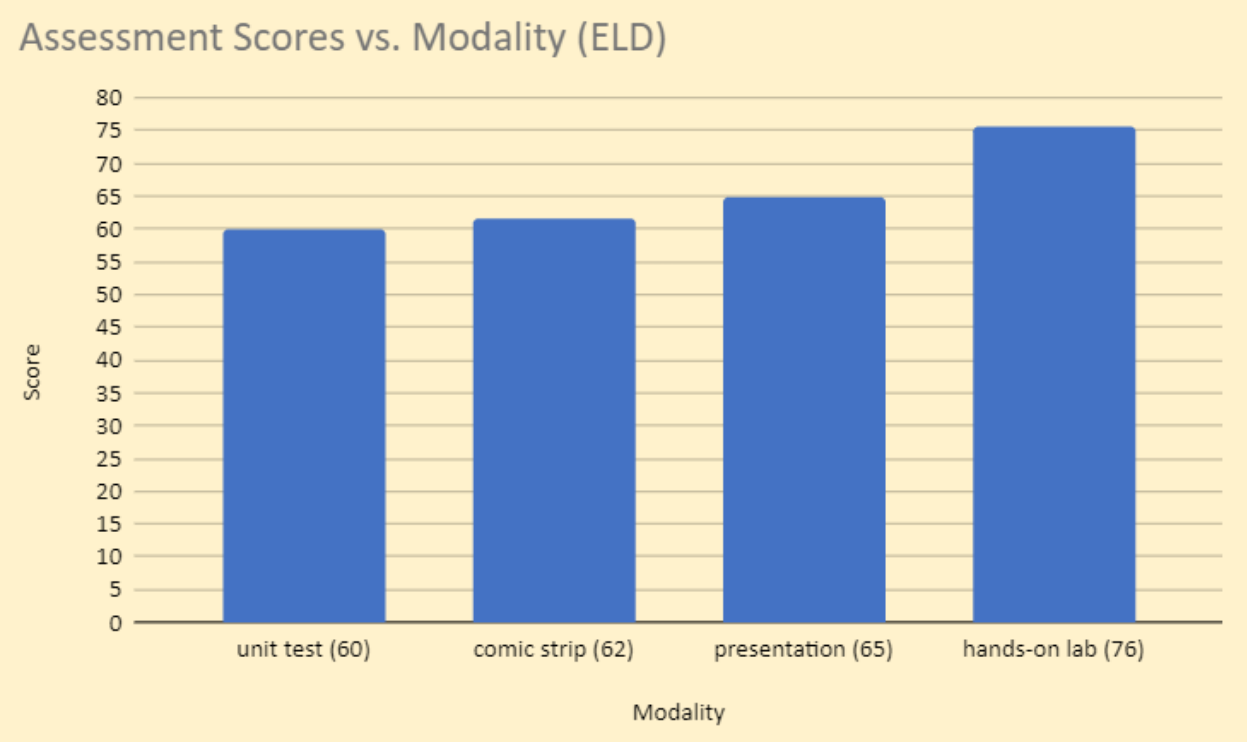


Figure 3 illustrates the results of the implementation of offering multiple modalities as options for the end of unit assessment for the ELL subgroup of the participant group. In addition to the increase in mean scores for the participants of this study, the mean scores of the ELL sub-group were just as promising. Students of the ELL subgroup demonstrated a mean score of 60% on the traditional multiple choice/ short answer assessment. In comparison, the comic strip mean score was 62%. The mean score of the infographic presentation was 65%, and the mean score of the hands-on-lab was 76%. The English Language Learners were able to demonstrate proficiency and achieve a passing score of at grade level standard when choosing the alternate modalities of assessment.

The participants of the ELL subgroup demonstrated notable improvement on the oral presentation and hands-on-lab modality options of the end of unit assessment. They were able to express their understanding of what they know and thereby increase their assessment scores. Participants on average choosing the traditional assessment method were not able to demonstrate an at grade level proficiency. Participants choosing the infographic/oral presentation and hands-on lab option were able to achieve grade level proficiency on the assessments.

Figure 3

Student Score (N=8) vs. Modality of Assessment (ELL)



Summary

This action research study was designed to study the effects of student choice in modality of assessment on test responses. My hypothesis was that student scores would increase on the end of topic assessments when given an opportunity to practice and choose a final assessment modality. In the next chapter, I will discuss the results of this action research study. The results

of this study will be compared to the studies that were presented in the review of literature. In addition, I will examine the implications of this action research study. Chapter V will conclude with my plan for future action as a result of implementing this project.

Chapter V

Conclusions

A large part of success in secondary education is the ability to navigate educational testing norms. Many assessments in all content areas are currently archaic in their composition. These assessments are modeled after IQ tests and contain questions that are written in a manner that allows logical and linguistic learners to achieve a high score. The pace and reading levels of compulsory textbooks further complicates this already difficult transition into middle school academia. In addition, traditional textbooks are also written in a manner that allows linguistic and logical thinkers to thrive, but what about the others? Gardner asserts that assessments are set up to treat all students the same while not allowing for students from various backgrounds and skill sets to thrive (Gardner, 1993). Recognizing the obstacles created by conventional means of evaluation, educators may allow students to show what they know by incorporating assessments with multiple modalities into their own classrooms. This action research project was created to determine the impact of integrating multiple modalities into the assessment process in a science classroom. The purpose of this study was to identify the impact on science achievement scores of learners given a choice on the mode of assessment at the end of a science topic. This study was designed to answer the question: *Does the use of student choice in modality of assessment on test responses improve student's scores on end of topic assessments?*

Science achievement scores are indicative of the difficulty that many students have being able to "show what they know." Often, students may understand the science content, however they may not understand the format of the assessment or be able to express their knowledge. Sometimes an assessment may be written in a modality that does not allow all students to express

their understanding of the concept. As a result, student scores on traditional assessments are lower than anticipated.

