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Exploring the Impact of Musical Mnemonic Strategies on Student Achievement and Engagement in Inclusive Science Classes

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EXPLORING THE IMPACT OF MUSICAL MNEMONIC STRATEGIES ON STUDENT ACHIEVEMENT AND ENGAGEMENT IN INCLUSIVE SCIENCE CLASSES

by

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Abstract

Students with disabilities often struggle with comprehending material and performing at grade level, and teachers often find new ways to help their students comprehend the curriculum. A common challenge for special education teachers is incorporating different learning styles and various instructional strategies to better assist their students. One teaching strategy and resource that many teachers incorporate is the use of music in their instruction. This research project examines how incorporating music teaching strategies into daily instruction impacts the level of engagement and the academic achievement level of sixth-grade students with and without mild/moderate disabilities within inclusive science classrooms. The study used a pre/post group design to evaluate the changes in student achievement and engagement prior to, during, and following a four-week intervention in which two special education and general education co-teaching pairs implemented musical mnemonic strategies during the daily warm-up portion of their lessons. Results were compared with two control classes taught by the same co-teaching pairs. The results indicated that students in the experimental condition made greater academic gains on the pre/post-tests than students in the control condition, and students with disabilities in the experimental group made the highest gains of all students in either condition.

Introduction

Problem Statement

Special education teachers are responsible for providing instruction that is individualized and adapted to meet the needs of each of their students. Often these students struggle with comprehending or remembering the material and curriculum presented. Darow and Adamek (2018) explained this when they stated, "Students with disabilities, like all students, have varying levels of motivation and differing responses to classroom environments and instructional practices" (p.1). The learning disabilities of these students often make it difficult for them to gain and/or demonstrate proficiency, and these students may need the material and instruction to be provided in a different method or strategy compared to their general education peers. Often times special education students require instruction that has been differentiated and "makes use of a variety of strategies to respond to the individual needs of students" (Ernest, Heckaman, Thompson, Hull, & Carter, 201, p. 191). Also it important to keep in mind that "when seeking to keep students with disabilities in the general education curriculum, there is a strong consensus that using instructional practices similar both in focus and implementation to practices used for students in the general educations setting with similar learning challenges is best practices"(Haydon, Musti-Rao & Alter, 2017, p. 2). Dewey argued that "children need an education that is authentic and allows them to grow mentally, physically, and socially by providing opportunities to be creative, critical thinkers" (Dewey, 1919, p. 138). There is some research to support that providing opportunities for students without disabilities to participate in music instructional strategies may have a positive impact on their proficiency of social, academic, and behavior progress (Bahrami, Izadpanah, & Bijani, 2019; Brogla-Krupke, 2003;

Governor, Hall, & Jackson, 2013; Tamminen, Rastle, Darby, Lucas, & Williamson, 2017). Research also has indicated that mnemonic devices may have a positive impact on the academic, social, and behavioral progress of students with disabilities (Haydon, Musti-Rao, & Alter, 2017). Therefore, students with disabilities may benefit from participating in music instructional strategies, in particular those that incorporate mnemonic devices.

Special Education Services

Students with disabilities receive special education services under one of the thirteen eligibility categories outlined in the Individuals with Disabilities Education Act. This group of students receives instruction tailored to their specific disability and needs. The Individuals with Disabilities Education of Act 2004 (IDEA: P.L. 108-446) provides the exact definition of what special education services mean. These services are "specially designed instruction, at no cost to the parents, to meet the unique needs of a child with a disability" (IDEA: P.L. 108-446). In addition, this act continues to explain that

> "specially designed instruction means adapting, as appropriate to the needs of an eligible child under this part, the content, methodology, or delivery of instruction—
>
> (i) To address the unique needs of the child that result from the child's disability; and
>
> (ii) To ensure access of the child to the general curriculum, so that the child can meet the educational standards within the jurisdiction of the public agency that apply to all children."

One of the largest categories of students with mild to moderate disabilities at Uintah Middle School are those who are eligible for special education services under the category of Specific Learning Disability. The Individuals with Disabilities Education Act of 2004 (IDEA: P.L. 108-446) also provides the exact definition of what this eligibility entails.

> "Specific learning disability means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia."

However, specific learning disability "does not include learning problems that are primarily the result of visual, hearing, or motor disabilities, of intellectual disability, of emotional disturbance, or of environmental, cultural, or economic disadvantage."

Music Instructional Strategies

Darrow and Adamek (2018) helped provide clarification of what music instructional strategies entail. Music instructional strategies refer to presenting the curriculum using music in multiple ways. These strategies may assist students in acquiring information, as well as demonstrating understanding using the songs taught. One way of incorporating music instructional strategies is to present curricular material within a song. For example, in a science class, a songs' lyrics could be based on the science unit being taught. In particular, music mnemonic devices may be a promising strategy to help students learn, and "music provides students another avenue by which to learn the subject material taught by the classroom teacher" (Brogla-Krupke, 2003, p.16).

Mnemonic Device

It is important to have a full understanding of what a mnemonic device is. Many people are familiar with mnemonic devices and use them often to help retain information. Mostafa defines this concept as "a learning method that develops specific ways to encode any given information for easier and efficient storage and retrieval" (2017, p. 80). Haydon, Musti-Rao, and

Alter (2017) give further explanation, “A mnemonic is any procedure or instructional strategy designed to improve a student’s memory” (p. 81). For example, in the context of teaching history, specific mnemonic devices include songs with lyrics that support comprehension and retention of the Preamble to the U.S. Constitution. The information and curriculum being taught can be arranged into musical form with the goal of helping students store the concepts and then retrieve the information more easily.

Engagement

Further definition and clarity are needed for the term engagement. This term often refers to academic engagement which consists of mainly looking at the students’ engagement level during academic instruction in the general education setting. Alrashidi, Phan, and Ngu (2016) help give clarification by explaining that this term refers to “students’ participation and identification with school and school-related activities” (p. 44). They continued to explain, “Engagement is a complex term that emphasizes students’ various patterns in motivation, cognition, and behavior” (p. 48). In order to observe and measure academic engagement, one common approach is to record instances of students being on or off task. On task behavior is when the student is actively engaged in the lesson. For example, on-task behavior for a student during a class activity that involves music could consist of students singing along, modeling the teacher’s movements, or taking notes.

Academic Achievement

It is also important to have a clear understanding of what academic achievement refers to. Academic achievement is an important variable when examining the learning of students with disabilities because it is the goal of a special education teacher to aid their students in performing at grade level. For example, in the context of middle school science classes, academic

achievement can be defined as percentage of points correct on pre-summative assessments and post-summative assessments for a specific unit of instruction. Scores from the pre and post assessments can be used to gauge the academic achievement of students.

Rationale

The National Center of Special Education Research explains that there is "A considerable gap in achievement in reading, mathematics, science, and social studies exists between youth with disabilities and their peers in the general population" (Wagner, Newman, Cameto & Levine, 2006, p.12). Often the general population assumes that students with disabilities have a limit of the amount of information they can learn and comprehend, but this is far from true. What makes this population of students unique is that they often require the information and curriculum to be presented in a different manner than their general education peers. It has been shown that students with learning disabilities have difficulties in thinking about their thoughts (Wiens, 1983) and a deficit in self-knowledge which lead to difficulties in learning (Vaidya, 1999).Education is definitely not a "one size fits all," and this is especially the case when working with students with disabilities. It is vital to implement teaching strategies and curriculum that are designed to meet students' needs. It is the special education teacher's job to assure that their students are receiving an education that has been tailored to meet their students' needs, and to implement various teaching strategies helps bridge this gap (Lloyd, K. 2017).

Music has often been referred to as a universal language. Regardless of language, ethnicity, or learning disability music can be enjoyed and appreciated by all. "As well as being integral to numerous social and courtship activities, music may also be a means through which people are able to cope with emotional conflicts, increase their self-awareness, and express their unspoken and often unconscious concerns" (Brogla-Krupke, 2003, p. 55). Not only does music

have the possibility to bridge the gap of proficiency academically but it has the capability of assisting students with their social and emotional progress, and this is often an area that is overlooked or bypassed.

Further study is needed to investigate the theory that using music instructional strategies results in a higher proficiency rate in core subjects for students with and without mild to moderate disabilities in inclusive general education science classrooms. Research in this area may help provide valuable information about whether or not these strategies have a positive effect on the students' behavior, emotions, and social skills and help decrease the occurrence of disruptive behavior. Many students with disabilities struggle with behavior and expressing emotions, but "music creates physiological responses, which are associated with emotional reactions" (Sze & Yu, 2004, p.3). Lloyd's (2017) research continues the support of implementation of music in the classroom because "the low performing students in these schools experienced success in the arts, with many being previously withdrawn or disruptive, now becoming active and productive members in class" (p.20). This research has shown that students perform and succeed at a higher rate when there is not a manifestation of undesirable behavior, and future research will help support these findings.

There has been a large quantity of extensive research on the benefits of music instruction in a general education setting. Sze (2004), states "Effective integration of music in the content areas creates a learning environment that makes all children want to learn" (p.3). However, there is a very limited amount of research on the benefits of this instruction when implemented into the curriculum of special education with students with mild to moderate disabilities. Due to the lack of reliable research, many special education teachers may be lacking the evidence needed to support the implementation of this teaching strategy; therefore, more research is needed to

examine the potential benefits of implementing music instructional strategies into the special education classroom when teaching students who are receiving special education services in inclusive science classes.

