The Rock Cycle

Assessment/Evaluation Plan

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Executive Summary

The main purpose of this treatise is to develop an assessment plan for an instructional unit on the rock cycle at Memphis School of Excellence in Memphis, Tennessee. The Memphis School of Excellence is required to revise their science curriculum to meet the new Tennessee science standards. The revision is to be implemented during the 2018-2019 school year. This shift to new instructional standards will significantly impact student learning because the current standards are built upon a previous course standard that the students never received. This change is compounded by the fact that 32.9% of students were evaluated to be less than proficient on the end-of-the-year examination in science (Tennessee Department of Education, 2018b). Despite these challenges, students who attend Memphis School of Excellence are nonetheless expected to show mastery of the science standards selected for their grade level during this transitionary period.

Assessment of student learning is a key component in determining if students have mastered the new science standards. One of the assessment plan's criteria is assessing students' learning through a practical framework that conducts investigations about student learning and allows educators to analyze the results for patterns in students' understanding and misconceptions. Furthermore, these assessments should answer specific questions about student learning and produce evidence of each student's achievement. This implementation is done through rubrics, which is one method of "providing meaningful and rapid feedback to learners" (Palloff & Pratt, 2009 p. 33). One of the goals in the construction of this assessment plan is based on authors Palloff and Pratt's (2009) principles of effective online assessment that guided the assessment plan. The following are a few of the assessment best practices that this study applied:

- Learner-centered assessments that include self-reflection

- Assessment techniques that fit the context and align with learning objectives
- Collaborative assessments through public postings of papers, along with comments from student to student
- Assessment that are clear, easy to understand, and likely to work in the online environment

In addition, the assessment plan focuses on eighth-grade students as part of the new state requirement by creating a unit of instruction that is a blend of online synchronous and asynchronous curriculum hosted through a learning management system. Within these unit of instructions, terms and definitions such as: fossils, electromagnetic waves, telephonic plates, and other natural phenomena help define rock parts as elements of the curriculum to raise students understanding. This design plan is based on one instructional objective and uses two formative assessments and one summative assessment to evaluate learning. The objective assessed is "identify (name) and model the processes and forces that change one rock type into another." This goal provides a comprehension plan for students to learn that primarily focuses on (1) the best scientific practices and (2) researching and explaining natural phenomena.

Target Audience and Instructional Need

Target Learners

The online assessments discussed in this document are being designed as part of an instructional unit for 8th-grade students at Memphis School of Excellence in Memphis, Tennessee. The student body at this school is composed of approximately 74% African American students, 25% Hispanic students, and 1% Asian students (Tennessee Department of Education, 2018b). 8.2% of students have a native language other than English and 53.2% of students are identified as economically disadvantaged (Tennessee Department of Education, 2018b). The demographics of students in the 8th grade are proportional to the demographics of the student body.

Instructional Need

32.9% of students, grades 3-8, are evaluated to be less than proficient on the end-of-the-year examinations in science (Tennessee Department of Education, 2018b). In addition to this, the science standards in the state of Tennessee were revised in 2017 to be implemented during the 2018-2019 school year. The shift to new instructional standards impacts student learning because the current standards are built upon a “previous” course they did not have.

Despite these challenges, students who attend Memphis School of Excellence are still expected to show mastery of the science standards selected for their grade level during this transitionary period. Although students have some prior knowledge on the rock cycle from 7th grade in the 2017-2018 school year, the state standards ultimately dictate what content is taught at each grade level.

Course Context

This unit of instruction is placed at the end of the 8th-grade science course. The course is a blended online synchronous and asynchronous course hosted through Canvas, a learning management system, and Zoom, a video conferencing software. This course context is attractive to students because it is interactive, discussion-based, and supports the exploration of scientific ideas. Because much of science involves observation and experimentation, inquiry activities are completed at home using safe materials while under adult supervision. In this case, students typically photograph their experiment and discuss their observations with their peers.

