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The Effects of Inquiry-Based Activities on Content Vocabulary Retention in 4th-Grade Science Students

Jillian Burns

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The Effects of Inquiry-Based Activities on Content Vocabulary Retention in 4th-Grade Science Students

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Jillian Burns

Saint Catherine University

St. Paul, Minnesota

Advisor Mary Hedenstrom

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Abstract

This action research project studied the effects of inquiry-based activities on content vocabulary retention in a fourth-grade science classroom in central Minnesota at a rural elementary school. Content vocabulary words specific to the rocks and minerals unit were introduced to students through the use of four different strategies, Time to Talk, Text Cards, Word Bank, and Graphic Organizers. Students completed various hands-on inquiry-based activities during their science lessons one to two times per week throughout thirteen weeks. The research utilized qualitative and quantitative data collection research methods; findings show that all students can strengthen their content vocabulary knowledge and retention when they are able to interact with their peers and complete hands-on activities when learning content-specific vocabulary. Future research could explore the use of visual access to the content vocabulary when they are using the terms; this can be as an individual word bank, word wall, or a classroom word wall. This study shows that inquiry-based strategies promoted content vocabulary instruction, especially time to talk and word banks.

Keywords: inquiry-based activities, elementary science, content vocabulary, retention, Time to Talk, Text Cards, Word Bank, Graphic Organizers

Vocabulary instruction is a valuable part of classroom instruction. Children enter their schooling career with a broad exposure to vocabulary. This wide array of exposure causes a learning gap between students (Coyne et al., 2007; Sparapani et al., 2018). If this gap in learning is not addressed at an early age, this gap in vocabulary knowledge will only continue to expand over time. One way to decrease this gap in vocabulary knowledge is to incorporate vocabulary instruction in early elementary classrooms. Students are already learning essential aspects of vocabulary learning through reading, writing, and speaking (Nelson & Allen, 2020). Instead of keeping vocabulary instruction primarily in literacy, it can benefit students if vocabulary instruction expands into other content areas, such as Science.

Science instruction includes complex terminology and words with different meanings in everyday life (Block, 2020; Brown & Concannon, 2019; Rice & Deshler, 2018). These aspects of science vocabulary also force the science teacher to be a language teacher. The teacher is responsible for teaching students intricate science concepts and science literacy during science instruction. Science literacy is the ability to read critically and understand science texts (Block, 2020; Brown & Concannon, 2019). Though this looks different at all age levels, high school and middle school students may read and interpret textbooks. At an elementary level, students are hearing and using the scientific vocabulary with the teacher's assistance.

Students are expected to learn and understand these words and the concepts in a very short and inconsistent amount of time. This inconsistency can be difficult for students, depending upon their vocabulary acquisition skills. Still, it is exacerbated for students with learning disabilities since most science terms have a different meaning when not used in the context of science (Rice & Deshler, 2018). When reviewing vocabulary words with elementary students, this researcher finds that students struggle to remember the definitions of science-specific vocabulary terms from previous classes. Students lack the skills and knowledge to help retain the terms taught during science lessons, which is then reflected in the fifth-grade science MCA scores. All students struggle with this, especially the upper elementary students, where science vocabulary becomes more intense. The end goal is to provide students with strategies that will help them learn, understand, and retain the definitions of science vocabulary in meaningful ways that will eventually improve test scores.

This research was conducted in a fourth-grade science classroom in central Minnesota at a rural elementary school. This research aims to contribute to the extensive research on teaching content-specific vocabulary to elementary students. This research provides information on how incorporating hands-on inquiry-based learning affects students' understanding and retention of science vocabulary.

Theoretical Framework

Vygotsky's social constructivist theory is built on Piaget's theories of active learningPiaget believed that cognitive development stems mainly from independent exploration, where children construct their understandings without any assistance. Piaget also theorized that children develop through interactions with their peers, not adults. Vygotsky, however, focuses more on the social interactions during learning and development. Through this theory, Vygotsky identified several factors that aid in cognitive development. This action research project is built on the zone of proximal development and scaffolding framework and the importance of social factors that help in cognitive development.

Vygotsky suggests that children learn best when they are in their zone of proximal development. The zone of proximal development is the area between what a child can do independently and what a child is incapable of completing (Vygotsky, 1978). In the zone of proximal development, an adult is there to assist the child in bridging the gap to help them complete a task successfully. Vygotsky (1978) calls this temporary adult support scaffolding. It is crucial that the task given to the child is one that they are not able to complete on their own but is still attainable once support is removed. In the beginning, the adult provides a great deal of support. Vygotsky (1978) calls this support scaffolding. However, as the child becomes more successful at completing the task, the adult gradually removes support, allowing more independence in completing the task. The removal of support continues until the child can complete the task independently.

Another part of Vygotsky's theory is the social aspect. Children learn through their social interactions with others (Vygotsky, 1978). When provided with opportunities that allow children to communicate with others while performing developmentally appropriate tasks, children can co-construct their knowledge. These social interactions increase understanding when scaffolded with adult social interactions. Children observe, learn, and then internalize the interaction with the adult, and then use that information to help construct their own knowledge and understanding (Vygotsky, 1978).