Literature Review

When beginning this research, the student researcher first did a broad search to find the benefits of music in the classroom and music education. The student researcher used ERIC, Academic Search Premier, Education Full Text, and Psychological and Behavioral Science Collections. The student researcher wanted to explore what benefits music and music teaching strategies had in general when used in the classroom. The initial search terms used were "instructional strategies" and "music," and this gave close to 200 peer reviewed articles about this topic. This was far too broad of a search, and after reading the abstracts of the articles it was determined that there were no specific articles related to music mnemonics and students with disabilities. The student researcher also chose not to include any of these articles due to the fact that they included too many variables not connected to the specific realm of the research questions. The student researcher then narrowed which specific terms would be most relevant, and used the words "mnemonic device" and "music" to search the databases. This time the search resulted in 10 articles. After reading all 10 articles the student researcher selected 3 articles that looked at the use of mnemonic devices when teaching students that were English language learners or students with disabilities. The student researcher determined that 3 articles was not a sufficient amount of research to provide enough support for designing and implementing an instructional intervention, so she did an additional change to the search words. She entered the words "mnemonic" and "music." This produced 73 additional articles, many of which directly addressed the subject of interest. After reading the abstracts of the 73 articles, the

student researcher chose an additional three to do a more thorough reading of the complete article. After reading these full articles, the student researcher decided to include them because they had a close connection within the subject of study (i.e., they related to using music and mnemonics to teach students with or without disabilities). The student researcher dismissed the other articles because the information provided was not closely related to the specific topic of investigation.

The IDEA law was passed in 1975 to ensure that any child with a disability would be guaranteed a quality education. A large part of a quality education is implementing teaching strategies and curriculum that have been tailored to best meet the needs of the students. Information should also be presented in a manner that will best support retention of the information. After reviewing the selected articles, the data presented in the research indicated that one effective instructional strategy may be the use of music to assist students with mild to moderate disabilities in being more successful in a general education setting. “Music provides students another avenue by which to learn the subject material taught by the classroom teacher, but with another intelligence” (Brogla-Krupke, 2003, p.28).

There is promising data supporting the theory of incorporating music within instruction for students with disabilities. Common themes can be found in recent studies and articles pertaining to this subject that also support using music in a classroom. Governor and colleagues (2013) state that there is “potential advantage for using science-content songs for teaching. Governor and colleagues (2013) research also found that analyzing lyrics can help students connect ideas and construct understanding of scientific concepts.” Even though there are numerous benefits for students that receive instruction that involve music, three major benefits

could be identified throughout the articles I reviewed: academic benefits, behavior benefits, and cognitive benefits. I will highlight each of these benefits in the following review of five research studies.

Tamminen and colleagues (2017) conducted a study to measure the effect of a music mnemonic device. The researchers believed of the substantial empirical evidence that music can be an effective mnemonic aid in memorizing lyrics or word lists, but they wanted to take it one step further and determine whether or not using music as a mnemonic device to new and novel stimuli. This study took place at the University of London and involved twenty-five females and fourteen males with the average age of twenty-one years old. The participants were given sixty-four familiar monomorphemic based words and a novel word pairs derived from each base word. The researchers assessed whether there was a difference in the participants' ability to remember and recall words by testing three variables: having the words presented through speech, having the words presented using unfamiliar music, and having the words presented using a familiar song. The researchers first allowed participants to become familiar with the novel words through a training session and then administered a first test. The researchers followed the same procedure for each variable testing. Each testing session was repeated the next day and again after one week. Following these sessions, the researchers carried out a pause detection task, a free recall task, and an old-new categorization task. The pause detection task measured the length of time it took the participant to remember the correct word. The free recall task had the participants state as many words they could remember in no particular order and in no particular recall method. The old-new categorization task provided the participants new words which they then had to organize and differentiate with the already known words. Based on their results, the researchers concluded that the participants were able to recall the list of novel stimuli much easier and had a

lower rate of pause detection when the words were presented with familiar music. Participants were able to recall around 7% more novel words than the other testing methods. Results of this study showed stronger lexical representation when the novel words were presented in familiar music.

Governor and colleagues (2013) also provide valuable information related to the possible benefits of using music while teaching science. The researchers wanted to see if there was a direct correlation between content rich songs in science and student engagement and learning. There were six middle school science classes that were involved, and the subjects included physical science, earth science, and life science. There were three types of data collected to help determine the correlation. Teachers interviews were conducted before, during, and at the conclusion of the study. Observations were done to gauge student engagement, and student focus groups were conducted. The participating teachers were provided with training so that all teachers could implement this strategy with fidelity; however, the teachers got to choose when to implement this teaching strategy. This resulted in the teachers implementing it at different times throughout the semester. At the conclusion of the study all six teachers involved in the study said that they believed that this teaching strategy was beneficial, regardless of any reserves that they may have had at the beginning of the study. Based on student focus groups, there was an overall positive reaction towards this style of teaching. Students reported that they enjoyed the material more and that they were able to stay engaged. The observations indicated students were highly engaged in the lessons, and the observer saw very little off task behavior. All teachers involved in the study provided qualitative evidence the increase of engagement (Govenor, et al., 2013). This study does not include any quantitative data, but it does provide extensive qualitative data to support the benefits of music instructional strategies for learning science content.

Students with disabilities often need instruction and material presented in a different fashion than general education peers. This is very similar to children learning a different language. The classroom practice of differentiating instruction enables teachers to meet each individual learner's needs (Applegate, 2018). Bahrami and colleagues (2019) researched whether musical mnemonics instruction has an effect on word recall and comprehension. This study followed 90 teenagers learning English in Shokoh language institute in a small town of Khorramdare, Iran. These students, ages 14-19, attended an English class 3 times a week. The researchers divided the group of students into two groups: an experimental group and a control group. The control group was the non-musical group and the experimental group received instruction through music. The researchers administered a Sample Quick Placement Test and selected only students that scored one standard below or one standard above grade level. The Sample Quick Placement Test tested the students on skills starting at kindergarten level. The students were then asked to read level specific material. The material increases in difficulty as the students progressed through the test. If the student was able to read the material without errors, that was considered their independent level. If the student made one or two errors, that was considered their instruction level. Three errors or greater was defined as their frustration level and they should not receive instruction on that grade level. Similar to the word list assessments, students were administered a pretest and a posttest pertaining to the comprehension portion.

To assure that the instruction was musically sound, the researchers enlisted the help of a professional musician to confirm harmony of the selected words by melody and rhythm of the music. Fourteen words were selected for this study and then recorded in a song format to the familiar Frozen song, "Let It Go." Baseline data consisted of student scores on the Sample Quick

Placement Test. This baseline data gave specific levels of ability for each reader and placed them on the exact reading level that matched their abilities. Data were collected using the posttest in which participants answered three trials of filling in word lists that included all fourteen words in succession. This posttest was identical to the pretest that was administered. The researchers were able to compare the growth using these data. They then came back 10 days later and did a fourth trial. Students also completed a comprehension assessment pertaining to the words. The results of the Independent T-Test were used to conclude whether musical mnemonics had any effect on vocabulary retention, long-term vocabulary retention, and vocabulary comprehension. For vocabulary retention, the mean and standard deviation of the musical group were 12 and 1 respectively while the mean and standard deviation of the non-musical group were 10 and 2 respectively. This helps show that there are benefits to musical mnemonic strategies for word recall. The data also showed that there was a higher correlation between the students that did well on the comprehension test and the students that were part of the musical group. For the comprehension test, the mean and standard deviation of the data obtained from the musical group were 11 and 1 respectively. The mean and standard deviation of the data obtained from the non-musical group were 10 and 2 respectively. Ultimately, the control group did show a higher level of achievement, but the statistics resulting in this study were not statistically significant. These results indicate that music is a promising strategy worthy of further investigation.

It is also imperative to implement teaching strategies that are evidence based and have been proven to assist students with disabilities. A study conducted by Haydon and colleagues (2017) provides evidence of the effectiveness of using mnemonic devices when instructing students with specific learning disabilities. This study involved four 9th grade students with mild to moderate learning disabilities. The researchers wanted to not only determine whether

assessment scores would increase, but also if off task behavior would decrease. This study was designed to compare choral responding and a choral responding plus mnemonic device during geography lessons. It used a time sampling observation tool to gather data for on task behavior. Students were expected to learn and memorize all 50 states. Researchers incorporated some training prior to the study. The teacher taught the students background information on the states. The students were also given instruction by the teachers on how to respond for choral responses. In addition, the teachers taught specific cues so they would know the correct timing for response. For the portion of the study that incorporated mnemonic devices, the teacher had a predetermined animal that would assist students in remembering the state's name. At the conclusion of the study, substantial differences of overall percentages of mean daily quiz scores were noted for all four students in the choral responding plus mnemonic device condition versus the choral responding condition. Those students that received instruction using choral responding and mnemonic device had an increase of over 34% higher than the other groups. The results of this study support the likelihood of possible benefits of incorporating mnemonic devices in educational instruction.

Brogla- Krupke's (2003) study, "Improving Student Achievement Through the Use of Music Strategies," also provides evidence to support the benefits of using music in instruction. The results of Brogla-Krupke's study validate the benefits of musical mnemonic strategies with general education students because they demonstrated an increase in proficiency after music strategies were implemented in a 5th grade social studies class. At the conclusion of this study there was not only an increase in assessment scores of all categories being tested, but there was also a report of higher engagement from the students. Therefore, Brogla-Krupke's study provides evidence that musical strategies may result in higher engagement rates and a decrease in

negative behavior. Brokla-Krupke (2003) found that, “the student's behavior in music was impressive during the entire time of the project” (p. 41). Ultimately, more research is needed in this area to determine whether or not music teaching strategies help improve students’ comprehension of academic material, easier recall of information, and decreased off task behavior.

Based on the research reviewed, music mnemonic strategies may be a promising way to improve student achievement and on-task behavior. In prior research, music has been associated with improvements in students’ recall and retention of vocabulary (Bahrami et al., 2019; Tamminent et al., 2017), as well as improved academic achievement (Brogla-Krupke, 2003). Mnemonics have helped improve the academic and behavioral performance of students with disabilities (Haydon et al., 2017). Additionally, both teachers and students have reported enjoying the use of music in instruction (Governor et al., 2013). While this research base is promising, further investigation is needed to more clearly determine the overall possible benefits that could result due to the implementation of music mnemonic instructional strategies. Specifically, no prior studies reviewed demonstrated statistically significant differences between experimental and control groups when examining the impact of music mnemonic strategies, and no studies examined the impact of music mnemonic strategies on the behavior and academic performance of students with disabilities. To help fill these gaps in the research, the proposed research study will answer the following research questions:

1. What are the effects of implementing music mnemonic instructional strategies on the academic achievement of students with and without mild to moderate disabilities?
2. What are the effects of implementing music mnemonic instructional strategies within a general education science classroom on the on-task behavior of students with disabilities?

