TIME TO WIKI:

A TOOL TO BUILD STUDENTS' SCIENCE VOCABULARY

by

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In presenting this professional paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the MSSE Program shall make it available to borrowers under rules of the program.

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ABSTRACT

Vocabulary forms the foundation for understanding scientific content and concepts. For students to be successful in science, they need to develop a working knowledge of the terminology. This requires the student to make the shift from simply reciting a word's definition or picking the definition from a group of phrases to using the terminology to express ideas and explain reasoning both verbally and in writing. In this study, a group of students collaboratively developed a website that was used as an instructional tool. This "wiki" allowed students to build their understanding of the science vocabulary and to develop their understanding of the science concepts as they created an online glossary and discussed content related questions online. The quantitative data did not clearly indicate that a wiki, as it was used in this study, was a consistently effective tool for increasing student understanding of science vocabulary and content. However, qualitative evidence indicated that using the current technologies available as part of science instruction engaged students and increased their interest level and enthusiasm for science.

INTRODUCTION AND BACKGROUND

Teaching and Classroom Background

Teaching science is one of my biggest challenges in the classroom. Initially, I wasn't completely comfortable with the level of my content knowledge because my own science background was weak. Now that I have completed several science courses through the Big Sky Science Project (BSSP) and have taught the curriculum for seven years, I feel much more confident in my ability to teach the subject.

Over the past three years, I have integrated more inquiry based teaching strategies into my instruction in order to improve my students' learning. There has been a noticeable improvement in my students' engagement in science as I have made these changes. In contrast to prior years when enthusiasm for science was low and discussions were almost nonexistent, my students routinely look forward to science, show interest in what we are learning, and participate readily in discussions and explorations. Many of them report that science is their favorite subject. Despite progress in student engagement, a high percentage of students continue to perform poorly on science assessments. I have implemented more formative assessments and probes to help me proactively address student misunderstandings and misconceptions and to guide my pacing and instruction. Nevertheless, my students still struggle to understand the science content as reflected by summative assessments. When they are asked to communicate their findings, to express their science understanding, or to apply what they have learned to a different situation, they are often vague or unsure of the concepts. Student entries in science journals are usually hastily done and often show little insight or depth of understanding. Overall, my students are not making the progress in science that I would like to see. Even students who are very capable in other areas tend to have a more difficult time with science. My goal is to find a way to help my students be more successful in the science curriculum.

School Demographics

Morin Elementary, a small, country school located in Yellowstone County between Billings and Pryor, Montana, currently has 35 students enrolled with four full-time teachers and a part-time Title I aide. Approximately 80% of the students are Native American children who live on the Crow Reservation with the balance being children from agriculture based families in the area. Beginning with the current school year, 2011-2012, we offer a school breakfast and hot lunch program with 82% of the students qualifying for free or reduced meals.

Morin Elementary had always met the Annual Yearly Progress (AYP) requirements in reading and math proficiency of the No Child Left Behind Act until the 2009-2010 school year when our percentages fell below the benchmarks. In response to low test scores, a new reading intervention program was implemented during the 2010-2011 school year, and we are currently assessing our math curriculum to see how we can improve instruction to address our students' lack of proficiency in that area. Teachers also recently completed a school-wide plan for improvement to address deficiencies.

Participants

Starting with the 2010 – 2011 school year, our staff implemented a system whereby students are placed in subject areas based on ability levels and not strictly by grade levels. With our small numbers and limited resources, we felt this was the best way to target instruction to individual needs. Students are not tied to a particular classroom, but move for reading, math, science, and social studies based on their current level of performance and where they can be most successful. Because of our grouping system, the science class I taught was a mix of students in grades four through six. I conducted my study with this combination class of two fourth grade students, six fifth grade students, and three sixth grade students. There were six girls and five boys with an ethnic background of 73 percent Native American students and 27 percent Caucasian. Three of the fifth grade students joined the class during the first quarter. These three students all had Individual Education Plans (IEPs) to address various identified learning disabilities. They initially had been placed with another group of students for science instruction, but after analyzing their performances in the classroom, we felt that they would benefit more from being grouped with the older students. The research methodology for this project received an exemption by Montana State University's Institutional Review Board, and compliance for working with human subjects was maintained.

Overview of Current Science Program and Curriculum

During the 2008-09 school year, a committee of teachers evaluated the science curriculum and reviewed science materials provided by several publishers. The Macmillan-McGraw Hill Science Curriculum was chosen based on how well it was aligned with the Montana Science Content Framework and how well it incorporated the 5E Learning Cycle Model. The 5E model is an inquiry lesson planning technique that starts with an engagement activity then moves students through a process that includes concept exploration, explanation, elaboration and finally evaluation. Science lessons were taught daily for 45 minutes. Students were divided into two classes for science instruction. The group of fourth through sixth grade students with whom I conducted my study mainly used the fifth grade textbook this year. Two earth science chapters, *Weather* and *Space,* and four chapters of life science including *Cells and Kingdoms*, *Classification of Life*, *Basic Genetics*, and *Ecosystems* were taught. Most students in this group had been in my science class the previous year when we covered the other half of the fifth grade textbook. Because most of my students have a limited science background, we spent approximately six to seven weeks on each chapter. The modified pacing was adapted to better meet students' learning needs. The extended time frame allowed them time to build and develop their science knowledge and allowed more time for deeper exploration of concepts. Since the class included sixth grade students as well, additional material from the sixth grade textbook pertaining to each chapter was also introduced to the entire group. This was done using the information for enrichment and extension purposes. Only the sixth grade students were assessed on this portion of instruction.

Focus Questions

Over the last several years, my Morin Elementary colleagues and I have focused on improving our science instruction. We have discussed many times what we need to do to teach science more effectively. A problem area that we have pinpointed is our students' difficulty in understanding and learning the science vocabulary. A search of the literature reveals a variety of strategies to address this particular problem. One promising direction of research indicates that strategies that tap into the many technologies that are becoming increasingly available to students can lead to improved student learning (Andrew, 2008). One such technology is a wiki, a website that contains a series of interlinked pages produced by collaborative efforts for a specific purpose. Entries and pages can usually be edited based on a set of protocols determined by the creator of the wiki (http://en.wikipedia.org/wiki/Wiki). My science students constructed a classroom wiki by creating a glossary of our science vocabulary words and posting additional entries to questions I asked relating to our science chapters. They were given choices about which words and questions they wanted to work with when making posts. I encouraged them to use text, audio, graphics, animations, and/or videos when developing their posts. O'Neill and Barton (2008) state that when "learners have some choice and control over what and how they learn . . . (it becomes more likely that) they will become more emotionally and intellectually connected" (p. 293) to the topic at hand.

The following are the focus questions I used to guide this study:

1. How will students' participation in the creation of a classroom wiki affect the students' development and retention of science vocabulary?
2. How will students' participation in the creation of a classroom wiki affect their understanding of the science content?
3. How will creating a classroom wiki affect student engagement in science?
4. How can the wiki be designed and implemented to optimize students' development of vocabulary and content understanding and to improve engagement?

CONCEPTUAL FRAMEWORK

Developing scientific vocabulary becomes more important as students progress from the primary grades to the more content-focused intermediate grades. Common strategies used to teach science vocabulary often fall short of moving students beyond mere recall and recognition of words to a higher level of understanding. This study focused on instructional approaches that utilize current technology to engage and challenge students to collaboratively build and develop their vocabulary and science knowledge.

While the development of science vocabulary is essential to understanding, there are many roadblocks that students face when working with scientific terminology including complexity and specificity of language. In addition, students may recognize words but lack the ability to use those words correctly or effectively to express their ideas. They are unable to communicate their understanding fluently. At-risk students, those from lower income families, often are behind their peers in reading achievement and experience even greater gaps than other students in content-specific word recognition.

Effective practices to promote comprehension are required to enhance scientific vocabulary acquisition. These practices include linking learning with peer interactions and socialization and combining reading and writing activities to develop communication skills. Student engagement in the learning process is another key factor, and technology is increasingly used to enhance and deepen students' involvement in the classroom. Web-based tools are available that can be used in a variety of ways to engage and challenge today's students. To construct a conceptual framework for this study, these topics are further explored in the following sections.

Importance of Science Vocabulary Development

A key to student success in science is development of a working vocabulary. Science is composed of specialized language that often uses words that may be familiar to students in other contexts along with words that are specific to the discipline. Making sense of the science content is dependent on sorting through what may be a confusing mix of familiar and unfamiliar words. Young (2005) notes that scientific literacy, in particular, depends on understanding the language or vocabulary of the content, both as it is presented during classroom instruction and within the text. Lack of comprehension of the science content can lead to many student difficulties including confusion, frustration, loss of interest, and misunderstanding. Improving vocabulary skills prepares students to learn the science content (Fisher, Grant, & Frey, 2009).

Roadblocks to Comprehension

The process of acquiring and developing a usable science vocabulary has many complicated dimensions. Science vocabulary is specialized and specific. In a study by Beck, McKeown, & Kucan (2002), three tiers of vocabulary were identified (Table 1). Tier 1 included basic, everyday words that occur with high frequency; Tier II words are frequent for mature, literate individuals, and Tier III are low frequency and limited to specific fields of study. The researchers also found that science textbooks are written with a higher vocabulary level than other content areas, which required comprehension of Tier II and Tier III words (DeLuca, 2010).

Table 1
Tiers of Language

Tier	Description	Examples
I	Basic, everyday words, high frequency words, usually no need for explicit instruction	Asleep, explode, particle
II	High frequency words for mature language users; can relate to multiple knowledge domains, need to be taught as it relates to a particular usage	Dormant, eruption, molecule
III	Low frequency words, limited to specific knowledge domains, requires explicit instruction	Volcanic, magma, igneous, isotope

Textbooks typically express scientific ideas in ways that are in sharp contrast to narrative or every day language more familiar to students (Honig, 2010; Lemke, 1990). Science combines technical vocabulary used to build conceptual frameworks, with complex, non-technical and procedural words that are necessary to define and explain relationships and connect ideas (Harmon, Hedrick, & Wood, 2005). Scientific language is distinctive in nature and is particular in the way it conveys ideas to others (Goldman & Bisanz, 2002). It is often theoretical and represents a unique way of knowing and thinking where even common and familiar words are used in a way that is specific to science (Honig, 2010). Because of the specificity of science vocabulary, students are often not exposed to the words outside of the context of science instruction. This leaves them with isolated, low frequency contact with the content vocabulary. "Such limitations narrow the multiple exposures students need to internalize word meanings and develop word ownership" (Harmon et al., 2005, p. 263). Students cannot just transfer the meanings of words they have learned from one topic to another. These issues negatively affect the comprehension level of many students (Harmon et al., 2005).

There are several other aspects that need to be considered when discussing a student's fluency with vocabulary as well. Chall (1983) identified two types of vocabulary that students need for reading. The first is word-recognition vocabulary, or words that students can pronounce when seen in print; the second is vocabulary words that students can define and to which they can attach meaning. Throughout the primary grades, instruction focuses on word recognition. However, development of understanding of word meanings becomes much more crucial for the increased comprehension required for intermediate grades and higher. Whereas vocabulary is often a part of reading and language arts instruction, it is the content areas where vocabulary instruction becomes "central to the development of new conceptual frameworks and the understanding of increasingly more sophisticated ideas" (Blachowicz & Fisher, 2005, p. 2).

In addition, there are different levels associated with word knowledge. These levels are commonly defined as unknown, knowledge that the word exists, partial knowledge, and finally, complete knowledge. The following ideas regarding these levels are drawn from the work of Blachowicz & Fisher (2005). A word is *unknown* when a student has had no prior contact with the word. Having heard the word or seen it before is considered to be *knowledge that the word exists*. *Partial knowledge* means that the student has an idea of what the word means, and the highest level of knowing, *complete knowledge*, indicates the student is comfortable with the meaning of the word. They are capable of using it in speaking and writing, often in various ways. Additionally, there are differences between a student's receptive vocabulary, words they understand in print, and their expressive vocabulary, words they use to express themselves in speech or writing.

Receptive vocabulary is typically broader than expressive vocabulary. For a person to be comfortable and confident when using words while expressing and exploring ideas, they need to have a deep knowledge and high level of understanding of a word. Scientific fluency includes the ability to flexibly read and write about science. “Fluency in a specialized language such as scientific discourse involves receptive knowledge and expressive knowledge of linguistic patterns and words” (Honig, 2010, p. 1).