This research study was designed to allow student choice in how they were assessed based upon their personal preference and learning style. Many of my students do not speak English as their native language, and they are not yet able to read and write in English proficiently. When these students are thrust into science classrooms where the expectation is to read and write fluently with domain-specific vocabulary, many flounder. In the classroom where this action research projected took place, I had often heard students verbally respond to questions showing understanding of the science lessons, and then falter on the written tests and quizzes that were given upon the same content matter. These observations provided evidence that some of my students were struggling to show what they know about the science content when given a traditional written test. Furthermore, these observations led me to believe that if students were given a choice of multiple modalities for assessment, their scores on would improve and would provide a more authentic glance at their understanding of the material.

The participants of this action research study were seventh grade students at a Title I kindergarten through eighth grade school. During the course of this study, students were introduced to multiple modes of assessment that included comic strips, traditional written assessments, hands-on labs, and oral/multimedia presentations. Both quantitative and quantitative data were extracted and were triangulated to illustrate the impact of student choice in modality of assessment. These measures were used to examine the effects of implementing multiple modalities of assessment in the science classroom.

Chapter IV presented the findings of the action research project. These findings were organized by analysis of exit tickets, researcher field notes, and multiple modality assessment

choices. The data demonstrated that the implementation of student choice on the end of unit modality of assessment had a positive impact on student morale and student scores on assessment. Students were able to express their understanding of what they know about the unit of study in a modality that worked best for them. This chapter is organized into the following sections: summary of findings, interpretation of findings, limitations, summary, and plan for future action.

Summary of Findings

The triangulation of the exit tickets, researcher field notes and multiple modality assessment choice data demonstrated that students were better able to show what they know about a science topic when given the option to choose their testing format for the end of unit assessment. Students were actively engaged for the duration of the assessments and were less stressed by the testing environment. For example, a student self-reported on an exit ticket that the ability to choose the modality of their assessment, "Helps me to focus and not stress." (see Table 1 in Appendix). This sentiment was echoed by others on their exit tickets. The data suggested that the increase in assessment scores after the implementation of student choice in mode of assessment was a result of the intervention. An increase in student assessment scores was evident universally across proficiency and language acquisition levels.

Exit tickets were utilized for the duration of the action research project. These exit tickets were assigned periodically to check in with students and survey the perceived understanding of a lesson. Exit tickets were also beneficial in gauging student feelings about test and quiz options. Analysis of the data exhibited that students felt frustrated and stressed when taking traditional assessments. As conveyed in Table 1, one student reported their frustration toward traditional tests as, "The way that the questions are worded makes it harder for me to

know what to do." This idea was echoed by another student who expressed that traditional tests "give me questions that I don't understand even though I probably know the answer." In contrast, students felt more confident and comfortable when being allowed to choose their modality of assessment. Students shared that the assessments including the multiple modalities allowed them to "give more effort simply because I got to choose, and I might actually have a chance." Students also reported that they would "worry less and try harder" on assessments that included showing what they know, therefore giving more effort on the task.

An additional indicator of student successes was discovered in the researcher field notes. For the duration of this study, field notes were documented in a Google Drive document. These notes captured the impact of the use of student choice in mode of assessment. Specifically, students were observed to be more engaged when given a choice on how they were to be assessed. For example, one student expressed, "I think I will do the lab so I can write a lot to explain all of the things I have learned." Another student asked, "Will we be able to do this every time we take a test from now on?" (See Table 2). Along with increased engagement, students also expressed contentment and excitement toward the prospect of future additions to the list of choices. One student declared, "I have an idea. What if I used the infographic instructions, but wrote a song instead?" Other proposed additions included children's story books, skits and power point presentations.

Additionally, students were provided feedback on all assessments given for the duration of the study. Student work folders contained traditional short answer and or/multiple choice assessments, comic strips, infographics, oral presentation rubrics, and written responses to hands-on labs. At the end of the eight-week unit of study, students were given the task of evaluating their student work and choosing the modality of assessment that would best show

what they know about the science unit of study. Analysis of the resulting data indicated that the mean score for students choosing the traditional multiple choice/short answer assessment was 70%, comparative to a mean score of 76% on the comic strip assessment, a mean score of 78% on the infographic/oral presentation, and a mean score of 84% on the hands-on lab assessment option. (See Figure 2) The mean scores of all alternative modes of assessment were relatively higher than the mean score of the traditional assessment. Data suggest that when students are allowed choice in modality of assessment, they are able to demonstrate an understanding of content.

