Title: A Puzzle Assembled

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Abstract

This project is curriculum and learning plans for middle school Earth Systems Science. Nine units, comprising a year-long course of study, contain standards, essential and instructional questions, learning goals, and extensive daily learning plans. Strategies employed in the learning plans are research-based strategies to increase student learning.

Curriculum

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Introduction

"After all, tomorrow is another day" (Mitchell 733). These famous last words of Scarlett O'Hara at the very end of the epic novel *Gone With the Wind* hold double meaning for us, as teachers. Certainly these words offer sage advice on how to deal with the daily setbacks that come with the grind of teaching – for we need to learn to step back from reactionary actions. However, the manner in which these words were written serve as a metaphor for both *what* we teach and the *manner* in which we teach, both things that we need to consider as we approach curriculum design.

Margaret Mitchell wrote the last chapter of *Gone With the Wind* first (Lambert). Before Mitchell penned anything else in the novel, she knew that Scarlett would end the novel in despair, with only her grim determination to help her face another day (Mitchell 733). Teachers, too, as we write curriculum in the current educational culture, need to begin with the end in mind. We should not step in a classroom to teach a lesson unless we have a solid grasp of what we expect students to know, understand, and be able to do by the end of the lesson, the unit, and the course. We must be clear as to what we expect student outcomes to be, both for the students and for ourselves.

It is only then, with the end in mind, that we can begin to focus on the steps that will help our students reach learning goals. Just as Mitchell went back and filled in the elements of the plot that would lead to the Scarlett's ending, so we must go back and fill

in the elements of the curriculum that will enable students to reach a deeper understanding of course content.

Standards

One of the assumptions about curriculum development is that it begins as a collaborative effort, driven by leaders in a school community (DuFour 156). This collaboration leads to a set of standards that guide the development of the written curriculum. States in many cases have taken away from local communities the roll of collaborative development of standards, often considering input from a wider variety of sources than a small, individual school district could consider. In the state of Colorado in science, this means the Colorado State Standards, newly revised and adopted for 2010. The applicable state standards Grade Level Expectations for Earth Systems Science, as released by the Colorado Department of Education (CDE) are reproduced following.

Sixth Grade

1. Complex interrelationships exist between Earth's structure and natural processes that over time are both constructive and destructive.
2. Water on Earth is distributed and circulated through oceans, glaciers, rivers, ground water, and the atmosphere.

3. Earth's natural resources provide the foundation for human society's physical needs. Many natural resources are nonrenewable on human timescales, while others can be renewed or recycled.

Seventh Grade

1. Major geologic events such as earthquakes, volcanic eruptions, mid-ocean ridges, and mountain formation are associated with plate boundaries and attributed to plate motions.
2. Geologic time, history, and changing life forms are indicated by fossils and successive sedimentation, folding, faulting, and uplifting of layers of sedimentary rock.

Eighth Grade

1. Weather is a result of complex interactions of Earth's atmosphere, land and water, [sic] that are driven by energy from the sun, and can be predicted and described through complex models.
2. Earth has a variety of climates defined by average temperature, precipitation, humidity, air pressure, and wind that have changed over time in a particular location.
3. The solar system is comprised of various objects that orbit the Sun and are classified based on their characteristics.

4. The relative positions and motions of Earth , Moon, and Sun can be used to explain observable effects such as seasons, eclipses, and Moon phases.

Defining and Limiting the Curriculum

Once a state or district identifies and adopts a set of standards, the province of curriculum development around specific content becomes the province of the teacher (DuFour 157). We must ask: What is curriculum – that thing that defines for us and students what students should know, understand, and be able to do?

A concise (and non-verbose) definition of curriculum is "the specific blueprint for learning that is derived from desired results … curriculum takes content (from external standards and local goals) and shapes it into a plan for how to conduct effective and engaging teaching and learning" (Wiggins 6-7). This means that curriculum has become more than a list of topics that are to be "covered," a word that has become almost four-letter in education. Curriculum is now a set of expected outcomes and a map of how to get those expected outcomes. A good curriculum includes guides for instruction, activities, and both formative and summative assessments.

A very broad base of knowledge is embedded in the Colorado State Standards, the kind of base that Wiggins and McTighe refer to as the Goldilocks problem of being

too big – impossible to teach in the time that teachers have (61). One of the important tasks we take on as teachers writing curriculum is sifting through the larger body of knowledge and deciding what *not* to teach. I think this is difficult for us, and because we want to give students all the knowledge that there is, we continually add to the content without making room for the additions. Because "schools have no procedure for systematically abandoning anything," (DuFour 165) teachers writing curriculum have the unenviable task of red-lining insignificant information to make room for significant learning.

We must throw out the bathwater and keep the baby; we must choose what to teach, the materials that will be needed for students to achieve learning, and the methods that will best facilitate learning for students (Parkay 6). I am reminded of the last classroom I inherited. Every textbook, every test, every handout, every material had been preserved. It was a case of not only *not* throwing out the bathwater, but of *bottling* it. As I write curriculum now, I have to remind myself that there is limited storage space, both literally (in the classroom) and figuratively (in a student mind).

Essential Questions

As teachers, once we have dissected the standards and limited the curriculum by eliminating non-essential materials, what next? We must take the essential material left

and formulate essential questions that will be the central questions that students will be working to answer in an instructional unit. These essential questions come in two scopes: overarching and topical (Wiggins 342).

Heidi Jacobs states that essential questions should be understandable by students, broad, substantial, realistic given time constraints, sequenced logically, should not be repetitious, and should be posted in the classroom (30-32). The best essential questions get to the essence of the content and lead to student generated questions (Wiggins 107). The best sets of essential questions for a unit of study include both topical questions – questions that have a right answer, and overarching questions – questions that encourage students to think. They also include open questions – questions that engage students creatively, and guiding questions – questions that lead to a particular conclusion (115-117).

In the curriculum format specified by Trinidad School District, these essential questions are divided into two categories: the "Essential Questions" ask open, overarching questions directly related to grade level expectations, and the "Instructional Questions" are more topical and guiding in nature. The model for curriculum in Trinidad School District is based in large part on the book Understanding by Design. The theme of Understanding by Design is that "backward is best" (Wiggins 14), and that leads to specific steps in writing curriculum to fit the District's model:

1. Identify desired results.

2. Determine acceptable evidence.

3. Plan learning experiences and instruction. (18)

Identifying Desired Results

When teachers identify desired results, we should ask what the students should know, understand, and be able to do at the end of an instructional unit. This practice involves asking what learning students should retain after the unit is completed (Wiggins 30), and asking what will demonstrate understanding after the unit is completed (DuFour 168).

"Curriculum and instruction are not separate, mutually exclusive elements of teaching; they are connected" (Parkay 271). This idea means that the statements of what students should learn is directly related to the activities and instruction that will accomplish unit learning goals. Even when what students should know, understand, and be able to do may seem the same, they are actually different, and may lead to different instructional strategies and assessments.

For example, the learning goal "Students will know the names of the planets in order from the smallest to the largest" may lead to a learning activity of writing a mnemonic device to aid recall. The learning goal "Students will understand that earth is small in the scope of the Solar System" may lead to a learning activity that has students

mathematically comparing the diameter of the planets and Sun to the diameter of Earth. The learning goal "Students will be able to model the proportions of the planets using athletic equipment (different-sized balls)" may lead to a learning activity that has students creating a scale model using familiar objects.

Each of these goals is related to Colorado Standards Eighth Grade Level Expectation Three, that "the solar system is comprised of various objects that orbit the Sun and are classified based on their characteristics," but each is also unique in the learning that will need to be accomplished by the student.

Consider an additional example. The learning goal "Students will know how water is cycled on Earth" may lead to an activity of creating a poster of the steps of the water cycle. The learning goal "Students will understand that changes in the water cycle in an area can impact that area negatively" may lead to research and writing of an essay about local drought or flooding. The learning goal "Students will be able to show the role of condensation and evaporation in the water cycle" may lead to an activity of converting water from one state to another in a laboratory exercise or demonstration and discussing the results in a lab report.

Each of these goals is related to Colorado Standards Sixth Grade Level Expectation Two, that "Water on Earth is distributed and circulated through oceans, glaciers, rivers, ground water, and the atmosphere" but each is also unique in the learning that will need to be accomplished by the student.

Determining Acceptable Evidence

Once the desired results are identified, we ask the question "How will we know that they know it?" Various kinds of assessments can indicate that learning has occurred. The word assessment, for most people, brings back the nerves and sweaty palms of the test that the teacher wrote, the students took, and the teacher graded. It was one-size fits all, and if you failed, you were S.O.L. (Student Out of Luck). Assessments, however, have become more than the unit test. Assessments follow one of two forks in the road: formative and summative, and both paths should lead to the same destination of accurate data about a student's learning progress.

Summative assessments may include traditional tests, but they should also include what are called "authentic assessments," those assessments that require students to solve large problems or complete project-like tasks that demonstrate understanding of one or more essential questions (Parkay 280; Wiggins 154). Other summative assessments include student portfolios which focus on a student's best work, peer and self assessments, and teacher observations. Good summative assessments will include one or more of the six facets of explanation, interpretation, application, perspective, empathy, and self-knowledge (Wiggins 163-166).

Although summative assessments, those that come at the end of a unit of study, or those periodically given standardized tests are powerful for answering the question

of what students *have* learned, it is in the other fork of assessment, formative assessments, that monitoring of learning is taking place, and it is those formative assessments that give us the real-time data (as opposed to standardized summative assessments, which come too late to genuinely affect student learning) to alter instruction. Formative assessments assess students *for* learning.

Formative assessments provide immediate feedback about what students have or have not learned during a lesson. They are used during instruction so that instruction can be adjusted (Popham 5). Some of these assessments are informal and some are formal, but both are intended to provide evidence of mastery (6). Unfortunately, there is a lot of confusion among us teachers about what formative assessment is. So here it is in a nutshell: it's not the assessment itself, it's what you do with it (Chappuis 15).

What happens when we consciously incorporate formative assessments into our classrooms (we all use some formative assessment)? In the Armstrong School District in Pennsylvania, the results of a three-year study showed that students took more control of their learning, had increased achievement as measured by summative assessments, and were more engaged in the classroom (Brookhart 54). Teachers in the Armstrong School District developed good practices over a period of years:

1. Clearly communicate to students the learning target.

2. Give descriptive feedback that is tied to the learning target.

3. Give guidance that helps students realize they can do what they need to do.

4. Raise the quality of classroom discourse. (56-57)

Whatever assessments are used throughout a unit, it is the collected evidence from assessments that should be used to evaluate what learning has taken place (Wiggins 169). Without assessment, we will not be able to tell what our students know and don't know. The use of formative assessments is an instructional strategy that should be part of any learning plan for a unit.

Planning Learning Experiences and Instruction

If it seems that the planning of instruction comes late in the curriculum writing process, well, it does. Instruction is an integral part of the curriculum development process, but we can plan effective instruction only when we know what it is we want students to know, understand, and be able to do, and when we understand the tools of assessment – a learning process for us that should never end. "This is all quite logical when you come to understand it, but 'backward' from the perspective of much habit and tradition in our field" (Wiggins 19).

One of the most important things to get away from in writing curriculum is the use of the textbook *as* the curriculum. The textbook should just be one resource among many (Wiggins 232). Avoiding the pitfall of using the textbook as a blueprint for instruction allows for richer and more robust learning to take place for students. The

blueprint is more than a chapter and a page, it is a set of instructional goals, activities, and strategies for reaching those goals through the activities.

The most definitive book for research-based instructional strategies is *Classroom Instruction That Works* by Robert Marzano, Debra Pickering, and Jane Pollock. I personally have attended three workshops and received two copies of the book in the last five years (a friend of mine actually has three copies). That may take a little wind out of the sails of the cover's claim that there are over a million copies sold, but only a little. There is common sense in the strategies categorized and described in the book, and the strategies are supported by research studies.

According to Marzano, the most effective instructional strategy category, in terms of student gains, is identifying similarities and differences (Marzano 7). This includes guided and independent identification using graphic organizers or through comparing, classifying, creating metaphors, and creating analogies (15-16). In a science classroom, an activity using this strategy might include biographies of three astronomers and an assignment to create a Venn diagram comparing the contributions to astronomy.

The second most effective strategy category for learning is summarizing and note taking. In a science classroom, this might include reading articles, highlighting the main ideas, and writing a summary. Marzano includes formats for summarization and four generalizations about note taking: that verbatim is the least effective, notes are never

finished, notes should help students review for tests, and the more notes the better (43-44).

The fourth category of instructional strategies is homework and practice. The most important generalization, according to the research, about homework and practice is that homework should be relevant and commented on and that practice should be focused and increase understanding (Marzano 60-71). The fact that homework should get feedback relates directly to the third category of instructional strategies – reinforcing effort and providing recognition. This should include genuine praise and should teach the idea that "the harder you try, the more successful you are" (59). In a science classroom, this might include a discussion activity in which small groups brainstorm, decide on a best idea, place that idea on chart paper, and post the chart in the classroom. It might look like a comment such as "Michael, thank you for your hard work in summarizing what makes a rock sedimentary. Would you like to put 'sedimentary' on the unit word wall?" Note that this comment in no way implies that Michael was right, but it does praise the hard work.

The fifth category of instructional strategies is nonlinguistic representations. This category includes graphic organizers such as time-sequence, cause-effect, concept maps, and other diagrams (Marzano 75-83). These strategies might be used in terms of a Venn diagram to identify similarities and differences, or pictures to aid in defining terms in

note taking. This strategy is particularly useful in science, where so much can be drawn and arranged into charts or graphs.

The sixth category, cooperative learning (Marzano 7), has gotten a bad rap in teaching. It has become a catch-all term for grouping. However, cooperative learning must have varied grouping, small grouping, and not be overused to be successful (87-88). In a science classroom, this might require students to draw cards from a deck to determine both group and role within the group.

The seventh category, setting objectives and providing feedback, includes student goals that are narrow but not too specific and are personalized from the teacher's goals (Marzano 94). The feedback should be "corrective," timely, specific, and at least in part provided by the student (97-99). One of the most effective ways to do this in a classroom is to use rubrics. Student self-evaluation of learning should certainly be a part of assessments.

The eighth category, generating and testing hypotheses, is a natural part of a science classroom. The final category, cues, questions, and advance organizers, includes pretesting, asking higher level thinking questions, using longer wait times before student answers are accepted, and front loading (Marzano 112-114). In a science classroom, this might include a homework assignment to brainstorm a list of sources of water pollution, ranking the sources, and writing a justification for the source receiving

the lowest ranking. This frontloads, pretests, organizes, utilizes a high level question (and is an example of an appropriate homework assignment).

Marcia Tate's *Worksheets Don't Grow Dendrites* explains twenty instructional strategies with more specificity. Each strategy includes research rationale, explanations, and sample activities across a variety of subjects. The twenty instructional strategies are brainstorming and discussion; drawing and artwork; field trips; games; graphic organizers, semantic maps, and word webs; humor; manipulatives, experiments, labs, and models; metaphors, analogies, and similes; mnemonic devices; movement; music, rhythm, rhyme, and rap; project-based and problem-based instruction; reciprocal teaching and cooperative learning; role playing, drama, pantomimes, charades; storytelling; technology; visualization and guided imagery; visuals; work study and apprenticeships; and writing and journals. Most of these strategies fall easily into one category from Marzano's research, and some fall into more than one.

Whatever resource we, as teachers, use to find instructional strategies, it is up to us to learn how to use them, to make them part of our every day teaching methods, and to evaluate which strategies apply in any learning activity.