Classroom science instruction often focuses on receptive knowledge, which includes reading and comprehension (Honig, 2011). This can be accomplished by having students define vocabulary words or choose the correct definition from several choices that are given. However, this type of assessment doesn’t measure a student’s ability to communicate the scientific idea behind the word. In content areas, students need a deeper, more thorough understanding of vocabulary because the words “are labels for important concepts; furthermore, retention of these word meanings is crucial to the learning of subsequent concepts” (Blachowicz & Fisher, 2000). To determine a student’s deeper understanding of the meaning behind the word would require a stronger focus on expressive assessment. A successful program to teach science vocabulary would promote an increase in the amount of words students comprehend as well as the ones they can effectively use to communicate ideas. In addition, it should support the movement of words from the basic receptive level to the higher expressive level (Blachowicz & Fisher, 2005). To accomplish these goals, students need a variety of opportunities to develop a broader understanding of the science vocabulary along with the ability to fluently use science words in a variety of contexts (Blachowicz & Fisher, 2000).

At-Risk Students

Students who engage in a wide variety of reading activities tend to develop extensive vocabularies (Nagy & Anderson, 1984; Harmon et al., 2005). Conversely, students who are "behind their peers in reading achievement engage in less reading, know fewer words, and hence find it increasingly more difficult to handle all reading tasks, including content area reading" (Allington, 2001; Harmon, et al., 2005, p. 264). Factors such as parent education level and family income influence reading achievement (Grissmer D. W., Kirby, S. N., Berends, M., & Williamson, S, 1995; Harmon, et al., 2005). By fourth grade, these factors have contributed to children testing below grade level on vocabulary measures (Chall, Jacobs, & Baldwin, 1990; Harmon et al., 2005). Without intervention, these children are at high risk for poor academic achievement in later grades (Chall & Snow, 1988; Harmon et al., 2005). It is essential for educators to develop a framework for effective vocabulary instruction in order to address these issues.

Effective Practices

Effective practices for promoting vocabulary development focus on impacting comprehension as well as word knowledge. Explicit, direct instruction is essential. This instruction depends on schema theory, the theory that knowledge is interconnected, and seeks to build interrelationships among words. New learning must build on existing knowledge (Harmon et al., 2005). "When students store new information by linking it to their existing schema, or network of organized information, there is a better chance the new words will be remembered later" (Bromley, 2007, p. 532).

Learning as a social activity is another important aspect. Students who interact with their peers have the opportunity to reflect and discuss differing points of view in order to gain a broader understanding of the text (Outhouse, 2008). Collaborative group work allows students to reach a common goal as they construct meaning through negotiation and discussion of their assignment or project.

Research indicates a link between movement, language, and literacy (Armstrong, 2003, Outhouse, 2008). Neuroscientists have identified various brain-based strategies as having a positive effect on learning; these include games, drawing, storytelling, technology, graphic organizers, semantic maps, and word webs in addition to movement. Many of these strategies are easily implemented, so if teachers strategically incorporate these techniques in a meaningful and purposeful way, a constructivist learning environment is created and the strategies are more effective (Outhouse, 2008).

An additional strategy to consider is linking of reading and writing components. Expressive vocabulary is used to communicate ideas and facilitate understanding. A language-rich classroom community where the teacher integrates reading and writing with hands-on science activities will allow students to move words from their receptive vocabularies to their expressive vocabularies. Ways of tying writing to science reading include jotting notes after a hands-on activity, documenting predictions, results, and conclusions of science explorations, writing in science journals, constructing graphic organizers, writing answers to questions, and finishing sentence starters (Honig, 2010). Immersing students in these types of activities will encourage development of their expressive skills. Teachers will be able to assess students' progress in acquiring domain-specific language as they evaluate the writing products of their students.

The Importance of Engagement

Research has shown a positive relationship between the level of student interest and engagement in a topic and the student's achievement. The correlation begins in the elementary years and increases as the student progresses through school (Sorge, 2007; Kresse, 2010). Student engagement refers to "a student's willingness, need, desire, and compulsion to participate in, and be successful in, the learning process" (Bonnia L., Demeester, D., Elander, K., Johnson, M., & Sheldon, B., 1997, p. 1).

The relationship between engagement and competence tends to be a self-perpetuating cycle. The learner must be invested in order to improve. This begins when they have an interest or a real purpose for engaging. Only then can instruction and practice help them gain competence. Finally, increased competence inspires continued motivation to be engaged. This cycle is supportive of student achievement (Irvin, Meltzer, & Dukes, 2007). Besides quality of work, engagement also influences how a student views their classes, teachers, peers, and the results of their efforts. As Jolly, Campbell and Perlman (2004) note, "Engagement gets students started and keeps them coming back" (p. 12).

There are multiple aspects of engagement however. Fredericks and McCloskey (2011) distinguish three distinctive dimensions: behavioral, emotional, and cognitive. The following table is adapted from their work and summarizes the characteristics of each.

Table 2
Types of Engagement

Type of Engagement	Descriptions	Involves	Influences
Behavioral	Focuses on participation, includes involvement in academic, social, or extracurricular activities	Habits and skills	Student achievement
Emotional	Focuses on positive reactions to teachers, classmates, academics and school in general	Motivation and feelings	Student's willingness to work
Cognitive	Focuses on the student's level of investment in the learning process; willingness to put forth the effort necessary to succeed	Beliefs and values	Student's ability to comprehend complex ideas or master difficult tasks

Behavioral engagement involves habits and skills that focus on participation and involvement in academic, social or extracurricular activities. This is closely tied with positive academic outcomes and the prevention of students' dropping out. Emotional engagement revolves around the feelings students have and their ties to their classmates, teacher, and the school. Strong emotional engagement creates student ties to the institution and influences the amount of effort a student is willing to put forward. Cognitive engagement shows a student's level of investment in the learning itself. A student who has strong cognitive engagement is thoughtful and purposeful in their approach to school tasks. They are willing to exert the extra effort it takes to comprehend complex, challenging ideas or to master difficult skills (Fredericks, 2011).

Since engagement encompasses a student's awareness, interest, and motivation, researchers have identified a wide assortment of indicators. Classroom behaviors such as homework completion, attendance, adherence to rules, staying on task, effort, asking questions when needed, and persistence in a subject are one group of measurements. Other factors include a student's ability to perceive himself or herself as successful, to recognize the utility of a subject, and voluntarily participate in both in- and out-of-school activities relating to the subject. The last group of indicators includes positive attitudes toward the subject or discipline and toward careers in those areas (Jolly et al., 2004).

Teaching practices can influence student motivation. Students need schoolwork that is actively engaging and builds on their interests and prior knowledge. Engaging tasks develop students' sense of competency, their connections with others, and give students a degree of autonomy while providing opportunities for originality and self-expression (Brewster & Fager, 2000). Kresse (2010) analyzed the results of numerous studies to identify effective strategies that positively impact elementary students' attitudes and interest in science. Strategies that showed positive influence include science instruction integrated with technology, active, hands-on learning, and cooperative learning activities. These findings provide guidance to teachers seeking to encourage and increase the engagement level of their students.

Using Technology to Foster Engagement

The power of technology to increase student motivation and interest is becoming more evident. "Research demonstrates that the effective integration of technology into classroom instruction can positively impact student motivation, engagement and interest in learning" (Reiners, Renner & Schreiber, 2005, p. 3). The U.S. Department of Education (1995) reported that students felt empowered and smarter when they had the opportunity to use computers in classroom activities. Page (2002) conducted a study of elementary students of low socioeconomic status and found that the use of classroom technology positively affected self-esteem and resulted in an increase in classroom interaction. Increasingly, students have personal and recreational experience with computers through gaming and social networking uses. Integrating the audio, visual, and textual aspects of computers into the instructional delivery system combines the recreational tool with the educational tool, which is "likely to motivate students to learn more interactively and to utilize their prior knowledge base" (Barger & Byrd, 2011, p. 4). In general, students respond positively to the use of computers (Lowerison, G, Sclater, J., Schmid, R. F., & Abrami, P. C., 2006). On-task behavior increases and students express more positive feelings when they participate in activities allowing them to be active learners through computer based activities compared to when they have been given other tasks to do (Barger, 2011).

Computer based learning activities are well suited for empowering learners and giving them the opportunity to control their own learning process. Information can be organized and displayed in various ways. They can include text, audio, graphics, animation, and videos allowing each learner to organize, represent and construct knowledge in a multitude of ways to best suit their own needs (Citrola, 2008). Incorporating audio and video technologies stimulates learning by bringing the content to life (Reiners et al., 2005), and can be appealing to students of various learning styles.

Students' enthusiasm for computers maximizes the opportunity for teachers to construct engaging learning tasks. The flexibility of computers can be used to meet the variable needs of learners. Learning tasks can be designed to be social and collaborative requiring students to build meaning together, or individual where learning is self-paced and user controlled. These multiple dimensions allow computers to be powerful tools in a teacher's arsenal of teaching strategies.

Wikis for Teaching

A wiki, a popular Web 2.0 technology, is a software-created web page that allows for collaboration among visitors. Simplicity of set-up and use make it a powerful tool for the classroom. After a wiki is established, anyone with access can add, edit and remove content. Pages can be linked to other pages with hypertext just like a web site, but without the need for specialized knowledge of computer language (Andrew, 2008). "Wikis present themselves as an interesting tool for enhancing social constructivist learning environments" (Bruns & Humphreys, 2005). The results are published in a web format allowing those with access to view the wiki from any networked computer with a browser. The social setting of the wiki format encourages students' collaboration skills. They promote active learning and student engagement (Andrew, 2008). Using innovative technologies such as wikis breaks up the predictability of traditional approaches to classroom teaching (Wetzel, 2009).

Precautions need to be taken when using wikis for teaching. They require close monitoring to avoid the inclusion of inaccurate, misleading, or biased information. Access can be limited and locked if necessary to avoid unwanted changes. Easy to use, easy to monitor, and engaging for students, wikis allow students to synthesize information for others to view and share as they work collaboratively (Wetzel, 2008). Wikis are a promising instructional tool.

Gaps in the Literature

Background research that was examined for this study showed many promising conclusions. However, most research that involved using Web 2.0 tools for instructional purposes focused primarily on high school or college age students. Studies that were done with elementary students mainly involved game playing strategies or other published software that were limited to specific content areas and involved a time consuming implementation period. Targeting intermediate grade students to find out how they respond to using an open-ended tool like a wiki to develop knowledge and understanding is a topic that has not been widely addressed in the current literature. The aim of this study is to provide information about the feasibility of using the widely available, easily adaptable tools of Web 2.0 for instructional purposes with younger students.

Conceptual Framework Summary

Successful science instruction has many facets. Engaging students is one essential element. Students who are engaged in the learning experience find excitement and pleasure in learning. They are more persistent when faced with unknowns and more confident in their ability to find solutions. They recognize the central importance of taking responsibility for their own learning.

> Though increasing students' subject matter understanding and competencies may be the most important goals of instruction, it is widely understood that students' attention, effort, and engagement in academic tasks is a critical intervening variable in determining whether those outcomes are attained. (Becker, 2000, p. 2)

To encourage and support student engagement, teaching strategies need to be interactive and collaborative in nature and allow the student to build knowledge in a way that is meaningful for them. Wikis are one component of an expanding network of social media tools that can be integrated into science instruction to encourage students' interaction with the content. As students work together to build a glossary of science vocabulary, author entries related to science content, and analyze and edit classmates' entries, they will have multiple opportunities to work with the concepts and language of science. They will have opportunities to build on existing knowledge and work with science vocabulary in ways that allow them to move words from their receptive vocabulary to their expressive vocabulary. Student writing will be used in an innovative way as an active learning tool. Learners will gain understanding and confidence as their science literacy grows, putting them on the path to success (Blachowicz & Fisher, 2000; Harmon, et al., 2005; Honig, 2010).

METHODOLOGY

Pre-Treatment Data Collection

My capstone project covered three chapters of science instruction. The first chapter, *Weather*, was started in September and was taught without an intervention strategy. This chapter lasted ten weeks. Baseline data was collected during this chapter for comparison with the later chapters of *Space* and *Cells and Kingdoms* for which the intervention strategy was implemented. To address my focus question regarding how using a wiki as an instructional tool would affect student engagement, I began collecting data in early October with the Science Learning Survey (Appendix A). This survey was given to students to assess their attitudes toward science. Questions focused on measuring attitudes that indicated cognitive engagement or the students' willingness to put forth the effort necessary to succeed. Follow-up interviews (Appendix B) were conducted with three randomly chosen students, one from each grade. The interviews asked students to expand on how they felt about science in general. They were asked whether the work was challenging, in what way it was challenging, and whether they enjoyed being challenged. Students were asked about their grades and whether they felt grades were important. Finally, they were asked to share how they felt they learned science best.

In late October, I began collecting additional data to measure engagement. A Student Engagement Class Observation Sweep (Appendix C) was used to note on-task and off-task behaviors during class time. This survey was completed once a week on different days and during different activities. Three to four times throughout the class period, I would note the time and what each individual student was doing. On-task behaviors included, speaking, reading, writing, listening, or being involved in a hands-on activity. In contrast, off-task behaviors included disturbing others, listening to others, working on another subject, playing, or other passive, non-engaged behavior.