Interpretation of Findings

Through the implementation of this action research project as well as qualitative and quantitative analysis of the data collected, I was able to draw the following conclusion: when students are given a choice in modality of assessment, student assessment scores increase as well as positive attitudes toward the testing environment. Data collection strategies including exit tickets, researcher field notes and multiple modes of assessment throughout the course of this study allowed me to arrive at this conclusion. While this overarching finding is significant, certain themes also emerged from the data. Specifically, stress of testing, empowerment of choice and inclusivity were discovered.

Stress of Testing

Throughout my teaching career, I never thought about how much stress is induced by the testing environment. I am a procrastinator, so I struggle in making time to study, but never really felt stress when taking an actual test. I have done well on traditional tests as a student, and now in retrospect it makes sense because I am a logical and mathematical thinker. Studies have shown that logical thinkers do well on standardized tests as they are written in a manner that is

focused on linguistic and logical skill sets (Gardner, 2006). I did not feel stressed myself as a student taking tests; and therefore, until implementation of this research project, I never took into consideration that many of my students were not reaching their potential merely because of testing formats, as well as the stress that the testing process induced.

Once I began collecting and analyzing the data, I was able to see the emotional effects of the testing environment and the implications that these feelings had on the success of the students within the context of this action research project. Students reported feeling confused, nervous, and overwhelmed during the assessment process. These feelings were evident when students expressed wanting to give up while taking an assessment because they felt like a failure. One student stated, "Taking tests is hard, because they are confusing. I don't want to try" (See Table 1). This sentiment was echoed by many students when sharing about feelings toward traditional testing formats.

As the study progressed, I began to see a metamorphosis in the testing environment. I witnessed students enjoying the assessment processes. They reported feelings of comfort and ability to focus on showing what they know about the science topic. Students reported that they felt more relaxed and therefore they could focus and try harder to do well on the assessment. The overall sentiment of the exit tickets became one of, "I got this!" Students began to thrive and exhibit positive attitudes toward the testing environment evidenced by a student comment, "Will we be able to do this every time we take a test from now on?" (see Table 2).

The implementation of student choice in mode of assessments often resulted in joy. Students who were once reluctant to complete their assessment, were diligent and happy to complete the task. When asked if they would try harder on the traditional assessment or a different modality, one student replied stating, "I would give more effort simply because I got to

choose and I might actually have a chance." (see Table 1). This sentiment embodies the impact of allowing student choice in modality of assessment. Students when given the opportunity to engage in a meaningful way will achieve success. Access to multiple modalities for assessment allows students to achieve in an engaging way that allows them to show what they know in a meaningful manner. Students find themselves less encumbered by the stress of testing, enabling greater achievement and more positive feelings about learning in general.

As discussed in Chapter II, Gottlieb (2021) examined the connection between the increase of access to the content by presenting content to learners in modalities that are a combination of visual, spatial, oral, and written sources. The research found that the incorporation of multiple modalities in learning scenarios give students the opportunity to show what they have learned. This study reinforces the idea that when students are exposed to content that is presented in a modality that is accessible to their learning style, students are more likely to be able to and express their knowledge.

Empowerment of Choice

As discussed in Chapter IV, the mean scores for the end of unit assessments were higher on the alternative modes of assessment. Students that were not at the grade level standard in the past were able to voice their knowledge in a modality that allowed them to express what they know. Students were observed to be asking more questions and exhibited less timid behaviors. Students appeared to be less afraid knowing that everyone was doing their own thing.

Student choice of modality of assessment allowed students to demonstrate confidence. This confidence and an increase in positive attitude toward assessment was instrumental in helping to dismantle the aversion that some students have toward science due to student performance on traditional assessments. Success on assessments provided the avenue that

allowed the students to shine and show what they know about a science topic. This success may give them the confidence and motivation to want to put forth more effort on future assessments.

Positive Benefits of Inclusiveness

According to Gardner (2006), the goal is for students to be able to express their understanding of a concept. If students are able to express themselves by using other modes, than the product should be honored and valued (Gardner & Hatch, 1989). I believe that this sentiment can be illustrated in Figure 3. Figure 3 demonstrates the score differentiation between the traditional assessment and the multiple modality assessment options. Due to an ongoing acquisition of the English language, English language learners struggle to interpret and understand the complexity of the text on traditional assessments. ELL students who previously left a response of IDK (I don't know), or an incorrect answer due to not knowing what the test question was asking, were able to express their thinking in a manner that displayed their comprehension of the science topic. English Language Learners choosing the traditional assessment as the means of their final assessment had a mean score of 60% comparative to those students choosing the hands-on lab assessment which had a mean score of 76% (See Figure 3). English language learners were able to express their knowledge of the science content in a manner that was compatible with their level of English Language acquisition.

When English language learners were given the opportunity to explore and practice assessment options that included different modalities in this study, they were given the opportunity to discover alternatives that were compatible with their strengths and interests. As a result, students that generally test below the grade level standard were able to "show what they know" and score proficient on the end of unit assessment. This resulted is evidenced in an overall mean score of 60% on the traditional multiple choice/short answer assessment compared

to a mean score of 62% on the comic strip, a mean score of 65% on the infographic presentation, and a mean score of 76% on the hands-on-lab assessment. Universally, scores were higher on the alternative modes of assessment, suggesting greater success and achievement.

As discussed in Chapter II, the research of Winarti et al. (2019) concluded that when there is a focus on multiple intelligences, then the potential for each student can be achieved. When students in their study were allowed to create games, poems, songs, and research projects to practice their multiple mntelligences, these students were able to score higher than students exposed to traditional learning modalities such as direct instruction. Students in this study showed improvement in test scores as did the students in my research project.