The constructivist theory states that children use their past experiences to help construct their own knowledge and understanding of a new experience. This construction of new knowledge constantly occurs in a classroom, especially in an elementary science classroom. Students are exposed to several different science content-specific vocabulary terms in an upper elementary science classroom. A majority of these words have different meanings in the context of science than they do in a students' everyday life. This complexity of terms pushes students into their zone of proximal development. The teacher then gives students tasks within their proximal development zone and provides assistance to help the students construct their own understanding through hands-on inquiry-based activities and interactive word walls. An interactive word wall is a display of words that helps to support continual learning and teaching. In the elementary science classroom, a topical word wall would be the best fit, as it only includes words that are specific to the current concept or theme being taught. Interactive word walls are very useful in helping students with academic writing. In order to have a successful word wall, it should include words that are relevant to the topic, and used frequently, new words should be added daily as the students encounter them and are taught. The social aspects are addressed through small group and whole group discussions that the teacher facilitates. These strategies are designed to support students in constructing their own understanding of the new science vocabulary words.

Review of Literature

Vocabulary instruction is very valuable in classrooms. Students enter school with a wide range of vocabulary words. This knowledge gap is typically addressed during the vocabulary or literacy block in a regular classroom. However, this is not the only setting in which vocabulary instruction can take place. Teachers can help improve students' vocabulary by incorporating explicit instruction into other content areas like science. The following literature review will outline the importance of vocabulary instruction, how science vocabulary instruction differs from other subjects, and different effective strategies that teachers can use to help improve student vocabulary use and understanding.

Importance of Vocabulary Instruction

Vocabulary, or words that we use to communicate effectively, is primarily thought of as a topic taught in literacy (Cohen & Byrnes, 2007). Children begin to develop their vocabulary when they are very young, around one or two years old (Cohen & Byrnes, 2007; Sparapani et al., 2018). This early exposure to vocabulary happens from both formal and informal exposure to words. Even the informal teaching of vocabulary positively affects children's learning when reading passages (Cohen & Byrnes, 2007; Kennedy et al., 2017). The way that children are exposed to vocabulary varies greatly; this results in children entering classrooms with an array of vocabulary knowledge (Coyne et al., 2007; Sparapani et al., 2018).

As stated in Sparapani et al. (2018), children enter their education careers with a wide range of vocabulary knowledge; some children have hours of exposure to books and communication, other children have minimal exposure to language and word meanings (Coyne et al., 2007; Sparapani et al., 2018; Suárez et al., 2020). As students continue in their education careers, these gaps in knowledge only increase. If these differences are not addressed early, children who fall behind in their vocabulary knowledge are at a higher risk of reading and learning difficulties and potentially having language and reading disabilities (Coyne et al., 2007; Kennedy et al., 2017). Nelson and Allen (2020) point out a definite link between early exposure to an extensive vocabulary and academic achievement (Cohen & Byrnes, 2007; Kennedy et al., 2017). So children who are exposed to a more extensive vocabulary at an early age are predicted to have higher academic achievement than children who are not exposed to vocabulary.

One way to help close this vocabulary-learning gap is to incorporate vocabulary education into early elementary classrooms. This learning should occur as soon as children start school, whether during preschool or early elementary (Sparapani et al., 2018). Students begin to learn and develop the tools they need to help them learn to read and effectively communicate with others at an early age. Reading, writing, speaking, and listening all play into other subject areas, and vocabulary is at the center of it all (Nelson & Allen, 2020). The students' learning and development skills will help them navigate other content areas, especially the complex concepts and terminology of science.

Science Vocabulary and Instruction

Although vocabulary instruction is essential in all subject areas, it is imperative to be included in science classrooms, especially during early elementary. An effective science teacher is also a language teacher. The complex terminology and multiple meanings of words make science seem like another language (Block, 2020; Brown & Concannon, 2019; Rice & Deshler, 2018). Science teachers not only need to teach students the required science content but also science literacy. Science literacy is the ability to critically read and understand science texts (Block, 2020; Brown & Concannon, 2019). This would look more like students reading and interpreting science textbooks in a secondary or middle school setting. However, this still applies at an elementary level, students may not be reading scientific terms on their own yet, but they still are hearing and using the words. This can be difficult for some students, especially students with learning disabilities because most terms used in science have one meaning in science and a completely different meaning outside the context of science (Rice & Deshler, 2018). These multiple meanings of words can lead to confusion for some students. Teachers must identify these words to assist students.