Another data tool allowed me to collect data on individual students to more specifically measure their engagement behavior. Once or twice a week, I observed a student for the entire class period. I used the Student Engagement Observation Protocol (Appendix D) to rate the student's engagement as indicated by the student's body language, focus, verbal participation, confidence displayed, enthusiasm and interest level, and apparent comfort in asking questions. I rated these behaviors on a five-point scale with a score of one representing a low level of engagement and a score of five showing a high level of engagement.

On the last day of the each school week, I distributed a Student Engagement Survey (Appendix E) to students to collect data regarding their perceptions of science for the week. They rated their agreement to four statements using a Likert scale. A score of one indicated they disagreed with the statement whereas a score of five indicated they strongly agreed with the statement. The statements addressed the degree to which students considered the work challenging, were inspired to do high quality work, understood why and what they were learning, and if they felt that the class time passed quickly. Although I never gave specific instructions for this, most students circled one of the five ratings at the top of the paper indicating an overall rating for the week.

During the non-treatment *Weather* chapter, vocabulary was taught explicitly during instructional time with vocabulary notebooks, a teaching tool I had used the previous year with basically the same group of students. Students were required to write the vocabulary words, definitions, and provide a drawing, illustration or diagram to explain the word. Students were familiar with how the notebooks worked and had overwhelmingly indicated that they liked using them the previous year. They also told me they felt the notebooks were useful study tools. The data I gathered teaching one chapter with vocabulary notebooks and two chapters with the wiki allowed me to compare the effectiveness of using the two different techniques to teach vocabulary.

To assess how well students learned the subject matter during instruction, I used a pre-test and post-test assessment (Appendix F). These data were gathered in order to help answer my first and second focus questions regarding whether the treatment would help improve vocabulary and content learning. When I administered the pre-tests, I gave the students instructions and indicated that the test grades would not be included in the grade book. I encouraged them to do their best. If they did not know an answer, they did not need to answer the question. These tests were not returned to the students, and the answers to the questions were not reviewed. The summative test at the end of instruction was the same as the pre-test assessment; the data was used to compare scores on the vocabulary component. Responses on the short-answer questions were compared as well and analyzed for the quality of the answers and the understanding that was communicated.

The Treatment

During our second science chapter, *Space*, I introduced the students to my treatment strategy, our classroom wiki. After setting up the home page and an *Space* page, I posted several discussion threads to initiate student responses. I also posted a link to a website that provided an introduction to astronomy for young people. The first class period was spent instructing the class in how to login to the wiki, how to navigate the pages, and how to read and respond to the discussion threads. After exploring the wiki and asking general questions, we spent time learning how to edit a page and make an entry to a glossary page.

The first lesson during the treatment phase was on the solar system, which highlighted eight important vocabulary words. I collaborated with students as a group over three class periods modeling how to create entries for these words. During the first class period, l began by giving each student a copy of the rubric I developed to score wiki posts (Appendix H), and we discussed the components of a good wiki entry. Using their textbooks and the Internet, I then had students suggest information they wanted to include in a post for the first vocabulary word. I then created the actual post on the interactive whiteboard. After completing several entries together, we scored the entries that we created and discussed ways we could improve them. I demonstrated how to edit entries by making some of the suggested changes. We incorporated pictures and diagrams and discussed how animations, audio, and video could be added as well. Students were instructed on how to add the sources.

On the second day of instruction, students were divided into groups of two or three and each group was assigned a vocabulary word. Groups collaborated on their research and writing as they created a post for their assigned word. I circulated and assisted the groups during this process. When the entries were complete, the class came back together to evaluate the entries using the rubric for guidance. Edits were made incorporating suggestions from the class.

After the class completed the first lesson on the solar system, I posted a question on the wiki relating to the science content in the lesson. Together, the class composed a response to the post. Students were asked to individually add to the class post or to edit it within a defined time period. At the end of that time, the class reviewed and discussed the posts using the wiki rubric to determine the quality of the posts. Questions as to how to create or edit posts were answered.

The wiki was used during two chapters of our science curriculum, *Space* and *Cells and Kingdoms*. The chapters each contained four to five lessons and took six weeks to complete therefore the total time period covered by the intervention was twelve weeks. Overall there were over one hundred vocabulary words in these two chapters. During instruction of each lesson, I posted questions pertaining to the concepts taught in the lesson. Students had several opportunities each week to respond to questions, explain relationships, and apply concepts, as well as define terminology by posting entries to the vocabulary words on our science wiki. A sampling of each student's posts over the course of the chapter were scored using the rubric, and a portfolio of work samples was created for each student to show changes over the period of the intervention.

Methods of Data Collection and Analysis

Table 3 and 4 show the data collection methods and timeline of the treatment strategies used in this study respectively.

Table 3
Summary of Methods

	Pre-Treatment Sept. to Nov., 2011	During Treatment Nov. 2011 to Mar., 2012	Post-Treatment Mar., 2012
Chapter pre-test	X	X	
Chapter final test (summative assessment)		X	X
Student Engagement Observation Protocol used by teacher to monitor student engagement behaviors	X	X	
Student Engagement Classroom Sweep	X	X	
Student Engagement Survey	X	X	
Teacher generated survey to measure science learning attitudes	X		X
Student journal entries		X	
Wiki entries scored with a rubric		X	
Vocabulary Cloze test		X	X

Table 4
Time Schedule of Intervention Strategies

Period	Activities
	Pre-Intervention Activities
Weeks 1-10	Administer Science Learning Survey, interview sampling of students, pre-test for *Weather*, Instruction for *Weather*, teacher and student completed engagement surveys, classroom engagement sweeps, summative assessment (post-test) for *Weather*
	Treatment Phase
Week 11	Pre-test for *Space*, Introduce and instruct in how to use wiki Teacher assessment of student engagement, teacher reflection journal
Weeks 12-16	Instruction of *Space* from fifth grade textbook and additional material from sixth grade textbook Assign vocabulary words for wiki, teacher-posted discussion thread topics and content related questions on wiki, formative assessments, weekly student engagement surveys, teacher completed classroom engagement sweeps and individual student engagement surveys Student journal, teacher reflection journal
Week 17	Review material and administer summative test on *Space* Teacher assessment of student engagement, teacher reflection journal Cloze test of vocabulary words from *Weather*
Weeks 18-22	Pre-test for *Cells and Kingdoms* Instruction of *Cells and Kingdoms* from fifth grade book and additional information from sixth grade book Assign vocabulary words for wiki, teacher-posted discussion thread topics and content related questions on wiki, formative assessments, weekly student engagement surveys, teacher completed classroom engagement sweeps and individual student engagement surveys Student journal, teacher reflection journal
Week 23	Review material and administer summative test on *Cells and Kingdoms* Teacher assessment of student engagement, teacher reflection journal Post-treatment science learning survey Cloze test of vocabulary words from *Space*

Table 5 presents the data triangulation matrix showing measurement tools for each research question of this study.

Table 5
Data Triangulation Matrix

Research Questions	Data Source #1	Data Source #2	Data Source #3
1. How will students' participation in the creation of a classroom wiki affect their development and retention of science vocabulary?	Pre-tests/Post-tests Compare vocabulary section	Rubric to analyze wiki entries for understanding and quality of work	Teacher Developed Cloze test
2. How will students' participation in the creation of a classroom wiki affect their understanding of the science content?	Pre-test/Post-tests Compare short answer sections	Rubric to analyze wiki entries for understanding and quality of work	
3. How will creating a classroom wiki affect student engagement in science?	Student Survey Pre-treatment and Post-Treatment	Student Engagement Observation Protocol, Student Engagement Survey, Student Engagement Classroom Sweep	Student Reflections
4.How can the wiki be designed and implemented to optimize students' development of vocabulary and content understanding and to improve engagement?	Teacher Reflection Journal	Student Reflections	

One of my research questions addressed how creating and working with a classroom wiki affect student engagement in science. Ruhe's (2010) paper on designing and writing surveys to measure student engagement detailed several aspects of student engagement including intrinsic motivation, positive affect, persistence, effort, and self-confidence. Each component of student engagement includes various dimensions. For this survey, I chose to focus on how students take responsibility for their learning as a way to determine engagement. Students who are engaged in their topic reflect on the material and their learning. Compared to students who simply memorize material in order to reproduce it on an exam, they exhibit intrinsic motivation. The Science Learning Survey that I produced using these guidelines measured student behaviors that reflected a "meaning orientation" vs. a "reproducing orientation" (Ruhe, 2010, p. 1). This provided a means to determine a student's level of engagement. I wrote questions to measure the following evidence of engagement: increased effort, persistence when faced with difficulties, seeking help when needed, explaining reasoning, learning from mistakes, and positive attitudes toward the work. These are the dimensions of responsible learning (Ruhe, 2010, p. 2) and indicate a student's deeper relationship with the material.

The survey was administered before the treatment in early October and again after treatment in March. This allowed assessment of whether any change occurred in the way students approached their responsibility for their science learning. The survey was administered to the entire class; however, it was administered separately to the students with IEP's so that I had an opportunity to discuss each question with them in more detail and to make the purpose of each question clearer. I wanted to avoid them just randomly making a selection as much as possible.

To analyze the results of the survey, I assigned a numerical value to the choices. Always = 5, Almost always = 4, Sometimes = 3, Hardly ever = 2, Never = 1. The data was entered into an Excel spreadsheet for analysis, and I created bar graphs depicting the results. I also looked at the mode, or most frequently occurring responses in order to establish the prevailing attitudes for each question. Calculating the mean for the response to each question also gave me an indication as to whether behaviors shifted when I compared pre- and post-treatment survey results.

Throughout the treatment period, I continued to conduct the Student Engagement Class Observation Sweep, the Student Engagement Observation Protocol, and the Student Engagement Survey as I had done during the pre-treatment phase. At the end of the treatment period, data from the pre-treatment period was compared with data from the treatment period in order to find any patterns that indicated a change in engagement levels of the students overall or individually.

To gather qualitative data regarding students' attitudes toward the wiki, I asked the students to comment on their experiences during the treatment period. At the bottom of the weekly Student Engagement Survey, I asked the students to respond to various questions: Did you feel comfortable using the wiki? Did you enjoy using the wiki? Did you feel the wiki helped you learn the information? Other questions were more open ended such as: What did you think needed to be changed about the wiki? What did you think was most interesting about the wiki? What questions did you have about using the wiki?

Research questions three and four were related to the effectiveness of a wiki in increasing student understanding. The first question was in what ways did creating a glossary as part of a wiki affect students' knowledge and retention of science vocabulary?

The second was how would it affect students' understanding of the science content? According to my literature review, strategies that contribute to greater understanding of science content vocabulary include (1) learning the vocabulary through reading and writing activities and then (2) applying the newly acquired words by explaining the ideas. The treatment I used to implement these strategies was to have students create wiki entries. Students' postings to the wiki were scored with a rubric that I developed (Appendix G) to determine their level of understanding of the vocabulary or science concept.

For my research purposes, the rubric focused mainly on whether or not the students were accurate in the information they posted and if they demonstrated some in-depth understanding of their posted concept. Posting to a wiki was a new experience for my students, and I did not plan to assess them on style or even writing mechanics. I did intend to assess them on whether they gave credit to their references as I expected them to use information they found on the Internet and from other resources. As students became more comfortable with the process of writing and posting and editing other students' entries, I expected them to broaden their scope by adding multimedia components to their entries such as graphics, pictures, animations, or other content that enhanced their postings. I added an assessment for these extra items to the rubric but chose to provide extra credit as encouragement for the students to branch out as they felt more comfortable with using the wiki. Not all student entries were scored with a rubric. I used several samples that represented entries from the beginning, middle, and end of the treatment period that were scored for each student in the class to assess improvement in the quality of students' work over the treatment period.

Writing entries for a wiki was a new way for my students to apply the science content. To collect additional evidence as to whether the wiki was a useful tool for helping students learn vocabulary, I used pre- and post-tests from the first science chapter on *Weather* in the fall. Gains made in vocabulary acquisition between the beginning and end of the *Weather* chapter were compared to gains made from the pre-to the post-test periods during the *Space* and *Cells and Kingdoms* chapters. The short answer sections were compared and analyzed to determine if there was a significant difference between results during non-treatment and treatment periods.