Course Goals

As a result of the 8th-grade science course, students are expected to engage in best scientific practices while searching for explanations for natural phenomena. Major scientific ideas students should understand by the end of the course include:

- Magnetism and electricity are non-contact forces that are used for human benefit.
- Waves are classified by their behaviors and electromagnetic waves are used to communicate between technologies
- An object's motion is dependent on the object's mass and the combination of the forces acting upon that object.
- Evidence of change in life over time are seen in fossils, the similarities between living species and recently extinct species, similarities in DNA, and comparative embryology.
- Some individuals in a population have traits that allow them to survive and reproduce more than other individuals, leading to the evolution/ change of a species.
- Humans influence the inheritance of genes.

- Data from technologies provide evidence that the universe began with a period of rapid expansion and is still expanding today.
- The structure of Earth and how it has changed over time can be described due to fossil evidence, data from seismographs, and continental floor features.
- Processes in the Earth create igneous, sedimentary, and metamorphic rocks.

Rock Cycle Unit Goals

As identified in Science Standards Reference (Tennessee Department of Education, 2018a), students should be able to "Describe the relationship between the processes and forces that create igneous, sedimentary, and metamorphic rocks." This standard has been used to develop the following objectives:

1. Identify (name) and model the processes and forces that change one rock type into another.
2. Explain the role of tectonic forces in the rock cycle.
3. Identify (name) the sources of energy that drive the rock cycle.

Subunit Outline and Description of Learning Activities

This portion of the unit, in which the design focuses on, uses the first objective, "identify (name) and model the processes and forces that change one rock type into another." The unit will be conducted both synchronously and asynchronously within Canvas and Zoom. Table 1 describes the sequence of instructional activities. Students will begin the unit by completing an independent reading about the rock cycle and completing a reading comprehension quiz before the weekly synchronous meeting. During the synchronous meeting, students will discuss the reading, the instructor with review key concepts from the reading, and students will complete a breakout session activity, and the instructor will introduce the summative assessment. After the

synchronous session, students will independently practice their learning through the completion of an interactive simulation. To demonstrate their understanding at the end of the unit, students will create a model of the rock cycle and reflect on the strengths and weaknesses of peer models asynchronously through Canvas.

Table 1
Unit outline for rock cycle instruction.

Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Students complete reading and reading comprehension quiz.		Synchronous Class Meeting	Independent Practice	Begin Models
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
	Initial Discussion Post Due		Discussion Post Responses Due	Individual Reflections Due

Description of Learning Activities

The instructional unit will begin by directing students to read the "Classifying Rocks" article produced by Discovery Education Science[1]. This four-page article discusses characteristics of the three major categories of rocks and the geological processes that lead to their formation. The "Classifying Rocks" article is the sole source design behind the development of the reading comprehension quiz (Appendix A).

During the synchronous meeting that follows the student reading, the instructor will begin the session by facilitating a discussion between the students, using probing questions to focus the student's attention by naming and describing the processes that determine the characteristics of the three major rock types. Once the students have completed the discussion, the instructor will briefly lecture on the key concepts that students need to understand for

[1] Discovery Education Science is a customized curriculum program only available to those with a subscription.

successful completion on the summative assessment. Students will then complete a breakout session activity where they will discuss the different processes: heating, cooling, pressure/compacting, erosion, etc. and how each affects the different classifications of rocks and report back their findings with the class. At the end of class, the instructor will explain to students the Modelling assignment.

The day after the synchronous meeting, students will participate in an asynchronous activity in the form of an interactive simulation/worksheet in which they will be presented with a diagram of the rock cycle, as seen in Figure 1 below.