Throughout my many years as a classroom teacher, I have noticed that many ELL students could express their understanding of science content during oral class discussions but were not able to express that same knowledge on the traditional testing methods. Through the introduction and practice of multiple modalities, students who were below the grade level standard, because "the way that the questions are worded makes it harder for me to know what to do" (See Table 1), were then able to express their knowledge in a manner that would allow them to "show what they know,"

The introduction of multiple modalities was not just a powerful intervention that enabled English language learners to "show what they know" about a science topic. This intervention proved powerful across all ability levels. Resource students struggling with comprehension, as well as gifted students grappling with boredom, were all able to find a modality that was comfortable and compatible to their learning styles. As shown in Figure 2, mean student scores for all alternative modes of assessment were higher than the mean score of the traditional assessment choice. In offering multiple modalities of assessment, students were given access to

multiple means of expression. In turn, students were able to choose an assessment that authentically expressed their knowledge about a science topic.

Reflection on Limitations

There are several limitations that may have affected the results of this action research study. At the time of this study, the world was in a world-wide pandemic, COVID-19. As a result, some students may have become exposed to persons that were COVID positive and either contracted the virus or had to quarantine for all or part of the research study. As a result, some students may have missed instruction, lab opportunities, or had to complete activities on their own at home. The understanding of the content of the unit lessons would not be on par with those students who were able to attend class daily.

Another limitation is the factor that the study took place over the course of eight weeks. This is a short timeframe and could have had an impact on the results of my study. If students were given more opportunities to practice and become comfortable with the multiple modalities of assessment, I believe that students would continue to thrive and try options that are at this time out of their comfort zone. Given a longer timeframe, scores on assessments could be compared longitudinally and produce richer data. Additionally, I acted as the teacher and researcher in this study which could have had an impact on the validity of the results. I as the researcher had a hypothesis for the outcome of this study and may have demonstrated a bias when interpreting the results of the study in favor of my desired outcome.

Summary

In the research literature, Gardner and Hatch (1989) discuss the bias of traditional paper-and-pencil tests. They argue that the traditional tests do not accurately depict the intelligences of the different modes of thinking and performance. So often, there is a very narrow depiction of

intelligence and achievement in schools. The common belief is that students that are smart do well on tests and therefore get good grades. Success is demonstrated as a quantifiable number on traditional tests that are modeled after the IQ test (Gardner, 2006). In my own practice, I have found that conventional assessments do not always reflect the true understanding of my students. The inclusion of multiple modalities of assessments allows educators to be inclusive of all student intellects and to give students the opportunity to express what they know about a given topic in a manner that is aligned with their multiple intelligences. Incorporating choice of mode of assessment on end of unit assessments allows students of various intelligences show what they know about a topic.

While multiple intelligence instruction may look different in different schools and classrooms, there is one common thread. Research has shown that when students are taught lessons according to their intelligence, they thrive (Winarti et al., 2019). Research also shows that most textbooks and assessments are written in a logical and linguistic manner, which are only two of the eight most commonly identified intelligences. What about the students who have intelligences that are spatial or interpersonal? How will they be given the opportunity to thrive? How will they be able to show what they know about a topic when the assessment is written in a way that is difficult for them to fully understand?

When I contemplated these questions, I realized that many studies had identified the strengths of teaching utilizing lessons that incorporated multiple intelligences, however there was little research on how to better allow students to show what they know. I wanted to examine how educators could apply the research of Gardner by offering multiple modes of assessment in the classroom as a means of honoring the intelligences that exist in the classroom, while embracing the intellects of all students. Therefore, my action research project explored the question: *How*

does the use of student choice in modality of assessment on test responses impact students' scores on end of topic assessments?

Over the course of eight weeks, students practiced four assessment alternatives. After the assessment options were introduced, practiced, and discussed, feedback was given on the products in their student portfolios. The assessment types that were practiced were: comic strips, traditional multiple choice and short answer, hands-on lab, and oral/multimedia presentations. At the culmination of the unit of study, students were given the opportunity to choose one modality that would be used to evaluate their understanding of the science unit. The data from the chosen modality were then analyzed and recorded.

Through analysis of researcher field notes, exit tickets, and multiple modality assessments, the data reflected that student scores increased when given a choice in modality of assessment. In addition, student attitudes toward the testing environment became positive in nature, in comparison to pre-intervention. This action research project supports the idea that incorporation of student choice in modality of assessment incorporates a wider conception of intelligence and achievement while allowing students to show what they know by developing their strengths. Future research could continue to study the importance of teaching and assessing with multiple modalities, allowing students to thrive and excel in their educational pathway.

Plan for Future Action

Following this study, I plan on presenting my findings to my colleagues at a staff meeting this coming school year. As a part of this presentation, I will discuss the procedure used in my own classroom as well as possible modifications for grade levels and course disciplines (in our K-8 school). I will also offer to collaborate with any grade level or specific subject area that is interested in implementing multiple modalities of assessment in their classrooms. My hope is

that the support and evidence I provide will inspire the participants to implement the use of multiple modalities as a means of assessment in their own classrooms.