Methods

Setting

This study took place at a middle-school in the mountain-west and focused on the academic achievement of students with disabilities in general education science settings. The middle school at which the study was conducted was located in a small rural community with a population of approximately 10,000 people. This school was made up of grades six through eight and had a population of approximately 700 students. Of this population, 87 (17%) of the students were receiving special education services. The majority of the students were eligible for services under the classifications of "Specific Learning Disability" or "Autism." This middle school had a minority enrollment of 16% of the student body; the majority of minority students were mainly Native American and some Hispanic. This school was not considered a Title I school; however, one of the feeding elementary schools did receive this funding. The middle school did struggle academically overall and was ranked 589 out of 932 schools for the state in which it was located.

The school at which this study was conducted also implemented a co-teaching model in which a special educator provided instruction along with the general educator in Math, English Language Arts, and Science. This study took place during the fifth year of the school implementing this instructional strategy. Since co-teaching was still fairly new, professional development was provided yearly for teachers to strengthen their understanding of this teaching style. Professional development included a full day seminar provided by the district at the beginning of the year. It also included at least two additional opportunities for the teachers to receive instruction on district designated professional development days. Co-teaching was also addressed during regularly occurring PLC meetings. The main model of co-teaching used at this

school was team teaching; however, alternative teaching and one-teach one-assist models were also frequently implemented. Team teaching is when both teachers are delivering the same instruction at the same time. Alternative teaching is when one teacher takes responsibility for the large group while the other works with a smaller group to provide an extension of teaching. One-teach one-assist model is when one teacher takes primary responsibility for teaching the content of a lesson while the other professional circulates through the room providing unobtrusive assistance to students as needed. Regardless of what co-teaching model is used, all instruction and planning are completed as a team effort. For this study, the special education teacher alternated with the general education teacher when providing whole class instruction, provided small group instruction during Response to Intervention, and helped facilitate classroom behavior protocols. The special education teacher also provided additional assistance for students who were receiving special education services within the general education classroom. This provided an inclusive setting which is the least restrictive environment for these students.

This study took place in four sixth-grade inclusive general education science classrooms, two control and two experimental, that were co-taught by a special educator and general educator. There was one special education teacher co-teaching with one general education teacher for each class. The same special education teacher was the co-teacher for all classes. Each teaching pair had one experimental group (one class per teaching pair) and one control group (one class per teaching pair). Data from the experimental classes were compared with data from the control classes. This also allowed for a statistical data analysis of all four classes. Each period had approximately 30(range 28-32) students, and approximately 16-18% of the students

within each class period were students receiving special education services. All instruction and assessments for all students occurred in this setting at all times for this study.

Participants

Student participants. One hundred and twenty sixth grade students with and without disabilities were invited to participate in this study. In order to be invited to participate, students had to be enrolled at the middle school and be in one of the co-taught sixth-grade science classrooms. There were no criteria that would exclude any students whose parents provide consent for them to participate in the study. Seventy-five percent of students that were receiving special education services in the science classes were eligible due to a specific learning disability. The next most common category of eligibility for special education services was autism; consisting of 17% of the special education population. The remainder of the students receiving special education services qualified under the Other Health Impairment eligibility.

Data for a total of 107 students were included for this study (see Table 1). Some students who were invited to participate did not return consent forms, and other students were absent on either the pre or post-test days, so their data were not included in the final analysis.

Teacher participants. This study also included information and data provided by the two general education science teachers and one special education teacher. The criterion for the inclusion of teacher participants was that all the teachers had to be co-teaching sixth-grade science and provide consent to participate in the study. The lead general education teacher was in her thirty-third year of teaching. She taught at an elementary level for the first twenty-eight years but then moved to a middle school setting when the school district opened a new middle school. She had a master's degree in elementary education and was certified to teach all subjects in first to sixth grade. The other general education science teacher was in his sixth year of

teaching. He previously taught seventh and eighth grade science, and this was his first-year teaching 6th grade science. He had a bachelor's degree in secondary education with an emphasis of science.

The student investigator was the special education teacher within this study. She was also the individual that collected the engagement data for this study. She was in her sixth-year teaching at this school and was the department head for special education. She had a bachelor's degree in mild to moderate special education and was pursuing her master's degree in special education with an endorsement for administration at the time the study occurred. The student investigator collected the observation data (in addition to an additional special education teacher), assessment data, and survey data. To prevent any implicit bias from the student investigator no student names were used on any of the forms. The students were asked to use only their lunch number when identifying their work, and seating charts with pictures and lunch numbers were provided for on-task observation purposes. At the time of the study, she was only teaching 8th grade students, so she was also unaware which students within the science classes were receiving special education services. To prevent any risk of coercion or undue influence on teacher participants, the student researcher explained to the teacher participants that their participation was voluntary, and that if they decided not to participate, their jobs at the school would not be affected in any way. The student researcher was a peer of the teachers, and was not in a supervisory role, which limited this risk.

Measures

Four measures were used to collect data for this study. These measures were designed to provide quantitative and qualitative data.

Pre/posttest. First, all of the participating teachers had previously made a common summative assessment to be administered at the end of a science unit on the water cycle (originally planned to span six weeks). This common summative assessment (Appendix D) was also used for the pre-summative. The assessment had eight questions where students matched a term with a correct item from a diagram, two fill-in-the-blank questions, and one essay question where students were required to explain the water cycle. The students were expected to use complete sentences and correct syntactic knowledge when completing the essay question. The first ten questions were worth one point each, and the essay question was worth five points. The essay question was graded using a rubric (Appendix G). The music instructional strategies were implemented at the beginning of the cycle in the experimental classes during the bell ringer portion of the class period. Data were collected and recorded at the beginning and end of the water cycle unit using the common pre/post summative assessment. All students took the assessment in the general education science class and had the test read aloud to them during the assessment time. Students with disabilities were allowed twenty minutes of extended time to complete the assessment. The special education teacher was not involved in the administering of the summative assessment so that she may maintain the anonymity of the special education students.

Student social validity survey. Second, to collect social validity data, student participants in the two experimental classes completed a hard copy survey at the end of the study. This survey (Appendix A) was given to the experimental group only to help provide data about how the students felt towards music in general. This survey was read aloud to the entire class. There was a provided script at the top of the survey for the teacher to read to help eliminate administration errors. The results of the survey were analyzed to examine whether or

not there was an overall positive feeling and outlook towards music used in lessons. This information was important in shedding light on whether students personally believed that using the music instructional strategy was beneficial to them and whether it assisted them in being more academically successful.

Teacher social validity survey. Third, a hard copy teacher survey (Appendix C) was administered at the conclusion of the study to assess the social validity of using musical mnemonic strategies. This survey pertained to the teacher's final thoughts and feelings towards using music instructional strategies in their classroom.

Behavior observation form. Fourth, an observation form (Appendix B) was also used in this study to collect data on students' engagement, operationalized as on-task behavior. This document was designed to gather information related to students' on-task behavior. Each observation lasted approximately 5 minutes during the bell ringer portion of class. The observations took place twice a week. A second observer conducted an observation at least once a week, in order to measure inter-observer agreement. Data collectors used momentary time sampling and rotated among a pre-planned sequence of students with and without disabilities to help reduce the influence of any biases of the observer during observation. To help ensure that the observers did not know which of the observed students were students with disabilities, the students were preselected by another special education teacher who had previous knowledge of who was receiving special educational services. The observers were given a seating chart with the student's pictures and lunch number only. The students that were to be observed for each observation had a mark by their picture. The observer used an intermittent gathering system. The observer used a timer set for 30 second intervals for the duration of 5 minutes. At each timed interval the observer documented "Yes" or "No" depending on whether the randomly

selected student being observed during that interval was exhibiting on-task behavior as defined for this study.

An additional measure (Appendix F) was used to ensure the participating teachers were implementing this strategy with fidelity. The observer looked for whether or not the participating teacher implemented the strategy in the experimental setting as they were previously trained and whether it was completed during the bell ringer portion of class. The observer also conducted observations in the control setting to gather data on whether the teachers were still completing the bell ringer, just without the music instructional strategy. These observations were originally planned to take place over a six-week period, but due the COVID-19 school closure the observations took place at least once a week over a four-week period. The observations were conducted on randomly assigned days and lasted for five minutes. The fidelity of observation form for the experimental classes included data on whether the strategy was done in the bell ringer portion, if the teacher took the full five minutes, whether the bell ringer included the preselected songs, and if movements were involved with the music. Similar fidelity of observation data was taken in the control classes as well. This data included whether the teacher had a bell ringer was presented to the class, and if the teacher took the full five minutes.

Dependent Variables

Academic achievement. This study looked directly at students' academic performance using pre/post end of unit assessments. The scores of the final summative assessment were compared to the scores received on the pre-test assessment.

On-task behavior. On-task behavior was gathered through observations by using momentary time sampling. On-task behavior was operationally defined for the experimental

group as the student standing up from his or her desk, singing or saying the words, or moving his/her body to the music. The student was considered to be off-task if the student was not standing up or engaged in another activity such as: writing or doodling on paper, looking at their book or other items, or not speaking the words or moving their body. These observations lasted for 5 minutes and occurred twice a week per class period in the experimental classes.

On-task behavior observations also took place in the control group. The observer used momentary time sampling for these observations as well. The operational definition for on-task behavior in the control group consisted of the student sitting at their desk, not speaking to anyone, pencil in hand, and completing the task that has been presented for the students on the board. The student was considered to be off-task if the student was not writing down what was being asked by the teacher, talking to their neighbor, getting out of their seat, or lying their head down on their desk. These observations lasted for 5 minutes and occurred twice a week per class period in the control classes.

Student social validity. Student social validity was assessed in the experimental classes using a survey, administered prior to and following the study. The survey included 11 questions, which assessed students' enjoyment of music, the degree to which they felt the music helped them learn and engage in class, and their perception of the behavior of the class (Appendix A).