Achieving a solid level of understanding of science literacy is challenging for students. Students need first to decipher the meaning of the word in science and then determine the interdependence of the words on each other, and finally, students can begin to understand the meaning of the word (Rice & Deshler, 2018). Without prior science literacy teaching, this process can be very frustrating and time-consuming for students. Students must use their reading skills to help them start the process of learning science since the two subjects are related (Block, 2020; Brown & Concannon, 2019). Teachers can work with the students to identify high-frequency science words to make instruction more effective (Rice & Deshler, 2018). Nelson and Allen (2020) write that science vocabulary can be broken into two separate groups: science process vocabulary and science content vocabulary (Nelson & Allen, 2020; Rice & Deshler, 2018). Science process vocabulary is words that students must know and understand to help students develop the process and the specialized language of science (Nelson & Allen, 2020). These are words that are likely to be heard and used outside the context of science. Science context vocabulary is words that students need to know to help them understand the concepts being taught (Nelson & Allen, 2020; Rice & Deshler, 2018). When students understand the vocabulary, it allows for a better understanding of the taught science concepts (Block, 2020). Science concept vocabulary includes words that are often only used in the context of science. By understanding this difference in words, teachers can help develop a system to divide words to better help students.

Science instruction requires students to discuss, present claims, and be involved in argumentation (Nelson & Allen, 2020). By introducing students to the different types of science vocabulary, teachers can repeatedly use these words to help students fully understand the meaning and when to correctly use the words (Nelson & Allen, 2020). Once students have a strong understanding of both the scientific process and concept vocabulary, they have a solid foundation for building on. With this foundation, students can use accurate vocabulary when discussing science concepts with peers (Nelson & Allen, 2020; Reed et al., 2019). This also allows for more repetition of words and concepts.

By accurately using science vocabulary words, students can engage in academic conversation by using reasoning and evidence to support their claims (Block, 2020; Donohue &

Buck, 2017; Nelson & Allen, 2020). Providing students with multiple opportunities to engage in academic conversation allows them to be better prepared for academic success throughout their educational careers (Block, 2020; Nelson & Allen, 2020; Suárez et al., 2020). Several strategies can help improve student vocabulary retention and understanding, such as accessing students' language resources, utilizing peer-to-peer discussions, visually displaying student learning, and incorporating a wide variety of hands-on learning activities.

Science Vocabulary Instruction Strategies

Student Language Resources

All students enter classrooms with their own resources for communication that are effective for each individual student (Suárez et al., 2020). These resources can be nonverbal in the form of gestures and hand motions, or verbal as different tones and registers of their voices (Suárez et al., 2020). Teachers should support these differences and use them to help students in the classroom or "meet students where they are at" by incorporating communication methods familiar to students (Suárez et al., 2020). Keeping the communication familiar to students will help transfer knowledge between contexts and emphasize the importance of vocabulary instruction (Brown & Concannon. 2019; Rice & Deshler. 2018)

Peer-to-peer Discussions

Suárez et al. (2020) suggest grouping students with similar linguistic resources at home to promote student understanding (Suárez et al., 2020). When students are grouped with similar peers, learning can intensify. Peer-to-peer discussion promotes students working and learning together. During the peer-to-peer discussion, the students become the teachers and help guide each other to defining and understanding science vocabulary and science concepts (Carrier, 2011; Reed et al., 2019). Exposure to others' thoughts and reasoning may challenge students to think deeper and reevaluate their thinking, and change misconceptions. However, the opposite is also true; students may gain misconceptions from peers during discussions (Reed et al., 2019). When implementing peer-to-peer discussion, it is imperative to include a whole group, teacher-facilitated discussion to conclude the lesson and provide any needed clarification (Reed et al., 2019; Donohue & Buck, 2017).

Visual Displays of Learning

Dual coding theory, or learning that includes visuals as well as verbal communication, suggests that both ways can help increase the likelihood of later retrieval (Jackson & Durham, 2016; Reed et al., 2019). Graphic organizers are one tool that includes written and visual depictions of vocabulary words. The verbal component is added through peer-to-peer discussion. These graphic organizers or visuals can then be posted around the classroom, creating an interactive word wall or a word bank. Interactive word walls include connections between students' concepts and artifacts during inquiry-based activities (Jackson & Durham, 2016). Classroom word banks give the students several opportunities to see the words as the teacher is using the words (Carrier, 2011). The interactive word walls and word bank allow the students to interact with the vocabulary words. Another visual is using text cards, mini worksheets that include different activities that allow students to interact with the words and their meanings (Carrier, 2011). Text cards may consist of matching pairs where students need to communicate with each other to find their matching pair, or they may be true and false statements where students need to determine if the statements are true or false. Text cards can also include an image related to the topic that poses a question that students need to discuss with their peers to come to a consensus about the answer. Students can use the text cards individually or in a small group. When in a small group, students make more time to talk and discuss vocabulary meanings (Carrier, 2011).

Inquiry-Based Hands-on Learning Activities

Block (2020) states that students are unable to learn science purely through scientific vocabulary. Students need hands-on, field-based scientific activities to help students understand the concepts (Block, 2020). These hands-on or inquiry-based activities are not limited to traditional science experiments. Students are encouraged to ask questions, be problem solvers, and be creative (Ed, 2015). Inquiry-based learning is done through crafts, songs, dances, and stories (Donohue & Buck (2017). When these activities are completed in meaningful ways, students can make meaningful connections between their work and their learning (Marzano, 2010; Suárez et al., 2020). By utilizing a wide variety of hands-on learning activities, students have a better chance of being exposed to the science vocabulary and concepts, which allows for better understanding and transfer between contexts (Brown & Concannon, 2019; Rice & Deshler, 2018).