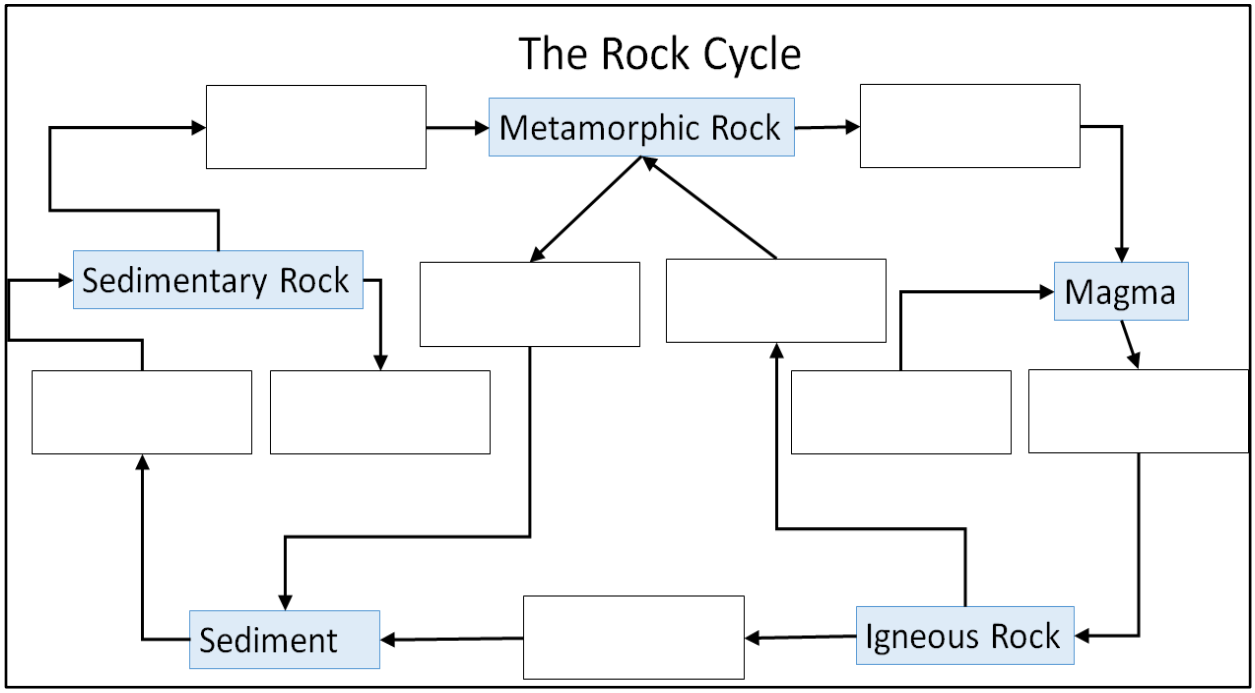

Figure 1. The Rock Cycle Worksheet

Parts of the cycle will be labeled and the students will be required to fill in the remaining blanks to identify the processes that have occurred between the identified rock types. The simulation will be available in Canvas and will provide students with real-time feedback on their

answers. A correct answer which completes the rock cycle will trigger a congratulatory message while an incorrect answer will trigger a message instructing the student to “Try Again”, along with a brief description of the portion of the cycle that they have gotten incorrect. Figure 3 shows an example of this. Because this activity will be “open book”, students will need to fully identify all processes in the rock cycle for the simulation to be counted as complete. Students will be able to repeat the activity many times as necessary to reinforce understanding of the rock cycle process. Once they are able to complete the activity with full accuracy, they will be able to proceed to the summative assessment. This assessment links directly to the first objective for the course, requiring that students be able to identify (name) the processes and forces that change one rock type into another.

