THE EFFECTS OF USING LEARNING PROGRESSIONS FOR STUDENT MASTERY

by

Michael Frederick Hill

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ABSTRACT

In order for students to achieve a high level of knowledge, teachers and students should be able to identify areas of understanding and areas that need improvement. Designing a progression that identifies concepts help guide teachers and students through the learning process. Students have the opportunity to show mastery in a concept before progressing to the next level. This action research provided students with a progression to guide their learning. Students reflected on each concept before moving to the next. As a result, students were able to show significant growth as well a sense of confidence in learning.

INTRODUCTION AND BACKGROUND

Context of the Study

How do teachers know students are learning? This is a question that is commonly asked of teachers by their administrators. Many teachers use end of unit tests and end of quarter exams to measure student learning, but how do they know ahead of time if students are on track? Do students have the necessary background to achieve expectations? These are the questions that I have been pondering over the last several years and even more now as we have moved into remote learning.

Green Level High School is a suburban high school located in Cary, North Carolina, about 15 miles southwest of Raleigh. The school is in its second year and serves students 9th, 10th, and 11th grades. Our school is very diverse. According to our enrollment records there are a total of 1386 students at Green Level High School (Carrillo, 2020). Of that total, 621 are white, 530 are Asian, 95 are Hispanic, 84 are African American or black, 50 are two or more races, three are American Indian or native Alaskan, and three are native Hawaiian. Only 49 students are on free or reduced lunch. Eighteen students are identified as Limited English Proficiency. The majority of the school's population lives within close proximity to the school. Based on 2019-20 end of course exams, most students are meeting or exceeding state standards in math, English, and science. Based on the most recent climate survey, Green Level High School is considered a positive, welcoming, and inclusive place to learn. There is a lot of school spirit and parents are active stakeholders in our parent-teacher-student association (Summers, 2020).

Throughout the last several years, I have noticed through my professional learning teams (PLT) and department meetings, that there were inconsistencies as to how teachers were assessing student learning. These conversations allowed me the opportunity to reflect on how I was evaluating the way my students were learning. What I have been seeing is that teachers are trying to cover as much as possible so that students would be exposed to the curriculum that would be assessed on the state end of course exams. Teachers for the most part were not going deep into the curriculum, just covering as much as they could. A true example of inch deep, mile wide. In addition to lightly covering material, I was seeing that teachers didn't know how well their students were doing until they gave quizzes and end of unit tests.

One of the teachers that I worked with, however, strayed from the inch deep, mile wide concept and only teaching to the test. This colleague, John McKinney, showed me how he used learning progressions to help students build a foundation and make connections in learning science. I began to research the idea of using learning progressions myself. I started to wonder if I used learning progressions with my students along with regular formative assessments, could I help my students not only meet essential standards, but at a deeper level?

This current school year has been especially challenging. We have been 100% remote learning thus far. Over the course of the last semester, our PLT has been struggling to find ways to reinvent how we teach. As our instruction has become completely digital, I feel that we have strayed from our ability to personalize learning.

Part of this was because we all felt that we had been in survival mode trying to figure this out.

After the completion of the first semester, we observed certain trends. Most of our students had been doing exceptionally well. For many of those, however, we found that the grades were inflated because students had been reciting what they found online. On the other side of the spectrum, students have been struggling mightily. Those were the students that had the greatest need of the structure of in person learning. In addition, there have been considerably less interactions as the majority of students had not been turning on their cameras or unmuting during class.

The one thing that we have gone away from in my department was frequent and regular formative assessment. I feel that more than ever this was a necessary part of instruction. For a myriad of reasons, we were not using this strategy to determine how much students were learning. As my action research focus has always been on formative assessment, I was curious to see how I could implement these strategies moving forward. In addition to using formative assessment strategies, I still believed that we still needed to give students a road map to guide their learning through the use of learning progressions.

Focus of the Study

It was my hope that through this action research I would be able to bring better structure to my online classes and give students that clear roadmap to organize their learning. The focus of my study was two-fold. How will learning progressions help students learn essential standards at a deeper level? How will the use of formative assessment strategies guide students through their learning progressions?

CONCEPTUAL FRAMEWORK

Formative Assessment

Formative assessment is a tool that teachers can use in their classrooms to see which strategies are working and or not working. This may be an oversimplification; formative assessment is so much more. It is a process where feedback is given to adjust learning (Popham, 2011). Formative assessment has been described as a process of interpreting evidence to determine where learners are, where they need to go, and how they get there (Lombardi, n.d.). He describes formative assessment as assessment for learning. There are educators who utilize their tests and quizzes as their only means to evaluate learning. Some may argue that these along with performance assessments, journals and research papers can be considered formative (Pinchok & Brandt, 2009). While data can be collected from them, they do not help students and teachers on a daily basis. Formative assessment should be used as part of daily practice to ensure students are making progress toward their learning targets (Gotwals, 2018). It is not a summative assessment occurring only a few times per marking period, and the results have an immediate effect on learning (Boston, 2002).

Formative assessment can be formal or informal. Formal assessment could include planned assessments such as a ticket-out-the-door, a classroom assessment technique (CAT) such as one sentence summary, or a planned student conference. They can be as informal as observing student interactions in class or through casual conversation with students. According to Alonzo (2018), these formative assessment

practices should be used as a part of a set of tools which need to be utilized in everyday practice. One method that is part of the formative assessment toolbox is feedback.

Feedback

Feedback helps both the teacher and the student to identify student needs and achieve learning goals. In fact, a number of researchers, according to Popham, are reporting that feedback can actually double the rate of learning (Popham, 2011). While many educators think of feedback as a teacher-directed process, students should be part of this as well. Two main parts of formative assessment are teachers giving feedback and students receiving feedback (Rushton, 2005). Accountability in learning must fall on the students as well as the teacher. This process needs to be modeled to students. Feedback given to students must be useful and actionable and teachers should communicate clear learning goals to students (Popham, 2011).

Schools, school districts, and states have put additional pressures on educators to show evidence that their students are demonstrating mastery of science through district and state summative assessments. Many are finding, however, that there are gaps that exist between the actual level of performance and the expected level of performance (Rushton, 2005). Formative assessment can fill those gaps. As mentioned previously, regular and consistent use of strategies such as formative feedback and regular informal assessment can put learning back on track if it is needed. It is almost assured that it will improve student learning in the classroom. Meta-analysis shows evidence of academic gain along with improved student learning (Pinchok & Brandt, 2009). If this is true then

formative assessment should be able to improve student test scores on district and state assessments (Popham, 2011).