Teacher social validity. At the conclusion of the study, all three participating teachers completed a social validity survey. The survey included 11 questions, which assessed teachers' perceptions of student behavior, engagement, and learning, as well as the time and effort involved in implementing the strategy (Appendix C).

Independent Variable

Three specific songs (Appendix E) were identified to be used for this study. The songs chosen were directly connected to the water cycle unit and to the State Core Standards. The songs align with the material being taught and cover specifically the topics outlined by the state standards. In the class periods that are in the experimental condition, teachers incorporated at least one song daily in the warm-up, bell ringer (i.e., first 5-7 minutes of class) portion of their lessons.

Design

This study utilized a group pre-post design. There was a control condition consisting of two class periods, and an experimental condition consisting of two class periods. These specific classes were selected for this study since these were the classes that provided instruction for the students with disabilities in a co-taught setting. The classes in the experimental condition implemented the intervention and class periods in the control condition did not. Each class period had approximately the same student numbers and demographics. Two co-teaching pairs participated in this study, and each pair of teachers had one class in the experimental condition and one class in the control condition. This provides adequate and reliable data to determine the effectiveness of the intervention.

Procedures

This intervention was implemented in the core subject of Science. It was implemented in co-taught general education settings and reviewed in the students' Study Skills class, a specialized class period where all students receive special education services. The material was not reviewed using the songs in the Study Skills class. The special education teacher provided the same review for all special education students, and she did not include music. The participating special and general education teachers were provided with all resources, supplies,

and training needed for this study. This intervention was designed to last approximately six weeks. However, school was dismissed after four weeks of the intervention, due to the global COVID-19 pandemic. On the day before school was dismissed, the post-test was administered, even though it was two weeks early and the unit of instruction had not yet been completed

Informed Consent. The guidelines provided by the Institutional Review Board of Utah State University were followed when conducting this study. A parent/guardian consent form was sent home with all potential participants in the experimental group. This consent form included information to inform students and their parents that (a) the study would examine the direct impact of music instructional strategies on their child's academic performance, (b) their child would be taught music mnemonic devices to aid in the memory and retrieval of information pertaining to the water cycle, (c) the study would determine whether there is a direct impact of on-task behavior while this instructional strategy was being implemented, (d) parents had the right to withdraw their child's participation at any time, and, (e) parents had the right to view the data gathered pertaining to their child. The consent form also specified that students for whom consent was not obtained would participate in all study protocols because they overlapped with typical day to day activities at the school. However, the data of these students was not be included in the analysis or results.

Pre-Intervention. The study began with the students in both conditions completing the pretest unit summative assessment to gather baseline data; the exact same summative test was used as the post summative assessment. The test had a range of depth of knowledge questions and included one question for which students had to complete a water cycle diagram. The participating teachers were also provided with training. This training was provided by the student researcher of the study and was conducted during a one-hour period after school the

week prior to starting the intervention. The participating teachers were given explanations and demonstrations of what to do during the songs and the movements involved. The training was held with all teachers participating in the study. An explicit framework was used when conducting the training. An "I Do, We Do, You Do" model was used. The instructor first modeled the songs and movements for the teachers. Everyone then did the songs and movements together. Finally, the participating teachers modeled the songs and strategies to one another independently to show adequate understanding. This training showed exactly what was to be done during the intervention. All needed resources and music were shown and explained as well. Specific movements were designed to accompany specific parts to the songs, so it was vital that the participating teachers had a concrete understanding of these movements. There was also a video for one of the songs that the teachers had access to watch for the correct movements.

Training was also provided to the educational assistants and special education teachers who collected engagement data for inter-observer agreement purposes. This training took place during a thirty-minute PLC meeting and was provided by the student researcher of this study. This training followed the training of the participating teachers. An explicit framework was used during this training as well. The first step of this training was to provide explanation of the observation form and answer any accompanying questions that may follow. Each element of the form was thoroughly defined to prevent future confusion. Prior to this training, another teacher had been asked to help during the mock observations as part of the data collection training. This teacher had been informed that they would be following along with one of the sixth-grade science teachers while singing a song. They were expected to follow along but to also show some off-task behavior. The educational assistants then watched while the student researcher of this study conducted an observation. A thorough explanation was then provided afterwards of

the reasonings behind each mark. Examples of on-task and off-task behaviors were modeled for the assistants, so they knew exactly what they were looking for. The sixth-grade science teacher then did the song again with the "mock student," and everyone conducted an observation together. At the conclusion of this observation a comparison took place to determine if there were similar results. The final step of this training involved having the educational assistants conduct an observation independently. A comparison followed this observation as well. The student researcher of this study planned on providing further training in future PLC meetings on an as-needed basis, but no further training was necessary because agreement was above 80%.

Intervention. The teachers were provided with the resources and music needed for lessons in their Science classes pertaining to the water cycle. The training and modeling were previously conducted so the participating teachers could implement this strategy with fidelity. The songs and resources needed were directly tied to the content that was being taught and state core standards. The songs and resources included mnemonic devices that assisted in information retention. All participating teachers used these strategies at least once a day in the experimental class periods. The teachers used the songs at the beginning of class as the bell ringer to help review the water cycle. The participating teachers did not use the songs in the control class periods.

Engagement data collection. Observations took place twice per week during the bell-ringer in both the control and experimental groups to gather data pertaining to on-task behavior. Observations were conducted by Zinna Eaton, the student researcher (special education teacher), as well as a second observer who was a special education teacher at the school who was not teaching the sixth-grade classes (Shanona Johnson). Inter-observer agreement percentages were calculated at least twice per week, using observation data collected by Zinna and Shanona. This

provided reliability of the measurement of the rate of on-task behavior. The observer randomly identified one special education student that had provided consent and one general education student that had provided consent for each observation, using a seating chart provided by the general education teachers. This form of selection helped assure that different students were observed each time, which helped limit any implicit biasness. The observers did not personally know the students being observed. Observers identified which student to observe using a seating chart (provided by the general education teachers) that includes students' lunch number. A momentary time-sampling observation form was used, and the observers recorded whether students were on-task every 30 seconds. One timer was used for both observers to confirm starting and stopping at the same time. The observers marked "YES" if the student showed any of the following behaviors: singing along or moving their body to the music. The students selected for the observation changed each observation time.

Summative assessment data collection. Quantitative data was gathered through the use of the common summative assessment. The summative assessment was used as a pre/post assessment. This summative assessment was administered two weeks prior to the ending of the six-week unit due to the COVID-19 pandemic and the closure of public schools. At the conclusion of the four-week period, the data received from the post summative assessment was compared to the results of the pre-summative assessment to gauge growth and academic achievement.

Fidelity of implementation data. Certain measures were taken to ensure fidelity of the outlined intervention. Observers (Zinna and Shanona) collected fidelity data on the participating teachers in the experimental classes to assess the degree to which they are implementing this strategy with fidelity. These observations looked at four separate indicators to help determine

whether or not the teachers executed the strategy as they were previously taught. This observation also determined whether there was a major difference in the implementation between the two general education teachers.

This study was planned to last for 30 school days (six weeks), and fidelity of implementation observations were to be performed for at least 10 of these days. The study actually lasted for 20 school days (four weeks), and fidelity of implementation observations were performed on 4 of these days. Also, a second observer collected inter-observer agreement for fidelity of implementation observations; for 7 of the 20 days two observers performed the observations to ensure the data was reliable. Inter-observer agreement was assessed by comparing the fidelity checklists completed by each observer and calculating the total number of points of agreement divided by the total number of points of agreement plus disagreement. All observations were done by the same person for the same length of time. It was important to ensure that the intervention was implemented with fidelity. The same precautions were applied to scoring the summative assessments as well. Zinna first scored the pre and post assessments independently and recorded the results. She then had Shanona score the assessments to ensure that scoring was comparable to Zinna's data. This provided the most accurate data for the final results.

Post-intervention. At the end of the instructional unit in which the study was implemented, students in both conditions completed the post-summative assessment, as well as the social validity survey. The student surveys were administered using paper copies, and there was a two-day window for administering the survey. Teachers also completed a social validity survey to gather information on the overall teachers' thoughts and reactions of this teaching

strategy at the conclusion of the study. The survey was administered using paper copies and there was a two-day window for completing the survey.

Data Analysis

At the end of the instructional unit, the student researcher scored the student assessments. The student researcher compared the proficiency rate of the water cycle pretest with the data received after the implementation of the music instructional strategies. This data was then used to determine whether the students that participated in the intervention had a higher score of academic performance when compared to the students and classes that did not receive the music mnemonic instructional strategies, and to determine whether the gap between special education proficiency and general education proficiency had gotten closer. The mean and ranges of the percentage scores for each class were used for the comparison. There was also a comparison between general education students and students with disabilities using the mean and ranges of the percentage scores for each group. In addition to the comparison of range and means, a paired samples t-test was also conducted to examine the statistical significance of differences in achievement between students in the control and experimental conditions.

There was also an analysis of data using the survey results. The students' surveys were analyzed to determine whether there was overall student satisfaction with the new instructional strategy, and whether there was a positive outlook towards the benefits of using music in school. Additionally, student responses on the survey were compared between the two experimental groups. A similar analysis took place using the teacher survey. The results of this survey were used to determine whether there was a positive trend in teacher satisfaction using the new instructional strategies, and whether they planned on continuing to use music in their classroom due to the benefits seen at the conclusion of the study.

The behavior observation data was analyzed by calculating the average amount of time students were on-task each day. These data were separated out for students with and without disabilities in each observed class. The average time students were on task was also calculated across all observation sessions per class.

Results

Academic Achievement

Summative assessments. The mean scores and ranges on the pre and post-summative assessments for students in the experimental and control conditions are provided in Table 2, and the mean scores are displayed in Figure 2. Overall, students in the experimental group had an increase in scores of 31%, while students in the control group had an increase in scores of 20%. Students with disabilities in the experimental group had an increase in scores of 47%, while students with disabilities in the control group had an increase in scores of 15%. Students without disabilities had an increase in scores of 29% in the experimental condition, and an increase in scores of 21% in the control condition.