In addition, I plan on implementing multiple modes of assessment in all my science classes in the coming school year. I am particularly interested in seeing the long-term effects of offering the modalities throughout the school year. Will students choose other modalities for assessment when given multiple opportunities to practice the skills? How will student proficiency increase whilst completing the multiple modality tasks over the course of the units?

As a result of student input, I also plan to incorporate additional modes of assessment to the list of options including composing short stories, picture books, song lyrics, and power point presentations. I will compile rubrics and instructions for these assessment options and teach the protocols and procedures in the same manner referenced in this study. Over the course of the school year, I plan to rotate the class instruction and practice of the modalities throughout the school year. At the culmination of each unit, I will incorporate student feedback into the processes in which the modalities are introduced, practiced, implemented, and graded.

I am optimistic that the incorporation of multiple modalities of assessment in my classes will allow students to explore their strengths and weaknesses as learners. As these students navigate their educational pathways, I anticipate that they will be able to use this insight to help them make choices about their learning in the future. I am also hopeful that my students will gain confidence in showing what they know about science in their future classes. Students that may have felt that they did not like the sciences because they were not able to test well in the past, may find an interest and passion for future studies in science.

References

Alsalhi, N. R. I. (2020). The representation of multiple intelligences in the science textbook and the extent of awareness of science teachers at the intermediate stage of this theory. *Thinking Skills and Creativity*, *38*, 100706. https://doi.org/10.1016/j.tsc.2020.100706

Bakula, N. (2010). The Benefits of Formative Assessments for Teaching and Learning: Part of a special issue: Action Research. *Science Scope*, *34*(1), 37–43.

Buyukkarci, K., & Sahinkarakas, S. (2021). The Impact of Formative Assessment on Students' Assessment Preferences. *Reading Matrix: An International Online Journal*, *21*(1), 142–161.

Chan, C., Chia, A., & Choo, S. (2017). Understanding Multiliteracies and Assessing Multimodal Texts in the English Curriculum. *The English Teacher*, *46*(2), 73–87.

de Brey, C., Snyder, T. D., Zhang, A., & Dillow, S. A. (2021, January 31). *Digest of Education Statistics 2019. 55th edition. NCES 2021-009.* National Center for Education Statistics. Retrieved April 18, 2022, from https://eric.ed.gov/?id=ED611019

Diane Scott-Jones & Maxine L. Clark. (1986). The School Experiences of Black Girls: The Interaction of Gender, Race, and Socioeconomic Status. *The Phi Delta Kappan*, *67*(7), 520–526.

Early Childhood Longitudinal Studies Program (ECLS) - kindergarten class of 1998-99 (ECLS-K). National Center for Education Statistics (NCES) Home Page, a part of the U.S. Department of Education. (n.d.). Retrieved April 18, 2022, from https://nces.ed.gov/ecls/kindergarten.asp

Emig, V. B. (1997). A multiple intelligences inventory. *Educational Leadership*, *55*, 47–50.

Fayer, S., Lacey, A., & Watson, A. (n.d.). *STEM Occupations: Past, Present, And Future*. 35.

Gardner, H (1975). *The Shattered Mind*, Knopf.

Gardner, H (1983). *Frames of mind: The theory of multiple intelligences*, Basic Books.

Gardner, H (1989). *To open minds.* Basic Books.

Gardner, H (2006). *Multiple Intelligences: New Horizons*, Basic Books.

Gardner H, Hatch T. Educational Implications of the Theory of Multiple Intelligences. Educational Researcher. 1989;18(8):4-10.

Huba & Freed. (2000). Learner-Centered Assessment on College Campuses: Shifting the Focus from Teaching to Learning. http://assessment.uconn.edu/what/index.html

Kennedy, B., Hefferon, M., & Funk, C. (n.d.). Half of Americans think young people don't pursue STEM because it is too hard. *Pew Research Center*. Retrieved April 18, 2022, from https://www.pewresearch.org/fact-tank/2018/01/17/half-of-americans-think-young-people-dont-pursue-stem-because-it-is-too-hard/

Kohlhaas, K., Lin, H.-H., & Chu, K.-L. (2010). Disaggregated Outcomes of Gender, Ethnicity, and Poverty on Fifth Grade Science Performance. *Research in Middle Level Education Online*, *33*(7), 1–1. https://doi.org/10.1080/19404476.2010.11462070

Lacey, T. A., & Wright, B. (2009, December 10). *Monthly Labor Review: Occupational employment projections to 2018*. Montlhly Labor Review. Retrieved November 2, 2021, from https://www.bls.gov/opub/mlr/2009/11/art5full.pdf

Lawrence Hall of Science Press Release. (2011, October 25). *Teachers have little time to teach science, study shows*. Teachers have little time to teach science, study shows | Research UC Berkeley. Retrieved January 28, 2022, from https://vcresearch.berkeley.edu/news/teachers-have-little-time-teach-science-study-shows

Matthews, K. (2018, December 13). *Why we need more people to get interested in STEM careers*. TechTalks. https://bdtechtalks.com/2018/12/13/need-more-people-interested-stem-careers/

Noble, T., Suarez, C., Rosebery, A., O'Connor, M. C., Warren, B., & Hudicourt-Barnes, J. (2012). "I never thought of it as freezing": How students answer questions on large-scale science tests and what they know about science. *Journal of Research in Science Teaching*, *49*(6), 778–803.