Finally, a teacher-generated Cloze test was created as a summative assessment of the students' vocabulary comprehension and retention. A Cloze test is a passage of text that has missing words that the reader fills in. It is used to determine the reader's comprehension of the text. I administered a Cloze test related to our *Weather* chapter in January, approximately a month after we finished the chapter, to determine the level of vocabulary retention by the students for the non-treatment chapter. Similarly, a Cloze Test related to our *Space* chapter was given in March, approximately a month after the completion of instruction, to determine the level of students' retention of vocabulary learned during a treatment chapter. A Cloze test for *Cells and Kingdoms* was administered in late April. The overall class results from the three tests were compared to see if there was an indication of change between the non-treatment chapter and the chapter taught with the intervention.

To record my observations throughout the treatment period, I kept a reflection journal about my thoughts and comments about the wiki design, issues that came up with its use, problems encountered by students, and other information that I felt would be informative and useful. Changes were made to the wiki design and its implementation over the treatment period based on comments that were recorded in this reflection journal.

Validity and Reliability

There are many aspects of validity to consider. Interpretive validity refers to how the data is interpreted. Were the behaviors of the participants accurately assessed for meaning? Evaluative validity is whether the researcher reported the data in an unbiased manner. Finally dialogic validity requires that the research be subjected to a peer review process in order to ensure the validity of the process (Mills, 2011).

Throughout the treatment process, steps were taken to assure the validity and reliability of the data collected. Colleagues were consulted at various points in the process to gather additional perspectives regarding the interpretation of data. Survey and interview results were shared with them, and their thoughts on the outcomes were discussed. This gave me an opportunity to discuss patterns present in the data and possible interpretations that I had not discovered. For reliability purposes, another teacher scored samplings of wiki rubrics in order to validate the scores I had given. Scores were compared to see if there was a high degree of agreement for assessment purposes. Discrepancies were discussed and mediated until a consensus was reached.

A student teacher that was working in my classroom performed engagement sweeps of the classroom periodically while I was teaching to ensure an accurate assessment of individual students' activities and engagement behaviors. She also administered and scored the Student Engagement Observation Protocol on various occasions. At the end of her student teaching period, she gave the students a survey she designed to find out students felt about working on the wiki. This survey provided another assessment of students' level of engagement. I reviewed responses to this additional survey to determine if the results supported the data I had collected.

Reliability relates to the dependability or trustworthiness of the data or the degree to which the test or treatment measures what it purports to measure (Mills, 2011). Using data triangulation and having a variety of data collection tools to measure the outcomes of each focus question addressed the reliability of the treatments that were applied in this study. While the rubrics measured depth of student understanding and the graphs measured changes in student understanding over time, I also used summative test scores to see if there were improvements over the treatment period. At the end of the treatment period, I administered a Cloze test which required the student to fill in spaces where vocabulary words had been omitted. The purpose of the Cloze test was to assess comprehension and to determine retention levels of the concepts and vocabulary words.

DATA AND ANALYSIS

Student Engagement

Student Engagement Survey and Interviews

The goal of this action research project was to learn whether having students create a wiki was an effective teaching strategy for engaging students and helping them gain a deeper understanding of science vocabulary and content. The student sample for this study was small so the data was influenced by several factors that bear noting. Initially ten students were part of the study. A fifth grade boy joined our class early on but after some pre-treatment data had already been collected. In addition, a fourth grade boy transferred out late in the data collection period after the second chapter had been taught. Comparison data from the pre-treatment period to the post-treatment period was not available for these students. Three other students who joined the class very early on but after pre-treatment data was collected were identified special education students with IEPs. One of these students had very poor attendance during the treatment period being absent for 24% of the class periods while another was absent for a large block of time in December. Results for the special education students are presented separately where appropriate. Finally, I was assigned a student teacher during the treatment period. She began observing in January and took over teaching duties for this group of students for the last four weeks of the treatment period.

In October, prior to the treatment period, the students completed the Science Learning Survey to assess their attitudes toward science. The questions focused on attitudes that reflect a student's willingness to put forth the effort necessary to succeed in science. The survey was administered again in March after the treatment period, and the results from the two surveys were compared. Although only nine students participated in the entire pre-treatment and treatment period, results of ten surveys are presented. Surveys were completed anonymously, and I was unable to separate the responses of the two students mentioned above from the others. Overall, the survey did not provide any clear, positive evidence that using the wiki improved student engagement.

Table 6 below summarizes the questions that relate to each of the measures of cognitive engagement. These are the dimensions of responsible learning and indicate a student's deeper relationship with the material. Table 7 summarizes the results of the Science Engagement Survey

Table 6
Signs of Engagement/Survey Questions

	Increased Effort	Persistence	Seeking Help	Explaining Reasoning	Learning From Mistakes	Positive Affect
Related Questions	1, 2, 3	1, 2, 3, 4	6	7	8, 11	5, 9, 10, 12

Table 7
*Results of Science Engagement Survey Before and After Treatment, (N=*10*)*

Question	Always		Almost Always		Sometimes		Hardly Ever		Never	
	B	A	B	A	B	A	B	A	B	A
1. When I come to a hard science problem or question, I guess or skip it.	--	--	3	3	5	6	--	1	2	--
2. I try to do the best I can in science.	4	5	5	2	--	3	--	--	1	--
3. When working on my science assignments, I like to be done as fast as I can.	--	--	--	--	3	6	4	2	3	2
4. If I can't get the answer to the science problem the first time, I keep trying until I do.	2	1	5	2	3	7	--	--	--	--
5. I am confident that I can figure a science question out even if it seems hard.	4	3	2	3	4	3	--	--	--	1
6. I ask the teacher for help if I don't understand the question in science.	1	1	1	2	4	4	4	3	--	--
7. When the question asks "why", I can explain my reasons.	1	1	4	2	3	7	2	--	--	--
8. When I get a science paper or a science test back, I check to see what mistakes I made to see if I can fix them before the teacher goes over the paper.	2	1	1	3	2	3	4	3	1	--
9. I feel uncomfortable when I don't know the right answer to a science question.	1	1	2	3	2	4	3	2	2	--
10. I am confident that I can get a good grade in science.	6	5	2	3	2	1	--	1	--	--
11. When I make a mistake on a science assignment, I try to be careful not to make the same mistake again.	6	6	3	2	1	1	--	1	--	--
12. I like to be challenged with hard questions in science.	--	--	3	2	3	5	3	1	1	2

Abbreviations: B-Before; A-After

Questions 1, 2, 3, and 4 related to the amount of effort the student was willing to put forth and their persistence in working through a challenging question. Comparing the results of pre- and post-treatment did not show positive results in this area. Students were slightly more likely to report that they skipped science questions they perceived to be hard. In the post-treatment survey, none of the students reported that they never skipped hard problems whereas two students had claimed to never skip hard problems in the pre-treatment assessment. Also, the number of students who reported that they hurried through their assignments at least sometimes doubled from three to six. The number of students who reported that they always or almost always kept trying when faced with a hard problem went down from seven students before the treatment to only three students after the treatment. Most students admitted that they only persisted sometimes. When reporting whether they tried to do their best in science, the results were more mixed. Half reported that they always tried their best while two said they almost always did. This was down from nine students who reported that they always or almost always did their best before the treatment. Three admitted that they only did their best sometimes, but there was no one who said that they hardly ever or never tried their best on the post-treatment survey.

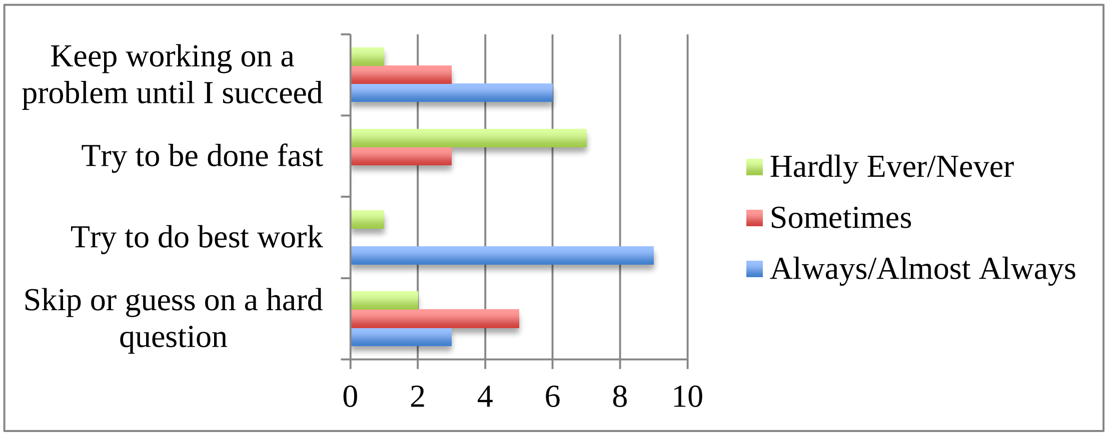

Figure 1. Student Responses Relating to Effort and Persistence-Pre-treatment, (*N*=10).

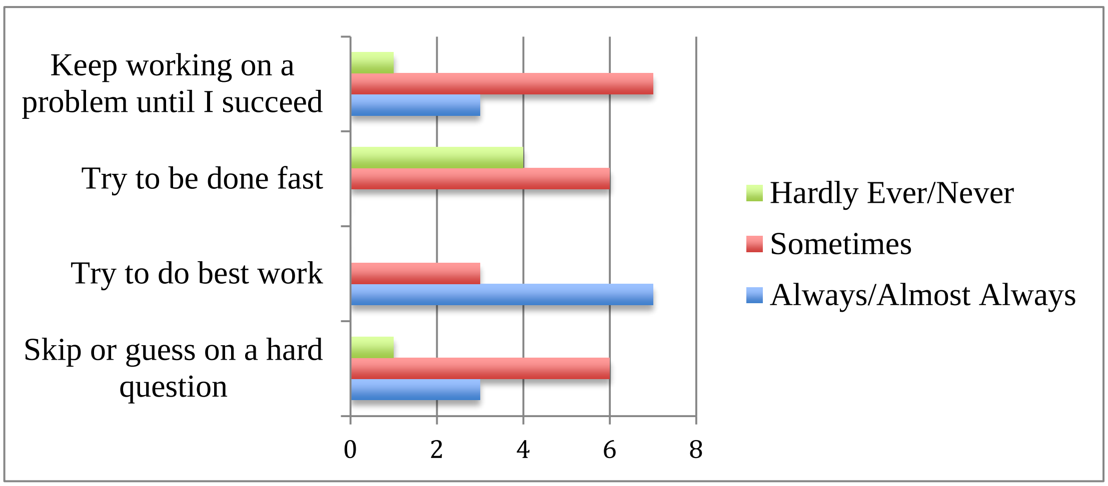

Figure 2. Student Responses Relating to Effort and Persistence-Post-treatment, (*N*=10).

Question 6 asked students about whether they sought help from the teacher if they didn't understand a question. There was a very small positive increase in students' self-reports in this area after treatment with one more student reporting that they almost always asked for help.

According to post-treatment Question 7, all of the students reported that they felt they were able to explain their reasoning at least sometimes when a question asked "why?" This was a positive result even though there were two less students who felt they could almost always explain their reasoning.

Question 8 was asked in order to determine if students took responsibility for trying to correct their mistakes before the teacher gave them the correct answer. The results between the pre- and post-treatment surveys showed a small positive shift in this area. The number of students reporting that they did this almost always or always increased from three to four. After the treatment period, one more student reported doing this sometimes and no one reported that they never tried to correct their errors on their own.

There was almost no change in the responses to Question 11, which asked if students tried to avoid making the same errors again. Six students said they always tried to be careful not to make the same mistake again both before and after the treatment period. Only two said they almost always tried to avoid repeat errors and one student reported that they hardly ever tried.

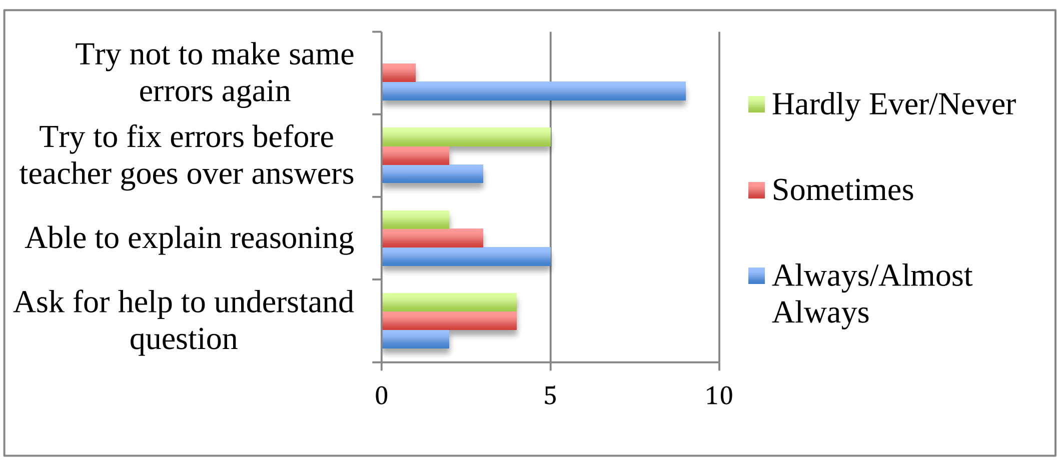

Figure 3. Student Responses Relating to Learning From Mistakes, Explaining Reasoning, and Asking for Help Pre-treatment, (*N*=10).