Based on the results of a paired-samples t-test (see Table 2), the difference in scores between the pre and post-summative assessments were statistically significant for all students for both the experimental classes (t-test, $t = 15.28$, df = 56, $p < 0.001$) and control classes (t-test, $t = 8.96$, df = 49, $p < 0.001$), but the effect size was larger for experimental classes (2.02), compared to control classes (1.27). Similarly, the difference in scores between the pre and post-summative assessments were statistically significant for students without IEPs in both the experimental classes (t-test, $t = 13.50$, df = 47, $p < 0.001$) and control classes (t-test, $t = 8.52$, df = 38, $p < 0.001$), but the effect size was slightly larger for experimental classes (1.95), compared to control classes (1.36). There was a different pattern of scores for the t-test results for students with

disabilities. For students with IEPs, the difference in scores between the pre and post-summative assessments was statistically significant (t-test, $t = 14.07$, df = 8, $p < 0.001$), and this group had the highest effect size (4.69). However, students with IEPs in the control condition did not have a significant difference in scores between the pre and post-summative assessments.

Engagement Data

Student engagement data are displayed in Figure 3. Students in the experimental group had an average on-task behavior of 94% (range of 90-99%) throughout the study, compared with students in the control group who had an average score of 74% (range of 68-81%). Students with disabilities in the experimental group had an average on-task behavior of 92% (range of 83-95%) throughout the study, compared with students with disabilities in the control group, who had an average on-task behavior of 66% (range of 62-74%). Students without disabilities in the experimental group had an average on-task behavior of 97% (range of 85-99%) throughout the study, compared with students without disabilities in the control group, who had an average score of 78% (range of 70-85%).

Inter-observer agreement was assessed for engagement data for seven observations. Across those observations, there was an average of 93.72% (range of 91-95%) agreement between the two observers.

Social Validity Data

Student Survey Data. The student participants of the experimental group were the only students that completed this survey. Average responses on the student survey are displayed in Figure 3. There was an overall positive response to music in general and to the teaching strategy

at the conclusion of this study. Specific questions were designed to determine students' perceptions of how beneficial this strategy was. Question #4 asked whether the students enjoyed the lesson more because of the teaching strategy. More than 94% of the students either agreed or strongly agreed with this statement. Similar results were found for two other questions on which 87% of the students agreed or strongly agreed that using music helped them remember the lesson better, and 92% of the students felt that they were bettered prepared for the summative assessment due to the implementation of the music teaching strategy. There was an overall consensus from the students that they benefited from this teaching strategy.

Two of the eleven questions on the survey were stated in a more negative fashion compared to the other questions. These questions were designed to ensure that the students were paying attention to the specific questions asked, rather than just saying they agreed with all the statements. When asked whether the students would prefer to do regular bell ringers without music over 93% of the students either disagreed or strongly disagreed with this statement. Also, over 94% of the students disagreed or strongly disagreed with the statement that using music made it harder for them to remember the information being taught. Students' responses on these questions align with their responses on the questions that were phrased positively towards music, and indicated overall that students felt positively towards the music teaching strategy.

There was one question that was considered an outlier because responses were not consistent with the other data. When asked if the music helped the students stay on task better, more than 77% of the population believed that it helped them. This was contradictory with the results of question #9 pertaining to whether the class was better behaved during the lesson with music. Forty percent of the student population either agreed or strongly agreed that the class was

better behaved; however, 38% of the students answered contrary and believed that the class was not better behaved during the lesson with music. There was even 22% of the class that answered "N/A" which provided no data in support or disagreement with this question.

Teacher Survey Data. Average responses on the teacher survey are displayed in Figure 4. General education teacher responses on the survey are displayed in Figure 5. General education teacher responses were analyzed separately because the special education teacher was also the student researcher. The overall results of the teacher survey were very similar to the results of the student survey. There was an overall positive outlook towards music in general and the new teaching strategy. All teachers involved in this study either agreed or strongly agreed that this teaching strategy assisted the students academically, the strategy was easy to implement, and the students were better behaved. They also stated that they would use this teaching strategy again, and they would recommend using music to their colleagues.

The only time that there was not a complete agreement was pertaining to whether the students stayed on task better and if the class misbehaved during instruction. Two of the three teachers that completed the survey believed that the class was better behaved, and the students stayed on task better. This data continues to support the overall positive benefits and outlook the teachers had on this teaching strategy.

Fidelity of Implementation Data

Observations were conducted to assess the fidelity of teachers implementing the strategy. Each teaching pair was observed seven times during the study. The results of the fidelity observations indicated that the teachers overall implemented the strategy with 92% (range of 84-

100%) fidelity, on average. One teacher implemented the strategy with 100% fidelity on average, while the other teacher implemented the strategy with 84% fidelity on average. Inter-observer agreement for the fidelity observations was conducted for three observations. The average percentage of agreement between the two observers for fidelity was 100%.

Discussion

Key findings

There were four major key findings at the conclusion of this study. Each key finding has implications for students' success in general education and/or co-taught science classrooms. The following key findings are directly connected to the overall achievement and engagement of the students in the inclusive general education 6th grade science class.

Academic achievement. The results of this study show that while students in both groups had improved scores over the six-week unit, students in the experimental condition had a higher improvement in scores that was statistically significant. Even though this study only took place over a four-week period, both the students with disabilities and general education students in the experimental group showed a much larger gain than students in the control group. The substantial effect size provides considerable support for teaching science using a music mnemonic device. These results support the findings of Brogla-Krupke (2003), who provided concrete evidence of the academic benefits due to the music strategies within the core subjects; "the interdisciplinary studies opened avenues for further student learning." The author helped show that different learning preferences are found within all classrooms and that music helps to address this issue. Students were able to recall the historical information from songs at a much higher rate, and this is very similar to the results of the students in the experimental group for

this study. Similarly, the students in the experimental group in this study scored significantly higher on average than the control group students, especially the students with disabilities.

This study was conducted to examine the potential benefits of using music mnemonic strategies on the academic success of students with mild to moderate disabilities. These results of this study support the findings of Haydon et al., 2017, who demonstrated that students with disabilities benefited from mnemonic strategies in terms of their academics and behavior. The results of this study indicate that students benefitted academically and behaviorally from the use of music mnemonic strategies, and in particular demonstrated greater benefits for students with disabilities compared to students without disabilities. The group of students that had the highest effect size was students with disabilities in the experimental condition. This is a particularly strong finding, since students with disabilities in the control group did not make statistically significant gains. Students with disabilities in the experimental condition had an improvement of 47%, compared with students with disabilities in the control condition who had an improvement of 15%, and students without disabilities in the experimental (gain of 29%) and control conditions (gain of 21%). These results indicate that music mnemonic strategies may specifically benefit students with disabilities and help close the gap in achievement between students with and without disabilities. It may be that the repetitive songs and movements on a daily basis helped students retain and recall the material. The effect size for this group also is a major support of why other teachers should consider using this teaching strategy. There was a large effect size for the difference in pre/post-test scores for the students with disabilities in the experimental condition, and this effect size was the largest out of all the groups of students in either condition. Additionally, based on the surveys, the students especially enjoyed this form of teaching, and they often requested to continue doing bell ringers in this fashion.

Behavior benefits. Many behavioral benefits can be attributed to music instruction, especially when working with students with learning disabilities. The results of this study align with those of Haydon and colleagues (2017), which indicated that students with disabilities showed improved behavior when they engaged in mnemonics. The results of this study build from Haydon and colleagues (2017), since this study had the added component of music mnemonic strategies (rather than just mnemonics without music). These results may be promising for helping address behavioral challenges or a lack of engagement of students with disabilities. A large population of students with disabilities struggle with exhibiting appropriate behaviors in a school setting but implementing an engaging teaching strategy can reduce or eliminate the undesired behaviors. The results from the study found that the students were engaged and on task at a much higher rate for all students during the portion of the class when the music instructional strategy was being used. The students who participated in the new teaching strategy were on task and engaged at least 90% of the time. When students are engaged, it can be inferred that the students will then have a higher likelihood to listen and learn the material.

With behavior being highly correlated with student success rates it is imperative that teachers utilize teaching strategies that will produce higher rates of engagement. The results of this study showed this correlation. The experimental group had higher on task and engagement levels, and also had higher rates of academic success. Based on this study, we cannot determine whether increased engagement resulted in increased academic achievement, or if the strategy itself resulted in increased academic achievement. However, both behavior and academics are linked, so it may be that the strategy improved both engagement and achievement.

Teacher and student social validity. Overall, students and teachers in this study had positive views of music in general and music in the classroom. Based on their responses on the surveys, both the students and the teachers indicated they believed that incorporating music in instruction was beneficial. One student reported that it was "so much fun getting to sing and dance around instead of doing work." He then stated that he realized that it taught him "stuff." Another student reported that she "wished that class would start like that every day," and that "it made science way more fun." Many students reported on the survey that the class was more off task and the music may have had a negative effect on classroom behavior, but they still preferred the musical instruction over regular instruction. However, teachers viewed the behavior exhibited by the students as part of being engaged in the teaching strategy and reported that they would definitely recommend this teaching strategy to their peers. Students and teachers also reported that they believed that music helped them learn the material better and then allowed them to remember it more easily while being tested. A student testified of this benefit when he stated that he "didn't really like the dancing part, but when I was taking the test, I could sing the whole song to get the answers right." These results support the findings of Governor and colleagues (2013) in their case study pertaining to using music in general education science. It was concluded that, "According to the teachers in this study, the use of key terms and phrases in science-content music helped students build their understanding of specific vocabulary based on how terms were used in the songs" (p.6). The results of the current study support those of Governor and colleagues (2013) and also build upon the theory that it specifically is beneficial for students with mild to moderate disabilities. These results demonstrate that both teachers and students viewed music mnemonic strategies favorably and would likely be interested in

implementing them or participating in them in the future. These results are aligned with the positive results based on summative assessment scores and observation data.

