

WHAT IS THE EFFECT OF TEACHER FEEDBACK IN STUDENT NOTEBOOKS
ON STUDENT ACHIEVEMENT?

by

Michael Scott Helseth

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Michael Scott Helseth

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DEDICATION

This paper is dedicated to my amazing wife, Michelle, with her unending encouragement and my children, Makenna and Kyan, who will forever be enrolled in my science class.

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ABSTRACT

Teacher comments and feedback on student work in science notebooks is a key element in understanding the development of students' thinking. In this investigation critical teacher feedback was given in student science notebooks with the purpose of improving student achievement and critical thinking. Every week during the intervention the student notebooks were scored using a rubric and were given critical feedback from the teacher. The results showed that critical teacher feedback did not have a significant effect on student achievement. The process of giving students feedback created a valuable formative assessment that the teacher can use to adjust instruction.

INTRODUCTION

For students to develop their science knowledge their work needs to be analyzed and critiqued and I, the teacher, need to keep a record of what concepts are being mastered and the ones that need more emphasis. Critical teacher feedback in student science notebooks is an important way to help students learn scientific concepts and this is an area I feel that I have to improve on, which is why I chose to make it my research project. Since teacher feedback is not at a high enough level in my students' notebooks, my understanding of student achievement and growth is inadequate. To accomplish this, my intervention consisted of giving students weekly feedback on their science notebook entries in the form of written comments and by scoring the students' work on a rubric.

My focus of my project was to determine the effect of teacher feedback in science notebooks on student performance. I specifically looked at how feedback affected the quality of their notebook entries and critical thinking about the science content. I was also interested in how the teacher feedback affected the students' attitude towards using a science notebook.

CONCEPTUAL FRAMEWORK

Science notebooks are frequently used as the preferred method of scientific communication at the elementary level (Minogue, Wiebe, Madden, Bedward, Carter 2010). The science notebook is a portfolio of the students' observations, experiences, and understanding of scientific concepts. The notebooks provide students a place to keep a running record of their knowledge, predictions, observations, and conclusions. It is where students expand and deepen their understanding of science phenomena while

communicating it to their teachers and others (Shepardson & Britsch, 2001; Leffler & Crauder, 2011). For elementary students, notebooks provide a means of engagement in scientific discovery (Nelson, 2010). The notebooks are a collection of authentic student work and thinking. From this collection teachers can then enhance future instruction to guide students to build understanding (Joyner, 2010).

If students and teachers have frequent access to the notebooks the opportunity for formative assessment, gathering information to improve teaching and learning, is endless (Leffler & Crauder, 2011; Keeley, 2010; Joyner, 2010). Frequent review of the notebooks may be critical to develop the appropriate level of instruction and provides the understanding to the teacher on student development (Leffler & Crauder, 2011). The notebook provides a critical formative assessment of the student's performance and understanding which can lead to better decision making by the teacher as to the next steps of instruction (Shepardson & Britsch, 2004). When used well, notebooks are an effective measure of how students will perform on future assessments (Aschbacher & Alonzo, 2006). However, in many science classrooms the notebooks are not used effectively either as formative assessments or with critical teacher feedback present which would enhance student learning (Ruiz-Primo, Li, & Shavelson, 2002).

Baxter, Bass, & Glaser (2001) found that "notebooks seemed to accurately reflect those aspects of inquiry that teachers attended to" (p. 138). Unfortunately, the teachers that were observed in this study only "attended to" the set-up of the notebook page e.g. name, date and time at the top of the page, followed by a focus question and then some observations (Baxter, Bass & Glaser, 2001; Nesbit, Hargrove, Harrelson, & Maxey, 2004). However, after the initial set-up and observations of an investigation, the

notebook entries ended with conclusions that were incomplete or without any conclusions at all, thus, leaving the learning cycle unfinished (Baxter, Bass & Glaser, 2001).

Inquiry-based science instruction is structured to develop students into scientific thinkers. All too often the opportunity for students to build their own knowledge does not happen (Ruiz-Primo, Li, Schneider, 2010). Teachers can use the science notebook to gather information about what students are thinking and what they understand. To adequately know what the students understand, the teacher must provide the students with high quality writing prompts. In one study, teachers gave very shallow prompts with no guidance or they gave prompts with full support, i.e. students copied down the same conclusion. Therefore, even though writing prompts were used students were not developing an understanding of the concepts. (Aschbacher, Alonzo, 2006).

Baxter, Bass, & Glaser came to the conclusion that the way science notebooks are currently used in many classrooms does not allow them to be used as a reliable assessment tool. The shift to high stakes testing promotes just giving students the right answers without them developing their own understanding. We are now faced with students copying down explanations that belong more to the class or teacher than to themselves. Therefore, the teaching of science and the use of notebooks tends to become robotic in that students copy what the teacher presents to the class; including notebook set-up, organization for data and conclusions about the investigation. This leaves students no opportunity to develop their own scientific skills, thinking, or knowledge. Without a chance for students to reflect and respond to what they have observed and learned; the opportunity for a teacher to access any potential evidence of actual student learning is missed (Baxter, Bass & Glaser, 2001).

A great deal of thought should be given to notebooks as they are implemented and evaluated. Only having students set up their notebooks does not give the students adequate opportunity to learn the content. Students might need their notebooks to help them develop their ideas and assist in their thinking. Without focus, notebooks can become a collection of random activities that do not seem to relate to the learning goals of the unit (Ruiz-Primo, Li, & Shavelson, 2002).

Students should be capable of producing scientifically sound written communication to help develop their own understanding but to also share their knowledge with others (Ruiz-Primo, Li, & Shavelson, 2002). To do this, students can engage in writing that creates connections from previous activities and observations. The writing might be connected to the main goal of the unit, thus creating an embedded formative assessment that can drastically impact students' learning. These powerful classroom based-assessments occur naturally at the heart of inquiry-based science but a study found that they were often incomplete and not utilized (Baxter, Bass & Glaser, 2001). Students usually do not totally grasp a new science concept during the initial investigation. That is why instruction should be adjusted to assist students in developing their ideas, for a teacher to do so they can use the students' notebooks to gain insight into what the students actually know (Aschbacher & Alonzo, 2006).

For students to develop their own understanding the instruction should be more than just fact memorizing activities. An effective instructional strategy to help student understanding is using the writing process (Butler, 1991). Writing provides students the power to organize their thoughts and knowledge while reflecting on what they have observed (Mason & Boscolo, 2000). Through written answers to prompts in the

notebook students are able to write argumentative statements that require the students to defend their understanding. These conclusive statements can then be published for the teacher, the class, or a larger audience to be read and discussed (Butler).

For students to make the connections to scientific concepts, they should have a conceptual understanding of basic science vocabulary. However, just defining the words in the science notebook does not go far enough. Ruiz-Primo, Li, and Shavelson, (2002) found that the more definitions a class had in their notebooks the lower their performance on the end of unit assessment, and classes that had a fewer number of definitions scored higher on the same assessment. Students should have repeated opportunities to develop and apply the connection between the definitions and observations through writing and drawings. With only copied definitions and explanations students are unable to develop their own scientific thinking and understanding (Ruiz-Primo et al.).