Looking Forward

Is it ironic that to look forward teachers must first look backward? Begin with the end in mind? The truth is that as society (and the learners within it) evolve, teaching must change, too. That change begins with the revision of curriculum from the traditional to the transformed, from rote to revised, from unyielding to uncovering.

The change does not end there, though. "Individuals and organizations have an amazing capacity to maintain their current beliefs and practices in the face of massive, well-intentioned efforts to change them" (Sparks 48). As teachers, we must develop new habits of mind and habits of practice. We must work at changing, because change is challenging, and it is easy to slip into comfortable practices, even if they are ineffective.

If we in the teaching profession want to improve instruction, we must take the time to learn what will work best for students, rather than what works best for us. Then we must go one step further, and implement what research works. Knowing what works is not enough, but a good curriculum is an excellent place to begin the change. A good curriculum clearly identifies what the overarching and instructionally specific learning goals are for an instructional unit, identifies how we will know that students have learned what we want them to learn, and has a plan for student learning that

includes appropriate and research-based instructional strategies. Certainly, this is what I am keeping in mind as I write curriculum for middle school Earth Systems Science.

However, even when I complete the curriculum, it will not be truly finished. Curriculum is never "done." It will evolve with every teacher that uses it, as it should, revised for content, pacing, and methodology. As Scarlett would say, after all, tomorrow *is* another day.

Works Cited

Brookhart, Susan et al. "Formative Assessment That Empowers." *Educational Leadership* 66.3 (2008): 52-57.

Chappuis, Stephen and Jan. "The Best Value in Formative Assessment." *Educational Leadership* 65.4 (2007-2008): 14-18.

Colorado Department of Education. *Colorado Academic Standards*. 10 December 2009: 23 April 2010 <http://www.cde.state.co.us/cdeassess/UAS/AdoptedAcademicStandards/Science_Standards_Adopted_12.10.09.pdfp> 90-98.

DuFour, Richard and Robert Eaker. *Professional Learning Communities at Work*. Bloomington, Indiana: National Educational Service, 1998.

Jacobs, Heidi. *Mapping the Big Picture*. Alexandria, Virginia: Association for Supervision and Curriculum Development, 1997.

Lambert, Gavin. "The Making of Gone With the Wind." The Atlantic Monthly Februray 1973: 12 April 2010 <http://www.theatlantic.com/past/docs/issues/73feb/gone.htm>.

Marzano, Robert et al. Classroom Instruction that Works. Alexandria, Virginia: Association for Supervision and Curriculum Development; 2001.

Mitchell, Margaret. *Gone With the Wind*. New York: Macmillan, 1964.

Parkay, Forrest et al. *Curriculum Planning*. Boston: Pearson, 2006.

Popham, W. James. *Transformative Assessment*. Alexandria, Virginia: Association for Supervision and Curriculum Development, 2008.

Sparks, Dennis. "Reach for the Heart as Well as the Mind." *Journal For Staff Development* 30.1 (Winter 2009) : 48-54.

Tate, Marcia L. *Worksheets Don't Grow Dendrites: 20 Instructional Strategies that Engage the Brain*. Thousand Oaks, California: Corwin Press, Inc., 2003.

Wiggins, Grant and Jay McTighe. *Understanding by Design*. Upper Saddle River, New Jersey: Pearson, 2006.

Pre-tests are fun to evaluate. Some questions, like "List the planets in order from the Sun outward" and "Number the planets from the smallest to the largest, starting with a 1 for the smallest" are fairly straightforward. Other questions provide insight to the thinking of students. Below are a few of my favorites, unedited.

In response to the questions "How far away is the Moon from Earth? How far away is Mars from Earth?":

- 3 Million miles – moon – Earth 3 billion miles – Mars – Earth
- Moon – 1,540,789 miles away Mars – 1,080 light years away
- 200 miles moon 3,000,000 miles Mars
- moon = 4,000 miles mars 4,329 miles
- Earth to Mars – 6 years away
- 20 meters away Mars is 510 meters away
- not very far

Clearly, I had some work to do with units of measurement and proportional distances. Students may always use diagrams to show understanding, but no students chose to use diagrams on this question, which surprised me. Although these answers are amusing (and I did chuckle when I read them), they definitely provide more information to me than a multiple choice item would provide.

The answers to another question on the pre-test, "What can happen to a star when it gets old?" showed me that there were some misconceptions that needed cleared up. An answer that a star will fall to Earth was a recurring theme, and occurred on 22% of pretests. That's a big misconception, and clearly indicated to me that most students did not associate "star" with "Sun" but rather with "meteor."

When I asked students what shape an orbit of a planet, comet, or asteroid takes on a formative assessment, three-fourths of the students responded that the shape was a circle. This is another example of a misconception that I might have missed without pre-

assessing, whether the pre-assessment was oral or written. Some students responded with egg-shaped or oval, but no students knew what an ellipse was.

Students pre-tested over eight learning targets on a short-answer pretest given before the start of the unit "The Solar System." Students completed unit and took short-answer post-test over same eight learning targets plus additional learning targets. Student mastery was measured on a rubric scale of 1 to 4:

1 Unsatisfactory

2 Partially Proficient

3 Proficient

4 Advanced

On two of the additional learning targets assessed, students either had complete mastery or no mastery. One additional learning target was assessed that is not included on the summary spreadsheet – all students had Advanced Mastery (which is not surprising as the question was "Why is it important to track the orbits of comets and asteroids?" I did not expect any students to miss the question as students were fascinated with watching asteroid orbits that would come close to Earth.

Some students were either no available for pre-testing due to suspensions or protracted illness. Two pretests were discarded as students were sharing answers. Two pretests were not turned in – students declined to provide a reason when confronted with the missing status of the pretest. Sigh – they are eleven twelve years old and very self-conscious of performance. Both of these students showed proficient mastery on the post-test and are generally high achievers. I hypothesize that the students did not want me to see that they did not know the material when pre-tested.

A copy machine error that was not noted until two days after the pretest is why the last four targets did not have pre-test data, but there is enough data to analyze to

gauge the effectiveness of the unit as planned. I have revised the unit as a result of post-test data. Of particular concern was the inability of students to name additional characteristics of the planets beyond their order, size, and classification. This element of the unit plan underwent the most revision. The activities associated with this learning target are more age appropriate and student-guided.

Overall, on the learning targets assessed on both the pre-test and post-test, student achievement increased from an average score of 1.5 – between Unsatisfactory and Partially Proficient – to Proficient. I was very pleased. The majority of students had no idea what a terrestrial planet and a gas giant planet were when the unit began and also thought that orbits were perfectly circular, so I believe that the overall average would be higher if I had been able to include that data.

In only two cases did students backslide on a learning target. There were several instances of student's not increasing knowledge on an individual learning target, but all students showed average improvement. The smallest increase in student achievement was reflected by pre-test to post-test improvement of 0.73, but this was atypical, as the average growth was reflected as an improvement of 1.51.

At the end of the objective post-test, I asked students to "Tell me about something you learned in this unit that is not on the test." I will never again give a test without this question. The answers reinforced the notion that we should be very careful of what we say, because students are like sponges. They really do absorb the strangest things. I think it is appropriate to end this reflection with a few of those responses. Again, no editing has taken place.

- One teaspoon of a netron star weighs 1 billion tons.
- A dog was the first living thing in space.
- That black holes gravity is so great that when something gets close to it the gravity then pulls it in and smashed it to the size of an atom.

- I learned that there is no life on any other planist (so fare) and that black holes are not holes in space. galaxies are realy fare away and that Pluto is not a planet and Jupiter has a lot of moons and that Infered telescopes see threw the dust and stuf in the outmost space.
- I also learned that Galileo got house arrest the rest of his life!
- I learned when big stars die they like explode called SuperNova.
- I learned why Pluto is considered a dwarf planet.
- I learned (to scale, on the football field) the closest star would be in Wyoming.
- I learned that we crashed a satelite into the moon to see if there was water or ice on it. Sure enough there was ice on it!
- One thing I learned was really cool. I learned there was a black hole in the middle of our galaxy.
- One thing that I learned that is not on this test is how planets form. They form when debris in space collides and gets its own orbit and gravitational pull.

… and these from sixth graders!

Pre- and Post Test Data "The Solar System" Unit C. Gongaware

		List the planets in order from the Sun out.		List the planets in order from smallest to largest.		assessed separately. Some assignments were not turned in.		Explain how a telescope works.		Know different types of telescopes.		Compare comets and asteroids.		Understand the contributions of Copernicus, Galileo, or Kepler.		Explain what will happen to the Sun as it ages.				Identify shape of orbit.	Identify gas giants and terrestrial planets.	Identify additional planetary characteristics.
Student		Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test Average	Post-Test Average			
A		4	4	1	4	1	3	1	3	1	4	1	4	1	4	2	4	1.5	3.75	Y	Y	4
B		4	3	1	4	1	2	1	2	1	2	1	2	1	2	1	2	1.38	2.38	Y	Y	1
C*		2	4	1	4	1	2	1	2	1	3	1	2	1	2	2	2	1.25	2.63	Y	N	1
D		4	4	2	4	1	3	4	4	1	4	2	4	2	4	1	2	2.13	3.63	Y	Y	3
E		4	4	1	4	1	2	1	3	1	4	1	3	1	1	1	3	1.38	3	Y	Y	2
F		2	4	1	4	1		1	3	1	3	1	2	1	4	1	4	1.13	3.43	Y	Y	2
G		2	4	1	4	1		2	4	1	3	2	2	1	2	1	4	1.38	3.29	Y	Y	1
H		4	3	1	4	1	1	1	3	1	3	1	1	1	2	1	3	1.38	2.5	N	N	1
I		2	4	1	4	1	3	1	4	1	4	1	2	2	4	1	1	1.25	3.25	Y	Y	3

Pre- and Post Test Data "The Solar System" Unit C. Gongaware

J		4	4	1	4	1		2	2	1	2	2	4	1	3	2	2	1.75	3	Y	Y	1
K*		1	4	1	4	1		1	4	1	3	2	4	1	4	1	2	1.13	3.57	Y	Y	2
L		4	4	1	4	1	1	2	3	1	4	1	2	1	4	2	2	1.63	3	Y	N	1
M		3	4	2	3	1	3	1	4	1	2	2	4	1	4	2	4	1.63	3.5	Y	Y	4
N		2	3	1	3	2	3	3	3	1	4	2	4	3	4	4	4	2.25	3.5	Y	Y	2
O		1	4	1	4	1		1	2	1	2	1	3	1	3	2	3	1.13	3	Y	Y	2
P		2	4	2	4	1		1	2	1	3	1	1	1	1	1	3	1.25	2.57	N	Y	3
Q		4	4	2	4	1	4	1	4	1	4	1	4	1	4	2	3	1.63	3.88	Y	Y	3
R		1	4	1	4	1	3	1	2	1	3	2	2	4	4	1	4	1.5	3.25	Y	Y	4
S		1	4	1	4	1	2	2	3	1	4	3	4	2	4	2	2	1.63	3.38	Y	Y	3
T		1	3	1	1	1		1	1	1	1	1	2	1	2	2	3	1.13	1.86	Y	N	1
U		4	4	1	4	1	2	1	3	1	4	1	3	4	4	1	3	1.75	3.38	Y	Y	2
V		4	4	3	4	1	3	1	1	1	3	1	1	1	4	1	2	1.63	2.75	Y	Y	2
W		3	4	3	4	1	3	1	3	1	3	1	3	1	2	1	4	1.5	3.25	Y	Y	3
X		4	4	2	4	3	3	2	3	1	4	1	3	1	4	2	4	2	3.63	Y	Y	2
Y		4	4	1	4	1	3	1	2	1	2	2	3	1	4	1	2	1.5	3	Y	Y	2
Z		2	4	1	4	2	2	2	3	1	4	2	2	1	4	2	3	1.63	3.25	Y	Y	2
Aa		2	4	1	4	1		1	2	1	1	1	1	1	1	1	2	1.13	2.14	Y	Y	1
Bb		3	4	1	4	1		1	1	1	2	1	2	1	3	1	1	1.25	2.43	N	Y	2
Cc		4	4	1	4	1	2	1	1	1	1	1	1	1	1	1	2	1.38	2	N	Y	1
Dd*		1	4	1	4	1		1	2	1	4	2	2	1	3	1	2	1.13	3	N	Y	2
Ee		4	4	2	4	3	3	1	2	1	4	1	1	1	4	1	3	1.75	3.13	Y	Y	2

Pre- and Post Test Data "The Solar System" Unit C. Gongaware

Ff		2	4	1	4	1	3	1	3	1	2	1	2	1	1	1	2	1.13	2.63	N	Y	2
Gg		3	3	1	4	2	2	1	2	1	2	3	3	1	3	1	3	1.63	2.75	N	Y	2
Hh		4	4	1	4	1	3	2	3	1	3	2	4	1	3	1	2	1.63	3.25	Y	Y	2
Ii		4	4	2	4	1	3	2	2	1	4	2	4	4	4	2	4	2.25	3.63	Y	Y	3
Jj		2	4	1	4	1	1	2	2	1	2	1	1	1	4	1	2	1.25	2.5	N	Y	2
Kk		3	3	1	1	1		2	2	1	2	1	2	1	2	2	3	1.5	2.14	Y	N	1
Ll		4	4	3	4	1	3	2	4	1	4	2	4	1	4	3	4	2.13	3.88	Y	Y	3
Mm		4	4	3	4	2		1	3	2	4	1	2	1	2	1	3	1.88	3.14	Y	Y	2
Nn		4	4	3	4	3	4	1	2	1	4	1	4	1	4	2	4	2	3.75	Y	Y	2
Oo		3	4	1	4	1		1	3	1	2	2	2	1	4	2	2	1.5	3	Y	Y	3
Pp		4	4	1	4	2		1	3	1	3	2	4	1	2	1	4	1.63	3.43	Y	Y	2
Qq		3	4	2	2	1		1	2	1	3	1	2	1	4	1	2	1.38	2.71	Y	N	1
Rr		1	3	1	4	1		1	2	1	2	1	1	1	1	2	4	1.13	2.43	Y	Y	2
Ss		2	4	1	4	2		1	2	1	1	1	2	1	3	1	4	1.25	2.86	Y	N	1
Tt		2	4	1	4	1	2	1	2	1	2	2	3	1	4	1	2	1.25	2.88	Y	Y	2
Uu		1	4	1	4	1		1	2	1	2	1	1	1	1	1	3	1	2.43	Y	N	1
Averages		2.83	3.85	1.38	3.79	1.26	2.55	1.34	2.55	1.02	2.89	1.43	2.53	1.3	3.02	1.45	2.83	1.5	3.01			2.04
																				83%	83%	

* Denotes student whose post-test data reflects required learning accomodations. Mastery

Vv	^		4		4		3		2		4		3		3		4		3.38	Y	Y	1
Ww	^		4		4				2		4		2		2		4		3.14	Y	Y	1

Pre- and Post Test Data "The Solar System" Unit C. Gongaware

Xx	^		4		4		3		4		2		2		4		3		3.25	Y	Y	1
Yy	^		4		3				2		3		1		4		3		2.86	Y	Y	3
Zz	^		4		4		3		4		3		3		4		3		3.5	Y	Y	3
AA	^		4		4				2		2		1		1		1		2.14	Y	Y	1
BB	^		4		4				3		3		2		1		3		2.86	Y	Y	2

^ Denotes student whose pre-test data was compromised or not collected.

1 means Unsatisfactory Mastery.