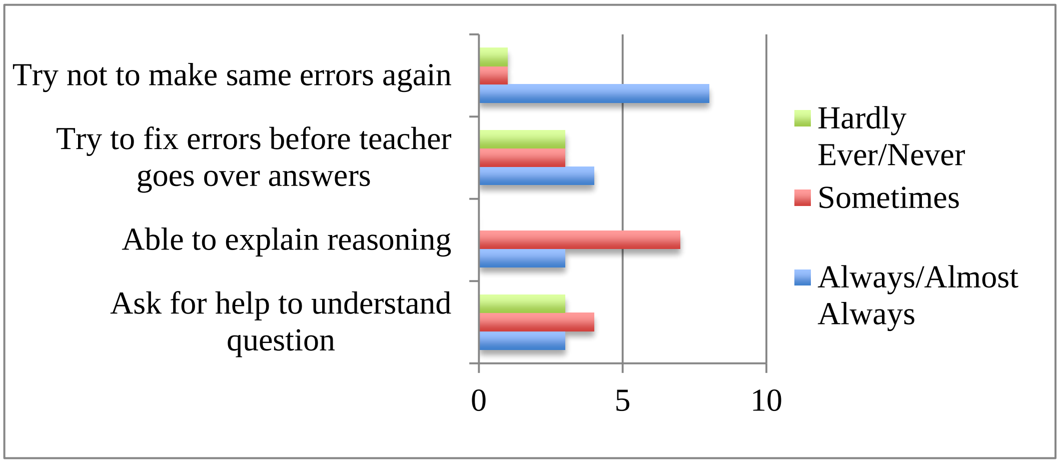

Figure 4. Student Responses Relating to Learning From Mistakes, Explaining Reasoning, and Asking for Help Post-treatment, (*N*=10).

Student confidence and positive affect, or having a positive attitude toward science were measured by Questions 5, 9, 10, and 12. Student confidence measured by Question 5 shifted slightly downward, and one student on the post-treatment survey reported that he/she never felt confident about his/her science knowledge. On the post-treatment survey, students reported more discomfort when they didn't know the right answer to a science question in class. The number of students answering that they almost always or sometimes felt uncomfortable increased by three. Students were slightly less confident in their ability to get a good grade in science. One student reported they hardly ever felt they could get a good grade. Finally, on the post-treatment survey, fewer students indicated that they liked to be challenged with hard questions in science.

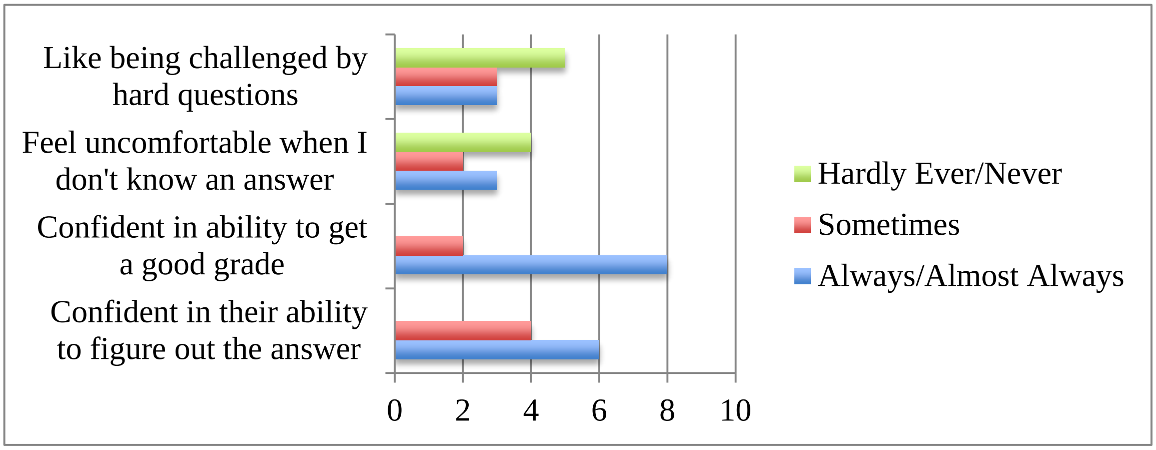

Figure 5. Student Responses Relating to Confidence and Positive Affect Pre-treatment, (*N*=10).

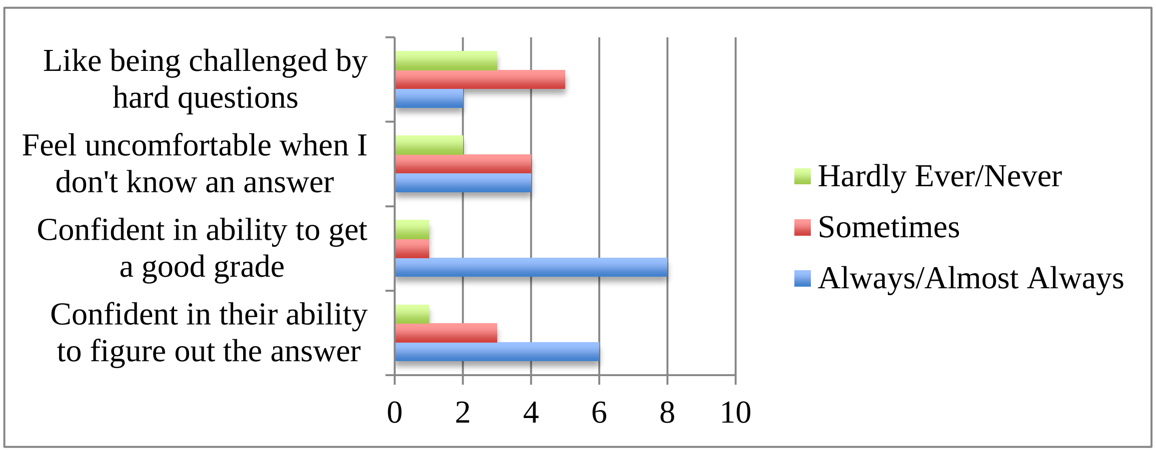

Figure 6. Student Responses Relating to Confidence and Positive Affect Post-treatment, (*N*=10).

Post-survey interviews that I conducted with three students in November and early April indicated students felt the wiki had a positive impact on their understanding of the science content. Their answers also indicated a positive change in their engagement in science. In November, a sixth grade boy replied that he did not like science when I asked him how he felt about the subject. In the April interview, the same boy said, “I like it. Sometimes I think it is fun. Sometimes it’s not interesting, but I still like it.” Both girls were positive about science in the pre-treatment interview as well as the post-treatment interview. They liked learning new and interesting things.

There was no change in whether the students thought science was challenging. All three students responded that they felt science was challenging in both interviews. Although the boy said he thought “challenging” was a negative thing, the girls did not seem to agree. The girls noted that “the questions were hard”, and “figuring out the answers”, and “explaining my thinking” were also hard, but they did not indicate they felt this was discouraging.

All three students indicated they were more satisfied with their science grades in the post-treatment interview. “It’s better than it used to be,” a fifth grade girl replied. She also explained, “I’m working harder at it.” “I think I’m doing better,” and “I feel more confident on the quizzes,” were the sixth grade boy’s responses. Although the sixth grade girl was happy with her science grade prior to working with the wiki, during the post-treatment interview she was pleased to report that her grade had gone up. “I’m understanding it more,” she stated.

In the post-treatment survey, the students all mentioned the wiki as a positive component when asked how they liked learning about science. The two sixth grade students liked reading what classmates wrote in response to the questions I posted on the wiki. The boy said it helped him to see what the other students were thinking and “helped him understand how they had learned” some of the information. “Sometimes they explain things, and it makes sense to me,” the girl reported. Even though they found students also wrote incorrect information on the wiki, this did not seem to bother them.

Correcting others' information was part of the learning process. "When I correct someone's answer, I know that I have really learned something," the boy shared.

At the end of the April interviews, I asked the students if I should continue to use a wiki as part of my science instruction. The answer from all three was a resounding "yes".

Weekly Observations and Surveys

Data to measure changes in the overall engagement of class members was collected with a Student Engagement Class Observation Sweep. Data assessing the entire class was collected once a week beginning in mid October during the non-treatment phase and continued through the treatment period. In addition, twice a week a specific student was observed for an entire class period and a Student Engagement Observation Protocol was filled out noting the student's engagement behaviors during the class. Observations were conducted by me and by my student teacher. The final data was collected at the end of February with seventeen weeks of data being gathered over all.

The results of the Student Engagement Class Observation Sweep are presented below.

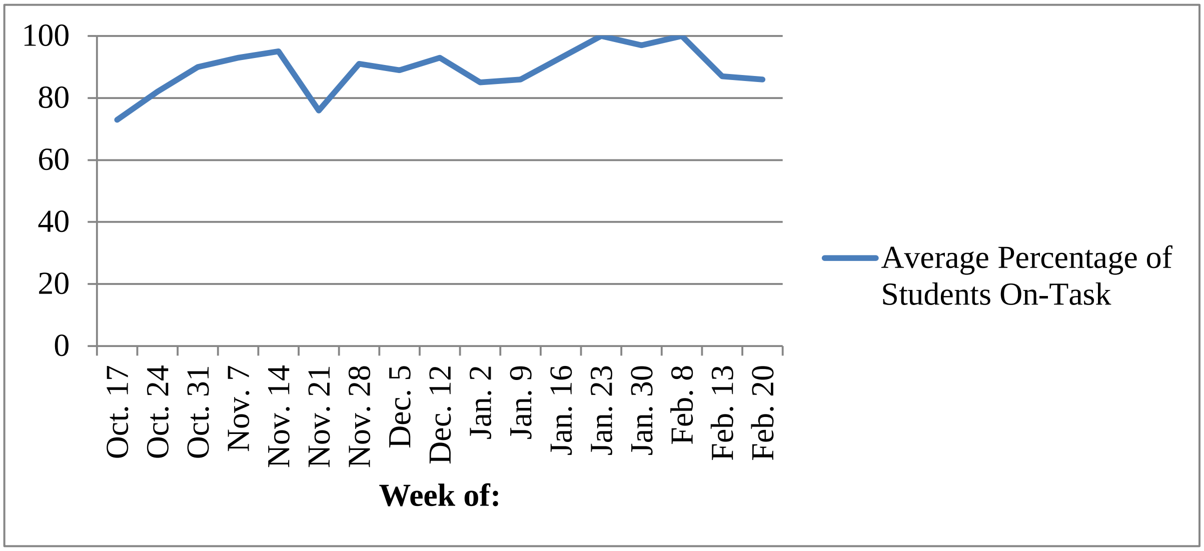

Figure 7. Average Percentage of Students On-Task During a Class Period.

Observed student engagement was quite high during the entire period over which data was collected ranging from a low of 73% during the pre-treatment *Weather* chapter to a high of 100% observed twice during the treatment period. Student interest increased noticeably during the *Space* chapter and tapered off slightly during the *Cells and Kingdoms* chapter. Data was strongly influenced by the type of activity we were doing in class for the day observed. Students were most engaged when the class was doing a hands-on activity such as making a poster, doing a classification activity or listening to Crow astronomy related stories. The students also showed a high level of engagement during reading and discussing of the textbook. The lowest engagement was shown while they watched a movie or went over worksheets. On the days when the students worked on the wiki, engagement was measured at 87-93%.

For the Student Engagement Observation Protocol, each behavior observed was given a score of one through five with a five representing a high level of engagement.

The overall observation for each student was averaged for a mean score to measure engagement. The results are displayed below.