Baxter, Bass & Glaser (2001) found that, “Noticeably absent in the notebooks were teacher comments on the quality of substance of the written work” (p. 134). If teachers were taking advantage of the embedded assessment then there would have been written comments in the notebooks giving feedback to either realign or challenge a students’ thinking (Ruiz-Primo et al.2002). This means that teachers are not monitoring their students’ thinking and understanding as well as not giving the students feedback in how to develop their thinking (Ruiz-Primo et al. 2002). To help students close the achievement gap, teachers can to respond to the students’ reasoning and thinking. Teachers may need to hone their assessment strategies so that they can make the most out of the embedded assessments as well as move towards empowering the students to do more self-assessing (Ruiz-Primo, Shavelson, 2002).

Time is often the culprit for teachers not utilizing science notebooks as formative assessment and providing feedback. Teachers should look into other strategies to reduce the large amounts of time that is needed to go through notebooks. One possible strategy is to take a random sampling of notebooks to read through, thus giving a snap-shot of what students understand (Aschbacher & Alonzo, 2006). Another strategy would be for teachers to focus on different components of the notebook, looking at specific parts instead of the full entry e.g. factual knowledge, procedural replication, or attitudes towards science.

The use of rubrics is also a highly effective way to give feedback to students in a timely manner (Shepardson & Britsch, 1997). Students will be unable to determine the quality of their notebook entry without feedback through rubrics on how well-balance, organized, and complete their notebook entries are (Ruiz-Primo, Ayala, & Shavelson, 2004)?

Data gained from a science notebook gives the teacher a real time record of the development of students' thinking. That data can be analyzed to see where future lessons can be adjusted and students' misconceptions are corrected (Nesbit, Hargrove, Harrelson, & Maxey, 2004). The most effective way to counter-act students' misconceptions is to provide guidance and direction in the notebook itself. Since the notebook is an ongoing record of a student's thinking and understanding leaving misconceptions unchallenged or not redirected then in future occasions the student might mistake the misconception as scientific fact (Aschbacher & Alonzo, 2006).

Regrettably, many science units conclude without the opportunity to link student's observations and learning to the questions and goals stated at the beginning of

the unit (Baxter, Bass & Glaser, 2001). Thus, teachers should take great care in choosing the entries that are included in the notebook and focused on. Notebooks reflect what teachers focus on, therefore, teachers can make sure that they are focusing on parts of the notebook that give students the greatest chance to develop their scientific understanding and knowledge. Once students have had that chance, then teachers may take advantage of the embedded assessment and provide adequate feedback to the students either guiding them through a misconception or challenging to apply that knowledge to other applications.

METHODOLOGY

Student science notebooks are the centerpiece of my science instruction. However, my student's science notebooks lacked teacher comments on the quality of the student's work (Baxter, Bass & Glaser 2001). The focus of my action research (AR) project was to determine the effect of teacher feedback in student notebooks on student achievement?

Participants

I teach 5th grade science at Hoover Elementary in Yakima, Washington. Yakima is located in central Washington where agriculture is the major economic industry. Even though my school is more of an urban school than rural, the agriculture industry affects many students in my school. Hoover Elementary is a K-5 school with 622 students, of those which 81% identify themselves as Hispanic and 15% White. The school is located in a high poverty area, where 89% of our students receive free or reduced meals. I was the science specialist in the 5th grade. I taught four periods of general science every day.

I used one of my classes as my project participants and carried out the project during the winter of 2013. The class that participated in the study was one, of my four classes, of 25 fifth graders (eleven boys and fourteen girls) whom I taught science to every day for 70 minutes. Due to district reading requirements, the students in my four science classes are grouped into ability groups. The intervention class was considered the second highest ability group, working at a low fifth grade level. A majority of the students have had enough success in school that discipline is not a major issue, and they were able to communicate through reading and writing. 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.

Intervention

This project took place over an eight week period during which the students were studying ecosystems. The Yakima School District has adopted the Science and Technology Concepts (STC) program from which this unit was taught. During this unit students built and observed ecosystems in aquariums and terrariums. Each aquarium contained several different water plants, snails, and mosquito fish. Each terrarium contained several different types of grass, isopods, and crickets. Once the ecosystems became stable the students conducted experiments on the effects certain pollutants had on the ecosystem: acid rain, agricultural run-off (fertilizer), and road salt. As the effects of the pollutants began to take place in the experimental ecosystems, students speculated about how pollution affects the people that live, work, and play in areas around polluted areas. Students then offered solutions as to how to mitigate or reduce pollution in these areas.

The use of science notebooks is a highly encouraged and wide spread practice throughout my school district. Whenever science is taught in my school, science notebooks, at least in some form, are being implemented. During the first lesson when students were setting up their notebook I discussed the importance of keeping a science notebook, and how it is a record of their current thinking and ideas as well as a future resource. After each notebook entry, the students taped the Science Notebook Rubric (Appendix A) into their notebook and reviewed their own work by scoring themselves in two categories, Scientific Content (scale of 1-4) and Organization and Conventions (Scale of 1-2).

The class was divided into two groups, Group A (seven girls and six boys) and Group B (seven girls and five boys). Only one group received feedback at a time. Group A received feedback at the end of weeks two, three, seven, and eight, while Group B received feedback during weeks four and five.

The notebooks were collected once a week for the duration of the AR project. The most current entries; consisting of observations of their ecosystem, notes recorded from class discussion and readings, and steps to the scientific process were reviewed. I gave rubric scores to all students. I gave feedback to either Group A or B on the quality of the whole entry, focusing on scientific conclusions that were made, drawings, and the organization of collected data. The feedback, either challenged students' conclusions, assisted the students in self-reflection, or affirmed the students work. Comments such as, "good job," "needs more," or "incomplete," were used sparingly. Questions like, "What are some possible ways photosynthesis could stop?" "What do you mean destroyed?" or

“What will change? How will not burning fossil fuels affect our lives?” challenged the students. Quality work was affirmed with comments like, “Nice clean data, good job.”

Prior to collecting the notebooks, the students assessed their own work by using the science notebook rubric (Appendix A). The students scored their own work on the quality of the content, scale of 0-4, as well as the organization, scale of 0-2. The students taped the rubric into the notebook and circled where they believed the quality of their entries. During the teacher review of the notebooks the teacher highlighted the cells that represented the quality of the entry. When the notebooks were handed back, the students took a few minutes to review my comments and rubric scores and respond to any questions. We then held a class discussion of what was noticed in the notebooks, both positive and negative. Examples of outstanding work and of common misconceptions were used to highlight the discussion.

Data Collection

At the beginning of the unit, students took a pre-unit assessment (Appendix B) to set the baseline for their knowledge about ecosystems, they also completed a questionnaire (Appendix C) about their attitudes towards the quality of their work and attitudes towards using the science notebook, and two small groups of students (five boys and five girls) were interviewed (Appendix D). At the conclusion of the unit the students were given the same assessment to determine the amount of growth they had throughout the unit, the same questionnaire to determine how their attitudes had changed over the course of the intervention, and the same students were interviewed.

The students were randomly divided into two cross-over groups, group A and group B. Group A received feedback after weeks two, three, seven, and eight. Group B

received feedback after weeks five and six. There was no feedback after week four due to the delay of the shipment of living materials or in week eight due to the class working on their final project of the unit.

After the notebooks were handed back with feedback and the students had a chance to review the comments, the students took a short quiz (Appendix E) over the main concepts they worked on the previous week. The weekly quiz scores assessed student achievement and growth, as well as a formative assessment where instruction was adjusted to reinforce concepts that the students were struggling with.