Olson, C. B., & Land, R. (2007). A Cognitive Strategies Approach to Reading and Writing Instruction for English Language Learners in Secondary School. *Research in the Teaching of English*, *41*(3), 269–303.

Özdemir, P., Güeysu, S., & Tekkaya, C. (2006). Enhancing learning through multiple intelligences. *Journal of Biological Education (Society of Biology)*, *40*(2), 74–78.

Potvin, P., & Hasni, A. (2014). Interest, motivation and attitude towards science and technology at K-12 levels: A systematic review of 12 years of educational research. *Studies in Science Education*, *50*(1), 85–129. https://doi.org/10.1080/03057267.2014.881626

Science Education In The U.S. Is Mediocre. Here's What We Can Do To Fix It. (n.d.). Retrieved March 24, 2022, from https://www.wbur.org/cognoscenti/2014/01/13/science-education-jacqueline-miller

Shepherd, M. A. (2020). Effects of Race/Ethnicity, Gender, and Intonation on Secondary Science Teachers' Evaluation of Spoken Responses. *Urban Education*, 55(5), 730-752.

Sulaiman, T., Abdurahman, A. R., & Rahim, S. S. A. (2010). Teaching Strategies Based on Multiple Intelligences Theory among Science and Mathematics Secondary School Teachers. *Procedia - Social and Behavioral Sciences*, *8*, 512–518. https://doi.org/10.1016/j.sbspro.2010.12.070

Teachers have little time to teach science, study shows | Research UC Berkeley. (n.d.). Retrieved March 24, 2022, from https://vcresearch.berkeley.edu/news/teachers-have-little-time-teach-science-study-shows

Teitelbaum, M. S. (2014). Falling Behind?: Boom, Bust, and the Global Race for Scientific Talent. In *Falling Behind?* Princeton University Press. https://doi.org/10.1515/9781400850143

Test results for California's assessments. CAASPP Test Results - CAASPP Reporting (CA Dept of Education). (2019). Retrieved December 20, 2021, from https://caaspp elpac.cde.ca.gov/caaspp/

Ucak, E., Bag, H., & Usak, M. (2006). ENHANCING LEARNING THROUGH MULTIPLE INTELLIGENCES IN ELEMENTARY SCIENCE EDUCATION. *Journal of Baltic Science Education*, *2*, 9.

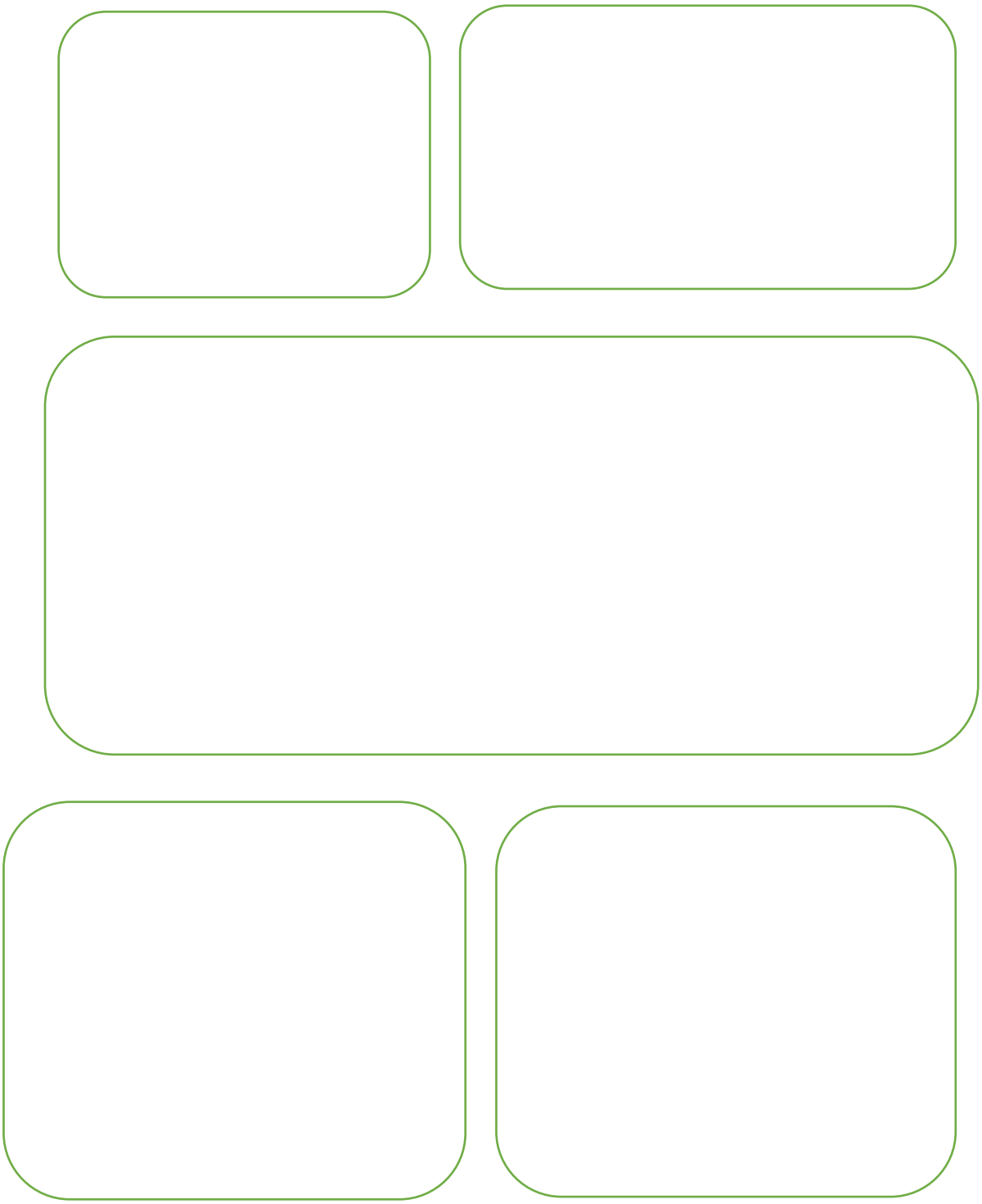
Understanding Multiliteracies and Assessing—ProQuest. (n.d.). Retrieved November 27, 2021, from https://www.proquest.com/docview/2099416102?pq-origsite=gscholar&fromopenview=true