Science vocabulary can be complex for students, and it is almost as if students are learning an entirely new language before they can begin to understand the concepts (Block, 2020; Brown & Concannon, 2019; Rice & Deshler, 2018). However, when teachers are aware of this barrier and address this difference during lessons, students tend to understand better both the vocabulary words and concepts (Nelson & Allen, 2020; Rice & Deshler, 2018). A review of the literature finds that vocabulary instruction is valuable not only in a literacy classroom but in all subject areas. By incorporating effective vocabulary strategies within activities into science education, teachers can help students determine what kind of vocabulary word they are trying to decipher and help to decode the word in the context of science. Several different strategies can be used in the classroom to help with science vocabulary instruction, such as adapting to students' learning resources, using peer-to-peer discussion, visual displays of learning such as interactive word walls, and incorporating hands-on inquiry-based activities. These strategies will help students develop skills to speak academically, which will help them throughout their educational careers (Block, 2020; Carrier, 2011; Nelson & Allen, 2020; Suárez et al., 2020).

Methodology

The research methodology used is classroom action research. Hendricks (2013) states that classroom teachers conduct classroom action research for the sole purpose of improving their practice. The researcher will collect data and interpret the results to improve their practice of teaching elementary science vocabulary. Due to the wide variety of available strategies, this researcher limited the study to four different strategies, giving students time to talk with peers, interactive word banks, text cards, and graphic organizers to organize their thinking.

The subjects for this study are fourth-grade students in a rural elementary school in central Minnesota that attend science as a special area subject. The class that participated in this study was comprised of 22 students, 10 of which are girls and 12 of which are boys. Of these 22 students, 9% receive special education services for math or reading, 13% are a part of the gifted and talented program, and 77% are general education students. This classroom is representative of the 4th-grade population at this school. Before the research, a letter (see Appendix A) was sent out to all families informing them of the nature of this study and allowing for families to have their student's data removed from the study. All families opted to participate in the study.

After receiving consent, all students completed a pre-assessment (see Appendix B) that consisted of fill-in-the-blank questions with a word bank. The purpose of the pre-assessment was to collect data on students' prior knowledge of the subject, specifically the content vocabulary.

Students completed this assessment individually. The teacher assisted by reading the questions aloud to students to help remove the potential reading barrier from the science content assessment. A similar assessment (see Appendix C) was used at the completion of the study in the form of a post-assessment. This assessment included multiple-choice questions as well. At the end of the assessments, students were allowed to “free draw” on the back of their paper until the class was finished. All students received time to free draw to help with the validity of the assessments. Both the pre and post-assessments gather quantitative data.

Other data tools used in the study include teacher field notes, student discussion recordings, and a strategy checklist. These qualitative data tools are used to gather observational data throughout the study. Teacher field notes are recorded after each lesson. The researcher recorded detailed notes of the intervention used during the lesson. These notes include what was done during class, how the students responded, and any unanticipated events that may skew data. Through the use of Google Forms, the researcher recorded which strategy was used during the lesson. Both data collection tools allow the teacher to reflect on the strategy used and how the students responded during the lesson.

Another qualitative observational data tool used was student discussion recordings. Recordings occurred during student small group discussions in which the participants were in groups of three to four, with a mixture of abilities. The groups selected for recordings were chosen based on how well they work together. One group, the blue group, consistently works well together, and one group, the yellow group, consistently struggles to work together as a group. Two groups, the orange and red groups, have a few members who consistently sit back and let others do the work for them. Two recordings also took place during stations, and each group was recorded during one of the stations. All recordings took place during different lessons.

After the lesson, the teacher listened to the recordings and documented the students' usage of the content vocabulary words and which strategies the students used during the discussion.

The researcher implemented these data collection tools over the course of thirteen weeks to determine the effect, if any, of inquiry-based activities on content vocabulary retention in an elementary science classroom, specifically 4th-grade students.