At the end of each of the eight weeks, I collected the notebooks. I then reviewed the week's entries, scored each notebook on the rubric, and give critical feedback to the appropriate crossover group, in the form of a question or specific praise. I recorded the feedback and then analyzed as to the type of feedback the students received. Using the International Center's Rigor/Relevance FrameworkTM (Appendix F), I examined the feedback to determine the level of questioning and comments that were given. The framework is a four quadrant matrix that combines the amount of rigor and relevance of the instruction. The rigor side of the matrix deals with the level of Bloom's Taxonomy: knowledge/awareness, comprehension, application, analysis, synthesis and evaluation. The relevance side of the framework is based on "The Application Model," developed by the International Center. These "five levels of relevant learning: knowledge in one discipline, apply knowledge in discipline, apply across disciplines, apply to real-world predictable situations and apply to real-world unpredictable situations" (McNulty & Quaglia 2007). When the two sides are combined in the matrix, Quadrant A learning is where the students learn information, Quadrant B is where students apply their

knowledge, Quadrant C students use the knowledge to analyze unique situations, Quadrant D is where students are adapting their knowledge to create solutions for complex problems (McNulty, Quaglia 2007).

By using the Rigor/Relevance framework to analyze the comments the teacher was able to assimilate how the student's achievement might be progressing in response to the feedback. When considering student achievement, I wanted to see if the students' ability to use and apply the science content was becoming more fluent and accurate. If students were provided with only Quadrant A type questions and comments the student were still struggling with the basic content. As the comments move into Quadrants B and C the students I was asking them to start applying the concepts we were working on, showing that the student's level of understanding had increased. If the feedback was in the Quadrant D category, the students were showing command of the content and the ability to adapt it to different situations. As Willard Daggett wrote (2005), "This (Quadrant D skills) enables students not only to gain knowledge, but to develop skills such as inquiry, investigation, and experimentation." Students successfully working in the Quadrant D have attained the highest level of student achievement. At this level of achievement students can critically think about and analyze, content in ways that can be applied to other situations. This level of thinking allows the students to work from a classroom model to real life situations.

Along with the teacher feedback, the week's entries were scored on the Science Notebook Rubric (Appendix A). The rubric scores were collected as a means of showing student growth and understanding in their notebook entries. The following table summarizes the data collection strategies for this project (Table 1).

Table 1
Data Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3
<i>Primary Question:</i>			
1. What is the effect of teacher feedback, in the students' notebook on student achievement?	Pre and post assessments from the treatment class comparing the two cross-over groups.	Rubric scores from science notebooks.	Weekly quiz scores
<i>Secondary Questions:</i>			
2. Does teacher feedback in science notebooks affect the quality of students' notebook entries?	Rubric scores from science notebooks.	Rubric scores from throughout the unit compared to each other on a timeline.	Student interviews, questions focused on how the feedback affects the quality of their work.
3. Does teacher feedback on science notebooks lead to increased critical thinking in subsequent entries?	Rubric scores from throughout the unit compared to each other on a timeline.	Analyzed teacher comments in the notebooks based on the rigor / relevance framework.	Weekly quiz scores, measuring achievement.
4. How does teacher feedback in science notebooks affect student attitude towards using a science notebook?	Pre and post treatment student questionnaires.	Student interviews	Teacher observations

DATA AND ANALYSIS

Students use science notebooks on a daily basis to record observations, record notes, collect and organize data, and reflect on their learning. The AR focused on teacher feedback in students' notebooks to determine if critical feedback helped student learning. The treatment class was divided into two groups. Every week of the unit, one of the two groups received written feedback in their notebook while the other did not. Results from the unit assessment, weekly quizzes, and weekly notebook rubric scores were compared to determine effect on student achievement.

Impact of teacher feedback in student notebooks on student achievement

During the treatment unit the class was randomly divided into two groups. Each week one of the two groups received teacher feedback in their science notebooks. Group A received feedback after weeks two, three, seven, and eight; while group B received feedback after weeks five and six. All students took a pre and post-unit assessment, used a rubric to reflect on their work in their notebook, and took weekly quizzes.

The feedback I gave in the notebooks did not have an effect on student achievement. Group A made an average gain of .4283 ($N = 12$, $SD = 17.95$). Group B made an average gain of .4725 ($N = 12$, $SD = 16.63$). This difference is not statistically significant $t(22) = .6253$, $p = .5382$.

Student notebooks were reviewed by the teacher and were scored using a rubric with a maximum of six points possible. Group A had an average rubric score of 3.167 ($SD = 0.175$). Group B had an average rubric score of 3.633 ($SD = 0.468$). By conventional criteria, this difference between group A and B is statistically significant, $t(10) = 2.29$, $p = 0.04$. However, the group that received less feedback performed better.

After student notebooks were returned with teacher feedback and a completed rubric, the students were given a quiz over the material that was covered in the last notebook entry. Group A had an average percentage of 50.83% (SD = 14.08). Group B had an average percentage of 48.65% (SD = 18.59). The difference is considered to be not statistically significant, $t(10) = 0.23$, $p = 0.82$.

Does teacher feedback in science notebooks affect the quality of students' notebook entries?

On completion of a lesson, after students had recorded the activities and their thoughts in their science notebooks, they then filled out a rubric and reflected on their work. I then collected and reviewed all of the entries scoring the students' work on the rubric for the rubric score (maximum score = 6).

Teacher feedback did not impact the quality of students' notebook entries. Group A, which received a total of four weeks of feedback had an average rubric score of 3.167. Whereas, group B, which received a total of two weeks of feedback, had an average rubric score of 3.633. This difference is statistically significant, $t(10) = 2.29$, $p = 0.04$.

When the rubric scores were compared with each other on a timeline, the first notebook entry (week two), the mean score was identical for the first notebook entry, 3.42. After the second week of the unit score for Group A slightly declines while Group B's scores varied widely. Figure 1, shows the comparison of the average rubric scores for Group A and Group B for the duration of the treatment unit.

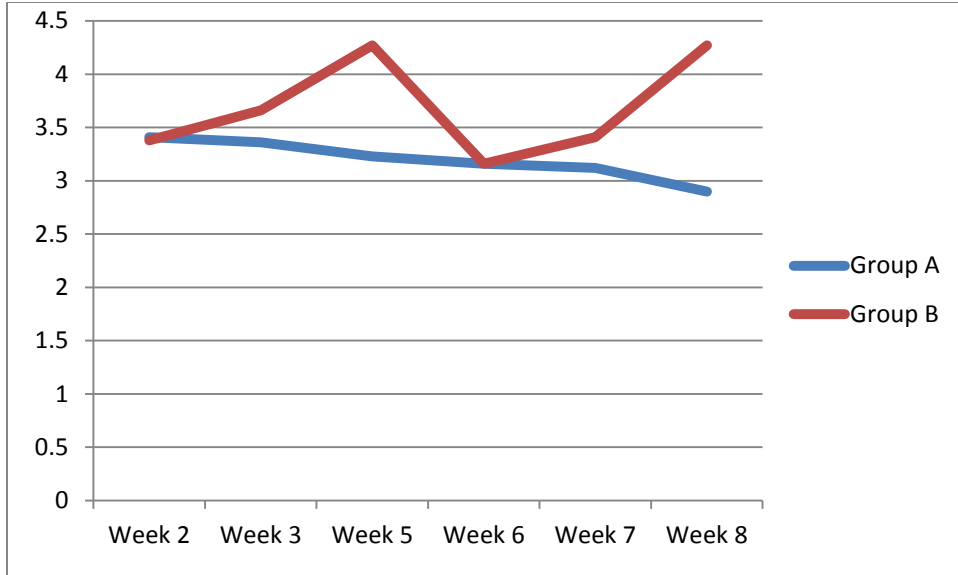


Figure 1. Comparison of average, weekly, rubric scores between Group A and Group B.