Limitations

There were some limitations within this study. The first main limitation for this research was that there was only one special education teacher involved within all four classes (experimental and control conditions), and that special education teacher was also the student researcher for this study. It is possible that having the special education teacher involved in all four classes may have influenced the results. However, this is unlikely because the general education teachers led the bell-ringer portion of the lessons in all four classes. It is also possible that the teacher social validity ratings were skewed as a result of one of the three participating teachers being the student researcher. The student researcher had a higher level of knowledge of music instructional strategies compared to the general education teachers, and this knowledge base may have influenced her ratings on the social validity survey. However, even when the ratings of the special education teacher are removed from the social validity survey results, the ratings of the general education teachers consistently indicate positive feelings towards music instructional strategies.

Another limitation was the data were collected using materials created by the teachers at the school. It is therefore unknown to what degree the formative and summative assessments were reliable and valid. Additionally, there were some absences on assessment and observation days, which opens up the possibility of the data being skewed. However, the group sizes ended up being very comparable (see Table 2), and the overall number of students involved in the study was appropriate for the statistical tests used.

An additional limitation is that the music mnemonic strategy may indicate a novelty effect. The students could be overly engaged due to the new strategy. Further research would be needed to know whether the strategies themselves hand that major of an impact. For example, a future study could implement a new strategy that doesn't involve music or mnemonics in the control group, while the music mnemonic strategies were implemented with an experimental group. This would help rule out the impact of the novelty of a new strategy.

An additional limitation is that there may have been differences in results between teachers. We attempted to control for this by having each teaching pair have one experimental class and one control class. However, more advanced statistical methods should be used in the future for studies on this topic that involve more than one participating teacher/teaching pair, to help rule out effects based on teachers. Additionally, it is also possible that differences in teachers' presentation styles and enthusiasm may have influenced the results. The emotion or enthusiasm of the teachers may have either encouraged or discouraged student engagement and/or participation. Even though both science teachers implemented the strategy with above 80% fidelity, one teacher took it a step further. She presented the songs with a higher level of excitement, and this made her students visibly more excited to participate. She even had her experimental class perform the song and movements to the other experimental group taught by the other teacher. This varying level of emotion towards the strategy could indicate differences in achievement that are related more to how particular teachers use the strategy, rather than just the strategy itself.

An additional possible limitation is the number of classes in which the strategies were implemented. This strategy was only implemented in 4 classes. A larger sample size would help

strengthen the results. This study also did not evaluate whether the strategies were generalizable to other content areas or grade levels. The students in this study were all sixth graders, so it is unknown whether younger or older students would benefit from the strategy in similar ways. It may be that the strategies are less socially acceptable to older students (i.e., high-schoolers), but future research needs to be done to determine if that is the case. Older students may be hesitant to participate in this teaching strategy because students at this age typically do not put themselves in a situation where they feel potential embarrassment in front of their peers.

Last, this study did not take into consideration the possibility of a worldwide pandemic which resulted in shortening the study by two weeks. With required school closure, the post-test was administered before the end of the instructional unit (two weeks early). Based on that, it is likely that students would have continued to make gains during the last two weeks of the instructional unit. However, it is promising that students made the growth they did between the pre and post-test, considering that they had not engaged with all of the planned content in the instructional unit. This growth provided insight for the two general education teachers that an entire six-week unit is not needed for this subject. It is possible that the additional two weeks of instruction could have changed the results of this study, but it is unknown whether the two weeks would have resulted in significantly different results than those that were found.

Directions for future research

While the results of this research are promising, further research is needed to more fully examine the implementation of musical mnemonic strategies in classroom. It would be valuable to determine if musical mnemonic strategies would be beneficial in subjects other than science. Based on the research reviewed, music strategies did show positive benefits for students in social

studies (Brogla-Krupke, 2003), as well as vocabulary (Bahrami et al., 2019; Tamminen et al., 2017), so it would be worthwhile to examine their impact in other subject areas. It would also be valuable to conduct this study with a larger student population. A larger participant pool would improve the confidence with which to make conclusions about the statistical analyses, and make it possible to use more advanced statistical analyses. Additionally, future research is needed to determine whether music mnemonic strategies have variable benefits based on grade-level. It may also be beneficial to research additional musical mnemonic strategies other than the one used within this study in science classes specifically.

Conclusion

Prior research has demonstrated that music mnemonic strategies may be beneficial for students' academic achievement and engagement (Bahrami et al., 2019; Brogla-Krupke, 2003; Governor et al., 2013; Haydon et al., 2017; Tamminen et al., 2017). The results of this study support prior research by demonstrating that students who participated in music mnemonic strategies made statistically significant growth in academic achievement, and their growth was higher than students in the control group. Additionally, the results demonstrate that the music mnemonic strategies were associated with improved academic engagement. Teachers and students both reported that they liked the music mnemonic strategies and would want to use them in the future. Future research should be conducted to further examine the use of music mnemonic strategies in other contexts, and to address some of the limitations present in this study.

Table 1

Student Demographics

	Total Students	Students with IEPs	Students with SLD	Students with Autism	Students with OHI
Experimental Group					
Class 1	28	5(17%)	4 (80%)	1 (20%)	
Class 2	27	7 (26%)	4(57%)	2(29%)	1 (14%)
Control Group					
Class 1	26	6(23%)	5 (83%)		1 (17%)
Class 2	26	6(23%)	5(83%)	1 (17%)	

Note: IEP=Individualized Education Plan; SLD=Specific Learning Disability; OHI=Other Health Impairment.

Table 2

Student Scores on Pre-Post Science Summative Unit Assessment

	Pre-test		Post-test		Difference in means (t-test)			
	Mean	SD	Mean	SD	t	df	P	Effect
Exp. Condition								
All students (n=57)	55%	17%	86%	12%	15.28	56	<.001*	2.02
Students w/IEP (n=9)	36%	9.4%	83%	13%	14.07	8	<.001*	4.69
Students w/o IEP(n=48)	58%	17%	87%	12%	13.50	47	<.001*	1.95
Control Condition								
All students (n=50)	54%	23%	74%	18%	8.96	49	<.001*	1.27
Students w/IEP (n=11)	40%	23%	55%	21%	3.16	10	0.010	0.95
Students w/o IEP (n=39)	59%	21%	80%	12%	8.52	38	<.001*	1.36

Note: *Significant at p<0.001; T-test is two-tailed; effect size reported is Cohen's d; SD = standard deviation; w/ = with; w/o = without.