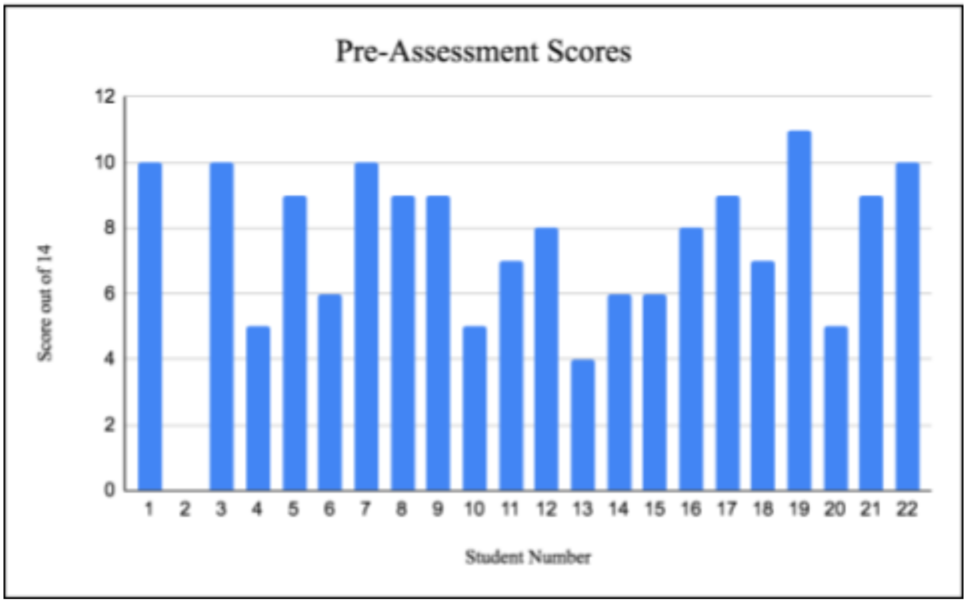
Data Analysis

This study took place during the first unit of the year, rocks and minerals. The researcher created and implemented various inquiry-based activities that incorporated the content vocabulary and allowed the participants to interact with the content vocabulary. The researcher hoped that the inquiry-based activities would help to improve the participants' retention of the content vocabulary. The researcher collected both quantitative and qualitative data through the use of pre and post-assessments, reflective teacher field notes, student discussion recording summaries, and a strategy checklist.

Content Vocabulary

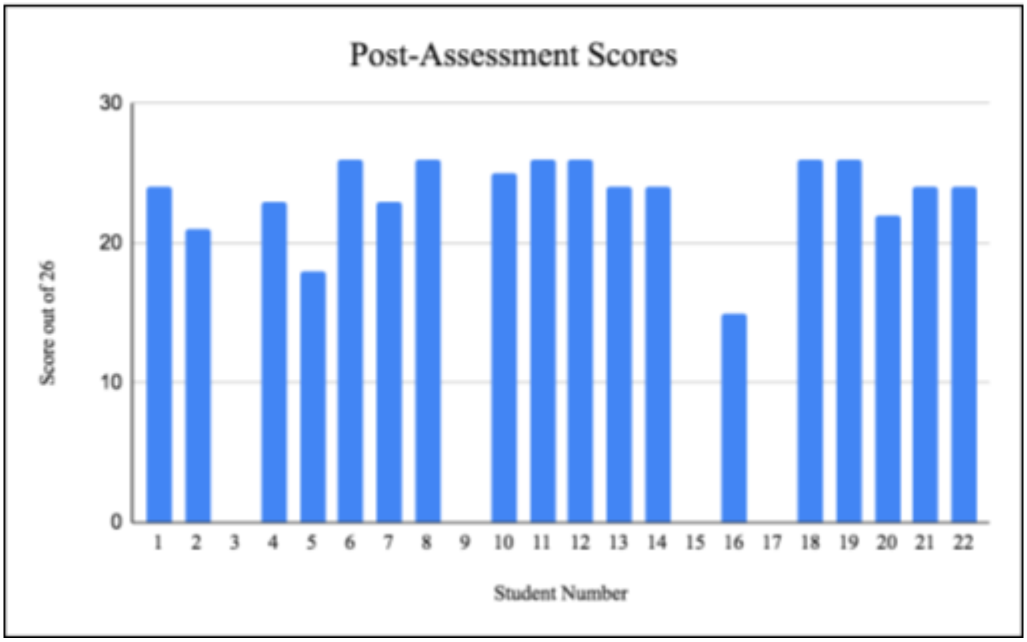
During the first week of research, the participants completed a pre-assessment for baseline data. The assessment included fourteen fill-in-the-blank questions containing content vocabulary for the rocks and minerals unit. The researcher provided participants with a word bank for the assessment. At least one participant was missing during the pre-assessment due to illness or unforeseen circumstances. Figure 1 shows the pre-assessment scores with a maximum possible score of 14. Each participant is labeled on the x-axis with a random number assigned to them at the beginning of the research. The y-axis represents the number of questions answered correctly out of 14. The goal is to receive at least a 70% or higher on an assessment to be considered proficient at the school where the researcher conducted this study. This level was carried over into this research. Of the 21 participants, 16 participants scored below the 70% threshold, and only 5 participants scored 70% or higher on the pre-assessment, resulting in a class mean of 55% on the pre-assessment.

Figure 1
Baseline Data from Pre-Assessment



After the thirteen-week study, a post-assessment was given to the participants to evaluate the effects of inquiry-based activities on content vocabulary retention. This assessment included 26 questions, ranging from fill-in-the-blank with a word bank to multiple-choice questions and matching. At least one participant was missing during the post-assessment due to illness or unforeseen circumstances. Figure 2 shows the post-assessment scores with a maximum possible score of 26. Each participant is labeled on the x-axis with a random number assigned to them at the beginning of the research. The y-axis represents the number of questions answered correctly out of 26. Of the 18 participants, 2 participants scored below the 70% threshold, and 16 participants scored above the threshold, resulting in a mean of 90% on the post-assessment.