Weekly quiz scores, shown in *figure 2*, were analyzed to determine if the teacher feedback effected student learning over the course of the unit. If there was a positive effect, the weekly quiz scores should have increased over the course of the unit. *Figure 2* shows an overall decrease in scores from beginning of the unit to the end of the unit.

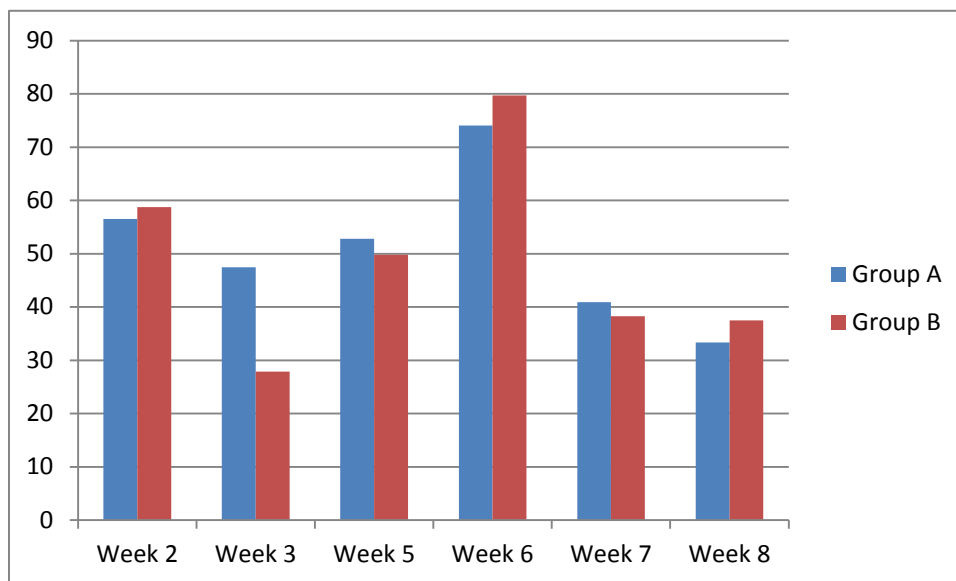


Figure 2. Weekly, average quiz scores comparing Group A to Group B throughout the treatment unit.

Does teacher feedback on science notebooks lead to increased critical thinking in subsequent entries?

An overarching goal of teaching is to have students critically think about their world. The feedback given in the notebooks was focused on asking students questions to lead them in thinking critically. The teacher feedback, given in response to the student's conclusions in the notebooks had a slight effect on the students' ability to critically think. Higher rubric scores indicate a deeper level of critical thinking. Group A's rubric scores (*Figure 1*) decreased throughout the unit while Group B's scores, although more erratic, increased from beginning to the end of the unit.

The teacher feedback that was given to students was analyzed after the unit to determine the level of questioning and feedback that was given. Throughout the entire unit, the majority of feedback that was written either encouraged students to complete the notebook entries, "Make sure you get your thoughts and ideas written in your notebook," or clarifying basic knowledge, "You have your producers and consumers backwards, remember producers - plants, consumers - animals."

The first set of feedback 61.5% of the feedback dealt with encouraging students to complete their work. The final week of feedback 27% of the comments were dealing with incomplete work. By week 3 only 18% of the comments were directing students to finish their work. Comments regarding learning information (quadrant A) ranged from a low of 15% in week two up to 70% in week six. During weeks three, five, six, and seven the greatest amount of feedback was in the category of learning information. In the final week of feedback, week eight, 45% of the feedback was given questions asking students to adapt their knowledge (quadrant D). For the majority of the unit, students struggled

with understanding the basic concepts and needed more guidance to develop their understanding. By the end of the unit, almost half of Group A was ready to adapt the concepts.

How does teacher feedback in science notebooks affect student attitude towards notebooking?

All students filled out a survey both pre and post treatment regarding their attitudes toward science. Ten students were also interviewed as well as teacher observations were recorded. Student attitudes were not affected by the treatment unit. Students understood the reason and purpose for using science notebooks prior to the treatment unit and their feelings toward the notebooks did not change over the course of the unit.

There was negligible change pre- and post-unit questionnaire except for a few questions. The question, “The data in my notebook is always organized,” had a pre-unit average response of 3.73 and a post unit response of 3.48. Eight students said their data was “Always” organized in the pre-unit questionnaire. During the post-unit questionnaire only one student said their data is “Always” organized. Students became more aware of how to organize their data and what organized data looks like.

The question asking, “I enjoy using the Science Notebook,” had an average pre-unit score of 4.15 and an average post-unit score of 3.88. The students did not enjoy using the notebook as much at the end of the unit. As most of the students in the interviews agreed that there was, “Too much writing (in the notebooks).” For students who do not enjoy writing, the notebook was seen in more of a negative way since the students were required to write in their notebooks.

Fewer students felt like they used their notebooks as a resource. The number of students who responded “Always” to the question stating, “I use my Science Notebook as a resource to answer questions,” dropped from 12 students pre-unit to only five students post-unit.

Two groups of students, a group of five boys and the other group of five girls, were interviewed pre and post treatment. The boy group shared similar thoughts in both interviews regarding why and how the notebooks are used. In both interviews the boys understood that the science notebook rubric helped focus them, “You try harder and you saw what you could improve on,” and “To help us get a better score on our tests or projects.” When asked about teacher feedback the boys responded in the pre-treatment interview with “You are just giving us advice to do other things we missed so we can’t get it wrong next time.” One boy stated that, “Sometimes I get mixed up,” when it comes to teacher feedback.

After the treatment the boys responded with, “The comments on the back of the rubrics gives us what we need to help most helpful instead of writing one thing that’s not important you tell us why it’s important, “ and “It helps because it gives us a hint.” While looking through his notebook one boy even said, “Oh, I never read this!” When the boys were asked how they felt when they did not receive feedback one boy said, “(I feel) Happy, cause we did the right answer.”

The attitudes of the girl group interview also remained the same from pre-treatment to post-treatment. In the pre-treatment interview when discussing the rubrics one girl stated, “Oh that, I don’t even get that, so it doesn’t help me at all.” Another student said, “I don’t even get it.” After the treatment one student said, “The rubrics

aren't helpful, they stress me out." While another student said, "It tell(s) you if got a one and a like I did, you need to focus." A couple students were unsure of the effect of the rubrics saying, "(The rubric helps) a little bit," and "I don't know."

Post treatment, when asked about teacher feedback one female student stated, "They confused me sometimes." Another student responded, "It kind of help(s) understand stuff." However, there was a consensus in both interview groups that there was "Too much writing" in the notebook.

Teacher observations were recorded throughout the unit. Time constraints seem to be the largest factor working against getting everything done. Many daily lessons had to be continued the next day, sometimes lessons had to be rushed as to stay on pace so the unit could be completed on time. One comment recorded was, "Got through things quickly, however, the final activities, writing in the notebook and filling out the rubric were very rushed and I'm afraid that it affected the quality of the student's responses." Many students really struggled on the weekly quizzes. Because of that, I started using a weekly study guide detailing the concepts the students were expected to know for the next weekly quiz. A study guide was also given for the post-unit assessment; time was given in class for students to review their notebooks and ask for clarification from the teacher prior to the assessment.