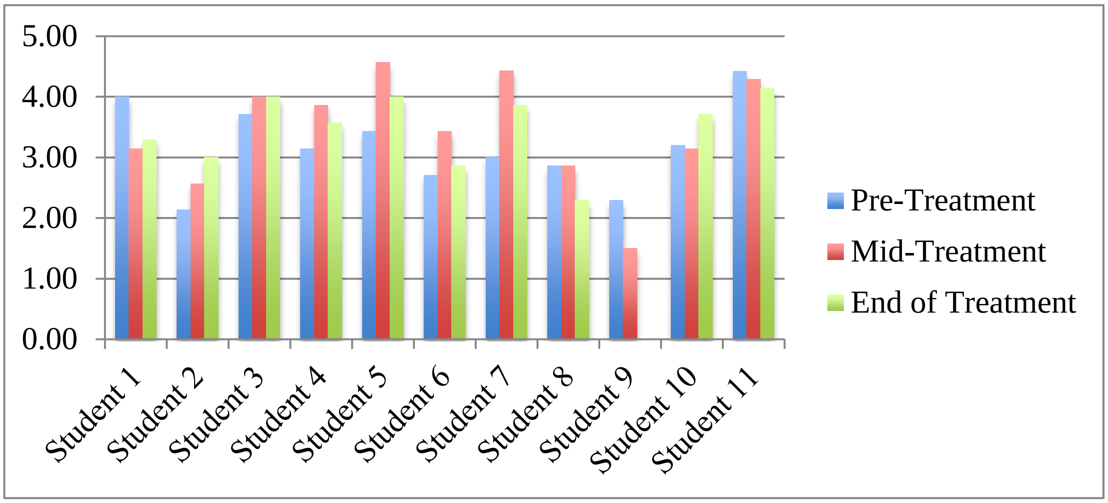

Figure 8. Results of Student Engagement Observation Protocol.

The results were not conclusive although a majority of the students showed the lowest level of engagement during the *Weather* chapter. Their attention increased during the *Space* chapter, and then showed a lower level of engagement during the *Cells and Kingdoms* chapter. Six of the eleven students displayed more evidence of engagement during the two chapters that were taught using the wiki.

Finally, data was gathered using the Student Engagement Survey to measure students' attitudes towards science instruction for the week. This survey not conducted during the non-treatment period as planned. It was completed during the treatment period at the end of the school week starting in December and continued into February for a total of nine weeks. The total number of surveys returned varied widely each week from five to nine. Some of this was due to absences, but that did not account for all of the differences. It is apparent that some students did not return the surveys after filling them out therefore the information is incomplete. I grouped the responses by week and made a chart to tally the responses given. Then I computed the percentage of fives, fours, threes, and so on for the week. The results of the Student Engagement Survey are shown below.

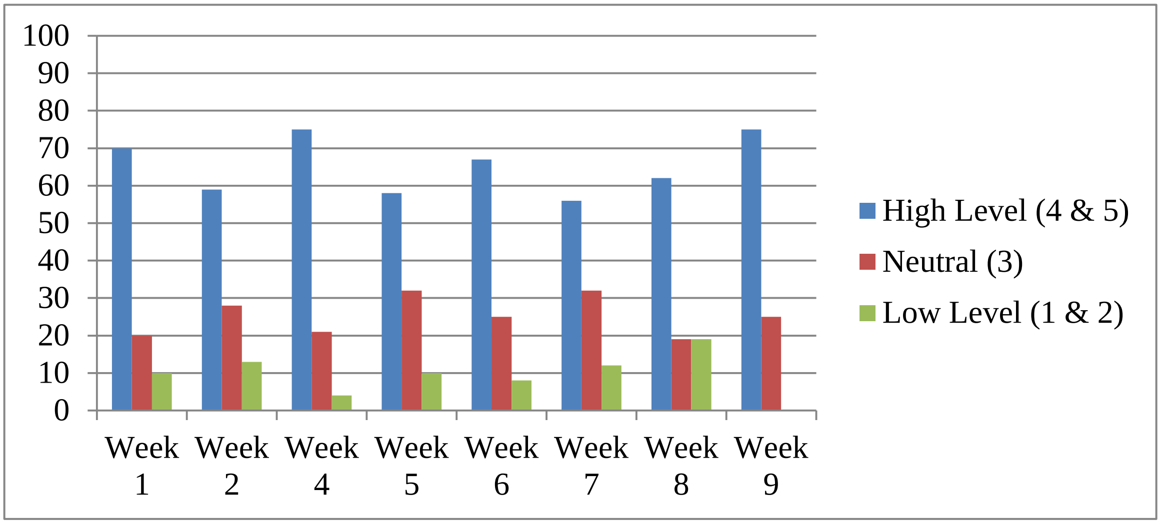

Figure 9. Student Reported Levels of Engagement.

Students reported a high level of engagement throughout the treatment period, but the levels did not change noticeably over the data collection period. Results for this data collection tool did not show an effect on students' engagement from the use of the wiki.

Science Vocabulary and Content

Pre-tests and Post-tests

Data to measure students' understanding of science vocabulary and content was collected in several different ways. Chapter pre-tests included with the curriculum materials from the textbook company were administered prior to the chapter's instruction. In order to ensure a clear comparison, the same test was administered again as a post-test at the end of the instruction. The tests contained two main sections; the first section assessed vocabulary knowledge while the second, short-answer section focused on assessing understanding and application of the science concepts.

For the first chapter, *Weather*, I was only able to compare the pre-test to the post-test for six students. Four other students, including the three identified special education students, joined the class after the pre-test had been given. Scores on the pre-test averaged 34%. On the post-test, scores averaged 58% for an increase of 24%. Students averaged 26% more correct answers on the vocabulary section and 24% more on the short answer section.

The students used the wiki in conjunction with the second chapter, *Space*. Pre-test scores were pretty similar to the first chapter with an average of 30% overall. The post-test average showed an increase to 68% however, for an increase of 38%. When these results were broken down between mainstream students and special education students, the scores of the mainstream students increased to an average of 76% whereas the special needs students' scores increased to an average of 47%. Vocabulary scores for mainstream and special education students increased 48% and 22% respectively. Short answer scores showed an increase of 32% and 20% for the two groups thus showing a marked improvement over the chapter taught without the wiki.

The wiki was used with the third chapter, *Cells & Kingdoms* as well, but the results for this chapter did not show an improvement over the non-treatment chapter. The pre-test scores were much lower on this chapter averaging only 22%. Post-test results increased to 49% for a 27% increase. This was broken down to show an improvement to 52% for mainstream students and to 42% for special education students. The increase of correct answers for the vocabulary section was 26% and 27% for the two groups, which was very similar to the improvement shown on the non-treatment chapter. On the short answer section, scores went up 27% and 12%. The 27% increase was also very close to the increase shown on the *Weather* chapter's short answer section.

Cloze Tests

Another data collection tool I used to measure the wiki's effect on acquisition of science vocabulary was a Cloze test that I created for each chapter. This vocabulary test was administered four to six weeks after the end of instruction for each chapter to measure how much vocabulary the students retained. Results on these tests showed students retained more vocabulary from the first chapter that was taught using the wiki but not on the second chapter. On the Cloze test for the non-treatment chapter, students scored an average of 35%. The average score on the Cloze test for the *Space* chapter was 45% and 33% for the *Cells and Kingdoms* chapter. There were large disparities between the scores of mainstream students and special needs students however, as shown below. Mainstream students' scores increased from 35% on the non-treatment chapter to 54% and 42% on the chapters taught with the wiki. Special needs students' scores remained the same at 24% for the first two chapters even though the first one was taught without using the wiki and the second one was taught with the wiki. On the third chapter, their scores dropped to 11%. The scores indicated that the wiki had a positive effect on vocabulary retention for mainstream students.

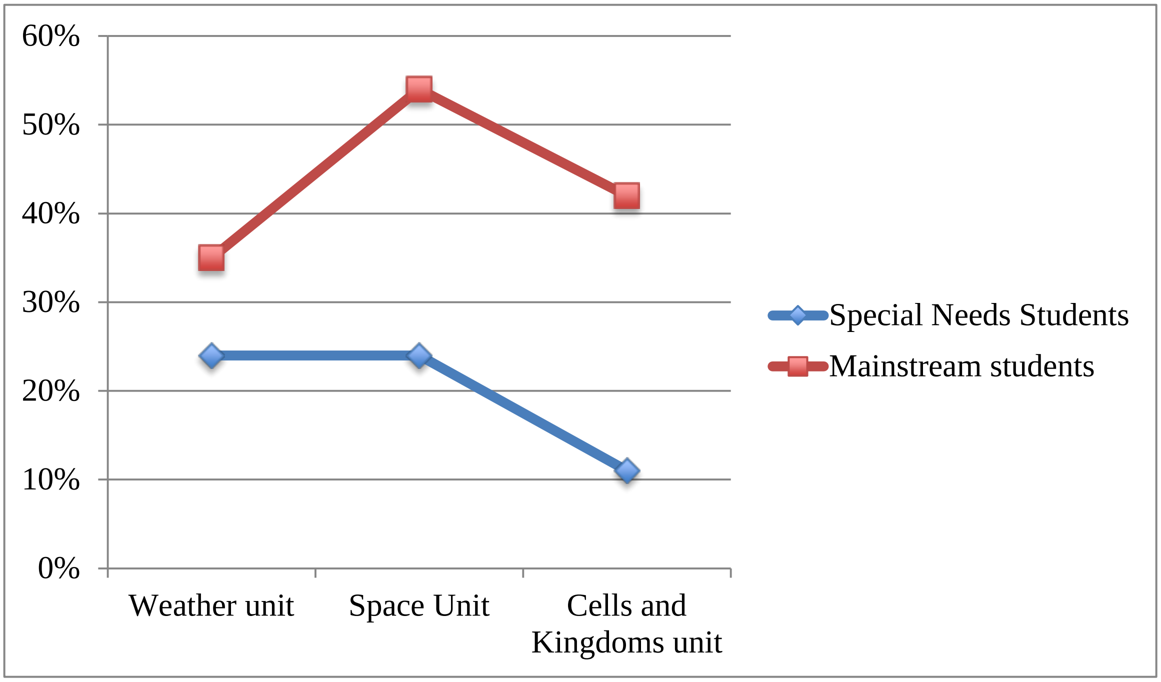

Figure 10. Results of Cloze Tests.

<u>Student Wiki Entries</u>

I had planned to score student wiki entries using a rubric to assess the accuracy and quality of student knowledge and to compare the rubric scores for growth over the course of the treatment period. However, I encountered several problems with that approach. First, use of the wiki was not consistent throughout the group of students. Four of the students, including all three special education students, had difficulty in learning to use the wiki. They needed much more support in locating, logging in, and working with the wiki than the other students. Three of these students made very few postings, and all of their postings were done during a very limited time frame. They did not make entries over the course of the entire treatment period so it was not possible to measure any growth for these students. The fourth student also had a difficult time learning the logistics of working with the wiki. He didn't successfully make any posts until late in the treatment period so I was unable to gather comparative data on him as well.

The rubric I designed did not fit well with the actual entries the students made. Though the other six students made numerous posts over the three months that we used the wiki, the entries were generally very brief, usually with fewer than ten words. Many of the entries simply provided a definition taken from the textbook, which they referenced, but none of the entries used a source beyond the textbook. When we were well into the second month of using the wiki, I realized that the students were not using the wiki as I had envisioned. They were not searching for information to add to their entries or expanding on other students' entries as I had intended. Student entries were not demonstrating any growth in understanding of the science vocabulary. Definitions that were posted continued to provide only basic information. We went over the wiki rubric again as a class, and I made several entries showing them what types of information I was looking for and what they could use for resources. During later work sessions, I observed students searching the Web for information and studying various websites, but their actual entries to the wiki changed very little. Also, only half of the students were making regular posts. I redesigned the wiki to provide the students more structure in which to work. Consequently, I created a wiki page for each lesson with an area for vocabulary and an area where I posted questions to check the students' understanding of the content from the chapter. Our procedure for working on the wiki changed as well. After the students had several opportunities to work on a wiki lesson page, we would go through the entries as a class. We would discuss the information that was posted and make corrections, changes, and additions as a class. The students responded well to these changes. During interviews and in journal entries, the questions were mentioned repeatedly as something they liked about the wiki. One student wrote, "I like answering the questions because it is fun." Another said, "I like the wiki. I like it because it asks us questions then we go over them and we know if we are right or wrong." The best part of the wiki was, ". . . seeing what other people say," another girl wrote.

Since the wiki design changed several times over the treatment period, I also changed the types of entries I required from the students. Therefore it was not possible to use the same rubric to compare individual's entries from the beginning to the end of the treatment period, and I was unable to gather comparative information for the students. The rubric I initially designed did not meet my needs as the wiki evolved so rubric scores were not part of my final data collection process.

Although the information the students provided as part of the glossary did not evolve much in complexity, the students collaborated and built a greater collective understanding as they made entries. One example was shown by their entries for the word "gravity."

> Gravity means:
>
> Student 1: The book says gravity is a force of attraction or a pull
>
> Student 2: between any two objects
>
> Student 3: Gravity never pushes. No matter where you are, your gravity is still the same.
>
> Student 4: Actually your gravity on Earth is different than your gravity on the moon.
>
> Student 3: (He's) right. It is your mass that stays the same.
>
> Student 2: The book says two objects don't have to touch each other to produce the force of gravity.