There are many challenges in implementing formative assessment for teachers. Many teachers feel they are on a time crunch to cover a certain amount of curriculum in a certain amount of time. Many teachers do not know how to use formative assessment in their class or are unsure where to begin (Alonzo, 2018). Teachers are struggling with setting quality learning targets, generating evidence that students are understanding, interpreting student responses, and taking student ideas into consideration when making instructional decisions (Gotwals, 2018). Perhaps one of the more problematic viewpoints regarding student understanding is the mindset that students either get it or they don't. Assessing student growth in this manner fails to focus on what learning needs students have. Only focusing on right or wrong prevents the teachers from uncovering what students do know and may inhibit them from expressing their true potential (Alonzo, 2018).

To implement formative assessment into the classroom, teachers may need to make instructional adjustments (Popham, 2011). Along with implementing strategies, teachers may need to strengthen their knowledge of their subject area, their pedagogy, assessment knowledge, and perhaps most importantly, learn what their students know prior to the lesson (Pinchok & Brandt, 2009). There are many ways formative assessment can be used in the classroom and it is not a one-size-fits-all approach. This includes the use of strategies like misconception probes to see what students may be thinking prior to the lesson. Another tool that could be part of the formative assessment toolbox is a

learning progression. Learning progressions are orderly building blocks that are presented to students to assist in achieving a successful learning outcome (Popham, 2011).

Learning Progressions

The National Research Council's *A Framework for K-12 Science Education* (2012) suggests that disciplinary core ideas and their related learning progressions are principles for the design of the framework. Learning progressions are defined by the Next Generation Science Standards as a method for students to build on and revise their knowledge and abilities and to guide their knowledge to a more scientifically based and coherent view of the natural sciences (NGSS, n.d.). Learning progressions can also be a set of criteria set forth by the teacher. Each progression is a set of subskills that students must master before moving to a higher cognitive skill (Popham, 2011). This provides a foundation for students to build on. One could even compare it to a road map to help students focus on where they have been and where they are going. The Council of Chief State School Officers consider learning progressions as one of the five attributes of formative assessment (Alonzo, 2018). In order to make progress using this model, students need instructional support and experience, as well as that the "understanding of the idea matures over time" (National Research Council, 2012, p. 26).

Learning Progressions can be beneficial to student learning by bringing to light what and how students are thinking (Shepard, 2018). This gives educators insight as to the next instructional step. Learning progressions in science are found to be the most useful when one scientific concept is built upon another. For example, students need to have basic foundational knowledge of the properties of matter before they can start

identifying chemical bonds and properties of chemical reactions. Learning progressions also prove useful in students identifying the interconnections of concepts.

Learning progressions can be used to support formative assessment practices using three questions: where are we going, where are we now, and how do we close the gap? The learning progression provides the ultimate goal students should be striving for. Once the pathway of the progression is set, teachers determine their students' current levels. Here teachers need to set clear learning targets and create levels where students can work their way up. Establishing these targets and levels gives teachers and students a framework from which to work from. This framework is the pathway students will take as their understandings becomes more sophisticated (Gotwals, 2018). Through this framework teachers and students can determine when and where to collect evidence about their current status within the learning progression (Popham, 2011). It should be noted that teachers use a learning progression to see how students are thinking and not so much as a tool to replace rubrics or grades (Gotwals, 2018). This can enable the teacher and the student to take a deeper look into their progress which will help them see the areas where they are either making connections or not. After teachers and students have determined where they are going and where they currently are, they can use the learning progression as a formative tool to determine how they can close the gaps. In doing so, they should continue working at the level where they are before moving on to the next.

METHODOLOGY

Demographics

The premise behind using learning progressions was to see if students had the fundamental knowledge to meet expected learning outcomes. If students were demonstrating these fundamental concepts, then they could move forward to the next progression or to dive deeper into the content. If not, learning progressions allowed teachers and students to see which concepts needed further instruction so that students would meet learning goals. The treatment group consisted of 22 students in my Earth and Environmental Class. This was a blended class of honors and academic students in grades 9 through 11. The treatment period covered two units of about three weeks each for a total of six weeks. This treatment occurred completely online through remote instruction. The units taught covered the geosphere and the hydrosphere. Upon completion of the treatment, seven students participated in a focus group where they discussed confidence and attitudes toward learning progressions. Prior to conducting this action research, the study received an exemption by the Montana State University Instructional Review Board and compliance for working with human subjects was maintained (Appendix A). In addition, I discussed my research with the school's administration and received approval and support (Appendix B).

Treatment

Learning Progression Implementation

Prior to each unit, students were given a copy of the Learning Progression. There were two progressions assigned, one for the geosphere unit (Figure 1) and one for the Hydrosphere unit (Appendix C). Students were asked to reflect on the learning progressions and identify which areas they already felt confident about and which they were unsure of. The purpose of this was two-fold. First, the information was used by me to see which areas I needed to focus on, and which areas needed less attention. This was similar to the process of using a pretest to guide instruction. The second reason I had students complete this self-reflection was so that they could see how these concepts progressed and as a guide to help them reflect on them as we moved through the unit.

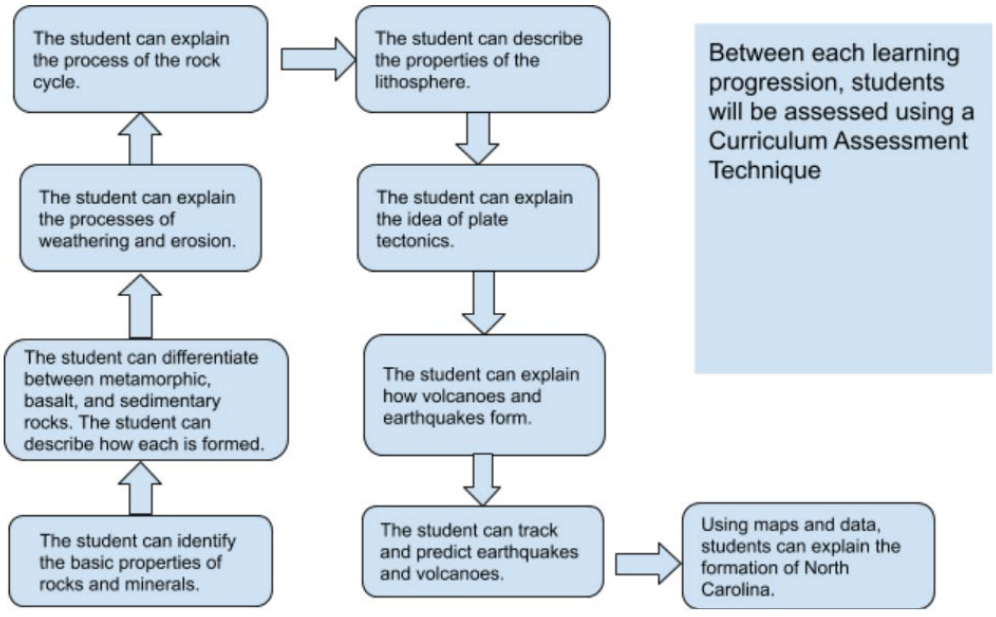

Figure 1. Geosphere learning progression.