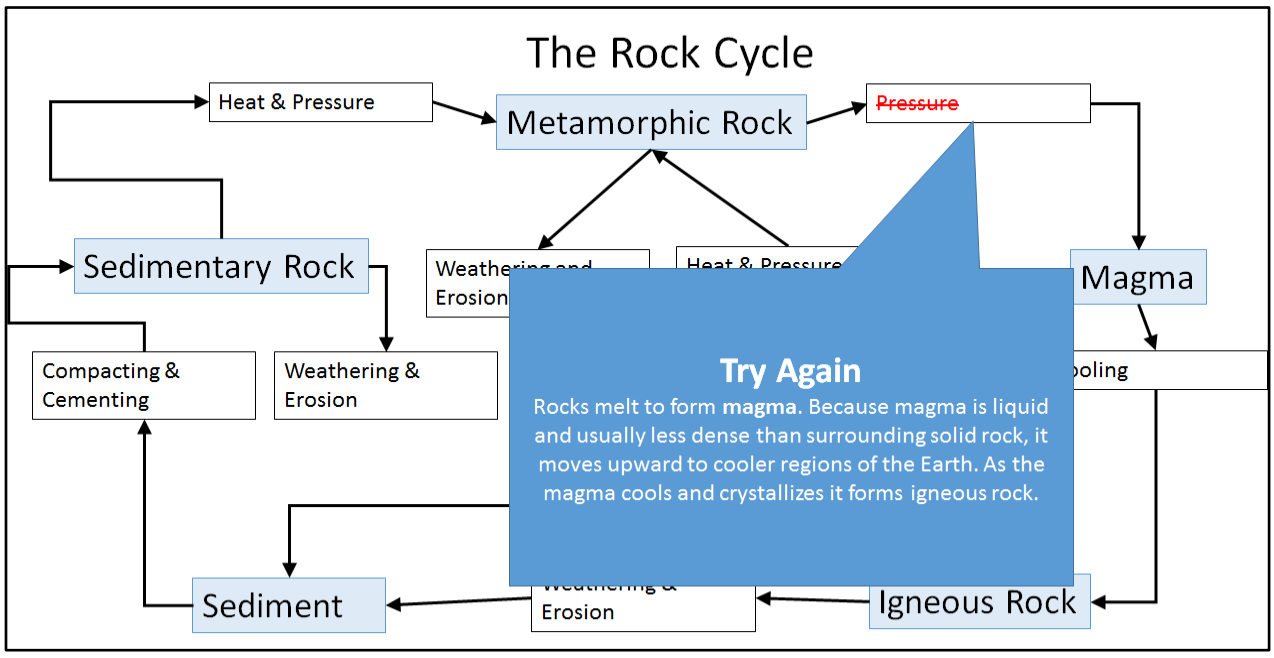

Figure 2. Worksheet with incorrect answer including correction and additional information

As a summative assessment, students will be directed to use materials readily available to them to create a model (diagram, physical representation, analogy or simulation) to demonstrate the processes that create the three major types of rock. Students will photograph their model if it is not digital and all students will post their models to a designated discussion board with an explanation of how their model represents the real-life phenomena. Students will then respond to their assigned peers' initial posts identifying three strengths and one weakness of their model in representing the scientific phenomena. Once students have received feedback from their peers, they will complete an individual reflection on the assignment, including what they have learned in the unit, a description of their model and its strengths and weaknesses, and a plan to improve the model if given the opportunity. The assignment instructions and rubric can be found in Appendix B.

Design Rationale

Reading Comprehension Quiz

The motivation behind the quiz design was founded on three pedagogical frameworks of assessing how effective the instructional design for this learning module is and using assessment data to provide feedback to students through formative assessments. First, the goal of the quiz design is to measure the students' comprehension of the required reading and to provide immediate feedback of the student's progression. Using the multiple-choice approach provides foundational knowledge for this course that students will later demonstrate their understanding through the summative assessment. The multiple-choice format allows the teacher the opportunity to make sure that each student understands the required learning objectives.