It occurred to me that this was the first time that the students were ever required to "know" or "learn" science. In the younger grades, science is often skipped or the focus is primarily on the science experience and not much time, if any, is spent on writing conclusions or learning why or what is scientifically happening; the teacher felt that the intensity of the unit might have overwhelmed students.

INTERPRETATION AND CONCLUSIONS

Critical teacher feedback did not have a positive impact on student learning. Weekly quiz and rubric scores did not increase over the course of the unit, many of them decreased. I wonder if one cause of this was student fatigue. With the weekly quizzes and multiple page notebook entries, the students became very overwhelmed and exhausted. This was the first time that any of these students had participated in science class where they were required to learn, remember, apply, and adapt scientific concepts. As the teacher, I should be aware of when students begin to feel overwhelmed and adjust instruction and assessments accordingly. Due to the timeline of both the AR and the district's timeline of when the unit was to be completed it was difficult to adjust the instructional pace to meet the student's needs. In the future I will not use the weekly quizzes. This became a huge stress for students, didn't give the desired results, and did not improve the student's learning. There are other ways to assess student understanding than a formal weekly quiz. Either entry tasks at the beginning of class, or exit tickets given to students prior to the end of the period would give better feedback as to how well students understand the content without the stress of a quiz.

Group B's rubric scored dropped substantially on their second set of feedback. A reason for this could be that students, in group B, during the first two weeks of the unit felt that they had the correct answer and were doing fine. Then when they got their first written feedback they became timid now knowing that they might not have had the correct answer. In regards to the feedback that I gave them, in week 4 (the first feedback for Group B) was longer and I was challenging the students more. It was around this point in the unit that I was getting frustrated that students weren't performing at the level

at which I had hoped (i.e. quiz scores). That frustration might have transferred into the comments, thus possibly having a negative effect on the students.

In the future, time needs to be structured into the lesson to allow adequate time for students to read and respond to the feedback given. One student in the post-unit interview was looking through his notebook and said, “Oh, I never read this!” when he came across some feedback. When the notebooks were handed out students were not given adequate time to read and respond to the feedback. It often felt chaotic and very rushed; with only 70 minutes for students to read and respond to feedback, take a quiz, and complete a lesson. If the feedback is important enough to write to the student then it is important enough to make sure the student has time to read and respond to the feedback. This time must be planned in to the weekly lesson.

When students responded to a feedback question, a short written discussion usually followed. This allowed students additional time to wrestle with the question and have a few more chances to develop their understanding. I often had students come to me not understanding the question. I would then restate the question or be able to point out the part in the notebook that I was commenting on. Once again taking the time in class for students to have reflective thinking and a chance to respond and develop their understanding.

The notebooks are a powerful classroom based assessment. Reviewing the entries, weekly, gave me a heightened sense of “where my students were” in regards to the concepts discussed in class. The notebook entries end with a conclusive question that asked the students to restate, apply, or adapt the content from the lesson. This final portion of the entry highlights where students are in the learning process. From these

questions I am able to adapt the review questions and teaching points that need to happen for students to be successful.

Reviewing the notebooks regularly gives a better insight to where the students are in the learning process than the weekly quizzes I gave during this unit. The quizzes could be adapted into the notebook entries, as stand-alone quizzes I did not feel that they produced usable data to positively impact instruction. I feel the stress of the unit, the pressure of weekly quizzes, and the rapid pace of the unit distracted from student learning. In the future, I will replace the weekly quiz with a focus question in the notebook. This way the students will not get “burned-out” on being formally assessed each week. Students need time to reflect and respond to the questions posed in their notebooks, and that time must be built in.

I am also curious to see how teacher feedback would affect students at both higher and lower levels of ability. The intervention class was a class identified at a low fifth grade level. How would students who are performing above grade level react to the intervention, what about students who were working below grade level? A study involving a whole grade level (three to four classes) would be extremely beneficial to determine the effects of teacher feedback.

VALUE

Science notebooks have always been a key component to science education in my classroom. Over the years the use of the notebooks have evolved from one being more focused on the setting up of the notebook to a notebook that tracks and records the students’ thinking, application, and adapting the content over the course of a given unit.

The notebook provides the students a living text that they are able to keep, adapt, and make personal as they learn about the world around them.

The next step for me is to now focus on weekly checks of the notebooks. The insight gained from the action research was how powerful weekly review of student work can be. Review of student notebooks seems to always get pushed back when other issues arise. Between planning, team time, discipline, and other meetings, reviewing student notebooks continually gets pushed back to another day. I need to find a way to limit this and make reviewing student notebooks a daily part of my teaching.

During the action research process I prepared for my treatment unit in a way that I have never done before. When preparing for a unit I usually just jump in and start teaching. I have the end goals in sight but the path to the goals comes one step at a time, and many times never reaching the final goal. Before I started teaching the treatment unit I had planned the specific goals of each week. Now if I can transfer this specific planning into the other units throughout the year, all of my teaching will be more focused with the end goals in sight and specifically how I will help the students attain them.

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APPENDICES

APPENDIX A

SCIENCE NOTEBOOK RUBRIC

Scientific Content

4	Conclusions are thoughtful and complete
	Provides complete explanation of questions / concepts
	All information recorded is accurate and use scientific vocabulary.
	All data recorded are well labeled and organized.
	Drawings and descriptions are detailed and mostly complete
3	Conclusions are thoughtful and complete
	Provides almost complete explanation of questions / concepts
	Most information recorded is accurate and use scientific vocabulary.
	Most data recorded are well labeled and organized.
	Drawings and descriptions are detailed and mostly complete
2	Conclusions lack details and are incomplete
	Provides incomplete explanation of questions / concepts
	Some information recorded is accurate and shows little use of scientific vocabulary.
	Some data recorded are well labeled and organized.
	Drawings and descriptions are missing details and incomplete
1	Conclusions do not reflect the activity
	Provides no explanation of questions / concepts
	Information and details are missing.
	Data is missing
	Drawings and descriptions are missing

Organization / Conventions

2	All pages are set up correctly
	All done correctly: spelling, punctuation, and capitalization.
	Table of contents reflects all entries to date.
	No pages are skipped
	Handwriting is neat
1	Some pages are set up correctly
	Some done correctly: spelling, punctuation, and capitalization.
	Table of contents reflects all entries to date.
	No pages are skipped
	Handwriting is neat

APPENDIX B

PRE/POST ASSESSMENT



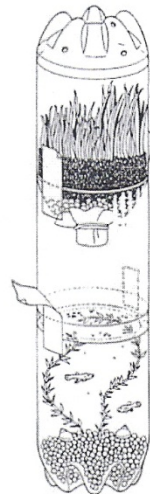
Student Name _____ Date _____



Ecosystems Summative Assessment- Version 1

Use the picture of the ecocolumn to answer questions 1-5.

Ecocolumn



LS1B

1. What do the fish use to breathe in the water?
 - a. Gills
 - b. Lungs
 - c. Nose
 - d. Nostrils

LS2C

2. Which are the producers in this ecosystem?
 - a. Green plants
 - b. Aquatic snails
 - c. Loose gravel
 - d. Fish eggs

LS2C

3. Which statement describes consumers?
 - a. Organisms that eat dead plants and animals.
 - b. Organisms that eat other things for food energy.
 - c. Organisms that make their own food.
 - d. Organisms that swim in an aquarium

LS2C

4. Snails are called decomposers in the aquatic model. Why are snails decomposers?
 - a. Snails attach themselves to plants.
 - b. Snails eat dead plants and animals.
 - c. Snails move slowly in the water.
 - d. Snails have shells that clean the water.