For each stage of the Learning Progression, basic concepts were outlined. These concepts built the foundation that students would need to know before progressing to the next stage. The Learning Progression for the geosphere unit began with students having to demonstrate their understanding of basic geologic concepts which include the properties of rocks and minerals progressing to identification of knowing the classifications of rocks and how they formed. The progression continued with understanding weathering and erosion before learning about the rock cycle. Students then continued to the lithosphere, plate tectonics, volcanoes and earthquakes, the changing lithosphere, and finally to analyzing how humans have impacted the geosphere.

The second unit students participated in was the hydrosphere. The same pattern that was used for the geosphere was used for the hydrosphere unit. The first stage of the Hydrosphere Learning Progression included properties of water which progressed to water distribution on Earth. The next stage in the progression was the hydrologic cycle which covered the movement of water on the surface and below. The next progression included water quality and treatment. Students then progressed to learning about watersheds and river basins and then on to point source and non-point source water pollution. The final stage in the progression had students analyzing local water quality and quantity and to develop mitigation plans for water conservation and protection. During this unit the CAT was used in the same method as the geosphere unit to assess whether students should move forward or receive more practice. Data from each of the formative assessments was used to determine how well students were progressing and for me to reflect on what changes I would need to make as we moved through the unit.

Pre and Post Assessment

Prior to the treatment, students were given a pretest to assess their knowledge of the curriculum set forth by the North Carolina Earth and Environmental essential standards. A separate pretest was given at the beginning of each unit. Each pre assessment consisted of five short answer questions that covered the main standards of the unit. The assessments were agreed upon by our Earth and Environmental professional learning team (PLT). The geosphere assessment was written by me for all students at Green Level High taking Earth and Environmental, and the hydrosphere assessment was written by another member of the PLT. In order to determine the amount of knowledge students gained, a post assessment identical to the pre assessment was given to all students.

Classroom Assessment Technique

A CAT was assigned to each student in both units. Students reflected on their prior knowledge about each standard at the beginning of each lesson. After the end of the lesson students updated their CAT with what they learned. This process of formative assessment was different than what is normally done in our PLT as the practice of formative assessment is inconsistent and not regularly used. The CAT gave me very specific feedback on what students were learning and not learning.

Data Collection and Analysis Strategies

Pre and Post Assessment

At the start of each unit each student was assigned a pre assessment (Appendix D & E). The Geosphere and Hydrosphere Pre-Assessments were completed by students prior to reviewing the learning progressions or previewing any of the content. At the end of the unit, an identical post assessment was assigned to students. Post assessment results were compared to the pre assessment to determine normalized gains.

In 1998, Richard Hake published a method to determine normalized gains using pre and post assessments. According to Hake, a normalized gain of less than 0.3 is considered low, greater than 0.3 through 0.7 is considered medium, and a gain of greater than 0.7 is considered high. This data was used to determine the amount of growth students made from the beginning of the unit to the end.

Classroom Assessment Technique

The CAT used was a diagnostic learning log (Appendix F & G). Each student was assigned a learning log through Google Classroom. Before beginning the next lesson, students were asked to fill out the CAT. After each lesson, students were to go back and make corrections and complete the learning log with information they learned. As this was assigned through Google Classroom, I was able to make a copy for each student. This enabled me to view their work as they completed it. Depending on the answers the students provided, the lesson was tweaked to accommodate the different levels of learning. Students who demonstrated understanding were assigned activities that allowed them to dive deeper into the subject. Students who were unable to answer questions

received remediation or supplemental work to help them understand the concepts. This was in the form of small group reteaching, lesson videos with questions using EdPuzzle, or supplemental reading or videos.

Learning logs were reviewed, analyzed, and sorted based on the depth of the student responses. The responses were divided into six categories: high level of knowledge, low level of knowledge, and incomplete. A learning log that was described as demonstrating a mostly high level showed evidence of critical thinking and an in-depth explanation for most of the questions. Learning logs that were deemed adequate level of knowledge contained answered that were correct but did not offer details, in-depth explanations, or evidence of critical thinking. For learning progressions that were considered to show a low-level of knowledge, answers were either partially correct or incorrect.

Comparing Assessment Results

Of the four teachers in the Earth and Environmental Science PLT, I was the only teacher to use learning progressions and learning logs with my students. We did, however, use a common assessment for each unit as well as identical assignments. Upon completion of each of the units, our PLT met to compare data. While normalized gains were not available for the other sections of this course, results of the final unit assessment, or post assessment for me, were used to compare the level of knowledge for each student.

Student Interviews

An interview with students in the form of a round table was also conducted to determine students' attitudes towards learning progressions. This occurred at the end of the treatment period. Seven students were chosen to participate in a round table discussion about learning progressions. This small setting allowed for students to openly discuss how they felt about using learning progressions. Students were asked questions that focused on specific feelings that I was looking for such as how learning progressions has helped develop a deeper understanding of content, whether learning progressions help organize their thinking, and if this is a strategy that should continue to be used (Appendix H). The data from these interviews helped me determine the effectiveness of learning progressions and how these may be used moving forward. The results of this action research were shared with my department and administration. The data collection methods have been triangulated to ensure sufficient evidence to support my focus question (Table 1).

Table 1. Data Triangulation Matrix.

Focus Question	Data Source 1	Data Source 2	Data Source 3	Data Source 3
How will learning progressions help students learn essential standards at a deeper level?	Pre- and Posttest based on unit essential questions.	Classroom Assessment Techniques to measure student progress.	Comparison of non-treatment classes assessment results	Interview data from student focus group.
Will the use of formative assessment strategies guide students through their learning progressions?	Pre- and Posttest based on unit essential questions.	Curriculum Assessment Techniques to measure student progress.	Comparison of non-treatment classes assessment results	Interview data from student focus group.