Secondly, this formative assessment tests student's cognitive learning by asking the learners to remember or recall facts and concepts through an online self-check quiz that provides

immediate feedback. The multiple choice format allow for unlimited attempts to retake the quiz and provides feedback on the students choice. The online self-check quiz allows for the teacher to reach formative objectives by (1) helping the students determine what they do and do not understand so teacher can address major misconceptions during the synchronous session, (2) providing immediate feedback so learner can quickly identify his or her problem areas, and (3) providing immediate feedback to the instructor so that instructor could adjust teaching techniques to improve learning. The self-grading quiz was one of the best formative techniques to help both the instructor and learners reach learning objectives. In order to validate this structure, authors Palloff and Pratt (2009, p. 93) outline of validity offered a practical guideline to self-grading quizzes. This guideline assisted in the construction of the self-grading quiz.

Table 2.
Table summarizing Palloff and Pratt's (2009, p. 93) characteristics of valid assessments.

Validity
Items are written clearly and are understandable
Content directly matches learning outcomes or unit objectives or both
Items have appropriate weight to the final score
Level of thinking required, based Bloom's Taxonomy, directly matches learning outcomes or objectives or both
Range of items is wide enough to represent learning outcomes

Finally, the reading comprehension quiz is appropriate and efficient way to assess students and affords instructors useful insight on learning. Authors Beebe, Vonderwell, and Boboc (as cited in Vonderwell & Boboc, 2013) states "effective assessment techniques can improve an instructor's understanding of students needs and provide the development of a

learner-centered classroom." The design methodology strengthening the overall course design in assessing learners' competencies.

The rationale behind creating the multiple-choice quiz is to provide additional opportunities to assess students by utilizing a formative approach that is aligned with the course objectives. The goal is to create a valid measurement of the learner's knowledge. In order to accomplish this construct, the assessment is centered around constructivist theory - "the belief that learning occurs as learners are actively involved in a process of meaning and knowledge opposed to passively receiving information" (Bhattacharjee, 2015, p. 67). Additionally, the design of the quiz is to test based on learner's actual knowledge of student's higher-order thinking. In this approach, there are three design principles considered as valid concepts. First, the selection of multiple-choice format as formative assessment is to give students feedback as they progress the course. Second, the assessment is design as interactive model that provides students with immediately feedback upon selecting the wrong answer. Third, there are accounts that multiple-choice quizzes are a proven an effective way to assess learning (Butler, 2018). In this design construct, this is practical way to gauge student progress and provide a useful self-check method for the instructor. The content of the multiple-choice questions concentrated on creating a fair test of knowledge for students. An example of this aim is to reflect the multiple-choice answers in way that the learner must grasp rock cycle in order to select the correct choice. The following below is an illustration of the arrangement of criteria to formulate the questions:

1. One of the choices are clearly wrong.
2. The correct answer is unambiguously.
3. Answers required a higher-level thinking.
4. No trickery answers.
5. Eliminate guessing by creating unpretentious sentence structure. (Dickinson, 2012)

In sum, the design of multiple-choice quiz is aligned with the course objectives and outcomes. And within this design, an effective assessment is one that also assesses whether the instruction was successful as well.

Synchronous Session

The synchronous session is designed using best practices for online course design that are rooted in constructivist principles. Constructivists believe that the role of the teacher is the facilitator who guides students in constructing their own understanding of course content (Bangert, 2004). This is shown when the synchronous session focuses of discussion between the students for a majority of the course, with the instructor providing minimal direct instruction. Constructivist practices used in this online synchronous session include discussion at the beginning of the session and collaboration during the breakout sessions. Small group, or "breakout sessions" have the same benefits of synchronous meetings (Wang & Cheng, 2009) and research continues to support the idea that small group learning is the most effective learning environment (Woodley, Hernandez, Parra, & Negash, 2017).

Interactive Model

One of the key qualities for assessment of students in online programs, offered by Morgan and O'Reilly as cited in *Assessing the Online Learner* (Palloff & Pratt, 2009) is "[s]ufficient and timely formative assessment[s] . . . [that] occur throughout the course and inform practice" (p. 43). Including the interactive model, after the required readings, but prior to the summative assessment gives students the opportunity to discover for themselves what parts of the Rock Cycle they are having trouble understanding. Palloff and Pratt further indicate that computer generated and scored tests can be used as a "means of providing immediate feedback to learners [with] explanations of incorrect answers" accompanying the responses (p. 45).