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Student		List the planets in order from the Sun out.		List the planets in order from smallest to largest.		Understand distances in space. Objective assessed separately. Some assignments were not turned in.		Explain how a telescope works.		Know different types of telescopes.		Compare comets and asteroids.		Understand the contributions of Copernicus, Galileo, or Kepler.		Explain what will happen to the Sun as it ages.		Pre-Test Average	Post-Test Average	Identify shape of orbit.	Identify gas giants and terrestrial planets.	Identify additional planetary characteristics.
		Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test					
A		4	4	1	4	1	3	1	3	1	4	1	4	1	4	2	4	1.5	3.75	Y	Y	4
B		4	3	1	4	1	2	1	2	1	2	1	2	1	2	1	2	1.38	2.38	Y	Y	1
C*		2	4	1	4	1	2	1	2	1	3	1	2	1	2	2	2	1.25	2.63	Y	N	1
D		4	4	2	4	1	3	4	4	1	4	2	4	2	4	1	2	2.13	3.63	Y	Y	3
E		4	4	1	4	1	2	1	3	1	4	1	3	1	1	1	3	1.38	3	Y	Y	2
F		2	4	1	4	1		1	3	1	3	1	2	1	4	1	4	1.13	3.43	Y	Y	2
G		2	4	1	4	1		2	4	1	3	2	2	1	2	1	4	1.38	3.29	Y	Y	1
H		4	3	1	4	1	1	1	3	1	3	1	1	1	2	1	3	1.38	2.5	N	N	1
I		2	4	1	4	1	3	1	4	1	4	1	2	2	4	1	1	1.25	3.25	Y	Y	3
J		4	4	1	4	1		2	2	1	2	2	4	1	3	2	2	1.75	3	Y	Y	1
K*		1	4	1	4	1		1	4	1	3	2	4	1	4	1	2	1.13	3.57	Y	Y	2
L		4	4	1	4	1	1	2	3	1	4	1	2	1	4	2	2	1.63	3	Y	N	1
M		3	4	2	3	1	3	1	4	1	2	2	4	1	4	2	4	1.63	3.5	Y	Y	4
N		2	3	1	3	2	3	3	3	1	4	2	4	3	4	4	4	2.25	3.5	Y	Y	2
O		1	4	1	4	1		1	2	1	2	1	3	1	3	2	3	1.13	3	Y	Y	2
P		2	4	2	4	1		1	2	1	3	1	1	1	1	1	3	1.25	2.57	N	Y	3
Q		4	4	2	4	1	4	1	4	1	4	1	4	1	4	2	3	1.63	3.88	Y	Y	3
R		1	4	1	4	1	3	1	2	1	3	2	2	4	4	1	4	1.5	3.25	Y	Y	4
S		1	4	1	4	1	2	2	3	1	4	3	4	2	4	2	2	1.63	3.38	Y	Y	3
T		1	3	1	1	1		1	1	1	1	1	2	1	2	2	3	1.13	1.86	Y	N	1
U		4	4	1	4	1	2	1	3	1	4	1	3	4	4	1	3	1.75	3.38	Y	Y	2
V		4	4	3	4	1	3	1	1	1	3	1	1	1	4	1	2	1.63	2.75	Y	Y	2
W		3	4	3	4	1	3	1	3	1	3	1	3	1	2	1	4	1.5	3.25	Y	Y	3
X		4	4	2	4	3	3	2	3	1	4	1	3	1	4	2	4	2	3.63	Y	Y	2
Y		4	4	1	4	1	3	1	2	1	2	2	3	1	4	1	2	1.5	3	Y	Y	2
Z		2	4	1	4	2	2	2	3	1	4	2	2	1	4	2	3	1.63	3.25	Y	Y	2
Aa		2	4	1	4	1		1	2	1	1	1	1	1	1	1	2	1.13	2.14	Y	Y	1
Bb		3	4	1	4	1		1	1	1	2	1	2	1	3	1	1	1.25	2.43	N	Y	2
Cc		4	4	1	4	1	2	1	1	1	1	1	1	1	1	1	2	1.38	2	N	Y	1
Dd		1	4	1	4	1		1	2	1	4	2	2	1	3	1	2	1.13	3	N	Y	2
Ee		4	4	2	4	3	3	1	2	1	4	1	1	1	4	1	3	1.75	3.13	Y	Y	2
Ff		2	4	1	4	1	3	1	3	1	2	1	2	1	1	1	2	1.13	2.63	N	Y	2
Gg		3	3	1	4	2	2	1	2	1	2	3	3	1	3	1	3	1.63	2.75	N	Y	2
Hh		4	4	1	4	1	3	2	3	1	3	2	4	1	3	1	2	1.63	3.25	Y	Y	2
Ii		4	4	2	4	1	3	2	2	1	4	2	4	4	4	2	4	2.25	3.63	Y	Y	3
Jj		2	4	1	4	1	1	2	2	1	2	1	1	1	4	1	2	1.25	2.5	N	Y	2
Kk*		3	3	1	1	1		2	2	1	2	1	2	1	2	2	3	1.5	2.14	Y	N	1
Ll		4	4	3	4	1	3	2	4	1	4	2	4	1	4	3	4	2.13	3.88	Y	Y	3
Mm		4	4	3	4	2		1	3	2	4	1	2	1	2	1	3	1.88	3.14	Y	Y	2
Nn		4	4	3	4	3	4	1	2	1	4	1	4	1	4	2	4	2	3.75	Y	Y	2
Oo		3	4	1	4	1		1	3	1	2	2	2	1	4	2	2	1.5	3	Y	Y	3
Pp		4	4	1	4	2		1	3	1	3	2	4	1	2	1	4	1.63	3.43	Y	Y	2
Qq		3	4	2	2	1		1	2	1	3	1	2	1	4	1	2	1.38	2.71	Y	N	1
Rr		1	3	1	4	1		1	2	1	2	1	1	1	1	2	4	1.13	2.43	Y	Y	2
Ss		2	4	1	4	2		1	2	1	1	1	2	1	3	1	4	1.25	2.86	Y	N	1
Tt		2	4	1	4	1	2	1	2	1	2	2	3	1	4	1	2	1.25	2.88	Y	Y	2
Uu		1	4	1	4	1		1	2	1	2	1	1	1	1	1	3	1	2.43	Y	N	1
Averages		2.83	3.85	1.38	3.79	1.26	2.55	1.34	2.55	1.02	2.89	1.43	2.53	1.3	3.02	1.45	2.83	1.5	3.01			2.04
																				83%	83%	
Mastery																						
Vv	^		4		4		3		2		4		3		3		4		3.38	Y	Y	1
Ww	^		4		4				2		4		2		2		4		3.14	Y	Y	1
Xx	^		4		4		3		4		2		2		4		3		3.25	Y	Y	1
Yy	^		4		3				2		3		1		4		3		2.86	Y	Y	3
Zz	^		4		4		3		4		3		3		4		3		3.5	Y	Y	3
AA	^		4		4				2		2		1		1		1		2.14	Y	Y	1
BB	^		4		4				3		3		2		1		3		2.86	Y	Y	2

* Denotes student whose post-test data reflects required learning accomodations.

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Unit Name: Climate

Graduate Expectation:

"Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system." (CDE)

Grade Level Expectation:

"Earth has a variety of climates defined by average temperature, precipitation, humidity, air pressure, and wind that have changed over time in a particular location." (CDE)

Essential Question:

- How do we distinguish Earth's various climates and how do those climates change over time?

Instructional Questions:

- What is the difference between climate and weather?
- What evidence exists that climate has changed over long periods of time?
- What characteristics define an area's climate and what are the different kinds of climates?
- How is climate change on Earth the result of human actions?

After Instruction Students Will:

Understand:

- That Earth has different climates
- Opinions vary as to the human contribution to climate change
- That climate change is always happening

Know:

- The difference between climate and weather
- The characteristics of climate regions

Be Able to Do:

- Make judgments and support opinions concerning climate change
- Explain direct and indirect evidence for climate change

Learning Plan (Including Instructional Strategies)

Day 1	
Administer pretest to determine readiness and what students already know.	

Day 2	**Instructional Strategies:** Analogies, Frontloading, Brainstorming, Models, Diagrams, Writing
Ask **"What was your grade on the last assignment? Is that your score for the whole unit? How is the comparison of those scores similar to the comparison between weather and climate?"**	
Have students write an analogy in their notes comparing grades and climate.	
Ask students to read their analogy and explain the relationship.	
Ask **"How would you define climate then?"** Allow students to develop a good definition for climate in their notes. Ask a few students to share. Create a class definition and post it.	Add **climate** to the unit word wall.
Ask students to brainstorm a list of all the things they know about climate. Students should share then in groups of three and come up with three things they would like to know about climate.	Do not allow longer than three minutes for brainstorming.
Ask groups for the things they would like to know about climate one at a time until all ideas have been shared. Post a list in the classroom.	
Hold up a globe. Ask **"If I was going to divide this globe into horizontal slices to represent temperature areas, how should I do it? What could I call those areas?"** Students should do this in their groups.	
When students have completed the task, allow students to share. Show students a	A good graphic and descriptions is at http://brunelleschi.imss.fi.it/museum/esim.

graphic of how scientists have divided the globe into temperature areas. Have students take notes over these, drawing and describing each zone in their notes.	asp?c=204801
Ask, **"In what zone(s) is the United States located?**	Remind students about Alaska and Hawaii if necessary.
Ask **"Can you think of any factors other than latitude that might affect climate?"** Allow students to think before accepting answers.	
Elicit at least altitude, distance from water, ocean currents, precipitation, greenhouse gasses, sunspots, volcanoes, continental drift	As a motivator, show the clip from The Day After Tomorrow when Dennis Quaid is explaining the North Atlantic Current.
Remind students about the experiment with land and water heating up.	Add **marine climate** and **continental climate** to the unit word wall.
Assisgnment: Write a paragraph explaining the differences you would expect between a marine climate (near the ocean) and a continental climate (far from the ocean).	
Homework: Read in student text about what affects precipitation.	

Materials:
Video Clip Chart or Butcher Paper

Day 3	**Instructional Strategies:** Models, Note Taking
Ask **"What do you think affects whether or not we get rain on any given day?"**	
Collect student responses on the board.	
Put up a topographical map of your area under the doc cam and give students a copy of the map.	Nice images of Colorado can be found at http://www.colorado-map.org/ .
Ask **"Do you see anything that might affect our climate?"** Have students point out what climate factors affect their climate.	
Assignment: Color the topographical map to indicate the amount of precipitation you think an area gets based on the topography. Include a key for your model and be prepared to justify your coloring.	

Materials:
Topographic Maps General Art Supplies

Day 4 – 6	**Instructional Strategies:** Diagrams, Identifying Similarities and Differences, Projects, Cooperative Learning, Note Taking, Writing
Choose students at random to show their maps to the class. Ask students to justify one or two decisions on their maps.	
Show a map that displays the actual rainfall for the United States.	A nice map showing average precipitation is at http://www.wrcc.dri.edu/pcpn/us_precip.gif
Ask students to compare their maps to the actual data map in writing in their notes.	
Students will work in pairs to define their climate region in both a small poster and a travel brochure. Give students rubrics for evaluation.	There are enough climate subdivisions to cover a large class and enough major divisions to deal with a small class. Also, some regions are easier to research than others, so you may not want to randomly group students.
Students will use class resources and computer lab resources to research their climate area.	Monitor groups for understanding.
On the third day, students will present their climate regions.	
Assignment: Students should take notes on other student presentations.	
Once presentations are completed, display map of climate regions using the computer projector.	There are many nice maps available online. Choose one appropriate to the regions the students studied. One that includes twelve regions is located at http://img127.imageshack.us/f/climatemapworldrn6.png/
Homework: Write a paragraph explaining what climate region you think you live in. Justify your answer.	

Materials:
Butcher Paper General Art Supplies

Day 7	**Instructional Strategies:** Identifying Similarities and Differences, Brainstorming, Labs

Formative Assessment: Explain the similarities and differences in two given climates. Students should draw two climate regions at random and explain one similarity and one difference using their notes. All students should participate.	
Ask **"How do scientists know that climates have changed over time? What kinds of evidence could exist?"** Allow students to think about this before accepting answers.	
Elicit responses such as the geologic record, fossils, ice cores, land cores, and tree rings	Show clip from *The Day After Tomorrow* when the scientists are collecting ice cores in the Antarctic.
Ask **"What might scientists look for in these kinds of evidence?"**	
Elicit responses such as chemical changes in CO_2 layers, sizes of tree rings, pollen from plants that no longer grow in an area, evidence of glaciers in areas that no longer have any ice, evidence of volcanic eruptions in rock layers	
Give student groups thin pieces of tree trunks. Ask students to identify years of high rainfall and low rainfall. Tell students they must justify their answers with tables or graphs and measurements.	If you are not fortunate enough to be able to get tree cross-sections, images are available online which can be printed for students.
Tell students they are looking at evidence of short-term climate changes.	Data for yearly rainfall is not available for my area, but you may be able to find data for students to use to compare their results.
Assignment: After analyzing the tree ring, what can you say about rainfall in your area over the life of the tree. You may assume that the tree added one ring each year (even though that might not be true).	

Materials:
Tree Cross Sections

Days 8 – 9	**Instructional Strategies:** Cooperative Learning, Summarizing, Recognition of Effort
Tell students that they are going to investigate sources of direct and indirect	

climate change evidence today.	
Divide students into five groups. Each group should get an article from the NSF Climate change page. Avoid the section "people" as human contributions will be investigated later.	Print the article, and then take out the Sky, Sea, Ice, Land, Life research highlights. The report is at http://www.nsf.gov/news/special_reports/climate/pdf/NSF_Climate_Change_Report.pdf#page=5&zoom=100
Tell students divide the article further, highlighting the important things to share with their group. When each group is finished. Groups should prepare a poster-sized graphic organizer that summarize their findings.	Monitor groups for understanding and participation.
Make sure students understand that they are looking at one research source.	
Students will present their findings in their groups. Each student should be able to contribute to the presentation.	

Materials:
Sets of Articles General Art Supplies

Day 10	**Instructional Strategies:** Discussion
Investigate the frequently asked questions of the National Climatic Data Center	Web site to access is http://www.ncdc.noaa.gov/faqs/index.html
These short articles and graphs should spark lively discussion and lead nicely into the question – how responsible are humans for current climate change? Students should take notes during the discussion.	
Assignment: We have looked at evidence that the climate is changing, but we have placed no blame for the change anywhere. Write one or two paragraphs expressing your current opinion on the causes of climate change.	

Day 11	**Instructional Strategies:** Reciprocal Teaching, Discussion, Writing, Note Taking
Ask **"Are humans a cause of climate change? Justify your opinion."**	

Pass out various articles both supporting and contradicting the human influence on climate change.	Make sure groups have copies of the same articles and that each group has enough articles that there are two articles more than there are group members so that fast readers don't have to wait for new material. Make sure the articles are not too long.
Students should read articles, share information, share articles, and take notes.	
Formative Assessment: Have students share information and ask students to repeat what they have heard and then allow the first student to clarify.	
When there are about 15 minutes left in class, bring the class together for a class discussion.	
Homework: Pre-write for tomorrow's essay.	

Day 12	**Instructional Strategies:** Writing
Summative Assessment: Students will write essays supporting their position on the causes of climate change. Students must support their view with concrete ideas. Give students a rubric for evaluation.	
Students may complete these essays at home if necessary.	