DATA ANALYSIS

Results

The results of the Geosphere Pre assessment and Post assessment showed an increase of 47 points from 33% to 80% (n=16) (Figure 2). One student reported that "I was able to read through all of them (learning logs) to use to prepare for the test." Another student said, "I understood the lesson better because I could see all the things that we needed to know."

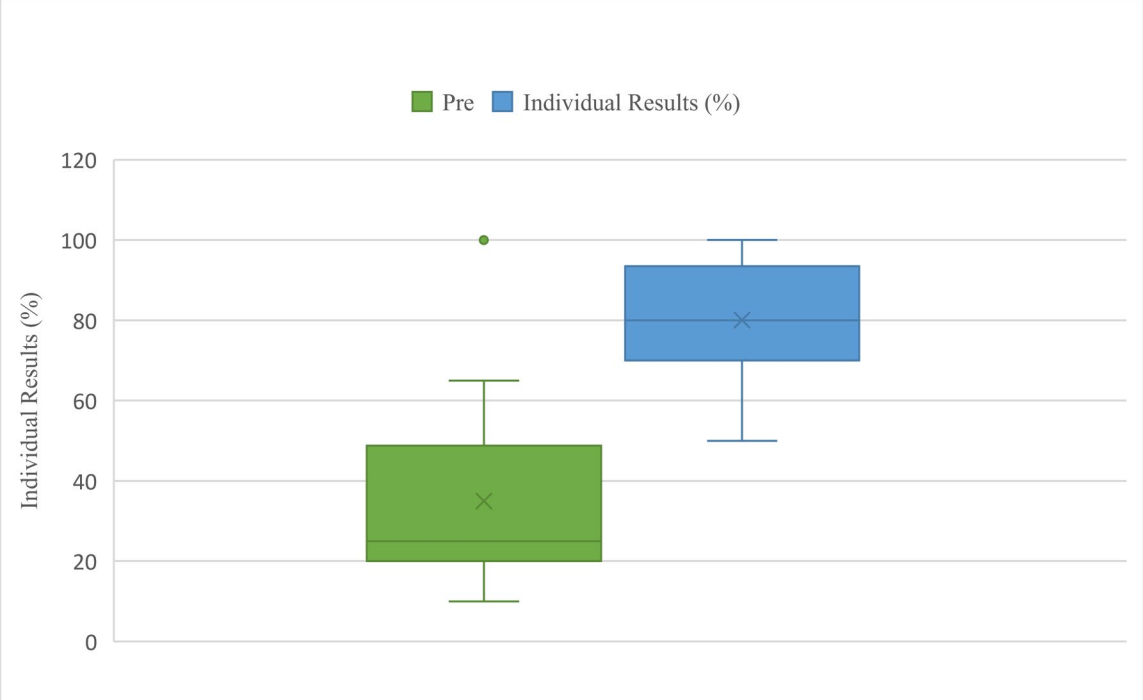

Figure 2. Boxplot showing results from the geosphere pre and post assessment, (n=16).

The normalized gains from the Geosphere Pre assessment and Post assessment indicate an average high-medium gain of 0.64 based on Hake's formula. Forty-four percent of students achieved a high growth with all those students scoring an A on the

Post Assessment. Six students (38%) ranked as medium growth and three (19%) were considered as low growth (Figure 3).

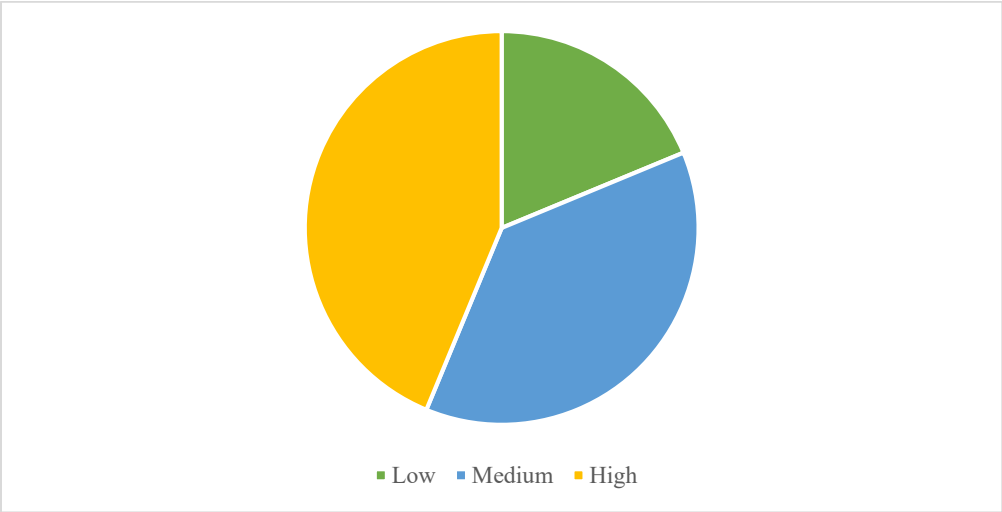

Figure 3. Pie chart showing distribution of Geosphere normalized gains ranking, (*n*=16).

The results of the Hydrosphere Pre assessment and Post assessment indicate a class average gain of 37 points from 46% to 83% (*n*=18) (Figure 4). This growth can be supported by one student who stated that, "getting feedback helped me understand what I missed so I could fix it." Another student claimed that, "I was able to use these (learning logs) as a study guide." "This (learning progression) helped me feel organized and prepared."

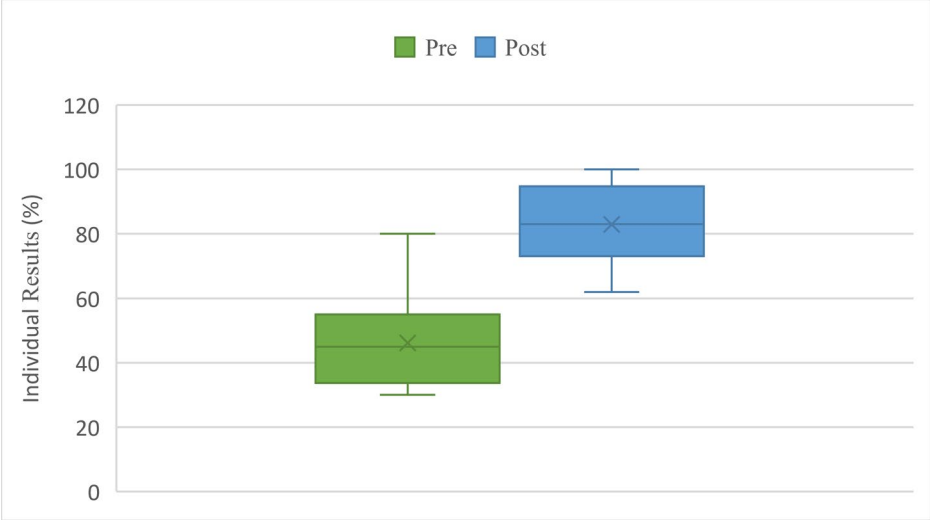

Figure 4. Boxplot showing results from Hydrosphere Pre and Post assessment, (*n*=18).