Wang, X. (2013). Why Students Choose STEM Majors: Motivation, High School Learning, and Postsecondary Context of Support. *American Educational Research Journal*, *50*(5), 1081–1121. https://doi.org/10.3102/0002831213488622

Washington, 4646 40th St NW. (n.d.). *Should multimodalities be incorporated into testing and assessment for multilingual learners?* CAL. Retrieved November 27, 2021, from https://www.cal.org/news-and-events/blog/multimodalities-multilingual-mysteries

Winarti, A., Yuanita, L., & Nur, Moh. (2019). The effectiveness of multiple intelligences based teaching strategy in enhancing the multiple intelligences and science process skills of junior High School students. *Journal of Technology and Science Education*, *9*(2), 122. https://doi.org/10.3926/jotse.404

Appendix A
Comic Strip Template



Appendix B

Comic Strip Rubric

CATEGORY	10 Excellent	9-8 Good	7-6 Satisfactory	**5-0 Needs Improvement**
Basic elements (title, author, six completed panels, backgrounds, characters, dialogue)	Comic strip contains all elements in a creative, organized form.	Comic strip contains all elements.	Comic strip is missing one basic element.	Comic strip is missing two or more basic elements.
Content	Tells a creative story that the theme /requirements	Tells a story that fits the theme and requirements	Tells a story somewhat on theme	Does not follow theme or fits requirements for story
Clarity/Graphics/ Organization	Comic Strip is easy to read and has all elements clearly presented. All information is organized appropriately. Graphics and backgrounds are appropriated and customized as needed.	Comic Strip is easy to read comic elements presented. Most information is organized appropriately. Most and backgrounds appropriate and customized.	Strip is somewhat and has most easy to read and has some clearly elements clearly presented. Some information is organized appropriately. graphics Some graphics appropriate are and some customization.	Organization of material is confusing to the reader. Comic Strip is hard to read and few elements are clearly presented. Graphics are not appropriate or not customized
Spelling, Grammar & Proofreading Dialogue/	No errors	No more than 1 error	No more than 3 errors	Several errors
Text	There is an appropriate amount of dialogue and text to bring the characters to life and it is always clear which character is speaking.	There is too much dialogue and text in this story, but it is always clear which character is speaking.	There is not quite enough dialogue or text in this story, but it is always clear which character is speaking.	It is not clear which character is speaking. Not enough dialogue

Total _____/100

Appendix C
Lab Write-up

Name:_____ Date:_____#: _____

Objective:

What do you want to know?

Hypothesis=

What is your prediction?

Procedure:

What steps will you take to find the answer to your question?

Data:

What are you finding out?

Conclusion:

What does your data tell you? How could you explain using scientific vocabulary to explain what happen?

Appendix D
Lab Write-up Rubric

	4	3	2	1	0
Hypothesis	State whether hypothesis was right or wrong. Uses relevant evidence to explain why you were right or wrong	State whether your hypothesis was right or wrong. Uses evidence from the experiment but it is not relevant to the hypothesis	State whether hypothesis was right or wrong but don't use evidence to explain why	Restated hypothesis but does not clarify if it was right or wrong	Does not mention hypothesis
Detail	Includes a full summary of the experiment is provided including what materials were used and what procedures were followed	Includes a summary of experiment but 1-2 details are missing.	Includes a very brief summary of the experiment with multiple details missing	Gives a very general statement on what the experiment was about (one sentence or so)	No detail about the experiment provided
Data	Full summary of data. Explanation of what you learned from the results provided	Some data provided but not a full summary. Explanation of what you learned from the results provided	Some data provided. Did not explain what you learned from results.	Very limited data provided. Did not explain what you learned from results.	No summary of data
Organization	Easy to understand and follow	Might need some clarification	A bit confusing, not very easy to understand	Hard to follow	Very difficult to follow OR totally off topic
Spelling/grammar	Fewer than 3 spelling/grammar errors	4-6 spelling/grammar errors	7-9 spelling/grammar errors	10-12 spelling/grammar errors	More than 12 spelling or grammar errors

Total _____ 20

Appendix E

Name: ..... Score: .....