Day 13	**Instructional Strategies:** Self Evaluation, Writing
Summative Assessment: Give students the notebook evaluation rubrics. Students may use only what they brought to class to evaluate their notebooks. Students will assign themselves a grade and write a paragraph explaining why they deserve the grade they are assigning themselves. Allow no longer than 20 minutes for this activity.	
Summative Assessment: Give students their pretests. Ask them to write a letter to you assigning themselves a subjective grade based on what they feel they have learned. They must explain what they have learned that they didn't know before. Tell them that this grade will count as an assessment grade, but that if you disagree with the grade, you will have a conference with the student so that you can come to an agreement about what the grade should be.	
Assignment: Study for the objective assessment.	

Day 14	
Summative Assessment: Administer the objective post test.	
Conference with any students who did not assign themselves an appropriate grade on the subjective self-assessment.	

Day 15 & 16	
Debrief students on the objective post test. Celebrate!	
Students have seen clips, so watch the movie *The Day After Tomorrow*.	

Curriculum Resources:

The Complete National Geographic: Every Issue Since 1888. DVD format, 2009.

Daily Warm-Ups: Earth Science. Portland, Maine: Walch Publishing, 2002.

The Day After Tomorrow. Emmerich, Roland. Twentieth-Century Fox, 2004. DVD

Discover! Weather. Dayton, OH: Milliken Publishing, 1999.

Lyons, Walter A. *The Handy Weather Answer Book*. Canton, MI: Visible Ink Press, 1997.

Padilla, Michael et al. *Weather and Climate*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

http://brunelleschi.imss.fi.it/museum/esim.asp?c=204801

http://www.colorado-map.org/

http://img127.imageshack.us/f/climatemapworldrn6.png/

http://www.ncdc.noaa.gov/faqs/index.html

http://www.nsf.gov/news/special_reports/climate/pdf/NSF_Climate_Change_Report.pdf#page=5&zoom=100

http://www.wrcc.dri.edu/pcpn/us_precip.gif

Unit Name: Earth in Space

Graduate Expectation:

"Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet." (CDE)

Grade Level Expectation:

"The relative positions and motions of Earth, Moon, and Sun can be used to explain observable effects such as seasons, eclipses, and Moon phases." (CDE)

Essential Question:

- How are seasons, eclipses, and Moon phases explained by the relative positions of the Earth, Moon, and Sun?

Instructional Questions:

- Why do seasons change on Earth?
- Why does the moon appear to change shape?
- Why can we see only one side of the moon?
- What are the similarities and differences between solar and lunar eclipses?
- How can the path of the Earth around the sun be described?

After Instruction Students Will:

Understand:

- Why we only see one side of the moon
- That the gravitational pull of the Moon and Sun on Earth cause tides
- Why we don't have lunar and solar eclipses every month
- Why it was such an achievement that we landed spacecraft on the moon

Know:

- The differences in neap and spring tides
- The length of a lunar cycle and lunar orbit

Be Able to Do:

- Diagram and explain the phases of the Moon
- Model both lunar and solar eclipses
- Explain why seasons change using a model, diagram, or written explanation
- Model lunar phases and identify their names

General Note: A few of the available online videos on YouTube are referenced specifically, but there are a plethora of short animations and videos that will reinforce all of the topics in this unit.

Learning Plan (Including Instructional Strategies)

Day 1	**Instructional Strategies:** Visuals
Administer pretest to determine readiness and what students already know.	
Assignment: Assignment needs to have begun three weeks prior. Students need to have been keeping track of the phases of the moon on a sheet. A sheet full of 35 circles with lines under them for the date of the observation is sufficient. Be sure that students know that the moon phase can be found on several online sites and in the newspaper ONLY if the evening was cloudy.	
Assignment: Students are to find a picture of the moon in a print source or a web source. Give this assignment at least a week before the unit starts to give students time to complete the task.	

Materials:
Daily Newspapers

Day 2	**Instructional Strategies:** Visuals, Cooperative Learning, Models, Drawing, Note Taking
Using the doc cam, show all student pictures of the moon. Ask students to record observations in their notes as the pictures are put up.	
After the pictures have been looked at, ask students to share their observations with a partner.	
Ask partner pairs for their weirdest observation. Allow all pairs to briefly share. If no one points out that all photos of the moon only show one side, put several pictures up at the same time and ask students to identify the differences and similarities. Repeat with other groups of pictures until the observation becomes apparent.	
Ask **"Why do we only ever see one side**	

of the moon?" Give students time to think, but do not have students share their thoughts.	
Assignment: Create a model or diagram that could explain why we only ever see one side of the moon. Write a long paragraph explaining your diagram or model.	
Provide students a rubric for evaluation of their model and paragraph.	

Materials:
General Art Supplies Marbles, Ping Pong Balls

Day 3	**Instructional Strategies:** Models, Labs, Movement
Aim a flashlight at the board in a dark room. Ask **"What do you think this represents in the Solar System?"**	
Give students a copy of a lab to investigate phases of the moon and materials.	
Student should be in groups of four: the observer, the flashlight holder, the moon holder, and the relief (it gets to be difficult to hold up the flashlight constantly).	
Students should follow the directions on the lab sheet. Each student should get a turn as the observer.	
Students should record their observations in words or diagrams as they do the lab.	
Assignment: Create a diagram that explains all the phases of the moon.	
	Note that the time of orbit of the moon has not been discussed. If a student brings it up, let them know that it will be addressed later in the unit.

Materials:
Flashlights Balls (Light in Color)

Day 4	Instructional Strategies: Technology, Models, Writing, Discussion, Providing Recognition, Note Taking
Select a few students to share their diagrams. Point out particularly diagrams	Put **waxing**, **waning**, **crescent**, **gibbous**, **new**, **full**, and **quarter** on the unit word

that have identified the Sun's and Earth's positions in addition to the Moon's position. Ask **"Is there any vocabulary that you should include on your diagrams?"** Elicit responses for waxing, waning, crescent, new, full, and gibbous.	wall with the word moon.
Ask if there were any difficulties in observations. If students do not bring up that the sun can get blocked out when Earth is between the Sun and Moon, ask **"How do we get full moons if Earth is blocking the Sun's light?"** Allow students to express their ideas.	You may want to have hula hoops on hand to demonstrate the plane of orbit of the Moon in relation to the plane of orbit of the Earth. Be sure to note the precession of the Earth and have students put it in their notes for future reference. Add **precession** to the unit word wall.
Show students animation of the Moon's behavior around Earth: search YouTube for **"What causes an eclipse of the moon?"** for a really excellent animation from the "Ask an Astronomer" videos.	
Formative Assessment: Have students use a hula hoop and an embroidery ring to demonstrate the plane of orbit of the Moon in relation to the plane of orbit of the Earth.	
Show animation at http://dumbscientist.com/archives/the-moon-wobbles Ask **"What could explain why the moon looks larger and smaller at different times of the month?"**	
Assignment: Write a paragraph and draw a diagram speculating on the explanation of a solar eclipse.	

Materials:
Hula Hoops Embroidery Ring

Day 5	**Instructional Strategies:** Discussion, Brainstorming, Models, Self-Evaluation
Give students any article about a solar eclipse that includes the locations for viewing a solar eclipse. Allow them time to read the article and highlight three things that they think are important.	
Have students share their highlighted	

items in groups of three and decide on what the most important detail is.	
Allow groups to share these with the class. If no one brings up the fact that it will only be visible in a small area, bring it up. Ask **"Why isn't the solar eclipse visible everywhere on Earth?"** Allow students to speculate.	
Formative Assessment: Using a model or diagram, in student groups, explain why a solar eclipse is only visible to a small area of Earth when it occurs. Give students time to complete this and then allow members of groups change places with members in other groups to share their models or diagrams. Monitor for understanding.	
Assignment: Reflect on the paragraphs and diagrams written the night before. Correct any misconceptions or errors.	

Materials:
News Article Objects to Represent the Earth, Moon, and Sun
General Art Supplies

Day 6	**Instructional Strategies:** Drawing, Discussion, Models, Note Taking, Technology, Providing Recognition, Identifying Similarities and Differences
Ask **"What might the moon look like during a partial eclipse?"** Ask students to draw images in their notes that show what a partial eclipse might look like.	
Allow several volunteers to present their drawings and explain their images.	
Formative Assessment: Ask "Has anyone changed their ideas about what a partial eclipse of the moon might look like?" If students do not answer, push with images of various partial eclipses and ask specific students to explain how the image could occur. Allow students to use objects to explain if they need to.	
Assignment: Create a Venn diagram for a lunar and a solar eclipse. The diagram should include all similarities and differences brought up in class.	
Ask **"Why can't you view a solar eclipse by looking at it?"** Make sure students understand that they should never look at the sun directly and especially that they should never look at the sun using any	

kind of scope without really special filters. Pass around a telescope solar filter for students to observe.	
Assignment: Design a safe way to view the Sun, and so a solar eclipse. Be prepared to explain it to the class and convince classmates that it is safe. (Tell students that if they get stuck, it is okay to do some reading in their text to help them. They should NOT try to observe the sun.)	

Materials:
Telescope Solar Filter

Day 7	**Instructional Strategies:** Discussion, Demonstration, Note Taking, Models, Identifying Similarities and Differences
Have students share their methods of observing the sun. Discuss as a class why each method would be safe or not safe.	
If no students describe the pinhole method, describe it to them, and then demonstrate it with a flashlight and a piece of cardboard.	
Ask **"Why can the Moon block out the Sun when the Sun is so much larger than the Moon?"**	
Formative Assessment: Have students demonstrate this for themselves using two circular disks.	
Ask students to write in their notes a reason why Earth has seasons. Ask a few students to share their thoughts. Ask **"Does your explanation account for the fact that when in is winter in the northern hemisphere it is summer in the southern hemisphere? If not, how could you change it?"**	
Use a magnifying glass set in place to focus light from the doc cam onto a sheet of paper. Ask **"What is happening to the paper where the light is focused?"**	
Tilt the paper so that the focused light is spread out at an angle. Ask **"Does this**	

change how the paper is heated by the light? How?"	
Ask **"How might this demonstration help explain the seasons on Earth?"** (Refer students to their definition and diagram of precession.)	
Use a model (globe and unshaded lamp) to show the position of the Earth and Sun in summer and winter. Ask **"Does the distance from the Sun have anything to do with the seasons? Can you explain your answer?"**	Make sure that students understand that it does not, and that the fact that seasons are opposite on the northern and southern hemispheres prove this.
Assignment: Draw a diagram that explains the position of the Earth and Sun during the four seasons.	

Materials:

Magnifying Glass	Globe	Lamp
Flashlight	Cardboard	Circular Disks in Two Sizes

Day 8	**Instructional Strategies:** Demonstration, Identifying Similarities and Differences, Note Taking,
Ask **"Why doesn't the Moon fly off away from the Earth?"** Students should be able to identify gravity as the reason, but won't be able to explain it. Demonstrate this with an object tied at the end of a string and swung around in a plane.	
Ask **"What would happen if I cut the string?"** Explain that gravity is like the string that connects the object to your hand and the object is pulling on your hand just as hard as your hand is pulling on the object.	If a student asks, explain that this is one of Newton's laws of motion.
Ask **"How might this help explain tides?"**	Be sure students understand what a tide is. If not, clarify it for them. Have students write a definition of **tide** in their notes and add tide to the unit word wall.
Ask **"Are there any more things that might affect the oceans on Earth?"**	

Have students write two questions in their notes that they want to investigate about tides. Allow each student to share one question in turn until no students have new questions. Compile a list of questions as students say them.	
Assignment: Read about tides in student texts and classroom resources to find the answers to the two questions. Define any vocabulary in notes using diagrams or words.	

Materials:
String Object

Day 9	**Instructional Strategies:** Reinforcing Effort and Providing Recognition, Note Taking Summarizing
Give students copies of the class questions. Have students present answers to the questions they posed until all questions have been answered, and present definitions of encountered vocabulary.	Be sure students are taking notes on the student presentations. Add appropriate vocabulary to the unit word wall as it is presented. Be sure that **neap tide** and **spring tide** are defined.
Assignment: Write a summary of what you have learned about tides.	
Give students a rubric for evaluating the summary.	
Assignment: Complete last day of moon diagrams begun a month ago.	

Day 10	**Instructional Strategies:** Self-Evaluation, Labs, Summarizing, Projects
Provide students time to evaluate their own summaries.	
Give students a question sheet for their lunar observations. They should use their data collection to answer questions about the rotation period, orbit, data collection methods, and position in the sky as a minimum.	
As students finish, give them articles about the moon landing to read, highlight, and summarize. A variety of articles can be found online.	
Assignment: Complete summaries of moon landing articles.	

Materials:
Lunar Landing Articles

Day 11	**Instructional Strategies:** Self Evaluation, Writing
Summative Assessment: Give students the notebook evaluation rubrics. Students may use only what they brought to class to evaluate their notebooks. Students will assign themselves a grade and write a paragraph explaining why they deserve the grade they are assigning themselves. Allow no longer than 20 minutes for this activity.	
Summative Assessment: Give students their pretests. Ask them to write a letter to you assigning themselves a subjective grade based on what they feel they have learned. They must explain what they have learned that they didn't know before. Tell them that this grade will count as an assessment grade, but that if you disagree with the grade, you will have a conference with the student so that you can come to an agreement about what the grade should be.	
Assignment: Study for the objective assessment.	

Day 12	
Summative Assessment: Administer the objective post test.	
Conference with any students who did not assign themselves an appropriate grade on the subjective self-assessment.	

Days 13 & 14	
Debrief students on the objective post test. Celebrate!	
Make pocket sundials.	
Show *Apollo 13* or other appropriate movie.	

Curricular Resources:

Apollo 13. Howard, Ron. Universal Pictures, 1995. DVD.

The Complete National Geographic: Every Issue Since 1888. DVD format, 2009.

Daily Warm-Ups: Earth Science. Portland, Maine: Walch Publishing, 2002.

Dixon, Dougal. *The Practical Geologist*. New York: Simon and Schuster, 1992.

Fraknoi, Andrew, ed. *The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook.* San Francisco: Astronomical Society of the Pacific, 1995.

http://dumbscientist.com/archives/the-moon-wobbles

Liu, Charles. *The Handy Astronomy Answer Book*. Canton, MI: Visible Ink Press, 2008.

Luhr, James, Ed. *Earth: The Definitive Visual Guide*. New York: DK Publishing, 2003.

Padilla, Michael et al. *Astronomy*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

Padilla, Michael et al. *Earth's Waters*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

Rees, Martin, Ed. *Universe: The Definitive Visual Guide*. New York: DK Publishing, 2008.

www.google.com (to find articles)

www.youtube.com (to find short animations as needed)

Unit Name: Earth's Crust

Graduate Expectation:

"Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system." (Colorado Department of Education)

Grade Level Expectation:

"Complex interrelationships exist between Earth's structure and natural processes that over time are both constructive and destructive." (Colorado Department of Education)

Essential Question:

- How is Earth's surface naturally changed over time?

Instructional Questions:

- What is a rock?
- What are the characteristics of the minerals that make up rocks?
- What are the three types of rocks, and how are they related by the rock cycle?
- What are the causes of weathering and erosion, and how do weathering, erosion, and deposition change Earth's surface?