The normalized gains from the Hydrosphere Pre assessment and Post assessment show a class average of 0.7 points which is considered medium, one tenth of a point below of what is considered high. The class range was between 0.16 and 1.0. Fifty-six percent of the class was ranked as high according to Hake's formula. Thirty-nine percent had medium gains, and five percent had low gains (Figure 5).

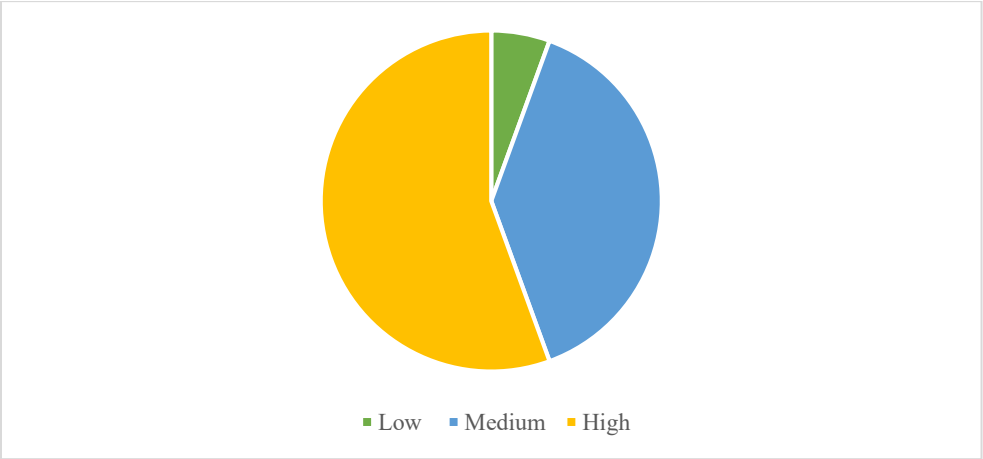

Figure 5. Pie chart showing distribution of hydrosphere normalized gains ranking, (*n*=18).

An analysis of the data collected from both the Geosphere Pre assessment and Post assessment as well as the Hydrosphere Pre assessment and Post assessment indicated that students had made gains. The effectiveness of learning logs was based on multiple data points to give a clearer picture. In addition to a pre and post assessment for each unit, students reflected on their knowledge after each standard through a diagnostic learning log, a CAT to formatively assess student progress.

For the geosphere unit, 36% showed a mostly adequate level of knowledge making it the category with the most students. Nine percent demonstrated a mostly high level of knowledge. Fourteen percent of the students demonstrated a low level of knowledge while five percent rated as high level of knowledge. Not all learning progressions were fully completed or had complete answers. Some simply answered "I know this" which does not indicate their level of understanding the standards. Thirty-six percent of students fall into this category (Figure 6).

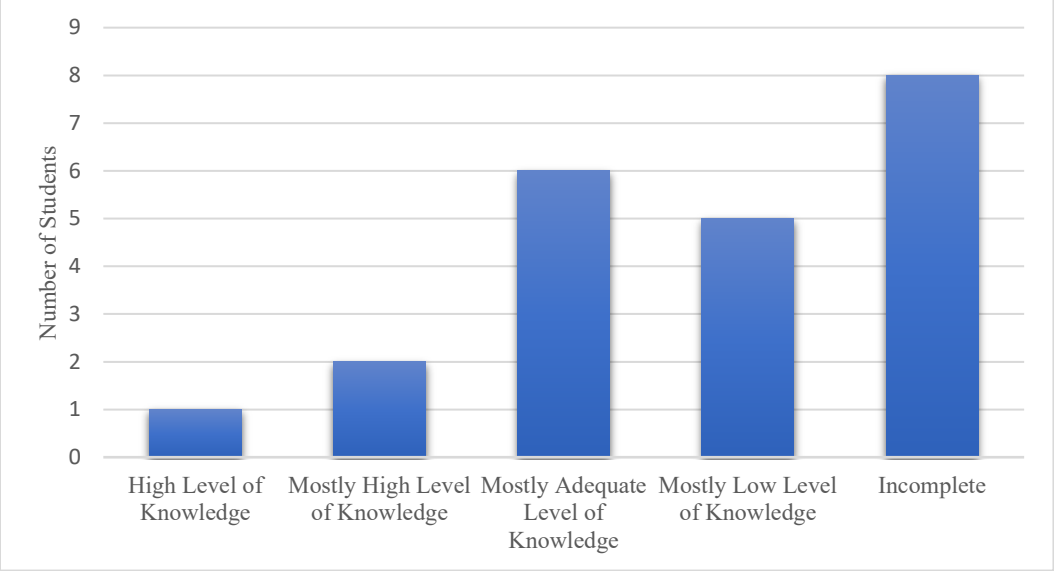

Figure 6. Bar graph showing distribution of geosphere student level of knowledge based on Diagnostic Learning Logs, (*N*=22).

Fifty percent of the students were rated as having adequate knowledge or better based on the CAT used for the hydrosphere unit. Of the group, 9% demonstrated a high level of knowledge, 5% with mostly high level of knowledge, and 37% with an adequate level of knowledge. This is compared to 14% of the students who were rated as having a low level of knowledge. As with the geosphere unit, this data set does not identify all students in the treatment group as 32% of the students had incomplete learning logs (Figure 7).