Including more information on the process that the students incorrectly identify gives them the opportunity to review that portion of the cycle and figure out where their error is. Once they have a firm understanding of how the rock cycle works, they will then be able to apply that knowledge to the summative assessment.

Summative Assessment

The summative assessment is learner-centered and provides learners with a choice in how they will demonstrate their understanding of the processes that create the three major types of rock. Providing learners with choice in how they will demonstrate their understanding of a concept supports the idea that "knowledge acquisition is a unique experience for each learner" and promotes self-regulation (Bangert, 20014, p. 221)."Threaded discussions foster academic communication and reflection" (Ke & Hoadley, 2009, p. 503) When students provide feedback to their peers, they are interacting with their peers to build a learning community. In addition, peer feedback on this task will increase the learners exposure to the content and allow them to evaluate their own understanding of the course content.

The individual reflection in the project provides students with an opportunity to reflect on their model and internalize what have learned in the unit of instruction (Vonderwall, & Boboc, 2013). In addition to demonstrating their understanding of the course content, students will develop a deeper understanding of the iterative engineering design process and how scientists work to better understand the environment around them.

References

Bangert, A.W. (2004). The seven principles of good practice: A framework for evaluating on-line teaching. *The Internet and Higher Education, 7*. 217-232.

Bhattacharjee, J. (2015). Constructivist approach to learning: An effective approach of teaching learning. *International Research Journal of Interdisciplinary & Multidisciplinary Studies, 1*(6). 65-74. Retrieved from http://oaji.net/articles/2015/1707-1438677336.pdf

Bulter, A. (2018). Multiple-choice testing in education: Are the best practices for assessment also good for learning?. *Journal of Applied Research in Memory and Cognition*, 7(3). 323-331. Retrieved from https://www.sciencedirect.com/science/article/pii/S2211368118301426

Dickinson, M. (2012). *The thing about multiple-choice tests.* Retrieved from https://www.learningsolutionsmag.com/articles/861/the-thing-about-multiple-choice-tests-

Discovery Science Education. (n.d.). *Classifying Rocks*. Retrieved from https://discoveryeducation.com

Ke, F., & Hoadley, C. (2009). Evaluating Online Learning Communities. *Educational Technology Research and Development, 57*(4). 487-510.

Palloff, R. M., Pratt, K., (2009). *Assessing the online learner: resources and strategies for faculty*. San Francisco: Jossey-Bass.

Tennessee Department of Education. (2018a). *TN science standards reference.* Retrieved from https://www.tn.gov/content/dam/tn/education/standards/sci/sci_standards_reference.pdf

Tennessee Department of Education. (2018b). *State report card.* Retrieved from https://www.tn.gov/education/data/report-card.html

Wang, Y., & Cheng, N.S. (2009). Criteria for evaluating synchronous learning management systems: Arguments from the distance language classroom. *Computer Assisted Language Learning, 22*(1). 1-18.

Woodley, X., Hernandez, C., Parra J., & Negash, B. (2017). Celebrating difference: Best practices in culturally responsive teaching online. *TechTrends, 61*. https://doi.org/10.1007/s11528-017-0207-z

Vonderwall, S.K., & Boboc, M. (2013). Promoting formative assessment in online teaching and learning. *TechTrends, 57*(4). 22-27.

Appendices
Appendix A
Classifying Rocks Quiz

Purpose: The purpose of this formative assessment / objective is to understand the student's process by providing relevant feedback to the learners and to close gaps, if any, in their knowledge between what they know and what they need to know.