LS2A

5. Name three living organisms and three non-living materials in the ecocolumn. Place them on the chart below.

Living	Non-living
1.	1.
2.	2.
3.	3.



Student Name _____ Date _____



6. What part of a cricket's body does the same job as fins do for fish?

- a. Antennae
- b. Legs
- c. Cerci
- d. Thorax

LS1B

7. Sami is planning a pollution experiment. Which question can Sami investigate using the class ecocolumns?

- a. Does acid rain do more harm in mountains than in lakes?
- b. How does acidic water affect plant growth?
- c. How long does it take for acid rain to change a forest?
- d. What areas in North America are most affected by acid rain?

INQB

8. In our class experiments, light, temperature and droppers of water stayed the same. Which word refers to the parts of an experiment that stay the same?

- a. Controlled
- b. Experimental
- c. Measured
- d. Changed

INQC

9. Which of the following variables was changed in your polluted ecocolumn?

- a. Amount of pollutant
- b. Type of pollutant
- c. Growth of plants
- d. Amount of mustard seed

INQC

10. Four nonliving things are listed below. On the lines that follow, give an example of how each nonliving thing helps a living organism.

LS2A

Shelter: _____

Air: _____

Water: _____

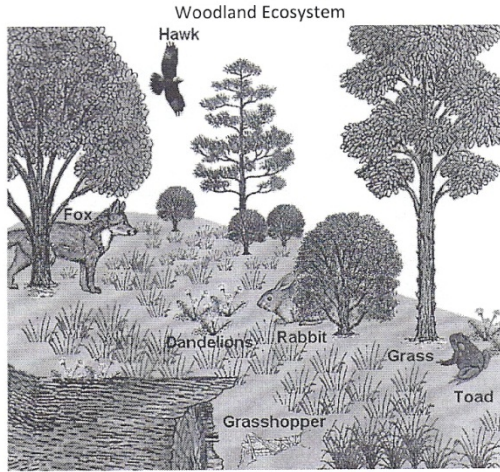


Student Name _____ Date _____



LS2B

11. Complete a simple food chain on the lines below the Woodland Ecosystem using the organisms found in the picture. Be sure to include arrows showing the flow of energy.



12. In your terrarium, the cricket and grass have an interdependent relationship. Identify what each organism gets from the other organism in this relationship.

LS2A
LS2B

13. In Seattle, a city near the ocean, fog often forms on summer mornings. Which of the following statements best explains how this fog forms?

PS2A

- a. Ocean water evaporates and then condenses in the air.
- b. Crashing waves spray tiny drops of ocean water into the air.
- c. Water runoff moves towards the ocean and collects near the shore.
- d. Rain clouds move in from the ocean and evaporate as they reach the shore.



Student Name _____ Date _____



14. Name two ways humans can affect the growth and reproduction of the fish in a river ecosystem.
Tell how each factor might affect the fish.

LS2F

Human actions	How this action could affect the growth and reproduction of the guppies
1.	1.
2.	2.

15. Which of the following characteristics will best prevent a tree from being blown over by high winds during a storm?

LS1B

- a. deep roots
- b. long branches
- c. thick bark
- d. wide leaves

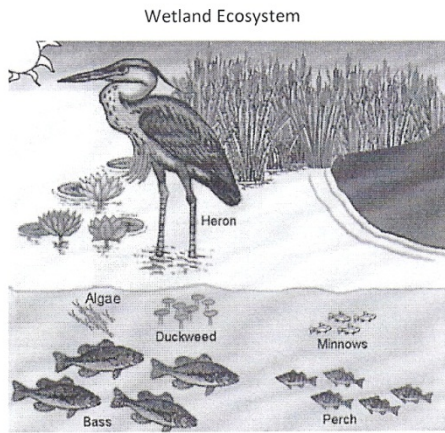
16. Naomi has a pet dog. Which of the following characteristics did the dog most likely inherit from its parents?

LS3B

- a. Its weight
- b. Its favorite food
- c. The color of its fur
- d. The place where it lives



17. Look at the picture of the "Wetland Ecosystem." If all the large-mouth bass disappear, describe how the number of perch and minnows in the food chain may be affected. Explain **WHY** this will happen.



LS2E

18. A tuna is an ocean fish that is well adapted to catching small, fast-moving prey. Which of the following adaptations most helps the tuna swim fast to catch its prey?

LS1B

- a. large fins
- b. sharp teeth
- c. small gills
- d. tough scales

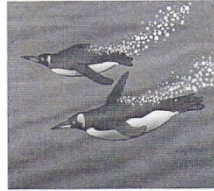


Student Name _____ Date _____



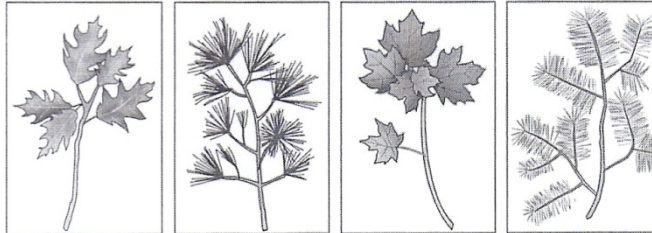
19. Emperor penguins are specialized birds that eat fish. Emperor penguins have developed many special characteristics that help them survive in the ocean environment. The picture below shows two emperor penguins swimming in the ocean.

LS1B



Which of the following characteristics most helps the emperor penguins survive in an ocean environment?

- Having very little sense of smell
 - Having very weak sense of taste
 - Having large feathers that absorb water
 - Having small wings that move like flippers
20. The pictures below show parts from four different plants. Based on the pictures, which of the following physical characteristics would be best to use to sort the plants into two groups?



LS1B

- The shape of the leaves
- The length of the leaves
- The length of the branches
- The thickness of the branches



21. All the ponds in an area dried up during a drought. Of the populations listed below which of the animals that live in the area is **most** affected by the drought.

- a. deer
- b. frog
- c. hawk
- d. squirrel

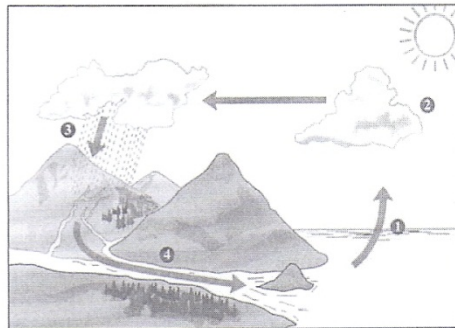
LS3A

22. Sandra put some isopods into an open box. She covers half the box with a piece of cardboard and then places the box outside on a summer day. All the isopods move under the cardboard. The isopods are most likely responding to which of the following?

- a. air pressure
- b. bright light
- c. wind
- d. fog

LS1C

23. The diagram below shows the four stages of the water cycle. Which change is happening at stage 1 in the diagram?



- a. Water is changing from a gas to a solid.
- b. Water is changing from a liquid to a gas.
- c. Water is changing from a liquid to a solid.
- d. Water is changing from a solid to a liquid.

PS2A



Student Name _____ Date _____



24. All the energy stored in food started as

- a. Energy from the Sun.
- b. Energy made by animals.
- c. Energy made by plants.
- d. Energy from water.

LS2B

25. Kayla built a terrarium. She planted grass and mustard seeds 5 days before she added animals.

What is the best reason for why she did this?