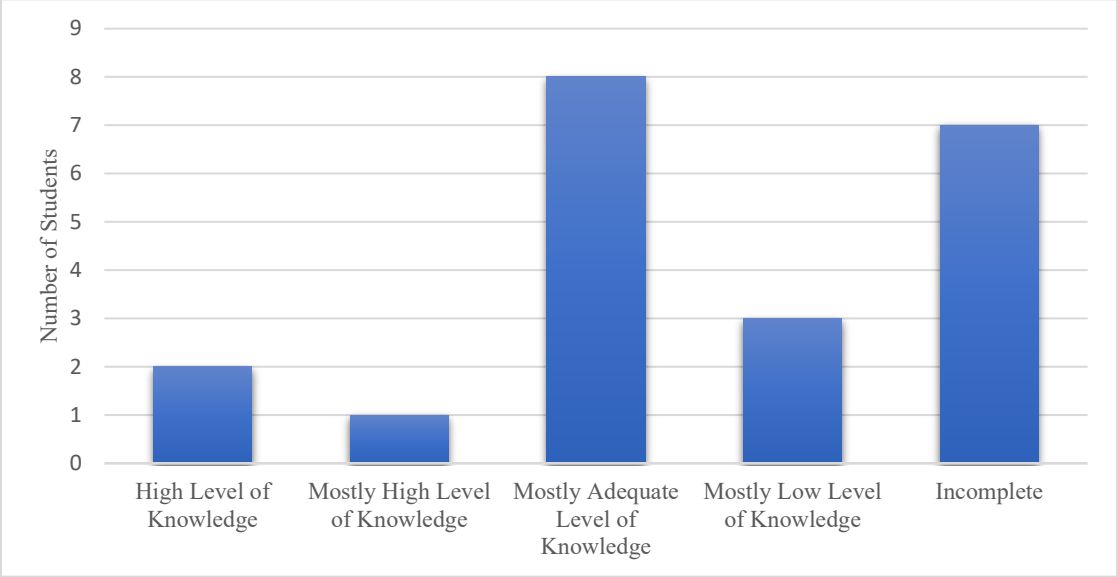

Figure 7. Bar graph showing distribution of Hydrosphere student level of knowledge based on Diagnostic Learning Logs, (*N*=22).

The amount of growth that occurred between the pre and post assessment can be supported by the feedback that was received from the students based on their responses to an interview upon completion of the second unit. Seven students participated in a focus group and answered five questions that allowed them to share their attitudes and

confidence level regarding learning progressions as well as be able to provide feedback to me so that improvements can be made. The first question asked students if learning progressions helped them better understand the lesson. All of the students felt the process was beneficial. One student stated that, “I was able to read through them again and use them to prepare for the test.” Another student had a positive experience which was noted by their statement, “It made sense to me because I can see how its all connected.” One student liked that I was able to see what they were writing by commenting, “I was able to work with you in a small group so that you could explain it better.”

Students were asked if using learning progressions helped them organize their thinking. One of the students responded, “I knew what was coming up next.” Another stated, “I felt more organized.” The third question was looking to see whether students felt that learning progressions are a strategy that should be used for future units. One of the students replied, “Yes, it is a good idea because we can see everything that is important to know. The fourth question asked students if learning progressions was something that should be used in other classes. One student responded with, “It is best in science because there are certain things you need to know before learning the next thing.” Another student said, “I think this could be useful in math class too.” Finally, I wanted to hear from students about what improvements could be made to the process. One student stated, “We should get a skills grade for each part or some kind of credit.” Another student said, “We should spend more time going over each one and reviewing each before moving on to the next.”

One other data point that was analyzed was the comparison with the other sections of Earth and Environmental Science at the school. Each of the four sections were identical in that students were in grades 9-11 and all assignments and assessments were identical. The average Geosphere Post assessment score for my class was 85%. The average for each of the other sections were 72%, 77%, and 82%. The average Hydrosphere Post assessment for my class was 83%. The averages for the other sections were 77%, 80%, and 83% (Figure 8).

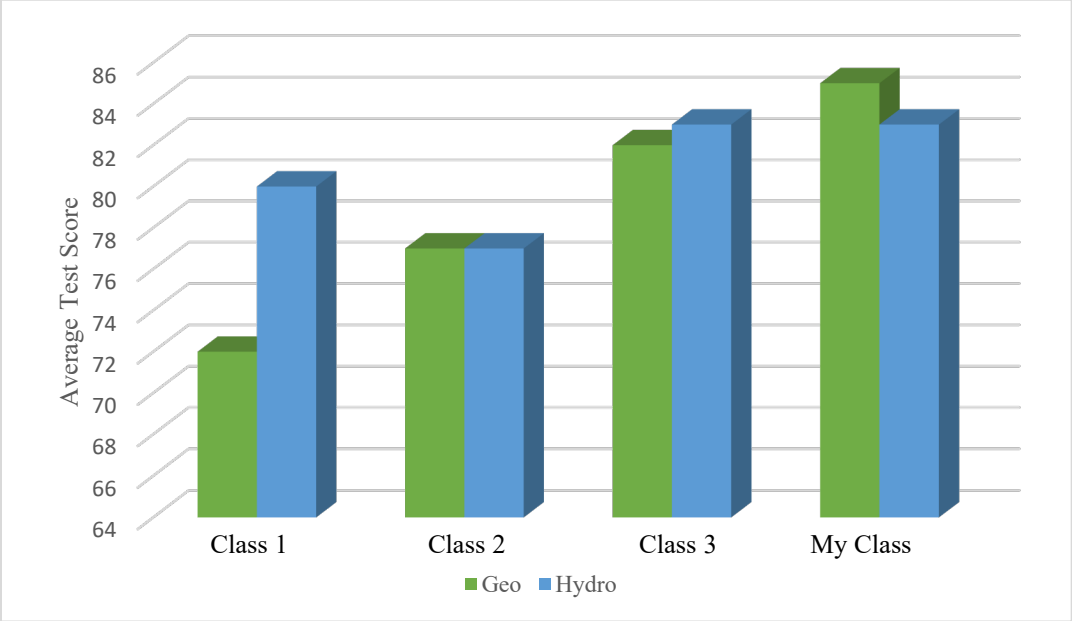

Figure 8. Comparison of other earth and environmental science classes.

CLAIM, EVIDENCE, AND REASONING

Claims From the Study

Based on the data that was collected, I feel that using learning progressions to guide students through a unit of study is a strategy that will help students achieve a greater level of success and deeper content knowledge. The majority of students showed high normalized gains between pre and post assessments. Most students demonstrated adequate or higher level of knowledge through diagnostic learning logs. Feedback from students indicated that this was a strategy that can be implemented as a regular practice in each unit. From what I saw, students were able to reflect upon each standard prior to moving forward. I also reviewed each student's response to determine whether or not students were grasping the concepts and needed enrichment or if students needed additional support. When comparing student entries on their diagnostic learning logs to their post assessment, it was evident that students demonstrated a higher level of knowledge due to either the further enrichment or the additional support students had. This is further supported by the comments from students in our focus group.