After Instruction Students Will:

Understand:

- that the processes of weathering, erosion, and deposition help shape the surface of the earth
- the difference between a rock and a mineral
- the similarities and differences among the types of rocks in the rock cycle
- the processes of the rock cycle

Know:

- the meaning of relevant vocabulary
- the process of weathering, erosion, and deposition as a way the surface of the earth changes
- some characteristics that scientists use to identify minerals that are in rocks

Be Able to Do:

- draw and label the rock cycle
- explain how one type of rock can change into another type of rock
- list and describe causes of weathering and erosion

Learning Plan (Including Instructional Strategies)

General Note: Make sure hand lenses are available to students each day of this unit so that students may examine materials closely at any time.
Daily Supplies: Hand Lenses, Batteries, Replacement Bulbs for Hand Lenses

Day 1	
Administer pretest to determine readiness and what students already know. Assignment: Read section in student text concerning the rock cycle.	

Day 2	**Instructional Strategies:** Identifying Similarities and Differences, Graphic Organizers, Analogies, Cooperative Learning
Show students an ice cube, a glass of water, and a balloon. Ask **"What do these have in common?"**	
Allow students to come to the conclusion that they are all forms of water –in liquid, solid, and gaseous state. Put the three states on the board and draw arrows between them.	
Ask **"How do these change from one state to another?"**	It is not important that students use the correct vocabulary, but that students see that states change through some process.
Ask **"What are the three classifications of rocks?"** Students should be able to list sedimentary, metamorphic, and igneous from the previous assignment.	
Put the three classifications on the board in a triangle. Tell students that they will learn how one type of rock changes into another and will learn the characteristics of rocks in this unit.	
Tell students that rocks of any type are made up of minerals and or other	Add **rock** to the unit word wall and have students define it in their notes.

materials that are stuck together by some natural process.	
Have students read in pairs what makes a mineral a mineral, and how scientists identify minerals.	
Formative Assessment: Monitor students as they read and begin the assignment, redirecting them as needed to the appropriate information. Ask specific students to share their work with the class or other students to keep learning focused and on target.	
Assignment: Students will create an outline with two Roman numerals. Roman numeral I is "What makes a mineral a mineral?" and Roman numeral II is "How do scientists identify minerals?" Guide students to the appropriate pages of the textbook and *The Handy Geology Answer Book*.	

Materials:

Ice Cubes Glass of Water Balloon

Day 3	**Instructional Strategies:** Reinforcing Effort & Providing Recognition, Demonstrations, Graphic Organizers
Formative Assessment: Begin class by asking students to share their outlines in groups of four or five and to choose the best outline from the group. Put the chosen outlines under the doc cam and allow students to explain their work. Students whose outlines are incomplete can take this opportunity to add information or correct information in their outlines. Choose the best outline from each class and copy and enlarge it to display in the classroom during the unit.	
	Add the words **mineral**, **color**, **streak**, **luster**, **crystal structure**, and **hardness** to the unit word wall.
Demonstrate streak for minerals under the doc cam. Allow students to streak various minerals from a streak kit.	
Demonstrate hardness for minerals under a doc cam using a hardness kit. Use the zoom feature of the doc cam or a field lens and the doc cam to look at crystal structure.	

Materials:

Mineral Streak Kit Mineral Hardness Kit Field Lens(es)

Day 4	**Instructional Strategies:** Demonstrations,

	Manipulatives, Writing and Journals, Note Taking
Begin by testing minerals for calcite using a hydrochloric acid solution. Demonstrate lab safety while doing this. Explain that this is a test that scientists use in the field to determine if a rock contains calcite.	
Demonstrate magnetism using a compass and iron or magnetite as well as minerals that do not have magnetic properties.	
Ask **"How do you think minerals form?"** Brainstorm ideas, making a list on the board. Circle the ideas that students think are the most likely two or three.	
Assign students to read about how minerals form and to summarize the two methods of formation in their notes.	
Formative Assessments: 1) After an appropriate time, ask students to share their summaries. 2) Pass around a broken open geode. Ask students to speculate on how the crystals formed in the geode. 3) Pass around a large chunk of halite (salt) or a gypsum rose. Ask students to speculate on how the crystals formed. 4) Place a piece of volcanic glass under the doc cam. Ask students why it doesn't have crystals.	
Assignment: Give students a summary of the mineral rights versus surface rights of Colorado. A good place to write the summary from is http://geology.com/articles/mineral-rights.shtml. Students are to write a letter to their state senator or congressman supporting the current system or opposing it.	

Materials:

Hydrochloric Acid Solution		Safety Equipment
Geodes (http://www.petrifiedwoodco.com/index.html)		
Halite	Gypsum Rose	Volcanic Glass
Compass	Magnetite	Iron

Day 5	**Instructional Strategies:** Experiments, Demonstrations, Identifying Similarities

	and Differences, Note Taking, Highlighting
With various classes, make different mineral crystals. This can be done by growing crystals using salt and laundry bluing, heating a solution of copper sulfate or alum and suspending a string in the solution as it cools, or evaporating a sugar solution. Use temperature variation to grow different size crystals. Place various igneous rocks under the doc cam (perhaps pieces of pumice, obsidian, granite, basalt, and gabbro).	Doing a different demonstration with each class will allow students to see various crystal formation and sizes.
Ask **"What do you see as similarities and differences in the rocks?"**	
Divide the rocks, at the guidance of the students, into two piles. Ask what characteristic they are using to divide the rocks. Repeat this again if students did not get the rocks divided into intrusive and extrusive piles. If necessary, divide the rocks and then ask students to come up with what characteristic they thought you used to divide the rocks.	
Once students have identified the size of the grain of the rocks as the characteristic, introduce the terms intrusive and extrusive. Ask students to speculate about what might cause the differences in the sizes of the grains (hint that the obsidian does not have crystals).	
Tell students all the rocks are igneous. Ask students to find the definition of igneous rock and write the definition in their notes.	
Write the terms intrusive and extrusive on the board. Ask **"What do you think the difference is in the meanings of these words?"** Let students answer. Have students write the definitions in their	Add **igneous rock**, **intrusive**, **extrusive**, **magma**, and **lava** to the unit word wall.

notes. Be sure that the definitions include the difference between magma and lava. Ask students to highlight "in" and "ex" in the words.	
Formative Assessment: On exit cards, have students define igneous rocks.	
Assignment: Have students read pages 74-80 from Roadside Geology of Colorado to read. Ask students to highlight the things they recognize as they read.	

Materials:

salt
alum
containers
various rocks (from the Washington School Collection Set)
laundry bluing
string
sponges or charcoal
copper sulfate
sugar solution

Day 6	**Instructional Strategies:** Discussion, Demonstrations, Identifying Similarities and Differences, Graphic Organizers, Note Taking
Discuss with students which of the things they read about and highlighted consisted of igneous rock.	
Show a slide show of images of items from the text: Spanish Peaks, stone walls, Fisher Peak, and Morley dome. Review terms from yesterday.	
Pass around a large chunk of conglomerate rock. Ask **"What is this? Is it igneous?"**	Students should be able to see that the rock is made up of pieces of other rocks. Students might speculate that some of the pieces might be igneous rocks.
Explain that the rock is a sedimentary rock. Ask a student to find the definition of sedimentary rock.	Have students put the definition in their notes. Add **sedimentary rock** to the unit word wall.
Formative Assessment: Have students read in pairs about sedimentary rocks and ask each student to create a table for the three types of sedimentary rocks – clastic, organic, and chemical. Check these tables for understanding.	
Assignment: Students should complete table of characteristics of the three types of sedimentary rocks.	

Materials:

Conglomerate Rock Sample

Day 7	**Instructional Strategies:** Identifying Similarities and Differences, Cooperative Learning, Mnemonic Devices, Note Taking, Reinforcing Effort & Providing Recognition, Manipulatives
Pass around a few numbered sedimentary rocks, including a large chunk of coal from a local mine. Ask students to try to figure out if each is clastic, organic, or chemical and to write this in their notebooks.	Add **clastic**, **organic**, and **chemical** to the unit word wall.
Place students in groups of four and have them record their results, one rock at a time, on white boards to share with their groups. Allow students to discuss each rock briefly so that the group is in agreement about the type of sedimentary rock. Ask the groups to report their decisions to you. If any groups selected the wrong group, place the rock under the doc cam and examine it.	
Use a graphic organizer to organize the process through which a sedimentary rock forms and have students copy it in their notes. Ask students to create a mnemonic device to remember the steps and to add that to their notes as well.	Add **erosion** and **deposition** to the unit word wall.
Allow students to share a few of these devices. If there is one device the students seem to really like, allow the student to have a piece of poster paper to make a poster to hang in the room.	

Materials:
Sedimentary Rock Samples

Day 8	**Instructional Strategies:** Identifying Similarities and Differences, Visuals, Note Taking
Place pairs of rocks of	

sedimentary/metamorphic and igneous/metamorphic from the Washington School Collection under the doc cam and ask students to identify the pairs that are related to each other. Guide students in this pairing until students have the rocks successfully paired.	
Ask **"What might change one type of rock into another type of rock?"**	
Explain that in each pair, one of the rocks is sedimentary or igneous and that the other is metamorphic.	
Have students read the section in their text about metamorphic rocks and to define metamorphic in their notes.	Add **metamorphic rock** to the unit word wall.
Formative Assessment: Ask students to identify the two types of metamorphic rocks and explain the difference on exit cards.	
Assignment: Students should reread the section on the rock cycle in their text.	

Materials:
Sedimentary/Metamorphic Rock Pairs Igneous/Metamorphic Rock Pairs

Days 9, 10, and 11	**Instructional Strategies:** Graphic Organizers, Drawing and Artwork, Storytelling, Self-Evaluation, Note Taking
Place the three rock types in a triangle on the board and draw a circle that connects them all.	
Ask **"What processes will make these rocks become another type of rock?"**	
As students identify processes correctly, add them to the diagram until the rock cycle is complete.	
Summative Assessment: Students should choose an assessment to complete over the next two days. They may create a rock brochure, write a story about a pet rock that undergoes lots of changes, or create a poster of the rock cycle. Post rubrics for each assessment. Students will have two days to work in class on their assessment choice. Students will present their assessments on the third day. After student presentations are complete, students should self-evaluate their learning using the posted rubrics.	

Materials:
General Art Supplies

Day 12	**Instructional Strategies:** Demonstrations, Brainstorming, Graphic Organizers, Note Taking
Put a sugar cube under the doc cam and tap it with another sugar cube. Put another sugar cube in a dish and drip water on it.	
Ask **"How do rocks get broken down into smaller pieces?"** Brainstorm, recording all ideas.	
Ask **"Are there any categories that we could divide these ideas into?"** Record the results on the board.	Have students put these in their notes.
Ask students to read the section in the text on weathering.	
Assignment: Students should reorganize (in whatever manner is most comfortable) their lists according to what they read and remove or add ideas as necessary.	

Materials:
Sugar Cubes Eye Dropper or Pipette

Day 13, 14, and 15	**Instructional Strategies:** Discussion, 1 – 2 Cards, Demonstrations, Experiments, Reciprocal Learning, Writing and Journals, Reinforcing Effort and Providing Recognition, Self-Evaluation
Allow students to share for the first few minutes of class. Students should continue adjust their lists.	
Ask **"What words should we add to the unit word wall?"**	At the least, make sure that **weathering**, **chemical weathering**, and **mechanical weathering** are added.
Formative Assessment: Using 1 – 2 cards, give a cause of weathering and ask students to display whether it is a cause of chemical or mechanical weathering.	
Place a handful of dirt on a table covered with paper. Ask **"How could I get this dirt to the other side of the table?"** Allow a few students to try their ideas if they are	

not too destructive.	
Ask **"What moves the weathered pieces of rock from one place to another in nature?"** Brainstorm, recording all ideas.	
Water related movement should be the predominant force. Add or remove any ideas necessary to accomplish the next assignment.	
Assignment: Give each student one of the agents of erosion and ask them to prepare a mini-lecture (1½ - 3 minutes) and written summary. Allow students to use their text and classroom resources to complete their assignment. On the final day, have students present their mini-lecture and offer their summary page to the class erosion notebook. Make a few photocopies of these books for classroom resources.	
Assignment: After the lesson is presented, students should write a paragraph of self-reflection about their effort and success/failure in teaching.	

Materials:

Dirt Butcher Paper General Art Supplies

Loose-Leaf Notebooks

Day 16	**Instructional Strategies:** Brainstorming, Identifying Cause and Effect Relationships
Ask **"What kinds of land formations occur when the material that is eroded gets deposited or during the process of erosion?"** Students will likely have come across many ideas for this while they were preparing their mini-lecture.	
Brainstorm a list of landforms, editing as necessary for the assignment.	
Give students a list of the causes of erosion.	
Assignment: Connect the landforms with the cause of erosion.	
Formative Assessment: Monitor student work carefully, guiding students to the appropriate resources and correcting as necessary.	

Day 17	**Instructional Strategies:** Self Evaluation, Writing

Summative Assessment: Give students the notebook evaluation rubrics. Students may use only what they brought to class to evaluate their notebooks. Students will assign themselves a grade and write a paragraph explaining why they deserve the grade they are assigning themselves. Allow no longer than 20 minutes for this activity.
Summative Assessment: Give students their pretests. Ask them to write a letter to you assigning themselves a subjective grade based on what they feel they have learned. They must explain what they have learned that they didn't know before. Tell them that this grade will count as an assessment grade, but that if you disagree with the grade, you will have a conference with the student so that you can come to an agreement about what the grade should be.
Assignment: Study for the objective assessment.

Day 18	
Summative Assessment: Administer the objective post test.	
Conference with any students who did not assign themselves an appropriate grade on the subjective self-assessment.	

Day 19	
Debrief students on the objective post test. Celebrate!	
Have a rock identification contest with rocks from the Washington School Collection. The student who gets the most right gets to bash open a geode. (Jim Gray's Petrified Wood Co. in Holbrook, Arizona, will sell and ship small ones very reasonably!)	

Materials:

Goggles Hammer Towels

Curricular Resources:

Barnes-Svarney, Patricia and Thomas Svarney. *The Handy Geology Answer Book*. Detroit: Visible Ink Press, 2004.

Chronic, Halka and Felicie Williams. *Roadside Geology of Colorado*. Missoula, MT: Mountain Press Publishing Company, 2002.

Daily Warm-Ups: Earth Science. Portland, Maine: Walch Publishing, 2002.

Dixon, Dougal. *The Practical Geologist*. New York: Simon and Schuster, 1992.

Kardos, Thomas. *Easy Science Demos & Labs*. Portland, ME: Walch Publishing.

Padilla, Michael et al. *Inside Earth*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

Padilla, Michael et al. *Earth's Changing Surface*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

Unit Name: Natural Resources

Graduate Expectations:

"Describe how humans are dependent on the diversity of resources provided by Earth and Sun." (CDE)

Grade Level Expectation:

"Earth's natural resources provide the foundation for human society's physical needs. Many natural resources are nonrenewable on human timescales, while others can be renewed or recycled." (CDE)

Essential Question:

- How do humans depend on and use renewable and nonrenewable resources?

Instructional Questions:

- What are the natural resources you use every day?
- What can you do to conserve natural resources?
- How do we use natural resources?
- What are the advantages and disadvantages of using nonrenewable resources?
- What happens when various natural resources are extracted from an area?
- How is water polluted and what are the consequences of water pollution?

After Instruction Students Will:

Understand:

- That some of the resources on Earth exist in finite quantities
- That without natural resources life could not exist

Know:

- How to determine if a resource is renewable or nonrenewable
- Where their energy comes from when they turn on the light

Be Able to Do:

- Determine personal actions to conserve resources
- Identify how fossil fuels impact their lives
- Evaluate the costs and benefits of natural resources

Day 1	**Instructional Strategies:** Homework
Administer pretest to determine readiness and what students already know.	
Homework: Set your bathroom faucet so that it drips. Document how many seconds pass between drips. Use a quarter cup measure and time how long it takes for the ¼ cup to fill with water.	