- a. Kayla wants to grow yellow flowers.
- b. Kayla needed time to trim the plants.
- c. Grass and mustard grow well in a terrarium.
- d. The growing plants are food for the animals.

LS2B

APPENDIX C
STUDENT QUESTIONNAIRE

Student Questionnaire Science Notebooks

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

1. I do my best work when I am working in my Science Notebook.

Always Sometimes Never

2. The Scoring rubric helps me do better in my notebook.

Always Sometimes Never

3. My notebook entries are always complete.

Always Sometimes Never

4. The data in my notebook is always organized.

Always Sometimes Never

5. I enjoy using the Science Notebook.

Always Sometimes Never

6. The Science Notebook helps me learn science.

Always Sometimes Never

7. Science Notebooks help me think about science.

Always Sometimes Never

8. I use my Science Notebook as a resource to answer questions.

Always Sometimes Never

9. I enjoy learning science.

Always Sometimes Never

APPENDIX D

STUDENT INTERVIEW QUESTIONS

**Student Interview Questions
pre and post-treatment**

- What is your favorite part of science?
- Why do we use notebooks in science class?
- What part of the notebook helps you learn science?
- Thinking about how we use the notebooks in class, what part is most helpful? What part is least helpful?
- How does the Science Notebook Rubric help you in your notebooking?
- How do teacher comments in your notebook help?

APPENDIX E
WEEKLY QUIZZES

Week #2 Quiz – January 7

QUESTION 1.1

Name _____ Date _____

Four nonliving things are listed below. On the lines that follow, give an example of how each nonliving thing helps a living thing.

Shelter: _____

Air: _____

Water: _____

Energy: _____



Model ecosystems may be used to learn more about the relationships that exist on earth.

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Week #3 Quiz – January 14

QUESTION 1.3

Name _____ Date _____

The process of respiration occurs

- A. only in algae.
- B. only in plants.
- C. only in animals.
- D. in algae, plants, and animals.



Model ecosystems may be used to learn more about the relationships that exist on earth.


STC® • Ecosystems

QUESTION 1.4

Name _____ Date _____

The process of photosynthesis is important to living things. Circle the statements that are TRUE about photosynthesis.

- A. Oxygen is taken in and carbon dioxide is given off.
- B. Carbon dioxide is taken in and oxygen is given off.
- C. Photosynthesis captures energy from the sun.
- D. Photosynthesis helps organisms get energy from food.

 Model ecosystems may be used to learn more about the relationships that exist on earth.

STC • Ecosystems

Week #4 Quiz – January 22

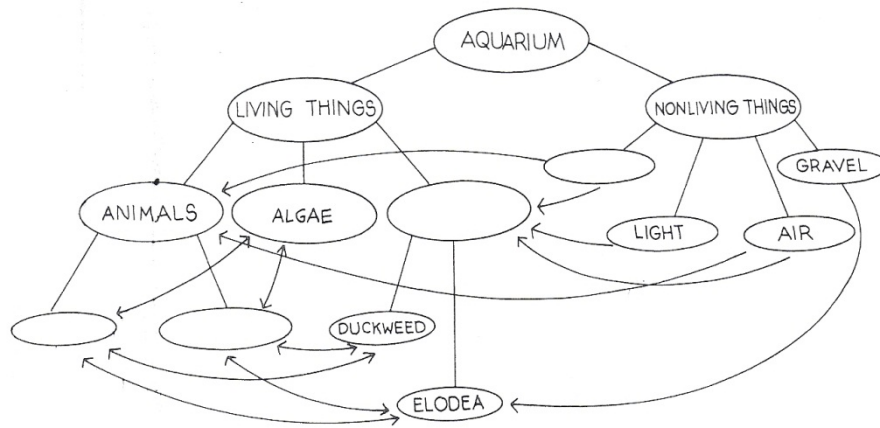
QUESTION 2.1

Name _____ Date _____

This web of relationships represents the aquarium we built in class. Using the Word Bank, fill in the four blank ovals and complete the web.

Word Bank:

mosquito fish plants water snails




Organisms in ecosystems have dependent and interdependent relationships.

QUESTION 2.2

Name _____ Date _____

In an ecosystem, some relationships are dependent, and other relationships are interdependent.

In your aquarium, the fish and the duckweed have an interdependent relationship. Identify what each organism gets from the other organism in this relationship.

 Organisms in ecosystems have dependent and interdependent relationships.
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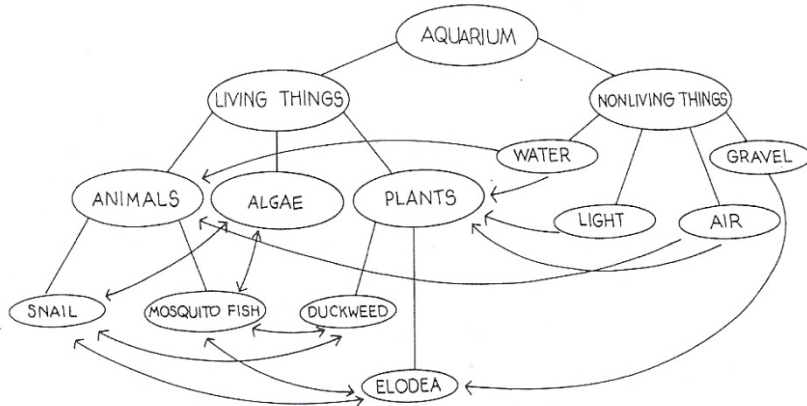
Week #5 Quiz – January 28

QUESTION 2.3

Name _____ Date _____

The web represents an ecosystem. Circle the role of the fish in this ecosystem.

- Producers
- Consumers
- Scavengers
- Decomposers




Circle the role of the snails in this ecosystem.

- Producers
- Consumers
- Scavengers
- Decomposers

Circle the role of the duckweed in this ecosystem.

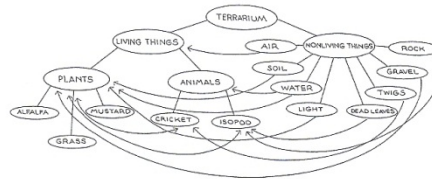
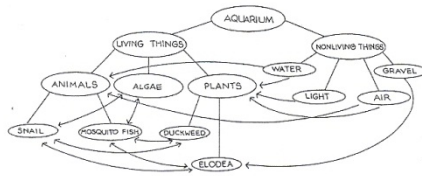
- Producers
- Consumers
- Scavengers
- Decomposers

 Organisms in ecosystems have dependent and interdependent relationships.
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QUESTION 2.6

Name _____ Date _____

Compare the aquarium web with the terrarium web. Use the Word Bank help you choose the best organism to complete each sentence below. Write your choice on the line.




Word Bank:

isopod grass cricket fungi

The _____ in the terrarium has the same role as the fish in the aquarium.

The _____ in the terrarium has the same role as the snail in the aquarium.

The _____ in the terrarium has the same role as the *Elodea* in the aquarium.

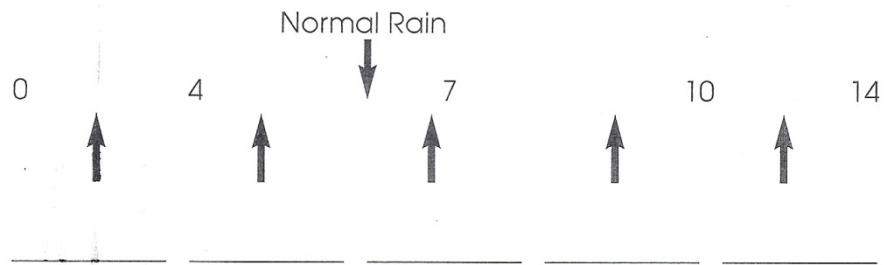
 Organisms in ecosystems have dependent and interdependent relationships.