The high differential between the Geosphere and Hydrosphere Pre and Post assessments can be attributed to several factors. One is that the assessment was a short answer, free response assessment and not a multiple-choice test. During the pre-assessment, if students did not know the correct answer, they indicated that they did not know instead of guessing for choices. The fact that the post assessment allowed students to explain the best way that they could and include as many details that would support their answer. The structure of this assessment, I feel, lent itself to student scores showing

a more accurate reflection of knowledge. I have also observed that many of the answers that students wrote on their post assessment were aligned with what was written on their learning log but with greater elaboration. This is also reinforced by the comments regarding the use of learning logs as a tool to prepare for the assessment during the focus group.

Value of the Study and Consideration for Future Research

Conducting this action research has created a conversation about how to formatively assess students and at what pace and sequence is most appropriate. There are four teachers on my professional learning team (PLT). I was the only teacher on the team that conducted this research or has ever implemented learning progressions. The data collected from this study has given us data that we can use to compare student growth.

I personally find the value in this strategy because not only have most students improved in their assessment, but because of the overwhelming positive feedback from students. Based on the experiences learned from this process, I feel that the implementation of learning progressions needs to continue with modifications in future units. While student scores showed a lot of growth and I am confident that my students improved immensely, I feel that this study needs to continue to become validated. The main concern that I have is that students were completing the assessments and learning logs remotely and I question how many students used resources such as class presentations, readings, their learning logs, or the internet to assist them in answering some or all questions. Another concern is that due to the nature of remote learning, I did not have data from all students. Some students completed the pre assessment and not the

post, some completed the post assessment and not the pre, and one student did neither. Furthermore, while the majority of learning logs were completed, several students either did not complete theirs, submit theirs, or pasted answers found online. The fact that students were learning remotely made it difficult to meet individually with students to give them valuable feedback or probe their thinking. Remote learning made it difficult for me to get immediate feedback as well. Nearly all students had their cameras turned off and many would not answer any questions during class discussion. Aside from the five or six students that reliably participated, most responses were posted in the chat and did not demonstrate the depth that I was looking for.

In addition to the challenges mentioned, there were some constraints that occurred during this action research that will need to will need to be considered before future implementation of learning progressions. Our school and departmental policy is that all teachers within a PLT use a common assessment. During the research, I had to create an assessment that would work for each team member. Each member of the PLT developed one of the lessons with input and feedback from the rest of the team. My unit to develop was the geosphere, so wring an assessment was not a concern for this unit. The hydrosphere unit, however, was developed by another teacher hence the assessment was not created by me. The problem with this was that the assessment did not align with the standards and did not completely match the content that was in the learning progression which aligned with the standards. I had to compromise with the PLT to make some changes to the assessment so that it fit the curriculum map.

Another constraint that I quickly ran into was pacing. All PLTs at our school are expected to be at a similar point in the unit and assign the same work. As I was using the diagnostic learning logs to guide instruction, I quickly found out that my pacing was going much slower than the rest of the team. I also found that additional or differentiated work would be required for my students based on their progression. As with the assessment I had to work out pacing with the team. I was fortunate to have administrative support as well as support from my PLT for these.

One piece of data from this experience that can be considered is the differential in Post assessment scores from both the Geosphere and Hydrosphere units compared to the other Earth and Environmental Science classes. The average scores for both assessments in my class were comparable to the other three classes, but depth of student answers in my class was much greater with my students as they were to elaborate deeper on each question. The number of students scoring greater than 85% was higher in my class than the others.

I am hopeful that our PLT, which may change next year, will see the value that I have in using learning progressions and formative assessment with feedback. I would like to continue this process next year. To do so, there will need to be more flexibility and autonomy for me to pace students and assign the work that is most appropriate for their level. I am hopeful that we can continue this conversation throughout the spring and summer. I am confident that administration sees the value in this as a best practice. I have had several conversations with our assistant principal who has been very receptive and supportive. In fact, I have been asked to share the findings of my research with the staff

so that others may have the chance to find the value in it themselves. Who knows, this may become part of our school-wide strategy to meet the needs of students.

Impact of Action Research on the Author

Throughout much of my tenure, I have collaborated with my peers as well as plan out units strictly based on the unit standards. I've used pre assessments to determine where students were at the beginning of the unit and to measure student growth. Implementing learning progressions helped me organize the building blocks of foundational knowledge needed to find deeper meaning of the content. I have discovered through the use of learning progressions together with diagnostic learning logs, I was able to see very specifically the concepts students were either understanding or struggling with. This action research has forever changed how I map out a unit. The positive feedback that I have received from students reinforces how I view the approach of systematically organizing the concepts to be presented. This action research has changed the way I map out units of study moving forward. It has taught me to be more thorough on the areas that need the greatest focus.

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APPENDICES

APPENDIX A

INSTRUCTIONAL REVIEW BOARD APPROVAL

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

MONTANA STATE UNIVERSITY

2155 Analysis Drive
c/o Microbiology & Immunology
Montana State University
Bozeman, MT 59718
Telephone: 406-994-4706
FAX: 406-994-4303
E-mail: cheryljj@montana.edu

Chair: Mark Quinn
406-994-4707
mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-4706
cheryljj@montana.edu

MEMORANDUM

TO: Michael Hill and John Graves

FROM: Mark Quinn Mark Quinn CMJ
Chair, Institutional Review Board for the Protection of Human Subjects

DATE: November 18, 2020

RE: *"Investigating the Effectiveness of Learning Progressions and Formative Assessment on Student Learning" [MH111820-EX]*

The above research, described in your submission of November 18, 2020, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

X (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

X (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation; and (iii) the information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by section 16.111(a)(7).

___ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

___ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

___ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

___ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B

ADMINISTRATIVE APPROVAL

Exemption Regarding Informed Consent and Administrator Approval

I, Karen Summers, Principal of Green Level High School, verify that the classroom research conducted by Mike Hill is in accordance with established or commonly accepted educational settings involving normal educational practices. To maintain the established culture of our school and not cause disruption to our school climate, I have granted an exemption to Mike Hill regarding informed consent and I approve this project.