1. Which are examples of minerals found in rocks ? 10 Points
   - ❑ Quartz
   - ❑ Zinc
   - ❑ Pyroxenes
   - ❑ Magma

2. What plays a role in rock formation? 10 Points
   - ❑ Pressure & Water
   - ❑ Cold & Heat
   - ❑ Water & Heat
   - ❑ Heat & Pressure

3. Rocks are classified in three main categories: 10 Points
   - ❑ Extrusive, Intrusive, Sediment
   - ❑ Granite, Marble, Sandstone
   - ❑ Igneous, Sedimentary, Metamorphic
   - ❑ Stalactites, Stalagmites, Sedimentary

4. Geologist are scientist who study... 10 Points
   - ❑ Igneous, Sedimentary, Metamorphic
   - ❑ Earth, Atmosphere, Crust
   - ❑ Trees, Rocks, Water
   - ❑ History, Processes, Materials

5. Igneous rocks are formed from... 10 Points
   - ❑ Minerals or Lava
   - ❑ Hot molten rock or Magma

- ❑ Obsidian or Crystals
- ❑ Water or Ice

6. Sedimentary rocks exist due to... 10 Points

- ❑ Cold, Heat, Salt
- ❑ Pressure, Gravity, Lava
- ❑ Heat, Water, Ice
- ❑ Ice, Water, Coal

7. Metamorphic rocks are formed when... 10 Points

- ❑ Magma loses heat, cools, and crystallizes
- ❑ Lava is less dense than surrounding solid rock
- ❑ Heat and pressure in earth's crust change existing rocks
- ❑ All the above

8. An example of metamorphic rock is? 10 Points

- ❑ Marble
- ❑ Basalt
- ❑ Sandstone
- ❑ Pumice

9. Gneiss is a type of metamorphic rock with folded look to it. 10 Points

- ❑ True
- ❑ False

10. Stalagmites are an example of igneous rock. 10 Points

- ❑ True
- ❑ False

Bonus question: Describe which rocks are most likely to be from a lava flow from a volcano?
+5 Points
[Short Answer]

Appendix B
Rock Cycle Model Assignment and Rubric

Learning Objective:
Identify (name) and model the processes and forces that change one rock type into another.

Part 1: Model Design
Due Tuesday

Using materials that are safe and available to you, create a model that represents the rock cycle, highlighting the processes that lead to the creation of the three major types of rock. Examples of models include physical models, diagrams, simulations, replicas, and analogies. Speak to an adult in your home about your plans before creating your model. If you are not sure if your idea for this assignment is a model, ask your instructor.

Part 2: Discussion
Initial Post Due Tuesday, Responses to Peers due Thursday

In your initial post, share your model with your peers along with a description of your model with your peers in the discussion board titled "Rock Cycle Model." If your model is not digital, you must take a photo and upload it on "files" in your account to embed it into your initial discussion post. If your product is digital, like a simulation, you can upload your file using the method above or you can share a hyperlink to the model you created.

You will respond to your assigned peers using the peer rotation guide by Thursday at the end of the day. In your responses, you will provide your peer with 3 glows (strengths of their model) and 1 grow (weakness in the model). Remember to use the peer critique guidelines when planning your peer responses.

Part 3: Individual Reflection
Due Friday

Write a maximum of a one-page reflection of this task. In the first paragraph, describe what you have learned in this unit. In the second paragraph, describe your model. In the third paragraph, discuss the feedback you received about the strengths and the weaknesses of your model. In the fourth paragraph, describe how you would improve your model. Submit your assignment on the assignment titled, "Rock Cycle Reflection"

[rubric on next page]

Rubric

Concerns Opportunities for Improvement	**Criteria** Standards for this Performance	**Advanced** Evidence of exceeding expectations.
	Student creates a model that attempts to describe the three major types of rock and the geological processes that lead to their development	
	Student shares a photo of their model or their digital model with their peers along with a description of how their model represents the scientific phenomena.	
	Student responds to their assigned peers' initial post and identifies 3 strengths and 1 weakness of each model.	
	Student submits a reflection that: ● Describes what they have learned in the unit of instruction ● Describes their model ● Describes the strengths and weaknesses of their own model ● Reflects on how the model can be improved	