Figure 2
Post-Assessment Data



Inquiry Strategies

One data collection tool used in this study was teacher field notes. The researcher completed field notes at the end of each lesson. The field notes included a narrative summary of the day's events. The observations were then split into what the researcher observed and wondered during the lesson. The teacher field notes also include any unanticipated circumstances that may skew data. Such as, on day nine, the researcher used no inquiry strategies as the participants completed a bonus holiday activity during class. Due to weather delays, the researcher used no inquiry strategies on day twelve as the participants completed a review activity about rocks and landslides.

Through the teacher field notes, the researcher was able to see how participants interacted with each other and reacted to the inquiry strategies that were used. Many participants used the word bank more towards the end of the research compared to the beginning. Participants were more actively engaged in the activities when they could physically complete the inquiry-based activities than lessons in which they had to watch a demonstration or a modified version of the activity. This results in participants appearing to have a better understanding of the concepts.

The researcher also utilized student discussion recordings. These recordings provide evidence about students' use of the science vocabulary while the specific strategies are being used. The strategy used can be seen in Figure 3.

Figure 3
Strategies used during student small group discussions.

Recording Number	Group	Strategies Used
1	Blue	• Time to Talk
2	Orange	• Time to Talk • Word Bank
3	Red	• Time to Talk • Word Bank • Graphic Organizer
4	All groups Station 3	• Time to Talk • Word Bank • Graphic Organizer
5	All groups Station 5	• Time to Talk • Word Bank • Text Cards
6	Yellow	• Time to Talk • Word Bank

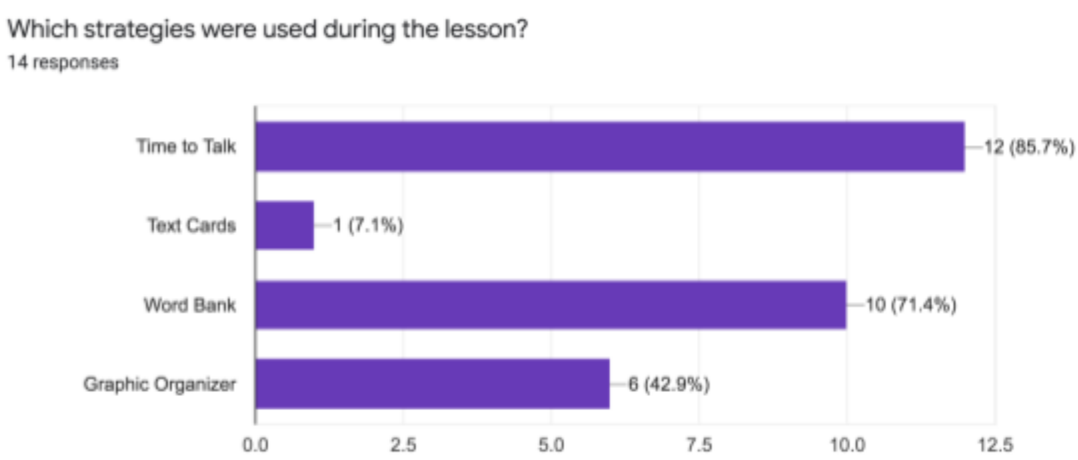
The student discussion recording summaries are evidence that when given the time to talk in a small group, all participants communicate at various levels. When listening to recording number three, participants were given a graphic organizer to help them review their past knowledge about minerals. All participants are heard on the recording. Some participants are heard more than others. One participant noticed that not all participants were actively involved in the discussion and heard saying, “remember, we need to work as a team,” which prompted the other participants to involve themselves.

When the stations were recorded, recording numbers four and five, participants showed evidence of using the content vocabulary correctly but inconsistently. In recording number four, a participant stated, “it is metallic and dull, but I don’t know the other ones,” shortly after another participant in the group correctly said the other answers, using the correct content vocabulary. The same is heard during recording number five, which occurred during the same lesson as recording number four, but at a different station in the classroom. Several participants are heard using the correct content vocabulary for identifying the color of the mineral. One participant is heard stating, “oh, color, that is a physical property.” During this station, only one group is heard mentioning the classroom word wall, word bank, to problem solve a solution when they were stuck on a problem, “Hey, what about the word wall (bank),” after using the resource, the group was able to come up with an answer.

Through Google Forms, the researcher completed a strategy checklist at the end of every lesson. The form includes the date of the lesson and all of the strategies used during the study. The possible strategies used are Time to Talk, Text Cards, Word Bank, and Graphic Organizers. This information is used to see the frequency of each strategy used. The frequency of each strategy used is shown in Figure 4.

Time to Talk was the most used strategy by the researcher, with it being used in 12 out of 14 lessons, or 85.7%. The Word Bank Strategy was used in 10 out of the 14 lessons, 71.4%. The researcher used graphic Organizers in 6 out of 14 lessons or 42.9%. The researcher used Text Cards the least, with only 1 out of 14 lessons, or 7.1%.