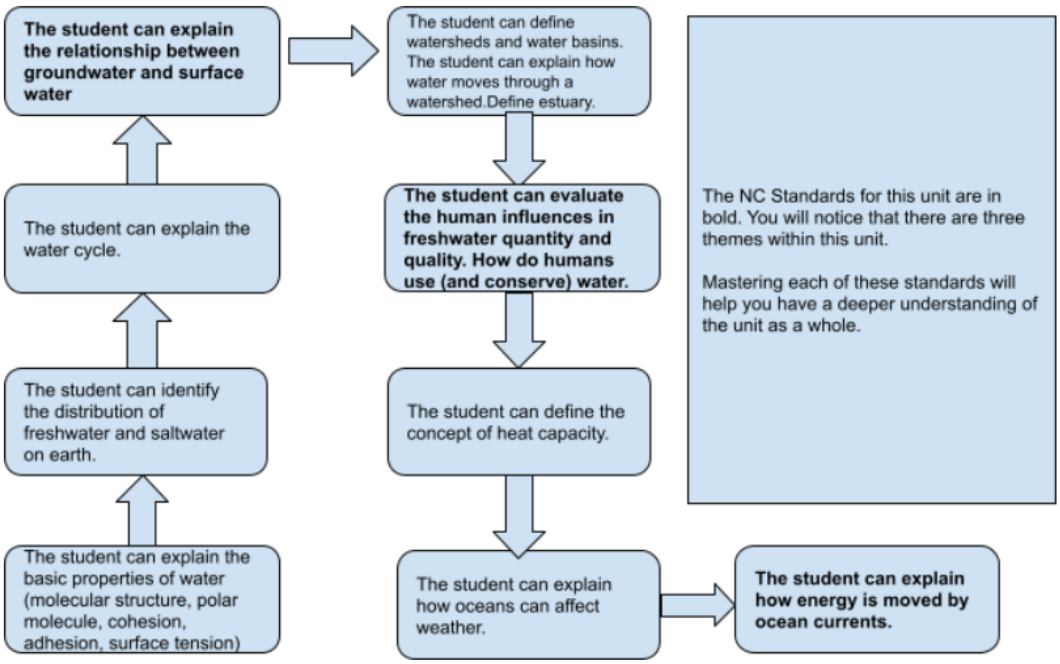
_____ (signed name)

Karen Summers (printed name)

11/13/20 (Date)

APPENDIX C

LEARNING PROGRESSION FOR HYDROSPHRE UNIT


The student can explain the basic properties of water (molecular structure, polar molecule, cohesion, adhesion, surface tension)
The student can identify the distribution of freshwater and saltwater on earth.
The student can explain the water cycle.
The student can explain the relationship between groundwater and surface water
The student can define watersheds and water basins. The student can explain how water moves through a watershed.Define estuary.
The student can evaluate the human influences in freshwater quantity and quality. How do humans use (and conserve) water.
The student can define the concept of heat capacity.
The student can explain how oceans can affect weather.
The student can explain how energy is moved by ocean currents.
The NC Standards for this unit are in bold. You will notice that there are three themes within this unit.
Mastering each of these standards will help you have a deeper understanding of the unit as a whole.

APPENDIX D

PRE AND POST ASSESSMENT FOR GEOSPHERE UNIT

Geosphere Free Response Assessment

Name:

Describe the process of soil formation.
Describe the formation of igneous, metamorphic, and sedimentary rock.
1. List the three types of plate boundaries. 2. Explain what happens to the lithosphere at each of these plate boundaries.
Explain why some volcanic eruptions are explosive while some are considered “quiet eruptions.”
1. Choose one way that humans have had an impact on the geosphere. 2. Describe two impacts that practice has had on the geosphere.

APPENDIX E

PRE AND POST ASSESSMENT FOR THE HYDROSPEHRE UNIT

The Hydrosphere: Unit 3

Pre Assessment

Answer the following questions to the best of your ability. Please do not look up any answers, this does not count as a grade. I just need to see what you know and what you have learned.

Explain why there is not an infinite supply of water on earth.
Explain how water moves through the water cycle.
Describe a watershed.
Identify several human uses of water.
What are some ways humans conserve water.
How are pollutants able to move through ecosystems and enter the groundwater?
How do humans influence the amount of freshwater availability? What do you predict for the future?

APPENDIX F

CURRICULUM ASSESSMENT TECHNIQE FOR GEOSPHERE UNIT

Learning Progression Student Personal Reflection/Diagnostic Learning Log: **Geosphere**

The student should be able to demonstrate understanding of each of the following learning goals. The space provided is for you to reflect on your level of knowledge.

Answer only the questions that match the standard that was covered in each lesson.

1) I can identify the basic properties of rocks and minerals. I can explain each of the following. a. Differentiate between a rock and a mineral. b. What are the chemical components of rocks? c. Explain the following hierarchy: element-mineral-rock
2) I can describe how igneous, metamorphic, and sedimentary rocks are formed. I can explain the characteristics of each?
3). I can explain the difference between weathering and erosion.
4). I can explain the rock cycle.
5). I can describe how soil is formed.
6). I can identify the properties of of the lithosphere. a. Define a tectonic plate. b. Define three types of plate boundaries: convergent, divergent, and transform. c. Know the difference between oceanic and continental crust.

7). I can explain the idea of plate tectonics. a. Understand how plates move. b. Describe what occurs at each type of plate boundary.
8). I can explain how volcanoes form. I can explain how earthquakes are formed.
9). I can predict where earthquakes and volcanoes will be located.
10). I can explain the negative impacts of humans on the lithosphere..

APPENDIX G

CURRICULUM ASSESSMENT TECHNIQUE FOR HYDROSPHERE UNIT

Diagnostic Learning Log

Unit 3- The Hydrosphere Name:

Explain the basic properties of water. These include molecular structure, water is a polar molecule, cohesion, adhesion, and surface tension.
Identify the distribution of freshwater and saltwater on earth.
Explain the water cycle.
Explain the relationship between groundwater and surface water.
Describe a watershed and basin. How does water move through a watershed? Define an estuary.
Evaluate human influences on freshwater quantity and quality. How is freshwater used and conserved?
Define heat capacity?
How is energy moved through oceans?
How do oceans affect weather?

APPENDIX H

STUDENT INTERVEIW QUESTIONS

STUDENT INTERVIEW QUESTIONS
How have learning progressions helped you develop a deeper understanding of the content?
Do you feel that using learning progressions has helped you organize your thinking?
Do you feel that using learning progressions are something that should be used in my science classes in the future
Do you feel that learning progressions could be a valuable tool in other subject areas?
What are some ways that this method could be improved?