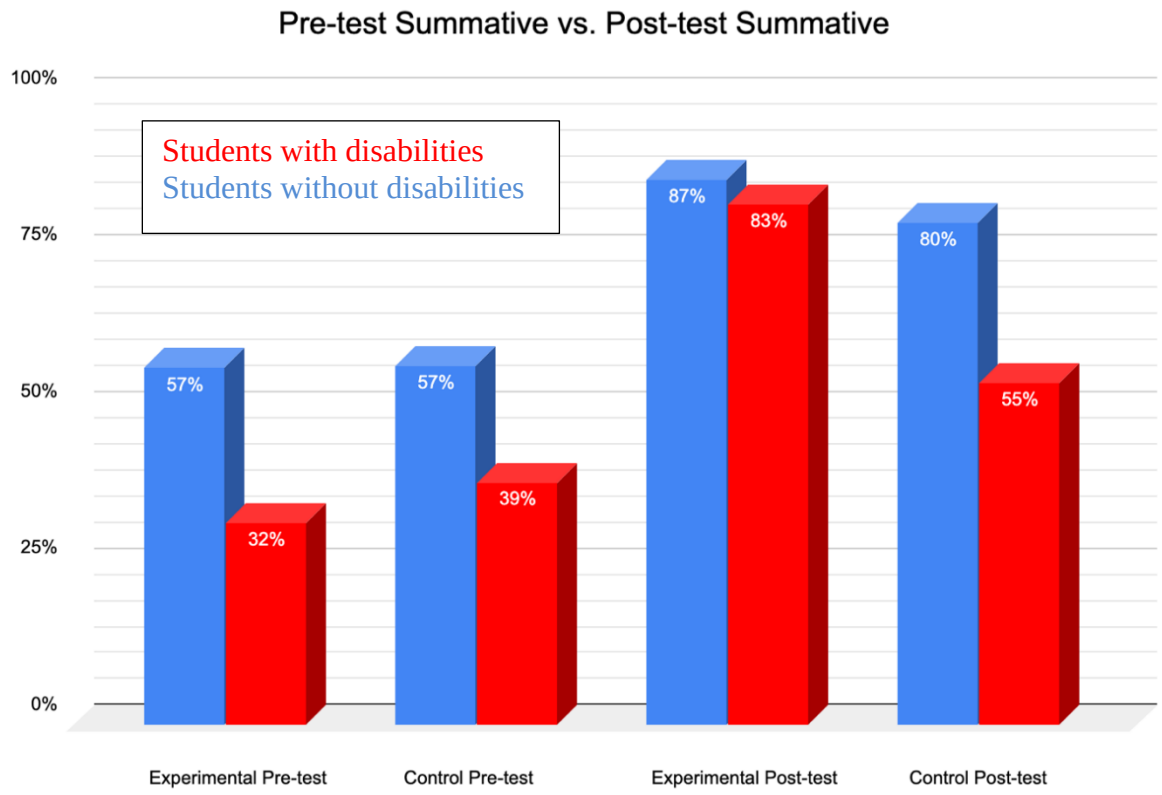

Figure 1. Graph of students' summative assessment scores

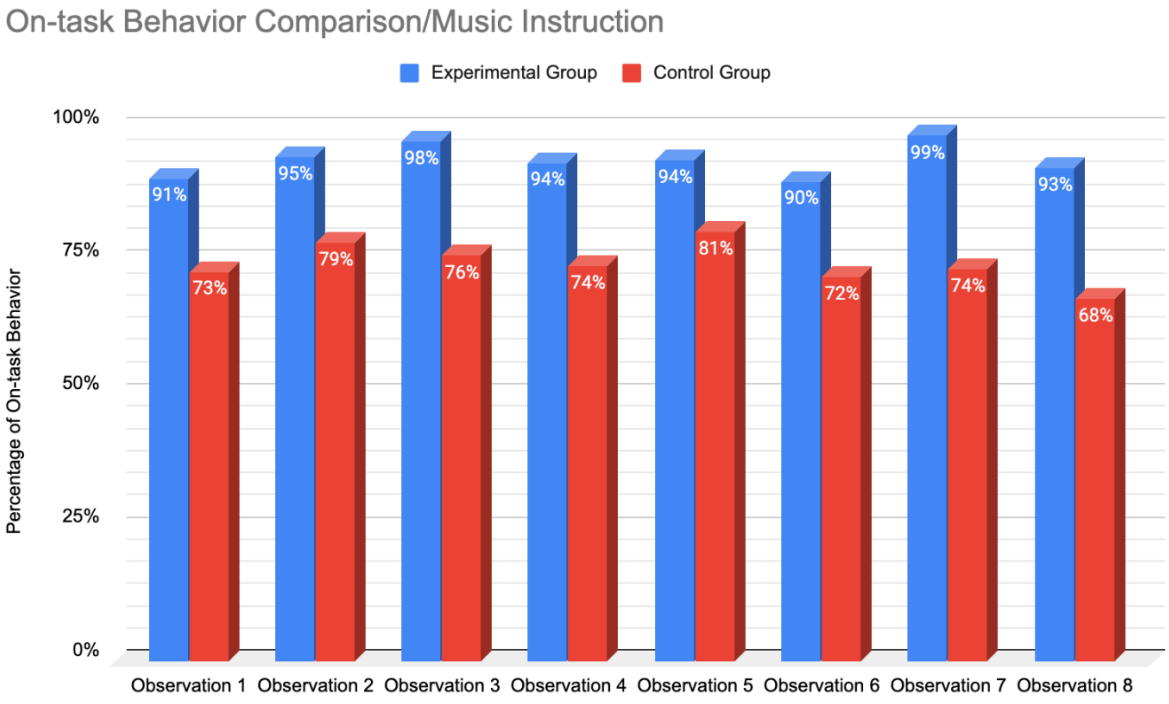

Figure 2. Graph of students' on-task behavior

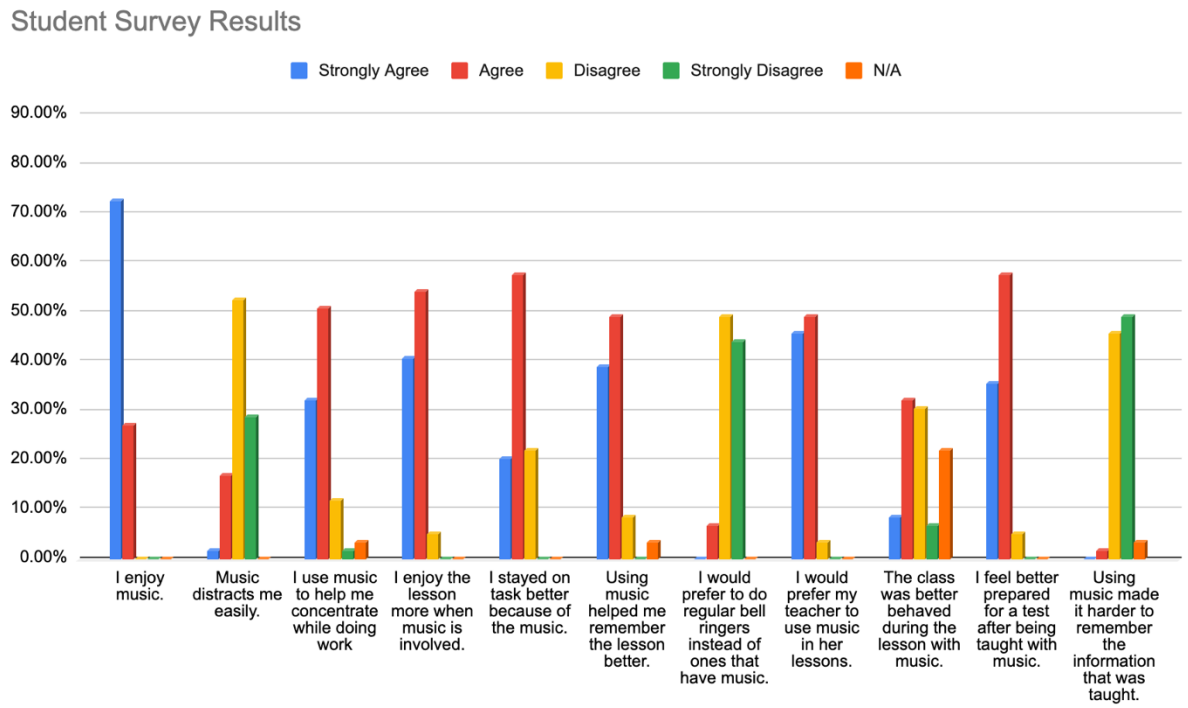

Figure 3. Student Ratings on Survey

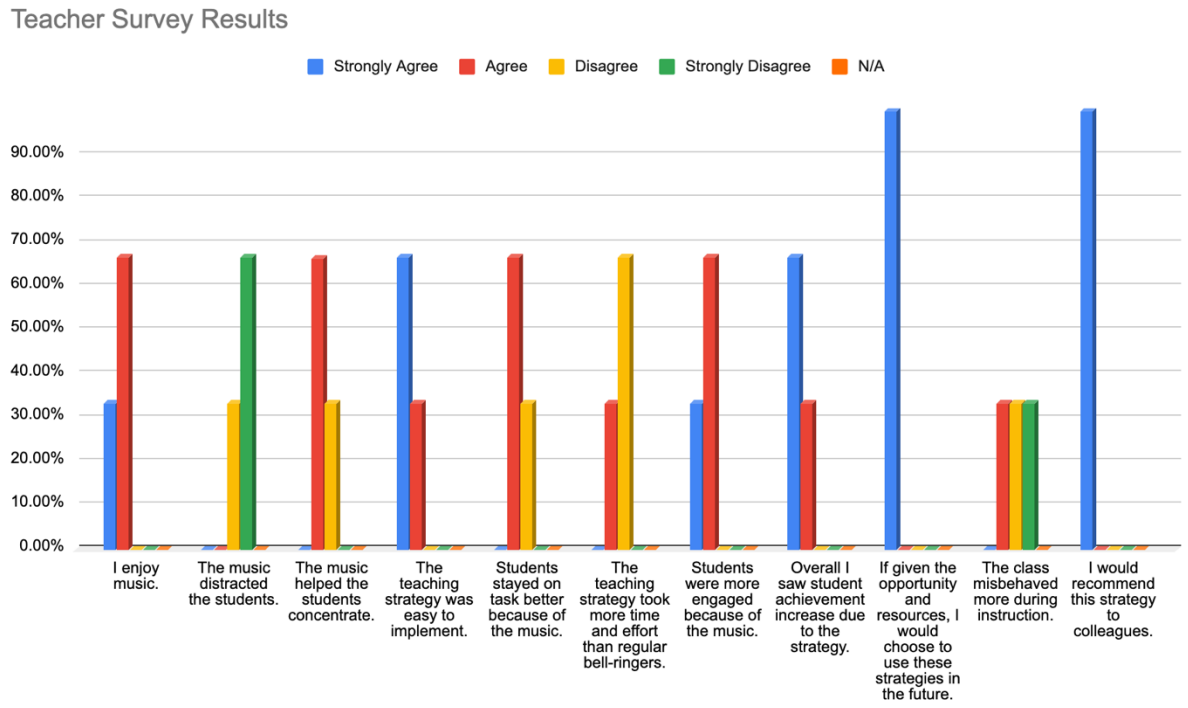

Figure 4. Teacher Ratings on Survey

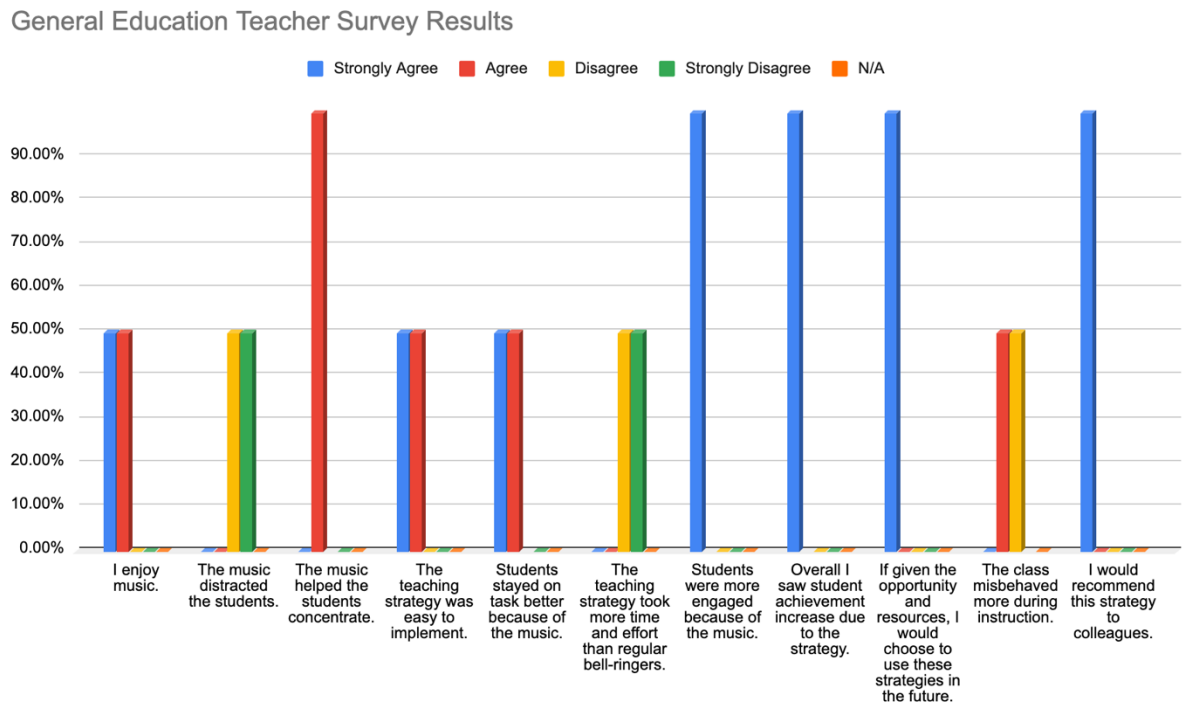

Figure 5. General Education Teacher Ratings on Survey

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Appendix A

Student Evaluation of Music Strategies

The purpose of this survey is for you to help your teacher understand how you felt about using music strategies in this class. Please check the box that describes how much you agree with each statement. If you are not sure or have no opinion, then just check the box "NA." Your response will be anonymous, so please answer all questions honestly. Please do not place your name anywhere on this form. Check only one box for each statement.