Week #6 Quiz – February 4

QUESTION 3.1

Name _____ Date _____

Fill in the blanks on the pH scale using the substances and their descriptions below.



Ammonia is very basic. Put "ammonia" in the correct blank on the pH scale that has an arrow pointing to where ammonia is on the pH scale.

Baking soda is slightly basic. Put "baking soda" in the correct blank on the pH scale.

Distilled water is neutral. Put "distilled water" in the correct blank on the pH scale.

Acid rain is more acid than normal rain. Put "acid rain" on the correct blank on the pH scale.

Vinegar is more acid than acid rain. Put "vinegar" on the correct blank on the pH scale.



Nature and human activity may affect an ecosystem in beneficial or harmful ways.

Week #7 Quiz – February 11

QUESTION 3.2

Name _____ Date _____

We used vinegar to make acid rain in our pollution experiments. Answer the following two questions.

What happens in the real world to make acid rain?

What effect does acid rain have on nature? List at least two ways acid rain is harmful.



Nature and human activity may affect an ecosystem in beneficial or harmful ways.

QUESTION 3.3

Name _____ Date _____

Describe one way that using salt on the roads is helpful.

Now, describe one way that using salt on the roads is harmful.



Nature and human activity may affect an ecosystem in beneficial or harmful ways.

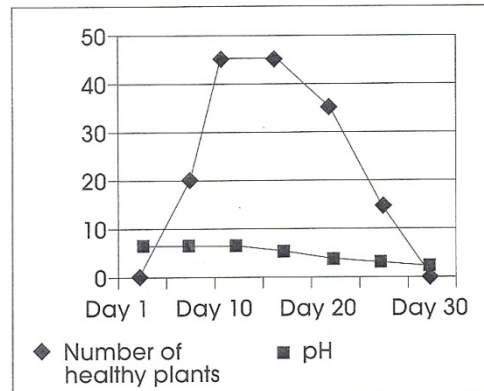
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Week #8 Quiz – February 20

QUESTION 3.6

Name _____ Date _____

A group of students did an experiment that we also did in this science unit. Data from that group's experiment are shown in the graph.



Which statement describes the relationship shown in the graph?

- A. As the pH increased, the number of plants increased.
- B. As the pH increased, the number of plants decreased.
- C. As the pH decreased, the number of plants decreased.
- D. As the pH decreased, the number of plants increased.

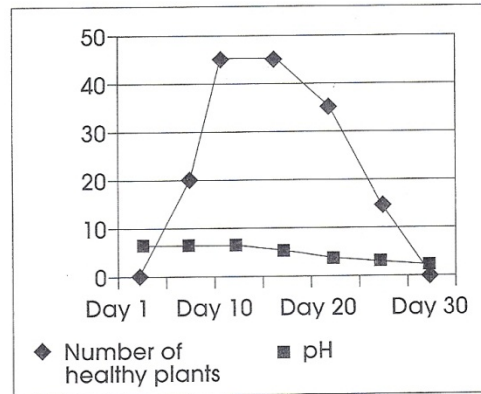


Nature and human activity may affect an ecosystem in beneficial or harmful ways.

QUESTION 3.7

Name _____ Date _____

A group of students did an experiment that we also did in this science unit. Data from that group's experiment are shown in the graph.



Based on the graph, which conclusion is correct?

- A. Changes in pH do not affect plants.
- B. Changes in pH can be helpful to plants.
- C. Changes in pH can be harmful to plants.
- D. Changes in pH are not important to plants.



Nature and human activity may affect an ecosystem in beneficial or harmful ways.

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Week #9 Quiz – February 25

QUESTION 4.2

Name _____ Date _____

How do ordinary citizens like us add to the Chesapeake Bay's problems? Describe three things that you and your family could do to help the bay. Discuss what the trade-offs would be for each of your three solutions.

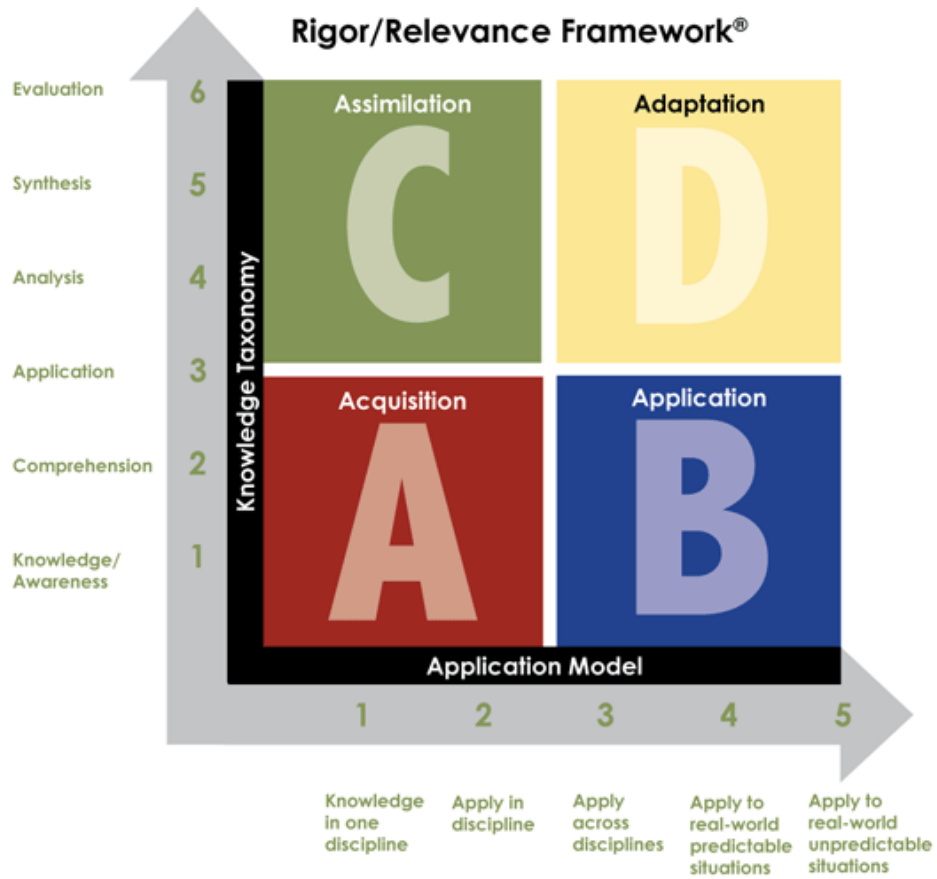


People can develop solutions to mitigate the effects of pollutants.

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APPENDIX F

RIGOR/RELEVANCE FRAMEWORK



A	B	C	D
Students gather and store bits of knowledge and information. Students are primarily expected to remember or understand this knowledge.	Students use acquired knowledge to solve problems, design solutions, and complete work. The highest level of application is to apply knowledge to new and unpredictable situations.	Students extend and refine their acquired knowledge to be able to use that knowledge automatically and routinely to analyze and solve problems and create solutions.	Students have the competence to think in complex ways and to apply their knowledge and skills. Even when confronted with perplexing unknowns, students are able to use extensive knowledge and skill to create solutions and take action that further develops their skills and knowledge.