Day 2	**Instructional Strategies:** Writing, Note Taking, Identifying Similarities and Differences.
Give students the conversion information between cups and gallons. Have students compute how long it will take to waste a gallon of water. Give students the conversion information between hours and years. Have students calculate how much water their "leaky" faucet will waste in a year.	Remind students of their data collection and analysis of personal water usage.
Assignment: Students should answer the reflection question: "Is it important to fix a leaky faucet? Explain your thinking."	
Put up several images one at a time under the doc cam such as sun, trees, animals, minerals, wind, petroleum, water, grown food, natural gas, coal, and ask students each time, "Do you think this is a renewable or nonrenewable natural resource?"	Students should use 1 – 2 cards to vote.
Ask, **"What do these images all have in common?"**	Define natural resource and put the word on the unit word wall.
Ask students **"What does it mean for a resource to be renewable on a human scale? What does it mean for a resource to be nonrenewable on a human scale?"**	Students will need clarification on what designates human scale.
Write definitions for renewable and nonrenewable on chart paper and post.	Put **renewable** and **nonrenewable** on the unit word wall.
Define fossil fuels for students. Ask them to write a question on an index card about possible pollution problems that come from mining or using fossil fuels.	Use these cards to determine the articles you need to have ready for Day 5.

Assignment: Give students copies of the images from the overhead. Students are to cut up the images and glue them to sheets to indicate another way to classify them besides renewable and nonrenewable. Students should be prepared to explain why they classified the resources the way they did.

Materials: Images of Natural Resources

Day 3	**Instructional Strategies:** Cooperative Learning, Storytelling, Drawing and Artwork, Graphic Organizers
Formative Assessment: Call on random students to present their classification charts of natural resources.	
Show students a video of oil spill damage. Ask **"If this is what can happen when we drill for oil, should we find another resource to use?"**	Allow a short discussion to build interest.
Have students jigsaw articles on what petroleum is and how we get it; what happens to petroleum after we get it out of the ground; and petroleum products that we use every day. Once students have read their articles, have them come together in groups to share their articles.	A search on Google will yield informational sites; a few are listed below. http://lsa.colorado.edu/summarystreet/texts/petroleum.htm , http://www.eia.doe.gov/kids/energy.cfm?page=oil_home-basics , A particularly effective picture of petroleum polymer products is in the June 2004 issue of National Geographic, p 82-83, and the article mentions BP.
Formative Assessment: Have students in groups explain another group member's article to you.	
Ask **"What would you be willing to give up to reduce the petroleum products you use?"**	Give students time to think and then have students share their answers. Add **petroleum** to the unit word wall.
Assignment: Give students choices for the assignment. 1. Write a story of what would happen if you woke up tomorrow and all petroleum products in your room were gone. 2. Draw a picture of your room with the petroleum products in it. Draw a picture of your room with the petroleum products replaced by something else. 3. Make a list of all the things in your room that are petroleum products. Across from each item, write the name of something you could use instead of the petroleum product.	

Materials: Web or Magazine Articles

Day 4	**Instructional Strategies:** Guest Speaker
In Colorado, a lot of natural gas drilling is taking place. If possible, a guest speaker from the local gas drilling company (whichever is currently drilling) would be beneficial to the student understanding of the economic and environmental issues. If no guest speaker is available, an appropriate educational video regarding gas drilling would be substituted.	Video the guest lecture so that it is available to other classes and the guest does not have to stay all day.
If a speaker is available, have students submit questions to you to ask if there is time. This serves two purposes – it will allow you to preview the questions for appropriateness and build interest in the topic.	Add **methane gas** to the unit word wall.

Day 5	**Instructional Strategies:** Demonstration, Discussion, Technology, Drawing
Demonstrate how charcoal forms.	This demonstration, and a materials list is in Easy Science Demos & Labs Earth Science.
Ask **"Why don't the wood pieces ignite?"**	
Ask **"Why does a match flare up at the end of the test tube?"**	
Ask **"Why isn't coal considered a mineral?"**	A short video on what coal is and how it forms can be found at http://www.coaleducation.org/miningtv/modern_videos.htm .
Ask **"What do we mostly use coal for?"**	
Ask **"Where does our power come from?"**	Visit the Tri-State web site to see where students are getting their power at http://www.tristategt.org .
Use the projector to investigate student power source.	Pay particular attention to the new technology, renewable energy, and energy efficiency.
Formative Assessment: Have students draw what they thing the pie chart (from the site that breaks down where energy comes from) would have looked like ten years ago, what it looks like now, and what they think it will look like in ten years.	

Homework: Read informational article on coal mining. (http://www.coaleducation.org/lessons/twe/mcoal.pdf)

Day 6	**Instructional Strategies:** Summarizing, Discussion, Peer Evaluation
Formative Assessment: Check for reading and understanding with an entry ticket. Have students list facts and information from the homework as they come to the door. If they cannot list something from the article, they go to the back of the line.	
Ask **"Can there be problems with mining or using fossil fuels?"**	Make sure students have an understanding of fossil fuel from Day 2 and Day 3 and add **fossil fuel** to the unit word wall.
Give each student an article that applies generally to their index card question from Day 2.	Explain that some of the articles may be from sources that are not objective, and give an example of subjective and objective.
Assignment: Write a summary of your article, including whether or not the article is from an objective source. Then exchange your article with a classmate. Read the article and summary and make three suggestions for improving the summary (not correcting language or usage). Rewrite your summary to include the suggestions. If you do not use a suggestion, include an explanation at the end of your summary explaining why you did not use the suggestion.	
Tainted waste water from gas drilling.	http://www.scientificamerican.com/article.cfm?id=wastewater-sediment-natural-gas-mckeesport-sewage
Water contamination from gas drilling	http://abcnews.go.com/WN/Media/touted-cleaner-energy-communities-natural-gas-clean/story?id=10908787
Diesel fuel spill	http://www.time.com/time/world/article/0,8599,1951412,00.html
BP spill / ocean pollution	a search on Google will provide a variety
Exxon Valdez spill (with a comparison to the BP spill)	http://www.worldpress.org/Americas/3571.cfm
Coal plants pollute water (5 minute video from the NY Times)	http://video.nytimes.com/video/2009/10/14/us/1247465176975/toxic-waters-from-air-to-water-waste.html?ref=air_pollution

Coal air pollution & waste	http://www.ucsusa.org/clean_energy/coalvswind/c02c.html with http://www.ucsusa.org/clean_energy/coalvswind/c02d.html

Materials: Multiple Handouts

Days 7 – 8	**Instructional Strategies:** Providing Recognition and Reinforcing Effort, Note Taking, Writing
Have students present their final summaries. Encourage students to take notes.	
Summative Assessment: Do the benefits of using fossil fuels outweigh the cost of mining and using fossil fuels?	Provide a rubric for evaluation to the students.
Options: 1. Take a side and write an essay defending your position. 2. Write a dialogue in which two people discuss the issue and one person persuades the other person to change his or her opinion. 3. Create a table summarizing the costs and benefits of mining and using fossil fuels.	Allow students to seek out information from their classmates that they may have missed. Alternately, you may have copies of good summaries for students to consult.
Homework: List as many things about renewable energy sources as you can in your notes.	

Day 9 – 11	**Instructional Strategies:** Brainstorming, Demonstrations, Reciprocal Teaching, Technology, Drawing and Artwork
Brainstorm a list of renewable energy sources.	
Ask, **"Are all these sources non-polluting sources?" "In what way might solar-cells, for example, be a cause of pollution?"**	Discuss briefly.
Ask **"What is a carbon footprint? Why do**	

you think it is called a carbon footprint?"	
Demonstrate renewable energy sources using an alternative energy kit. Describe each as it is demonstrated.	
Formative Assessment: Ask students to explain to a partner which is their favorite renewable energy source and why. Then ask students to explain to another students what their partner's favorite energy source is and why. Monitor groups.	
Take students to the library so that they may research one of the renewable energy sources. Students are to take notes – not print.	
Summative Assessment: Create a poster or brochure about a renewable energy source.	Give students a rubric for evaluating the assessment.
Allow students to present their posters or brochures to the class.	

Materials: Butcher Paper, Copy Paper, General Art Supplies, Alternative Energy Kit

Day 12	**Instructional Strategies:** Discussion, Writing
Ask **"Why is it important to reduce water pollution?"**	If necessary, remind students of the demonstration of how much of the world's water is usable.
Ask **"What will happen when we run out of nonrenewable resources and when we overuse renewable resources?"**	
Assignment: Write a pledge for yourself outlining what you need to do to conserve the natural resources on Earth. Sign your pledge. Get at least one other person (not in the school) to read and sign your pledge.	

Curricular Resources

Daily Warm-Ups: Earth Science. Portland, Maine: Walch Publishing, 2002.

Kardos, Thomas. *Easy Science Demos & Labs*. Portland, ME: Walch Publishing. 2003.

http://abcnews.go.com/WN/Media/touted-cleaner-energy-communities-natural-gas-clean/story?id=10908787

http://lsa.colorado.edu/summarystreet/texts/petroleum.htm

http://video.nytimes.com/video/2009/10/14/us/1247465176975/toxic-waters-from-air-to-water-waste.html?ref=air_pollution

http://www.coaleducation.org/lessons/twe/mcoal.pdf

http://www.coaleducation.org/miningtv/modern_videos.htm

http://www.eia.doe.gov/kids/energy.cfm?page=oil_home-basics

http://www.scientificamerican.com/article.cfm?id=wastewater-sediment-natural-gas-mckeesport-sewage

http://www.time.com/time/world/article/0,8599,1951412,00.html

http://www.tristategt.org

http://www.ucsusa.org/clean_energy/coalvswind/c02c.html

http://www.ucsusa.org/clean_energy/coalvswind/c02d.html

http://www.worldpress.org/Americas/3571.cfm

Unit Name: Plates and Geological Events

Graduate Expectation:

"Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system." (Colorado Department of Education)

Grade Level Expectation:

"Major geologic events such as earthquakes, volcanic eruptions, mid-ocean ridges, and mountain formations are associated with plate boundaries and attributed to plate motions." (Colorado Department of Education)

Essential Question:

- How are geologic events and geologic formations associated with plate boundaries and the result of plate motions?

Instructional Questions:

- How and why do plates move?
- How do plates interact with each other?
- What evidence exists that supports the theory of plate tectonics?
- How are earthquakes and volcanoes related to plate boundaries and plate movements?
- What geologic formations on Earth's crust are associated with plate movements and plate boundaries?

After Instruction Students Will:

Understand:

- that Earth's crust is moving slowly through time and the continents were not always where they are now
- that there is an abundance of evidence that supports the theory of plate tectonics
- why plates move

Know:

- the meaning of relevant vocabulary
- that many geologic formations exist because of plate movements and plate boundaries
- the layers of the earth

Be Able to Do:

- demonstrate how plates interact with each other
- explain the evidence that supports the theory of plate tectonics
- explain how earthquakes, plate movement, and volcanoes can create geologic formations
- label diagrams of plate interactions and Earth's layers

Learning Plan (Including Instructional Strategies)

Day 1	
Administer pretest to determine readiness and what students already know.	
Assignment: Read section in textbook concerning the layers of Earth.	

Day 2	**Instructional Strategies:** Questions, Discussion, Visuals, Diagramming, Identifying Similarities and Differences, Note Taking
Hold a hard-boiled egg under the document camera. Ask **"How is a hard-boiled egg like Earth?"** Allow the students to discuss this for two minutes, jotting down their ideas in their notebooks. Have student pairs report their findings, recording the major ideas on the board.	
Have student pairs report their findings, recording the major ideas on the board.	Be sure that the words **crust**, **upper mantle**, **lower mantle**, **inner core**, and **outer core** are mentioned. If they are not, prompt students. Add these words to the word wall.
Crack the egg. **Ask "How is the shell more like the crust now?"**	Add the word **plate** to the word wall.
Formative Assessment: Cut the egg in half and show it to students under the doc cam. Point to parts of the egg and ask students to write on their white boards which layer of Earth is represented. Check student responses.	
Students should define the key terms in their notes and sketch a diagram of the layers of Earth.	
Formative Assessment: Monitor students to make sure that they are doing this correctly. Encourage students to write the definitions in their own words, and periodically ask a student to share a definition.	
Ask **"What other foods might make good models of the layers of Earth?"**	
Put a world map (non political) under the doc cam. Ask students where they think the major plates might be. Allow students	

to come to the map and outline where they think the plates might be.	
Assignment: Pass out world maps to students. Students are to outline and label the plates of the crust. They will need to find this information in their textbooks or in another resource. Have students keep these maps. They will add boundary types later to the maps.	

Materials:
Hard-Boiled Egg Knife World Map (Nonpolitical)

Day 3	**Instructional Strategies**: Visuals, Providing Recognition, Brainstorming, Note Taking, Summarizing, Writing
Turn on the lava lamp. Check student maps. Place a couple of the good ones under the doc cam for other students to see.	
Remind students of the Essential Question. Ask **"How do you think plates might move?"** and have students record their thoughts in their notebooks. Allow guided discussion of this for a few minutes.	
Read in the textbook about convection currents in the mantle.	
Ask **"How is a lava lamp like the convection currents in the mantle? How could this cause the plates of the crust to move?"** Encourage student discussion. Have students record in their notes what a convection current is and how they think it might move Earth's plates. Allow several students to read their responses.	Add **convection current** to the word wall.
Ask **"What do you think happens along the boundary where two plates meet?"**	Place the words **divergent boundary**, **convergent boundary**, and **transform boundary** on the word wall. Have students define these words using pictures in their notes.
Read about each of the boundaries in the textbook. Have students mark the	

boundaries on their world maps as divergent, convergent, or transform.	
Formative Assessment: After reading about each boundary, ask students to explain using their hands what happens to plates at plate boundaries.	
Formative Assessment: Have students answer the question "How do plates of Earth's crust move?" on exit cards.	
Assignment: Summarize what the three different types of plate boundaries are in a paragraph. Remind students that they will be creating a poster tomorrow, and that if they want any special supplies, they will need to bring them.	

Materials:
Lava Lamp

Days 4 & 5	**Instructional Strategies:** Technology, Drawing and Artwork
Ask a few students to read their paragraphs.	
Show maps of the ocean floors from National Geographic DVDs using computer projector. Identify ocean trenches and the mid-ocean ridges.	
Summative Assessment: Tell students that they are going to create a poster of Earth's layers and the three types of boundaries. Give students a rubric for evaluation of the project. At a minimum, students should have the three main layers of the earth labeled and the three plate boundaries labeled with arrows showing the direction of movement of the plates at those boundaries. Students should distinguish between continental crust and ocean crust. Students should also be able to label trenches, mid-ocean ridges, rift valleys, and mountain ranges. Make sure that part of the rubric is related to use of class time appropriately and keeping table space clean. Assign students a number to put on the back of their poster from a master list. Students should not put their names on their posters.	

Materials:
Poster Paper General Art Supplies

Day 6	**Instructional Strategies:** Technology, Role Playing
[This is to be used if students are on target in the learning plan. This lesson can be discarded if students are behind.]	
Show a video relevant to the topics of the	

unit. There are several sources online for such videos. The site www.hulu.com usually has at least a few that relate to plates and geologic events. Another site is http://earthquake.usgs.gov/learn/kids/ .	
Assignment: Students watch the video as if they were a teacher creating questions that students who are going to watch the video will have to answer. Students should consider what is important to know, what is nice to know, and what format will work best for the questions. Students should prepare a key for the questions. Have a rubric prepared to give to students to attach to their questions.	