> Student 5: The larger the mass the more gravity an object has. Like Jupiter is bigger so it has more gravity and Earth is smaller so it has less gravity than Jupiter.
>
> Student 4: Its distances are really far.
>
> Student 6: The book says the strength of gravity decreases when the objects are farther apart.

Another example that showed collaborative learning was student entries for the word “cell.”

> Student 1: the smallest unit of living things
>
> Student 2: It carries out life processes (born, grow, reproduces, matures, dies).
>
> Student 3: Cells contain organelles.
>
> Student 4 and 1: Organelles are things inside the cell to keep it working.
>
> Student 4: the very smallest living thing
>
> Student 5: The book says cells are the smallest unit of living things that carry out the basic processes of life.
>
> Student 6: the smallest unit of livings things that we know of on Earth

When they responded to the questions that I posted, students built on previous entries and combined their knowledge. One question I posted was as follows:

Describe fungi. Why are they important?

> Student 1: Fungi is like a plant but can’t make its own food.
>
> Student 2: They grow on your skin. They can make an infection spread.
>
> Student 3: Fungi is something used in medicine.
>
> Student 4: EWWWW, I know. It also grows on humans and causes athlete’s foot so WEAR FLIP FLOPS!

Though I had hoped the students would search the Internet for deeper meaning and more complex definitions for their postings, the students' entries contained mostly information that we discussed as a class. Even though the information students posted to the wiki was not deep, the students I interviewed felt they benefited from reading classmates' entries and responding to what had been written. One student told me, "I liked it when they gave examples. It helped to see what they were thinking." Another shared, "It helps to read (the wiki) and see how (that person) understood it, and then it might make sense." He added, "It helped me learn. I think we should write more about how we learned what we wrote down so the other kids could be helped."

Wiki Design

Teacher Journal

Throughout the treatment process, a Teacher Reflection Journal was kept to record my observations about the learning process and the effectiveness of the wiki in enhancing student learning. Early observations noted that the identified special education students struggled with the technology more than the other students. I assigned a classmate who was comfortable with the technology to assist those students when they ran into problems. I also observed that all the students were having a hard time navigating the wiki pages as I had originally constructed them. It was time consuming to navigate between the various pages of vocabulary words. In response, the format of the wiki was changed part way into the *Space* chapter to make it simpler for students to understand and navigate. As mentioned earlier, I did not get the volume of entries that I expected from the students. As a result, for the second chapter in the treatment phase, *Cells and Kingdoms,* I required students to post on four vocabulary words and to respond to three separate questions. I had students fill out and hand in sheets telling me where they had made posts so that I could more easily monitor their work.

Student Journals

Student journal entries also helped me determine how to make changes in the wiki. I frequently asked them to tell me what they liked or didn't like, what they thought worked or didn't work, and what new features they would like to see incorporated into the wiki. Only one student ever told me that it was too hard. That was the only negative comment I received about the wiki.

From reading the student journals, I learned that several of the students had a hard time saving their entries. This explained some of the problems I noted in the use patterns for the special needs students. They tried to make entries but had not saved their work correctly.

Students had many ideas about how to improve the wiki. Some suggestions they made were to add quizzes and games. These were all things that were possible and could have been easily implemented by the students, but they never reached the level of realizing that they had the ability to add and create those types of things themselves.

The students felt there were many benefits from working with the wiki. Several students mentioned that they could use the wiki from home for studying or making entries. My students do not frequently study outside of school hours so this was an important point and would be a definite advantage for them if they followed through on using the wiki outside of class time.

Many felt that using the wiki helped them learn the information better. Some felt it was because the information was written by classmates in words they could understand. One student commented that she learned from reading through the entries because, “there are different answers that kind of mean the same.” She also mentioned that the wiki helped her remember the information better because, “There are easier words to understand.” Another student said he could remember information from the wiki because, “it’s all in kid words.” Most students thought it helped them get better grades because they used it to study for their tests and quizzes. “It helps me study and know what to go over,” a fifth grade girl commented.

Though my quantitative data did not give a clear indication as to whether the wiki was beneficial in increasing student engagement or acquisition of science vocabulary and content knowledge, the students were very clear about their enjoyment in learning how to use a wiki. Even the students who struggled, viewed the opportunity to use the computer as a learning tool as “fun” and helpful.

INTERPRETATION AND CONCLUSION

Student engagement, or a student’s willingness to put forth effort, is an essential factor for students to be successful in learning new science vocabulary and content. One of the purposes for this study was to determine if using a wiki would affect student engagement in science. I collected data on two types of engagement, behavioral and cognitive, as defined by Fredericks & McCloskey (2011). The qualitative data gathered during this research project was inconclusive in showing whether a wiki was an effective teaching strategy for increasing student efforts in science. The Student Engagement

Survey showed very few indications of increased cognitive engagement when it was administered after the implementation of the wiki. Upon examining student responses to the survey, I felt that the pre-treatment survey did not accurately reflect student efforts. On the initial survey, few students reported hurrying through their science assignments whereas I often observed errors that were made from not reading directions or information carefully. On the pre-treatment survey, half of the students reported that they were able to explain their answers, however, I observed that number to be much lower. Overall, I found the student responses on the post-treatment survey to more in line with my observations of my students' efforts. I found the comparisons between the two surveys therefore to be uninformative when trying to determine the wiki's impact on student cognitive engagement as measured by their efforts. Although I cannot be sure why this was the case, I feel it may have been because the students had more practice at being reflective later in the school year. They did not have much experience in being asked to think in an evaluative manner at the beginning of the school year, but it was something that we did periodically throughout the year in different subject areas so they became more experienced at thinking that way.

The weekly observations and surveys of classroom behaviors showed high levels of behavioral engagement when the students worked on the wiki; however, other teaching strategies showed high levels as well. These data appeared to be influenced by the topic that the class was studying as much as it was influenced by the methods that were used to teach the information. This information may have been more useful if I had been able to compare activities across the three topics. For example, I would have liked to compare student engagement on days that the students worked on vocabulary notebooks during the

Weather chapter to days that they worked on the wiki during the other two chapters. However, I did not collect my data in a way that I was able to make these comparisons possible.

Cognitive engagement as measured by students' enthusiasm was definitely increased by the implementation of the wiki. The sample of students I interviewed all expressed more satisfaction with how they were doing in science as well as a high level of interest in what they were studying. All of the students reported that they enjoyed working with the wiki, and they all felt it had a positive impact on their understanding of science as well. Student confidence in their ability to succeed is an important component in student success. This was strong evidence that the wiki has the potential to be an effective teaching strategy.

The student population of my science class was 91% at-risk students with 73% exhibiting low reading achievement. Chall, Jacobs, & Baldwin, (1990), point out that such students in particular struggle with vocabulary development, and my students, current and past, exemplify these difficulties. They struggle with acquiring and understanding new science vocabulary. Many of them rely on memorizing definitions to learn the science and never progress to a deeper level of understanding. Communicating and expressing their ideas either verbally or in writing are difficult tasks. Students need to be taught specific strategies to learn the science vocabulary, and they need a basic understanding of the vocabulary to develop an understanding of the science content (Blachowicz & Fisher, 2000).

Two of my focus questions were designed to assess whether the wiki was an effective tool to help students learn more effectively. The data gathered in this research project did not provide clear evidence that using a wiki was an effective strategy for learning science vocabulary and content. When comparing results from the *Space* chapter and *Weather* chapter, the wiki seemed to improve student scores on both science vocabulary and content. However, these results did not hold true for the third chapter, *Cells and Kingdoms*. Several factors, as previously noted, may have influenced these results. The wiki was not used as consistently through the teaching of the third chapter due to the class being taught by a student teacher. It is possible these results may have been different if there had been one teacher throughout the treatment period. There were differences in how the class was structured and taught and classroom management during the third chapter as well that may have influenced the results. The students also had less background knowledge in *Cells and Kingdoms* as indicated by the lower pre-test scores, and I felt that it was a more challenging chapter with more difficult and specialized vocabulary.

Data collected from the Cloze tests showed positive results for mainstream students with a 19% increase for the *Space* chapter that was taught using the wiki and a 7% increase on the *Cells and Kingdoms* chapter. Special needs students showed no improvement. In my science class, I have students at three different grade levels. The Cloze tests that I developed were the same for all of the students. There were no accommodations for reading level or difficulty, which may have been frustrating for some of the students with lower reading levels. The tests were also two pages long, which may have been overwhelming for the special needs students. I have used premade Cloze tests frequently, but have not had any experience in making my own. I believe I made the tests too difficult. The mainstream students struggled with the tests so I feel the tests were well beyond the special needs students' level of understanding. I believe the difficulty of the tests had an influence on the accuracy of the results.

I felt that the students' responses on the content portions of the tests were better quality in later chapters. The points earned overall on the content sections increased, but I also gave more partial credit on questions. In the science chapters that were taught later in the school year, I found the students' ability to express their ideas and to demonstrate understanding increased. While I did not collect data to measure this, I do feel the students' work with the wiki contributed to this improvement. The students worked with the vocabulary more as they worked with the wiki; they had more exposures to the words and had to use the science words as they answered questions and explained their reasoning. The literature points out that multiple exposures and combining of vocabulary with writing activity helps students to form a better understanding of the content (Blachowicz and Fisher, 2005; Honig, 2010), and I saw this demonstrated in my students' work.

My final focus question related to how the wiki should be designed for optimal effect. I changed the design several times over the treatment period to make it easier for the students to use. Students expressed a preference for the format that was in place during the third chapter, *Cells and Kingdoms*. They liked practicing questions that required them to apply their understanding of the science content. They also liked reading the responses of other students and found that the student-friendly language used by their peers enhanced their own knowledge. Even when responses contained incorrect information, they found it valuable to add to or correct their classmates' information. One frequent comment was that they wanted to go over the information together as a class to check their thinking. This was not done as frequently as I would have liked on the third chapter. In the beginning, I allowed students a lot of latitude in deciding how frequently they wanted to make entries to the wiki. As the study progressed, the wiki became more structured, and I required more accountability from students. Though the technology seemed easy to use, my students still experienced frustrations and setbacks as they worked with something that was new and undefined. They were challenged to work in ways that were unfamiliar to them, and some were more comfortable with this than others. I believe the wiki could have been more effective if I had started with more structure at the beginning and broadened it over the treatment period.

Various studies have shown that students feel more empowered and are more engaged when they are able to use computers as part of their learning process (Reiners, 2005; Barger, 2011; Lowerison, 2006). Likewise, my students were excited by the opportunity to use technology as a learning tool. They enthusiastically embraced the opportunity to work on the computers despite the hurdles they encountered; furthermore they were excited by the ability to collaborate and build knowledge collectively with their classmates. Measurable changes in their learning or understanding were not as evident as I had anticipated or desired, but I believe the results were encouraging for these initial efforts.

VALUE

This research project was an adventure into new territory for my students and me. We learned some valuable lessons together. The literature lacks examples documenting the use of wikis with elementary age students. The skills required to successfully build an effective, 100%, student-constructed wiki may be beyond the scope of elementary students; however, I found that there is definitely potential for using the wiki as a productive teaching tool with younger students. I found the students needed more guidance and structure than I had initially assumed in my original set up. An approach that I think would be beneficial would be to start out the school year constructing the wiki as a class under my direction and gradually turning over responsibility for the wiki as we progressed through our science chapters. This approach would give them the chance to acquire the skills they need for the required tasks and help them become aware of the learning opportunities provided by building a wiki.

I could not have predicted how well this project was embraced by the students. Their enthusiasm for working on the wiki never waned. I found that they are truly hungry for opportunities to use technology in a meaningful way. Coming from an older generation, I sometimes find it more comfortable to teach using traditional tools over which I have better control. I become frustrated when the technology is not seamless, and it is easy to fall back on something that I consider safe. My students do not share this same baggage. They are willing to take the risk that sometimes the technology won’t work as planned; they are eager to weather the bumpy road on the journey to see what new areas can be explored. As a teacher, I need to get on board and overcome my abhorrence to the risk that there might be some “wasted time” when there is the opportunity to spark their desire to learn. We faced many lapses in our Internet connection, loss of unsaved work, conflicts between users when too many students were trying to work on the same page at the same time, and the inopportune timing of an entire page being wiped out in error just before a test. The students, however, were not deterred. They enjoyed the wiki and always looked forward to computer time. They rarely complained about the problems or inconveniences. While the time we invested did not always seem productive to me, I feel that there was enormous potential to harness something very powerful in their positive and open-minded attitudes to the process. The challenge for me is to find the best way to accomplish that goal.