Figure 4. Frequency of each inquiry-based strategy used during lessons.



Overall, the researcher used these data collection techniques to help determine the effectiveness of inquiry-based activities on content vocabulary retention in elementary science students. The researcher identified common themes to note the content vocabulary retention in elementary students through action research. Time to Talk was the easiest strategy to implement in the classroom. The participants in this study really enjoyed communicating with others. The lessons within this unit allowed for several small group discussion opportunities, which allowed for time to talk. Another strategy that was used often was the word bank. This strategy required a little more time and thought to create, however, once posted; it was used daily. The word bank is one that researchers will continue to implement in the classroom for all grade levels. By having the words posted, the students were more likely to use the terms appropriately, and to remind others when they are stuck or used a different word. These conclusions from the findings allow the researcher to make further analyses and research recommendations.

Conclusion

This action research study aims to determine the effects of incorporating hands-on inquiry-based learning to support student's understanding and retention of science vocabulary, specifically in a 4th-grade classroom. The research focused on answering the question, “How do hands-on learning and inquiry-based learning affect students’ understanding and retention of science vocabulary in a fourth-grade science classroom?” Participants completed various hands-on inquiry-based activities during their science lessons one to two times per week throughout thirteen weeks. The researcher collected data from pre and post-assessment, teacher field notes, student discussion recordings, and a strategy checklist.

The analysis of data provides essential information about the quantitative data collected. All students improved their scores from the pre-assessment to the post-assessment. After the pre-assessments, 76% of the participants were below the 70% passing score. After the intervention, only 11% of the participants were below the 70% passing score. One of the two students who scored below the passing score is a special education student.

Analysis of the qualitative data shows that once students are more familiar with the inquiry-based strategies, such as the word wall, they are more likely to use it when struggling to remember a word. Through the use of the student small group discussion recording, the researcher can see that when students are given time to talk with their peers, in conjunction with other strategies, such as the word wall, graphic organizers, and text cards, students can identify and correctly use the content-specific vocabulary. This was a common theme throughout the teacher field notes as well.

This action research demonstrates that it is beneficial to have students interact with their peers and complete hands-on activities when learning content-specific vocabulary, as found in the review of the literature. By providing students with these opportunities, they are able to construct their own understanding of the content vocabulary, which results in students having a higher retention rate of the content vocabulary. Teachers should encourage the students to use the content vocabulary whenever possible or "speak like a scientist" to help with the retention rate of the content vocabulary.

Given that this action research project took place during the COVID-19 pandemic, this resulted in some challenges in the research and likely caused some confounding variables to skew the results. These limitations include:

- Some students were absent for a portion of the intervention due to illness or having to quarantine. At this time, the researcher was not allowed to provide these students with any work to complete.
- Due to COVID-19 protocols, some activities were limited. Some hands-on activities were not allowed to occur, so the activities were done as a teacher demonstration.
- Classroom seating charts had to be mirrored in the special area classrooms, science room. This caused less diversity in student groupings.

Based on the findings and conclusions of this action research project, the researcher recommends the following course of action:

- When learning new content vocabulary, students should have the opportunity to communicate with their peers while interacting with the content vocabulary.
- Students should have visual access to the content vocabulary when using the terms; this can be an individual word bank, word wall, or a classroom word wall.
- Students should have multiple opportunities to correctly use the content vocabulary. This can be through text cards, graphic organizers, interactive activities such as experiments or investigations. This will allow for students to construct their own understanding of the content vocabulary.

Research should continue on the topic of content-specific vocabulary instruction in elementary science setting to address the challenges and questions that arose during this action research. The researcher is confident that the inquiry-based strategies used during the intervention, especially time to talk and word banks, promoted content vocabulary instruction and retention of rocks and minerals vocabulary in an elementary science setting.

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Appendix A

Hands-on Inquiry-Based Vocabulary Instruction in Science Education
Parental Permission Form

September 24, 2021

Dear Parents/Guardians,

In addition to being your child's Science Specialist teacher, I am a St. Catherine University student pursuing a Masters of Education. As a capstone to my program, I need to complete an Action Research project. I am going to study the relationship between hands-on learning and the students' understanding and use of science vocabulary.

In the coming weeks, I will be incorporating more hands-on learning activities to introduce new vocabulary words as a regular part of my fourth-grade rocks and minerals unit. Learning the vocabulary of science content will improve students.

All students will participate as members of the class. In order to understand the outcomes, I plan to analyze the data obtained from the results of these activities and lessons such as student's test scores, and student surveys, to determine if hands-on learning activities help students to better understand and retain the meaning of science vocabulary. All strategies implemented and assessments given are part of normal educational practice.

I will be writing about the results that I get from this research. However, none of the writing that I do will include the name of this school, the names of any students, or any references that would make it possible to identify outcomes connected to a particular student. Other people will not know if your child is in my study.

The purpose of this letter is to notify you of this research and to allow you the opportunity to exclude your child's data from my study.