Question	Strongly Agree	Agree	Disagree	Strongly Disagree	N/A
I enjoy music.					
Music distracts me easily.					
I use music to help me concentrate while doing work.					
I enjoy the lesson more when music is involved					
I stayed on task better because of the music.					
Using music helped me remember the lesson better.					
I would prefer to do regular bell-ringers instead of ones that have music					
I would prefer my teacher to use music in her lessons.					
The class was better behaved during the lesson with music.					
I feel better prepared for a test after being taught with music.					
Using music made it harder to remember the information that was taught.					

What was your favorite or least favorite part of using music in this unit?

_____

_____

_____

Appendix B

Student Observation

Student Name_____ Start Time:
Observation Date_____
Environment _____ End Time:_
Behavior Being Observed _____
Have your stopwatch/timer ready. At the end of each interval, look to see if the target student is engaging in the behavior at that moment. Mark + (yes) or – (no).

Taking peer comparison data:
Before starting, establish a plan for which peers will be observed and in what order. Immediately after observing the target student, look at the first peer and determine if he/she is engaging in the described behavior. Mark + (yes) or – (no). In the next interval, observe the target student, then look at the next peer in the established order. Continue in this fashion, cycling through the peer group as needed to reach the end of the observation. Data should be taken in 15 sec intervals. The % at the end provides an estimate of the entire peer group behavior.

Calculate the % by adding the # of +s divided by the number of intervals (20) and multiplying by 100.

Date:	Intervals: (Mark + or -)									
Time:	1	2	3	4	5	6	7	8	9	10
Student										
Peers										

	11	12	13	14	15	16	17	18	19	20	+s /20	% of Intervals
Student												
Peers												

Appendix C

Teacher Evaluation of Music Strategies

The purpose of this questionnaire is to help determine whether using music instructional strategies had an overall positive effect on the proficiency level of students. Please check the box, using the code provided at top, that describes how much you agree with each statement. If you are unsure please check the N/A box. Your response will be anonymous, so please answer all questions honestly. Please do not place your name anywhere on this form. Check only one box for each statement.

Question	Strongly Agree	Agree	Disagree	Strongly Disagree	N/A
I enjoy music.					
The music distracted the students.					
The music helped the students concentrate.					
The teaching strategy was easy to implement.					
Students stayed on task better because of the music.					
The teaching strategy took more time and effort than regular bell-ringers					
Students were more engaged because of the music.					
Overall I saw student achievement increase due to the strategy.					
If given the opportunity and resources, I would choose to use these strategies in the future.					
The class misbehaved more during instruction					
I would recommend this strategy to colleagues.					

What was one outcome from using this teaching strategy?

_____

_____

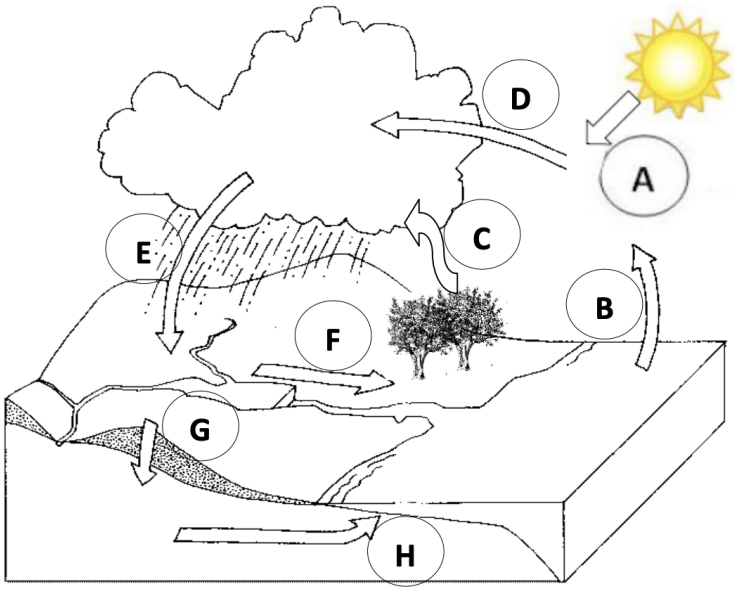
_____

Appendix D

Pre/Post Summative

Name: _____ Date:_____ Period: _____

Exploring the Water Cycle Pre - Assessment



Match the letters in the diagram above to the correct term in the list below.

1. Condensation _____
2. Groundwater _____
3. Infiltration _____
4. Evaporation _____
5. Transpiration _____
6. Precipitation _____
7. Runoff _____
8. Solar Radiation _____

Multiple Choice. For each statement, circle the correct answer.

9. Most of the energy that drives the water cycle comes from _____.

a. The Sun b. Earth's cores c. Earth's oceans d. the equator

10. _____ is the driving force behind excess runoff after a big precipitation event.

a. precipitation b. steepness of a hill c. gravity d. solar radiation

Pretend you are a drop of water. Describe a trip through the water cycle. Begin your journey in the ocean. For each phase of your journey, be sure to explain how heat energy is affecting you.

_____

_____

_____

_____

_____

_____

_____

Appendix E

Song #1
The Water Cycle Song
(sung to the tune of "Clementine")

Evaporation, condensation, precipitation all day long.

They're the steps of the water cycle
And they continue on and on.

Song #2
Water Cycle Song Sing to 'Ten Little Indians'
Condensation, gas to a liquid.
(Shake your hands like they're wet)
Freezing, freezing, liquid to a solid.
(Rub your arms like you're cold)
Evaporation, liquid to a gas.
(Raise your fingers like Itsy Bitsy Spider-'out came the Sun and dried up all the rain')
Melting, solid to a liquid.
(Wave your hands back and forth like you're cooling off yourself)

Condensation, gas to a liquid.
Freezing, freezing, liquid to a solid.
Evaporation, liquid to a gas.
Melting, solid to a liquid

Song #3

Water Cycle Song
Music and Lyrics by: Have Fun Teaching

The Water Cycle
Takes the water and moves it
Up and Down and all around the

Earth Evaporation comes
When the heat from the Sun
Warms up all the groundwater
Then it turns to water vapor

Condensation takes over
It goes up to the clouds
Water vapor cools down
And it changes to a liquid, now

Precipitation happens
When the drops get big
It falls like Rain, Snow, Sleet, and Hail upon my head
I know it's the water cycle happening again
Evaporation, Condensation, Precipitation

Song #4
Water Cycle Rap

Lyrics:
Water, water, water, water
Water cycle
'Round and 'round and 'round goes the
Water cycle
Water, water, water, water
Water cycle
Come on y'all, get down with the
Water cycle
Let's do it!
Here we go!
Precipitation, water falls down
Accumulation, water gathers all around
Evaporation, water rising from the ground
Transpiration, plants sweat the water out
Condensation, water turns into a cloud
And when the cloud gets heavy,
The water cycle just keeps goin' 'round
Precipitation, water falls down
Accumulation, water gathers all around
Evaporation, water rising from the ground
Transpiration, plants sweat the water out
Condensation, water turns into a cloud
And when the cloud gets heavy, what happens?
It just keeps goin' 'round
Oh, that's really dope, actually
Water, water, water, water
Water cycle
'Round and 'round and 'round goes the
Water cycle
Water, water, water, water
Water cycle
Come on y'all, get down with the
Water cycle
Precipitation, we're talkin' rain, sleet,
Hail, snow, oh!
Accumulation, into rivers, oceans,
And the ground, you know, you know it
Evaporation, that's steam rising from the spouts
I'd love a spot of tea
Transpiration, flowers and leaves
And stems sweat the water out
Condensation, drops appear
On the side of your glass when water turns
To a liquid from a gas
Water, water, water, water
Water cycle
'Round and 'round and 'round goes the
Water cycle
Water, water, water, water
Water cycle
Come on y'all, get down with the
Water cycle
One more time
Precipitation, water falls down
Accumulation, water gathers all around
Evaporation, water rising from the ground
Transpiration, plants sweat the water out
Condensation, water turns into a cloud
And when the cloud gets heavy, what happens?
You know, it just keeps goin'
Around and around and around and around
And around and around and around and around
And around and around and around--
Okay, we get it.
Water, water, water, water
Water cycle
'Round and 'round and 'round goes the
Water cycle
Water, water, water, water
Water cycle
Come on y'all, get down with the
Water cycle

Appendix F

Fidelity of Observation

Teacher:_____ Date:_____ Period: _____

Begin Time: _____ End Time: _____

Question:	**YES**	**NO**
Was the strategy implemented during the bell ringer?		
Did the bell ringer take 5-10 minutes?		
Did the bell ringer include preselected song(s)?		
Were the appropriate movements to the songs included?		
Did teachers provided corrective feedback if students were performing the movements incorrectly?		

Notes:

Appendix G

Rubric for Essay Question

4 pts	3 pts	2 pts	1pt
Student includes all parts of the water cycle. Student also uses complete sentences that start with a capital and end with proper punctuation.	Student does not include one part of the water cycle. Student makes minor mistakes when writing complete sentences that start with a capital and end with proper punctuation.	Student does not include two or three parts of the water cycle. Student makes minor mistakes when writing complete sentences that start with a capital and end with proper punctuation.	Student does not include four or more parts of the water cycle. Student makes major mistakes when writing complete sentences that start with a capital and end with proper punctuation.