Day 7	**Instructional Strategies:** Self Evaluation, Peer Evaluation, Technology, Reinforcing Effort & Providing Recognition
Allow some of the students to share what they thought were their best questions from the video assignment. Ask students how the video was relevant to what they are studying. Give students a few minutes to self-evaluate their questions based on the rubric. Collect the questions and rubrics.	
Pair or group students randomly and give posters to each group. If possible, the posters given to the students should not be from students in the same class.	
Give students copies of the rubric and have them evaluate the posters based on the rubrics. This should be timed so that students have to make decisions. Students should spend no more than ten minutes discussing a poster. Collect the posters and rubrics.	
Ask **"Since the plates are moving, where do you think the continents were a long time ago?"** Allow students to speculate on this. Some students may have heard of Pangaea. If they have, this is fine.	

Access www.scotese.com and load the interactive map of Pangea. As you slowly drag the mouse across the map, the continents will move to their present positions. Explore the maps available for the remainder of class. Provide students the web address and encourage them to explore the various maps at home.	

Day 8	**Instructional Strategies:** Providing Recognition, Cooperative Learning, Summarizing, Note Taking, Visuals, Models, Technology
Begin by handing students their maps and tape and allowing them to hang their work in the hallways near the classroom. They can now sign their names to their work.	
Place the term continental drift on the board. Ask students to write down in their notes what they think this means. Have students share their thoughts with a partner. Then have pairs share with pairs. Come to a consensus of a definition and put it on the board.	Add **continental drift** to the unit word wall and have students correct their definition as necessary.
Write the **theory of plate tectonics** on the board and ask students to copy it into their notes.	
Read about the evidence for the theory of plate tectonics from the student text and summarize each type of evidence in student notes.	
Sea floor spreading can be demonstrated with a simple paper model. The magnetic stripes can be modeled with iron filings and a bar magnet. Pass around a core sample.	
Assignment: Give students who do not have Internet access a copy of the Wikipedia article on Alfred Wegener. Students should read the article for homework.	

Materials:
Tape or Wall Adhesive Iron Filings Bar Magnet
Core Sample

Day 9	**Instructional Strategies:** Graphic Organizers, Reinforcing Effort & Providing Recognition, Movement, Writing, Drawing and Artwork
Use a graphic organizer to summarize the evidence that supports the theory of plate tectonics. A concept map is a good choice. Put the theory of plate tectonics in the middle circle. Have students complete the concept map using their texts and notes.	
Formative Assessment: Monitor student progress. As you see good maps, use the doc cam to allow students to share their maps with the class. If you see a map that seems to be disorganized, pair that student with a student who has a well-organized map.	
Reinforcing Activity: Assign students, or pairs of students, the name of a country or continent. Tell students to organize themselves into the supercontinent Pangaea. Then tell them to SLOWLY move to their present positions in the world today. This models the theory of plate tectonics and continental drift.	
Assignment: Ask students to write a newspaper article, poem, or draw a comic strip about what happened to Alfred Wegener when he proposed the idea of continental drift. Provide a rubric for evaluation.	

Day 10	**Instructional Strategies:** Demonstrations, Models, Note Taking, Think-Pair-Share, Brainstorming
Give students an article about an earthquake in the immediate area. These happen with fair frequency in Colorado (small ones), so use an article that is most recent to the date of the lesson. As an alternative, use an article about a big earthquake. Ask students to read the article silently and underline anything they find interesting. Allow students to share for a few minutes with each other and then the class.	

Ask if any students know what a fault is. Come to a consensus about what a fault is and write the definition on the board.	Place the word **fault** on the unit word wall.
Explain to the students that there are three types of faults they will need to know – normal faults, thrust faults, and strike-slip faults.	Add **normal fault**, **thrust fault**, and **strike-slip fault** to the unit word wall.
Use foam blocks painted with stripes to represent sedimentary layers of rocks to demonstrate each type of fault.	After explaining each fault, have students draw a diagram in their notes of the fault.
Formative Assessment: Pass around the foam blocks. As each student gets them, ask students to demonstrate one of the faults with the blocks.	
Ask **"What do we call the movement along a fault?"**	Elicit the answer and place the term **earthquake** on the word wall. Have students write a definition in their notes.
Read in the student text about how mountains form. Discuss this, but do not demonstrate.	
Assign students to groups of three or four, assigning appropriate roles such as group sheriff and group recorder (one way to do this is to use a deck of cards and have particular suits associated with particular roles) and have them brainstorm what they would need to put in an earthquake survival kit. Have them put their lists in their notes.	
Assignment: Create a demonstration for one of the ways mountains, valleys, or plateaus form.	

Materials:
Foam Blocks

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Day 11	**Instructional Strategies:** Projects, Demonstrations, Writing
Ask students to give you their top five items for an earthquake survival kit. Compile a list as long as there are students in the class.	Assign each student to bring one item to class to place in a box that will be their class survival kit. Students will have their items returned at the end of the unit.
Ask **"How do you think the ground**	

moves during an earthquake?" Let students discuss this for a few minutes. Use a metal or plastic coil toy to model two types of waves – P waves and S waves. Use a sheet of paper or a large towel to model the surface waves.	
Formative Assessment: Allow students to present their demonstrations of mountains, valleys, or plateaus.	
Assignment: Students should write a reflection about their demonstration presentation and evaluate their own understanding of how plate movement forms mountains.	

Materials:
Coil Toy Large Towel

Day 12	**Instructional Strategies:** Project, Technology, Note Taking, Demonstration, Independent Reading
Collect items for the earthquake survival kit. Allow a few students to read their reflections before collecting them.	
Show a video of a news story about a volcanic eruption. A short search on Google will lead you to several options.	
Ask **"What exactly is a volcano?"** Allow the students to brainstorm.	If they do not come to a formal definition, provide one, write it on the board so that students can put it in their notes, and add **volcano** to the word wall.
Ask "Where do you think volcanoes form?" Have students mark volcanoes on their world maps. Point out the Ring of Fire and island chains.	
Ask **"How did the Hawaiian Islands form?"** To demonstrate this, use a small eye dropper with red colored water and a piece of blue paper. Have a student pull the paper slowly across a surface as another student drops liquid slowly onto the paper. Explain that such an underwater volcano is called a hot spot and that hot spots occur under land too,	

such as at Yellowstone.	
Assignment: Students should read in the student text about volcano landforms and define each in their notebooks using either words or a picture. Advise students they will have to use these notes in an activity tomorrow.	

Materials:

Eye Dropper Colored Water

Day 13	**Instructional Strategies:** Reinforcing Effort, Technology, Note Taking, Visuals
Allow students to add the landforms to the word wall.	
Use a power point presentation to show the students the various volcanic landforms.	
Formative Assessment: Have students use the notes they took as an assignment to try and identify the landforms as they appear in the slideshow. Have students check to see how they did. Collect these.	
Go back through the power point presentation, explaining each picture and allowing students to correct their notes or drawings in their notebooks.	
Assignment: Make sure notebooks are complete. Collect all assignments and handouts together with the notebooks if they have strayed.	

Day 14	**Instructional Strategies:** Self-Evaluation, Writing
Summative Assessment: Give students the notebook evaluation rubrics. Students may use only what they brought to class to evaluate their notebooks. Students will assign themselves a grade and write a paragraph explaining why they deserve the grade they are assigning themselves. Allow no longer than 20 minutes for this activity.	
Summative Assessment: Give students their pretests. Ask them to write a letter to you assigning themselves a subjective grade based on what they feel they have learned. They must explain what they have learned that they didn't know before. Tell them that this grade will count as an assessment grade, but that if you disagree with the grade, you will have a conference with the student so that you can come to an agreement about what the grade should be.	
Assignment: Study for the Objective Assessment	

Day 16	
Debrief students on the objective post test. Celebrate!	
Allow students to bring a treat • Earthquake cake is fun – that's a cake that's been shaken up • Lava pudding (Pudding that's been colored orange) Allow students to watch a content-appropriate video with no assignment attached.	

Curricular Resources:

Barnes-Svarney, Patricia and Thomas Svarney. *The Handy Geology Answer Book*. Detroit: Visible Ink Press, 2004.

The Complete National Geographic: Every Issue Since 1888. DVD format, 2009.

Daily Warm-Ups: Earth Science. Portland, Maine: Walch Publishing, 2002.

http://education.usgs.gov/ (An **awesome** site with maps, lectures, lessons, activities, and other things that could be used for teaching, enrichment, reteaching. Particularly nice is the copyright-free images.)

http://en.wikipedia.org/wiki/Alfred_Wegener

Padilla, Michael et al. *Inside Earth*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

Scotese, C. R., 2002, http://www.scotese.com (PALEOMAP website).

Unit Name: Geologic Time

Graduate Expectation: Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet.

Grade Level Expectation: Geologic time, history, and changing life forms are indicated by fossils and successive sedimentation, folding, faulting, and uplifting of layers of sedimentary rock.

Essential Question:

- How does the geologic record form, and what does it indicate about geologic time, history, and changing life?

Instructional Questions:

- How are fossils formed?
- What do fossils tell us about the evolution of life and environments of the past?
- How do scientists determine both relative and absolute geologic time?
- How is the geologic record divided, and why is it divided that way?

After Instruction Students Will:

Understand:

- That the geologic record explains how life and environments evolve.
- That gaps in the geologic record exist but are not a reason to reject the rest of the geologic record.
- That humans have been on Earth for a very short time, geologically speaking.

Know:

- How fossils form.
- How scientists use relative and absolute dating to determine the age of rocks and the fossils the rocks contain.

Be Able to Do:

- List the geologic eras in order.
- Explain characteristics of at least one period.
- Distinguish between the categories of fossils.

Learning Plan

Day 1	
Administer pretest to determine readiness and what students already know. Although this is the first instructional day of the unit, pretest should take place several days before unit begins.	

Day 2	**Instructional Strategies:** Note Taking, Models, Demonstrations, Cooperative Learning, Demonstrations, Graphic Organizers
Pass around fossils and ask **"How do you think a fossil forms?"**	
Have students record their ideas in their notebooks for a few minutes. Then have students trade notebooks and read what another student thought. Have students repeat this with another student's ideas.	
Ask student if any of the ideas that they read were particularly good. Allow a few students selected by their classmates to read what they wrote.	
Take a mold for Play-Doh and ask **"What would you call this?"**	Be sure that students come up with the word mold. If they don't, prompt the response.
Stuff the mold with Play-Doh. Unmold the Play-Doh and ask **"If this comes out of the mold, what do we call it?"**	Elicit the response cast if students do not volunteer it. Have students add mold and cast to their notes and define these terms in their own words. Add these words to the unit word wall.
Formative Assessment: Have a few students read their definitions. Correct as necessary and allow students time to make corrections in their notes.	
Choose a student randomly. Give the student modeling clay and a small container. Ask the student to warm up the clay in his hands and then to press the clay into the bottom of the container.	
Choose another student randomly and allow the student to choose an item from	

which to make a fossil.	
Spray the clay with non-stick cooking spray. Allow a student to press the fossil into the clay. You may want to have spoon handy.	
Remove the item, mix the plaster of paris, and pour it over the clay. Set this aside for tomorrow's class.	
Assign students to read about how bone fossils form in student text.	
Assignment: Write a good definition for fossil. Create a flow chart explaining how bone becomes a fossil.	

Materials:

Plaster of Paris
Non-Stick Cooking Spray
Modeling Clay
Play-Doh
Petrified Wood
Leaves, shells, feathers, dead insects
Small Containers
Ammonite Fossil, Coprolite (or other fossil)
Molds for the Play-Doh

Day 3	**Instructional Strategies:** 1-2 Cards, Note Taking, Graphic Organizers, Visuals, Reinforcing Effort & Providing Recognition, Models
Pop out carefully the fossil.	
Formative Assessment: Have students use 1-2 cards to show you they understand which item is the mold and which is the cast. Pass the cast around so all the students can see it.	
Ask randomly chosen students to share their definition of fossil.	After establishing a good definition, write the definition on the board, have students write it in their notes, and add fossil to the word wall.
Create a class flow chart for how a bone becomes a fossil. Post the chart in class.	Optional: Allow student volunteers to provide graphics for the chart.
Show students clip of Jurassic Park with the mosquito in the amber. Ask **"Is this a fossil?"** Allow students to have a brief class discussion.	As students are discussing which of these things are fossils (they all are, of course) remind them of what they decided the best definition of a fossil was.
Show students the Picketwire Canyon dinosaur tracks. Ask **"Are these fossils?"**	

Allow students to have a brief class discussion.	
Pass around a piece of petrified wood. Ask **"Is this a fossil?"** Allow students to have a brief discussion.	
Show students a picture of a carbon fossil. Ask **"Is this a fossil?"** Allow students to have a brief discussion.	Add trace fossils, petrified fossils, preserved remains, and carbon fossils to the unit word wall.
Have student groups create a four square chart on chart paper. In each square, place one of the fossils that you asked about. Students should write a few sentences for each explaining how they formed	Students may need to refer to the student text or supplementary texts to find out how to explain these fossils.
Formative Assessment: Have each group report on one section of their chart. Check that the other sections of the chart are filled in correctly. Post the completed charts.	
Pass around the coprolite. Ask students to speculate what kind of fossil it is. Tell them you will tell them tomorrow what kind of fossil it is.	

Materials:
Chart Paper Markers Petrified Wood
Photographs of Picketwire Canyon Dinosaur Tracks and a Carbon Fossil
Coprolite

Day 4	**Instructional Strategies:** Humor, Note Taking, Brainstorming, Demonstrations, Writing
Ask students what kind of fossil the coprolite was. Allow them to speculate, and then tell them what it is. Give them a minute to stop "ewwwwing."	
Ask **"Can you think of anything else that might preserve remains besides what you have already learned about?"**	Make sure that students include ice, tar, peat, mummification, bogs. Have the students put the list in their notes.
Set up a table with quarter sheets of numbered papers. Have a simple shape that doesn't resemble anything specific on the top sheet. Choose a student at random and ask them privately to go back to the	This is a version of the telephone game, or the gossip game, only on paper. If this can be repeated with multiple classes, it can show how a recent common ancestor might evolve into very different species

table and carefully draw the shape on the paper marked 2 and to bring you the original when finished. Repeat this process with each student in the class as the class is progressing.	over time.
Ask **"If you found a fossil, what would you want to know about it?"** Allow a class discussion for a lengthy amount of time, and record student responses on chart paper. Post.	
Assignment: Hand out a sheet that shows preserved tracks. Several sets of tracks should be small. One set should be larger. The larger set and the one of the smaller sets should go around for a brief time and then the larger set should go off alone. Ask students to write a report explaining what happened as if they were a scientist that had come across these fossilized tracks.	

Day 5	**Instructional Strategies:** Reinforcing Effort & Providing Recognition, Models, Summarizing, Note Taking
Allow a few students to share their paragraphs. Have student drawn shapes posted across the board in the order that they were drawn.	
Point to the first and last shapes. Ask **"Do these look like they could be related?"** Allow student responses. Try to get students to say that they are related by the drawings that were between them.	
Remove three or four of the drawings from various points in the line of drawings. Ask **"Does the fossil record for this organism still make sense, even with a few drawings missing?"**	
Tell students that this is a model that demonstrates the fossil record for an organism. It shows how an organism can change over time and how fossils can show that, even if there are gaps in the fossil record.	Add **fossil record** to the unit word wall and have students define it in their notes.