> **If you decide you want your child's data to be in my study,** you don't need to do anything at this point.
>
> **If you decide you do NOT want your child's data included in my study,** please note that on this form below and return it by October 5th. Note that your child will still participate in the vocabulary instruction but his/her data will not be included in my analysis.

In order to help you make an informed decision, please note the following:

- I am working with a faculty member at St. Kate's and an advisor to complete this particular project.
- The benefit of this study is to identify different strategies that I can use in my classroom to help improve students' understanding and use of science vocabulary. This study poses minimal risks to your child(ren).
- The final report of my study will be electronically available online at the St. Catherine University

library. The goal of sharing my research study is to help other teachers who are also trying to improve their teaching.

- There is no penalty for not having your child's data involved in the study, I will simply delete his or her responses from my data set.

If you have any questions, please feel free to contact me at jburns@alexschools.org. You may ask questions now, or if you have any questions later, you can ask me, or my advisor Dr. Mary Hedenstrom at mnhedenstrom@stkate.edu, who will be happy to answer them. If you have questions or concerns regarding the study, and would like to talk to someone other than the researcher(s), you may also contact Dr. John Schmitt, Chair of the St. Catherine University Institutional Review Board, at (651) 690-7739.

You may keep a copy of this form for your records.

______________________________ ________________

Jillian Burns Date

OPT-OUT: Parents, in order to exclude your child's data from the study, please sign and return by [October 5th, 2021]

I do NOT want my child's data to be included in this study.

____

Name of Child

______________________________ ________________

Signature of Parent Date

Appendix B

Name ______________________________ Class Code ____________

Rocks and Minerals Vocabulary Pre-Test

Directions: Use the word box to fill in the blanks.

Rock Cycle	Sedimentary	Metamorphic	Igneous
Fossil	Weathering	Crust	Core

1. A ____ rock is formed from layers of rock pieces, shells, or other particles.

2. A ____ rock is formed from melted rock that is cooled.

3. A ____ rock is formed from another rock that has changed because of heat and pressure.

4. Remains or traces of a living organism from the past that is preserved in a rock is called a ___________________________________.

5.The ________________________________ is the central part of Earth.

6. The layer just below the Earth's crust is the _____________________________.

7. ___________________________________ is the breaking down of rocks over time caused by wind, rain, chemicals in soil, extreme temperatures and other natural occurrences.

8. The _________________________ _____________________ is the constant forming, breaking down, and reforming of rocks that occurs over time.

Rocks and Minerals Vocabulary Pre-Test (Cont.)

Directions: Use the word box to fill in the blanks.

Luster	Mohs Scale of Hardness	Streak
Erosion	Mantle	Geologist

9. A ______________________________ is a scientist who studies rocks and minerals.

10. A __________________________ test determines a mineral's true color.

11. To see how a mineral reflects light, you would need to do a ________________________ test.

12. The second layer of the Earth is the ___________________________.

13. The ____ ranks minerals from softest to hardest.

14. ___________________________ is the moving of sediments.

Free Draw

Appendix C

Name____________________________________ Class Code_______

Unit Test: Rocks and Minerals

Word Bank				
Mantle	Sedimentary	Igneous	Core	Luster

___________________________ 1. rock formed from layers of rock, shell, or other particles

___________________________ 2. layer of Earth below the crust

___________________________ 3. central part of Earth

___________________________ 4. rock formed from melted rock that cooled

___________________________ 5. how a surface reflects light

Word Bank			
Fossil	Hardness	Metamorphic	Weathering

___________________________ 6. resistance to being scratched

___________________________ 7. rock that has been changed into new rock by heat or pressure

___________________________ 8. remains or traces of past life preserved in rock

___________________________ 9. Breaking down of rocks by wind, rain, chemicals in soil, and extreme temperatures

Science Concepts

Write the letter of the best answer.

_____10. Scientists who study rocks and minerals are called _______.

A. Engineers C. Geographers
B. Geologists D. Biologists

_____11. Igneous, sedimentary, and metamorphic are types of _______.

A. volcanoes C. rocks
B. fossils D. metals

_____12. Which does NOT cause weathering?

A. cementation C. water
B. wind D. temperature changes

_____13. The Mohs scale is a way to rank the ________ of a mineral.

A. color C. hardness
B. quality D. texture

_____14. To find the true color of a mineral, you would do _______.

A. an acid test C. A Mohs test
B. a streak test D. a laser test

_____15. Fossils are usually found in _______.

A. the inner core C. sedimentary rock
B. cubic crystals D. volcanic glass

_____16. The constant forming, breaking down, and reforming of rocks is known as ________.

A. the rock cycle C. mining
B. erosion D. compaction

_____17. _______ is magma that reaches Earth's surface.

A. fool's gold
B. clay
C. cement
D. lava

_____18. The hardest mineral on Earth is ________.

A. calcite
B. mica
C. quartz
D. diamond

19-24. Match the word to the correct definition

igneous	layers of sediment join together
metamorphic	melted rock cools and hardens
sedimentary	changes are made by heat and pressure