Outhouse (2008) showed that student collaboration is a strong component in increasing individual learning. Collaboration between users is an inherent part of the process of building a wiki, and I had hoped this would be an area where I would see growth in my students. Over the course of the project, I did not observe much evidence of growth in student collaboration, although the few instances in which collaboration was evident were encouraging. For the most part, entries on topics were mostly independent of what had already been posted and often redundant. However, during the final interviews, I found that students did learn from reading their classmates’ entries. They commented that reading “kids’ words” helped them to understand the science ideas and mentioned repeatedly that they enjoyed reading their classmates’ entries. Again I feel that this project highlighted a potentially powerful teaching approach that I can more effectively use to benefit my students’ learning.

Although all my students welcomed the opportunity to work on the computers and to use technology, there was a great disparity in how easily different students integrated the new process. Students with more computer background jumped in and forged ahead. When they encountered challenges, they were confident enough to keep going and to navigate through them. Sometimes they sought out my help or asked a classmate for help, while other times they used trial and error to find a solution. Their confidence was key. This clearly illustrated the self-perpetuating connection between competence and engagement that was referred to by Irvin, et. al. (2007). Other students, those with less computer background, struggled more. They looked busy and told me they were doing well when I checked on them, but they were not moving forward like the others. Often when they encountered a problem, they just quietly waited for the class period to end without reaching out for help. To the observer they appeared to be engaged. Watching how individual students responded to the challenges presented by a new process offered an enormous amount of insight into my individual students. Even in classes with small numbers, students can fall through the cracks. Collecting and analyzing data during this project helped me to see how that was happening in my classroom. Fortunately I will have the opportunity to work with the students who struggled the most for another year so the knowledge gained from this project will be invaluable in my teaching next year.

One change I will incorporate into my teaching practice is how much focus I put on teaching science vocabulary. I will be much more explicit in my instruction and make multiple efforts to help students build connections between the words and the concepts they convey. I will build in more opportunities for students to integrate the words in writing activities.

I often tell my students that we are “learning to speak science”, and I encourage them to use common terminology to help them understand ideas, but I always ask them, “What is our science word for that?” I teach a science class of second and third grade students, and I am trying to help them acquire the tools they need to learn science vocabulary as well. The wiki provided students with opportunities to write about their science learning in a way they enjoyed. They need to have expanded exposure to additional venues so that they can increase their expressive science vocabulary. Blogging and on-line discussions are other tools that I will explore.

The most valuable result of my research project was what I learned from reflecting on my teaching. I faced many factors this school year that made it difficult to collect consistent and reliable data; however, I learned the importance of having data to corroborate perceptions even in small classrooms where you think you have a very clear picture of what is happening. It would have been easy to conclude that the wiki was an effective teaching tool based solely on students’ opinions. The data I collected helped me to understand that there is value in using the wiki in the elementary grades, but that I need to do more work on finding the most effective format and in teaching the students how to use it for their benefit. I will continue to use the wiki in my teaching while incorporating the knowledge I have gained from this study. Our science adventure continues.

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APPENDICES

APPENDIX A

SCIENCE LEARNING SURVEY

Science Learning Survey

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. When I come to a hard science problem or question, I guess or skip it.
   Always Almost Always Sometimes Hardly ever Never

2. I try to do the best I can in science.
   Always Almost Always Sometimes Hardly ever Never

3. When working on my science assignments, I like to be done as fast as I can.
   Always Almost Always Sometimes Hardly ever Never

4. If I can't get the answer to the science problem the first time, I keep trying until I do.
   Always Almost Always Sometimes Hardly ever Never

5. I am confident that I can figure a science question out even if it seems hard.
   Always Almost Always Sometimes Hardly ever Never

6. I ask the teacher for help if I don't understand the question in science.
   Always Almost Always Sometimes Hardly ever Never

7. When the question asks "why", I can explain my reasons.
   Always Almost Always Sometimes Hardly ever Never

8. When I get a science paper or a science test back I check to see what mistakes I made to see if I can fix them before the teacher goes over the paper.
   Always Almost Always Sometimes Hardly ever Never

9. I feel uncomfortable when I don't know the right answer to a science question.
   Always Almost Always Sometimes Hardly ever Never

10. I am confident that I can get a good grade in science.
    Always Almost Always Sometimes Hardly ever Never

11. When I make a mistake on a science assignment, I try to be careful not to make the same mistake again
    Always Almost Always Sometimes Hardly ever Never

12. I like to be challenged with hard questions in science.
    Always Almost Always Sometimes Hardly ever Never

APPENDIX B

INTERVIEW QUESTIONS

INTERVIEW QUESTIONS

1. How do you feel about science? Explain what you mean.

2. Do you feel science is challenging? In what way? How do you feel about being challenged?

3. How do you feel about your science grades? How important do you think it is to get good grades?

4. How do you learn science best?

APPENDIX C

STUDENT ENGAGEMENT CLASS OBSERVATION SWEEP

Student Engagement Class Observation Sweep

Date: ______________________

Day of the Week: ___________________________

Activity/Activities: ____

Sample Observation

Students:

Time:	Sally	Bob	Leslie	Dan	Mark	Jim	Kari	John	Jackie	Jenny	
1:05	F4	N1	F5	N1	F3	N3	N1	N1	N1	F5	
1:15	N3	N1	N1	N1	N1	N1	N1	N1	N1	N1	
1:25	F1	F3	F3	N1	F1	N3	N1	N3	N1	F1	

On Task	Off Task
N1-on task: listening/watching	F1-off task: passive
N1-on task: writing	F2-off task: working on another subject
N3-on task: speaking	F3-off task: listening to others
N4-on task: reading	F4-off task: disturbing others
N5-on task: hands on activity	F5-off task: playing

Source: Adapted from Student Observation Engagement Tool. Available at: http://www.schooltransformation.com/resources/resources.htm.

APPENDIX D

STUDENT ENGAGEMENT OBSERVATION PROTOCOL

Student Engagement Observation Protocol

Date:______________________ Student: _____________________________

Observations	Very High	High	Medium	Low	Very Low
Positive Body Language: body postures that indicated they are paying attention to teacher or other students					
Consistent Focus: focused on the learning with minimum disruptions					
Verbal participation: expresses thoughtful ideas, reflective answers, and questions are relevant to learning					
Student Confidence: exhibits confidence and can initiate and complete a task with limited coaching, can work in a group					
Interested: exhibits interest and enthusiasm, uses positive humor					
Questions: feels comfortable seeking help and asking questions					
Overall level of engagement:					

Rating Scale:

1 = low level of engagement

2 = low to moderate level of engagement

3 = moderate level of engagement overall, or high level of engagement fro a short time

4 = high level of engagement for a major portion of the class period

5 = high level of engagement or the entire class period

Source: Adapted from Student Engagement Walkthrough Checklist. Available at: http://www.leadered.com/pdf/Student%20Engage%20handbook%20excerpt.pdf.

APPENDIX E

STUDENT ENGAGEMENT SURVEY

Student Engagement Survey

Name ______________________________

Date _________________

Please circle the number that represents your feelings about class this week

strongly agree	agree	neutral	disagree	strongly disagree
5	4	3	2	1

The work is interesting and challenging	5	4	3	2	1
You are inspired to do high-quality work	5	4	3	2	1
You understand why and what you are learning	5	4	3	2	1
Time seems to pass quickly	5	4	3	2	1

Source: Adapted from Student Feedback. Available at: http://www.leadered.com/pdf/Student%20Engage%20handbook%20excerpt.pdf.

APPENDIX F

SAMPLE TEST PAGES
GRADES 4, 5, AND 6

SAMPLE TEST PAGE GRADE 4

Test A

Weather and Climate

Write the word or words that best complete each sentence in the spaces below. Words may be used only once.

air masses	clouds	rain gauge	wind vane
barometer	cold front	thermometer	
climate	current	warm front	

1. A tool called a(n) ________________ measures air pressure.
2. The seasonal weather pattern that happens year after year is called ________________ .
3. A(n) ________________ forms when cold air pushes under warm air.
4. Tiny water droplets or ice crystals form ________________ .
5. A(n) ________________ points in the direction from which the wind is blowing.
6. A directed flow of a gas or a liquid is a(n) ________________ .
7. A tube that collects water and measures how much rain has fallen is a(n) ________________ .
8. When warm air pushes over cold air a(n) ________________ forms.
9. Large areas of air that share the same properties are called ________________ .
10. A(n) ________________ measures temperatures in degrees Celsius or degrees Fahrenheit.

SAMPLE TEST PAGE GRADE 5

Chapter Test A Name ______________________ Date __________

Answer the following questions.

16. **Communicate** What creates a valley breeze?

____

____

____

17. **Classify** What are the three main climate zones on Earth? In the chart below, describe each climate zone.

Climate Zone	Description

18. How can being near a large body of water affect the climate of a region?

____

____

____

SAMPLE TEST PAGE GRADE 6

Chapter Test A Name ______________________ Date __________

On the line next to each word, print the letter of the word's meaning. Meanings may be used only once.

_____ **11.** condensation

_____ **12.** convection cell

_____ **13.** Coriolis effect

_____ **14.** evaporation

_____ **15.** high pressure

_____ **16.** isobars

_____ **17.** latitude

_____ **18.** maritime climate

_____ **19.** sea breeze

_____ **20.** tornado

A. a wind that blows from the sea toward land

B. the process by which water molecules leave a lake and enter the atmosphere

C. a circular pattern of rising air, sinking air, and winds

D. forms when cold, dry air mixes with warm, moist air

E. created by air flowing outward from the center of a system

F. the process by which a gas changes into a liquid

G. one factor that affects climate

H. lines on a weather map that connect points with equal air pressure

I. causes winds in the Southern Hemisphere to move counterclockwise

J. a weather pattern of warm summers and mild winters

APPENDIX G

SAMPLE SHORT ANSWER QUESTIONS

SHORT ANSWER QUESTIONS FROM PRE-AND POST TESTS

GRADE 4

Use information in the table below to answer the next two questions. What is the relationship between temperature, rainfall, and the rate of growth for potatoes? What is it for rice?

Would it be possible to grow potatoes and rice on the same farm? Why or why not?

The climate on one side of a mountain is dry. What will be the climate on the other side? Explain why.

Why might people be very uncomfortable if a stationary front was forecasted for their region?

The atmosphere is made up of oxygen, nitrogen, carbon dioxide, and water vapor. What are some of the possible effects if the gases in the atmosphere changed? What would happen if the atmosphere could no longer hold water vapor?

GRADE 5

What creates a valley breeze?

What are the three main climate zones on Earth? In a chart, name each one and describe each climate zone.

How can being near a large body of water affect the climate of a region?

When does a tropical storm become classified as a hurricane?

What kind of weather can be expected with a low-pressure system?

A meteorologist predicts that it will rain today. The air temperature is warm, but a layer of very cold air is approaching. What type of precipitation might fall?

GRADE 6

Examine the weather map below that shows several fronts and areas of high and low pressure across the Chaptered States. Describe the weather that is likely to develop in the Midwest. Explain the reason for your answer.

Suppose that Earth begins to rotate faster. Would the Coriolis effect change? Explain your answer.

What is the weather expected to be like when cumulus clouds appear?

Weather patterns are closely related to latitude. Explain why most hurricanes form in areas of latitude of about 5 degrees North and 20 degrees North and between 5 degrees and 20 degrees South.

A meteorologist is a scientist who studies the weather and climate. Using Doppler radar, a meteorologist can predict a tornado up to 20 minutes before it reaches the ground. What is the meteorologist most likely looking for in the Doppler radar?

APPENDIX H

ASSESSMENT RUBRIC FOR SCIENCE WIKI POSTINGS

Assessment Rubric for Science Wiki postings

	4	3	2	1	0
Content	Posting provides accurate information in writer's own words.	Posting provides mostly accurate information in the writer's own words	Posting provides some accurate information in the writer's own words	Posting provides accurate information that has been copied from another source.	Posting is inaccurate.
	Provides more than minimum definition, shows a great deal of in-depth thinking and understanding about the topic.	Provides more than the minimum definition and shows some in-depth thinking and understanding of the topic.	Provides more than the minimum definition and shows very little in-depth understanding of the topic.	Posting is the basic definition with little in-depth understanding of the topic	Posting does not show any understanding of the topic by the author.
	Posting is clear and logical.	Posting is mostly clear and logical.	Posting is somewhat clear and logical.	Posting is mostly unclear and somewhat hard to follow.	Posting is unclear and hard to follow.
	Posting provides appropriate citations and references that are required.	Posting provides most of the appropriate citations and references that are required.	Posting provides some appropriate citations and references.	Posting provides little of the appropriate citations or references.	Posting does not give credit for resources.
Extra Credit:	Posting includes additional material (hyperlink, illustration, multi-media, etc.) that enhances the information.		Posting provides additional material that does not necessarily enhance the information.		No additional material has been added to the post to enhance the post.

Source: adapted from A+Rubric, University of Wisconsin-Stout (Online)
Available at: http://www2.uwstout.edu/content/profdev/rubrics/wikirubric.pdf.