Oral Presentation Rubric

	4-Excellent	3-Good	2-Fair	1-Needs Improvement
Delivery	• Holds attention of entire audience with the use of direct eye contact, seldom looking at notes • Speaks with fluctuation in volume and inflection to maintain audience interest and emphasize key points	• Consistent use of direct eye contact with audience, but still returns to notes • Speaks with satisfactory variation of volume and inflection	• Displays minimal eye contact with audience, while reading mostly from the notes • Speaks in uneven volume with little or no inflection	• Holds no eye contact with audience, as entire report is read from notes • Speaks in low volume and/ or monotonous tone, which causes audience to disengage
Content/ Organization	• Demonstrates full knowledge by answering all class questions with explanations and elaboration • Provides clear purpose and subject; pertinent examples, facts, and/or statistics; supports conclusions/ideas with evidence	• Is at ease with expected answers to all questions, without elaboration • Has somewhat clear purpose and subject; some examples, facts, and/or statistics that support the subject; includes some data or evidence that supports conclusions	• Is uncomfortable with information and is able to answer only rudimentary questions • Attempts to define purpose and subject; provides weak examples, facts, and/ or statistics, which do not adequately support the subject; includes very thin data or evidence	• Does not have grasp of information and cannot answer questions about subject • Does not clearly define subject and purpose; provides weak or no support of subject; gives insufficient support for ideas or conclusions
Enthusiasm/ Audience Awareness	• Demonstrates strong enthusiasm about topic during entire presentation • Significantly increases audience understanding and knowledge of topic; convinces an audience to recognize the validity and importance of the subject	• Shows some enthusiastic feelings about topic • Raises audience understanding and awareness of most points	• Shows little or mixed feelings about the topic being presented • Raises audience understanding and knowledge of some points	• Shows no interest in topic presented • Fails to increase audience understanding of knowledge of topic
Comments				

Appendix F
Traditional End of Unit Assessment

The traditional end of unit assessment contained 23 questions. Twelve questions were multiple choice, and 11 were short answer.

Questions were similar to the following:

1. Samantha made toast. She took butter from the refrigerator and then left it on the warm stove. What kind of change most-likely took place with the butter?

   A. Physical

   B. Liquid

   C. Solid

   D. Chemical

2. Rubio buys a dozen eggs and places them in his refrigerator. Five weeks later he removes the eggs from the refrigerator. The eggs have a very strong unpleasant odor. Has a physical or chemical change occurred? Explain using evidence in your response.

   _____

   _____

   _____

   _____

   _____

   _____

Appendix G

Researcher Field Notes Template

Date:	Field Notes:

Appendix H

Exit Tickets

Exit Ticket #1

What is a physical change?

What is a physical change?

How well do you feel that you understood today's lesson?

1 2 3 4 5

Exit Ticket #2

What is a reactant?

What is a product?

How well do you feel that you understood today's lesson?

1 2 3 4 5

Exit Ticket #3

How do you know when energy has been absorbed?

How do you know when energy has been released?

How well do you feel that you understood today's lesson?

1 2 3 4 5

Exit Ticket # 4

How well do you think you did on today's quiz? Why?

Exit Ticket #5

Did you enjoy making the comic?

What was the best part?

What was the worst part?

Exit Ticket #6

Where do you find a product?

Where do you find a reactant?

How well do you feel that you understood today's lesson?

1 2 3 4 5

Exit Ticket # 7

How well do you think you did on today's quiz? Why?

Exit Ticket #8

What was the best part about the lab?

What was the worst part about the lab?

Exit Ticket #9

What does the word synthetic mean?

Give an example:

How well do you feel that you understood today's lesson?

1 2 3 4 5

Exit Ticket #10

What are the benefits of using synthetic materials?

How well do you feel that you understood today's lesson?

1 2 3 4 5

Exit Ticket #11

How well do you think you did on today's quiz? Why?

Exit Ticket #12

What was the best part about creating the infographic?

What was the hardest part about creating the infographic?

How do you feel you did on the oral presentation?

Do you enjoy presenting to the class?

Exit Ticket #13

Is there a concept you would like me to review again tomorrow?

How well do you feel that you understood today's lesson?

1 2 3 4 5

Exit Ticket #14

How do you feel you did on the Unit test?

What types of questions were the easiest?

What types of questions were the hardest?

How did taking the traditional test make you feel? Explain.

Appendix I
End of Unit: Exit Ticket

Name:_____

Period:_____

We will be having a test this week on Chemical Reactions! Here is the good news... you get to choose how you will be tested- But only if you answer all the questions below in complete sentences.

Please use your portfolio to look over all the activities that we have done for the Chemical Reactions Unit. Also, pay careful attention to the feedback you received on each activity.

1. Do you want to take the online Savvas test (traditional test)? Yes or no. EXPLAIN

2. Do you want to make an infographic about evidence of chemical reactions/ chemical vs. physical changes? Yes or no. EXPLAIN

3. Do want to do a hands-on lab identifying evidence of chemical reactions? Yes or no. EXPLAIN

4. Do you want to make a comic strip explaining physical/ chemical changes as well as evidence of a chemical reaction? Yes or no. EXPLAIN

5. How does making a choice help to show me what you know about chemical reactions?

6. What is your favorite part about science class?

7. How does choosing your assessment make you feel about the test?

8. What is the hardest part about science class?

9. Would you put forth more effort if you got to choose your assessment type every topic?

10. Why do you think you have a good or bad grade in science?