Ask "Does anyone know what it is called when an organism changes over time?"	Add evolution to the unit word wall and have students define it in their notes.
Ask "Does anyone know what it is called when an organism ceases to exist?"	Add extinct to the unit word wall and have students define it in their notes.
Have students read about the fossil record in their text.	
Assignment: Write a summary of the book material read.	

Day 6	**Instructional Strategies:** Writing
Summative Assessment: Students will write an essay that answers the first two Instructional Questions. Give students rubric for essays. Students will have class time to work on this essay, but if it is not finished, students should complete the essay for homework. Students should be encouraged to use their notes.	

Day 7	**Instructional Strategies:** Models, Demonstrations, Identifying Similarities and Differences, Movement, Graphic Organizers, Drawing and Artwork, Writing, Note Taking
Have a box full of papers from the year under the document camera. Tell students that the box has in it documants that you have been putting in it since the beginning of the school year, and you are looking for a memo from September. Ask "Where do you think that memo is?"	Get students to articulate that it should be near the bottom of the box.
Ask **"Where do you think the memo I got last week is?"**	
Explain that the principle demonstrated by the box of papers is the law of superposition. Ask **"How do you think this applies to fossils?"** Allow discussion.	Write law of superposition on the unit word wall and have students define the law in their notes.
Formative Assessment: Put up a photograph of a rock face where the layers are distinct. Use 1-2 cards to make sure students understand that the top rock layer is the youngest rock.	
Pull out a paper from the middle of the stack. Ask **"What can you tell me about the age of this paper?"**	Get students to articulate that the paper is older than the papers on top and younger than the papers on the bottom.

Tell students that this is called relative age.	Add relative age to the unit word wall and have students write the definition in their notes.
Formative Assessment: Have students put themselves in order by date of birth. Ask various students in the middle to express their age in terms of the people on their left and right. Ask the people on the ends **"If you were a layer of rock, would you be on the top or bottom?"**	
Ask **"Is there anything that could have happened to the box that might have made the relative ages of the papers mixed up?"** Take a few student responses.	
Ask **"Is there anything that might cause layers of sedimentary rock to get mixed up?"** Ask students to write down a few ideas in their notes.	
Explain what an unconformity is. Model this using sheets of colored paper	Have students diagram an unconformity in their notes, using colored pencils or crayons to show the layers of rock. Add **unconformity** to the unit word wall.
Show a picture of the iridium line at Trinidad Lake State Park. Explain what this line is.	
Explain to students what an index fossil is.	Add **index fossil** to the unit word wall and have students define it in their notes.
Assignment: Find a drawer or box at home and explain in a paragraph how the content does or does not follow the law of superposition.	

Materials:
Box of Papers Stack of Multi-Colored Paper

Day 8	**Instructional Strategies:** Reinforcing Effort, Notetaking, Demonstrations, Identifying Similarities and Differences, Graphic Organizers
Allow a few volunteer students to read their paragraphs.	
Ask several students **"How old are you exactly?"** Explain that when scientists want to know the absolute age of fossils, they use scientific methods.	Add absolute age to the unit word wall and have students define it in their notes.

Have students do the doubling penny for twenty days, expressing the number of pennies rather than a dollar amount.	
Ask **"If you know that something has been doubling every day and you know how much you have, could you figure out how many days it has been doubling?"**	
Formative Assessment: Ask several students about several specific amounts and have them come up with how many days doubling occurred.	
Tell students that some elements in nature behave like the doubling penny, but in reverse. Tell students that this is called radioactive decay, and the time it takes for half of a radioactive substance to decay is called a half-life, and scientists use this to determine how old rock is, and so the fossils in it.	
Demonstrate this using a large brownie under the doc cam. Trace the brownie on a paper. Tell them that the half-life of the brownie is exactly one minute, and that as brownies get old, they become sponges. After one minute, cut the brownie in half, replace it with a piece of sponge, and give the brownie to a random student. After another minute, cut the brownie in half again and give it to another student. Repeat this for several minutes.	
Formative Assessment: Before you distribute the brownie pieces, ask the student how old the brownie is.	
Assignment: Create a Venn diagram comparing relative age and absolute age.	

Materials:
Brownies Sponges Knife

Days 9 – 11	**Instructional Strategies:** Demonstrations, Models, Drawing and Artwork, Cooperative Learning, Note Taking, Projects, Reinforcing Effort & Providing Recognition, Self-Evaluation

Using a ream of paper + 44 sheets, divide the ream into bundles that represent the number of years each of the periods endured. Stack 8 reams to show how long ago the Precambrian Era endured. Rip off a small corner to show how long humans have been on Earth. Label each and leave displayed in the class. You can also do this with rolls of toilet paper (1000 sheet rolls work best and may be easier to display).	
Allow students to draw periods. There are twelve of them, which should work out well for an average class. Give students a piece of butcher paper color-coded for the eras. Each student will be responsible for creating a part of a large poster over the next two days. Students should use texts and class resources to create their strip of geologic history. It should contain information about changes in geology and life. Give students a rubric for evaluation of their strip.	
On the third day, students will combine their strips to create a complete picture of geologic time. Each student will present his strip to the class. Display these.	
Students should take notes over student presentations.	
Assignment: Students should evaluate their own work in a paragraph explaining what grade they have earned and justifying the grade.	

Materials:
Butcher Paper of Various Colors, Cut Into Strips
Various Art Supplies

Day 12	**Instructional Strategies:** Questions, Mnemonic Devices, Providing Recognition
Complete student presentations, if necessary.	
Ask **"Why is the end of each of the**	

periods where it is?" Elicit answers including mass extinctions, changing life forms, changing geology.	
Assignment: create a mnemonic device for remembering the eras. In each group, students should choose the one they want on their geologic timeline. Allow students to write the mnemonic device across the timeline.	
If time permits, allow students to watch an appropriate video.	

Day 13	**Instructional Strategies:** Self-Evaluation, Writing
Summative Assessment: Give students the notebook evaluation rubrics. Students may use only what they brought to class to evaluate their notebooks. Students will assign themselves a grade and write a paragraph explaining why they deserve the grade they are assigning themselves. Allow no longer than 20 minutes for this activity.	
Sumative Assessment: Give students their pretests. Ask them to write a letter to you assigning themselves a subjective grade based on what they feel they have learned. They must explain what they have learned that they didn't know before. Tell them that this grade will count as an assessment grade, but that if you disagree with the grade, you will have a conference with the student so that you can come to an agreement about what the grade should be.	
Assignment: Study for the objective assessment.	

Day 14	
Summative Assessment: Administer the objective post test.	
Conference with any students who did not assign themselves an appropriate grade on the subjective self-assessment.	

Day 15	
Debrief students on the objective post test.	
Celebrate: Something to do with dinosaurs!	

Curricular Resources:

Barnes-Svarney, Patricia and Thomas Svarney. *The Handy Geology Answer Book*. Detroit: Visible Ink Press, 2004.

Chronic, Halka and Felicie Williams. *Roadside Geology of Colorado*. Missoula, MT: Mountain Press Publishing Company, 2002.

The Complete National Geographic: Every Issue Since 1888. DVD format, 2009.

Daily Warm-Ups: Earth Science. Portland, Maine: Walch Publishing, 2002.

Dixon, Dougal. *The Practical Geologist*. New York: Simon and Schuster, 1992.

http://geology.er.usgs.gov/paleo/eduinfo.shtml (Educator Resources for Paleontology from the USGS)

Kardos, Thomas. *Easy Science Demos & Labs*. Portland, ME: Walch Publishing.

Padilla, Michael et al. *Earth's Changing Surface*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

Unit Name: The Solar System

Graduate Expectation:

"Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet." (Colorado Department of Education)

Grade Level Expectation:

"The solar system is comprised of various objects that orbit the Sun and are classified based on their characteristics." (Colorado Department of Education)

Essential Question:

- What are the elements of the solar system and how are they classified?

Instructional Questions

- What tools do scientists use to study the solar system and beyond?
- What are the basic characteristics of the planets in our solar system?
- What are asteroids and comets and how have they shaped Earth?
- How do scientists think the solar system formed?
- What is beyond the eight planets?
- What will happen to the Sun as it gets old?

After Instruction Students Will:

Understand:

- The general proportion of sizes between the planets and the sun and the proportional distances between the objects of the solar system
- That scientists use a variety of tools to explore the solar system and space beyond the solar system
- That stars experience a life cycle
- That asteroids and comets have varying compositions and orbits and that it is important to find and track these objects

Know:

- The names of the planets in order from the Sun out and their basic characteristics
- How an optical telescope works
- Who Galileo, Copernicus, and Kepler are and what they contributed to astronomy
- The shape of an orbit
- The similarities and differences between comets and asteroids
- The life cycle of the Sun

Be Able to Do:

- Identify similarities and differences among the planets
- Use technology to observe the motion of objects in the solar system
- Use a telescope, binoculars, or the naked eye to observe an object in the night sky
- Model impact craters, comets, and the solar system

Learning Plan (Including Instructional Strategies:

Day 1	
Administer pretest to determine readiness and what students already know.	
Show students a view of the night sky using the projector and *Stellarium* software (available free online).	
Assignment: Read section in textbook concerning the eight planets.	

Day 2	**Instructional Strategies:** Note Taking, Discussion, Mnemonic Devices, Providing Recognition, Identifying Similarities
Ask **"What is a planet?"** Allow students to use resources to find the definition that excludes Pluto. Be prepared to discuss what a dwarf planet is.	Add **planet** to the unit word wall and have students put the class definition in their notes.
Ask **"What are the names of the planets from the sun out?"** Have students write this list in their notes and share with a partner. Choose a student at random to provide a list.	Write the list on the board and underline the first letter of each of the planets. Label the list "**From the Sun Out**."
Ask **"What are the names of the planets from the smallest to the largest?"** Have students write this list in their notes and share with a different partner. Choose a student at random to provide a list.	Write the list on the board and underline the first letter of each of the planets. Label the list "**From Smallest to Largest**."
Assignment: Explain to students that they are going to create a mnemonic device for remembering these lists. Give students time to complete the task.	
Place students in groups of four and have them share their mnemonic devices for each of the lists. Students should choose the best mnemonic device for each list from their group and write it on the board.	Allow students to vote on which is the best mnemonic device in the class, and allow each of those people to create a poster of their mnemonic device to post in the room.
Ask **"What kinds of things would you use to describe a person to a detective?"** Allow students to brainstorm and write all ideas on the board.	
Ask **"Would these apply to a planet?**	After this activity, you may want to

What kinds of things would you use to describe a planet to a scientist?" Allow students to modify elements of the list, strike items, and add items as necessary until the class has a good list of characteristics of the planets that they would like to know.	prepare "Planet Detective Notebooks" that consist of a cover sheet (with the list of characteristics) and four sheets of paper, cut in halves or quarters. Students can assemble these into whatever shape notebook they wish and decorate the covers as they like over the next two days.

Materials Needed:

Paper General Art Supplies

Days 3 and 4	**Instructional Strategies:** Projects, Note Taking, Research, Writing, Self-Evaluation
Assignment: Students should use classroom and web resources to fill in their "Planet Detective Notebooks."	Add **gas giant** and **terrestrial** to the unit word wall.
Formative Assessment: At the end of Day 4, have students number as sheet of paper from 1 to however many students are in the class and hand each student a numbered index card with a description of a planet written as if it were the description of a criminal that a detective was looking for. Students should identify the planet on a sheet of paper next to the number of the index card. After an appropriate time, have students pass the cards in a proscribed rotation and repeat the activity as many times as you feel is necessary.	
	As students are completing their assignment, periodically ask random students to share out some information that they have located.
Summative Assessment: Assign students to write a reflection of their learning on the final page of the Planet Detective Notebook with a grade assignment and a justification for the grade. Students should turn in their Planet Detective Notebooks.	
	Choose a few of the outstanding notebooks to display copies of and display a correct identification chart of the index card descriptions for students.

Day 5	**Instructional Strategies:** Models, Modeling
Ask **"How far is it from goal to goal on a football field?"** (At least a few students will know that it is 100 yards, or 300 feet.)	

Hand out a paper model of a football field. Have students write "SUN" at one end and "NEPTUNE" at the other. Ask students to divide the football field in half lengthwise. Have students to put the planets where they think they would go and draw circles to represent the correct sizes of the planets on the top half of the divided football field. Give students enough time to complete this on their own.	
Put several interpretations under the doc cam to examine.	Do not comment on the rightness or wrongness of these diagrams.
Hand out a table of the planets with columns for the distance from the sun, scaled distance from the sun, diameter, and scaled diameter. Have students fill out the columns for the distance from the sun and the diameter. The units don't matter, as long as the class all used the same units.	
Work through the proportions that will scale the distances and diameters to fit the football field.	Students may or may not be able to write and solve proportions on their own. After you do a few of them with the students, they will likely be able to repeat the procedure, even if they don't understand why.
Assignment: Complete the table for class tomorrow.	

Day 6	**Instructional Strategies:** Models, Movement, Demonstrations, Drawing
Take students to the football field.	
Using balls for the planets (I recommend from smallest to largest – large marble, golf ball, 2 baseballs, 2 volleyballs, large bouncing ball with hula hoop, large beach ball.)	
Put students in a large circle about 22-24 feet across (depending on if you are using a 22" or 24" beach ball to represent Jupiter) to represent the Sun. Have students call	Although these will not be perfect proportions, the smallest balls represent the terrestrial planets and are solid. The volleyballs and balls for Jupiter and Saturn

out the planets and throw them the balls corresponding to the planets.	are filled with air and represent the gas giants.
Take a 300 foot string to represent the length of the football field. Have washers hanging from the string at the appropriate places with wire or beads glued to the washers to represent the sizes of the planets. A quarter is about the size of the sun for this activity.	You may want to have students help you prepare this ahead of time or offer extra credit for students who locate items that demonstrate planet diameter. Jewelry wire and small beads are good fits and can be easily stuck to the washers with a glue gun. You may want to paint the washers ahead of time so the wire and beads will show up.
Introduce the Main Belt, the Kuiper Belt, and Pluto, if a discussion of dwarf planets has not already occurred in response to student questions. Be prepared to answer the question of where the nearest star is (from Trinidad, CO, the nearest star would be in Wyoming).	
Assignment: Complete the bottom half of the football field with the correct locations and circle sizes for the planets. Handout reflective fake e-mail for students to respond to.	

Materials

300 Feet String	8 Washers	Jewelry Wire, Various Gauges
Small Jewelry Beads	Quarter	Beach Balls, one Slightly Smaller
Hula Hoop	2 Volleyballs	2 Baseballs
Golf Ball	Large Marble	

Day 7	**Instructional Strategies:** Models, Note Taking, Identifying Similarities, Technology, Drawing
Formative Assessment: Ask students to share their questions and observations from the activity.	
Ask **"What is a telescope? How do you think a telescope works?"** A formal definition is not important.	Add **telescope** to the unit word wall.
Put up on the projector a picture of an eye and how it works. A very good site is www.stargazing.net/naa/scope2.htm, which not only describes the eye but also	

applies the principles to optical telescopes.	
Tell students that they will have to compare the optical telescopes. After reading through the material on the site, encouraging students to draw diagrams and take notes as they read, provide students a handout of the text.	Add **reflecting telescope** and **refracting telescope** to the unit word wall.
Assignment: Create a Venn diagram comparing reflecting and refracting telescopes.	
Display half of a Galileoscope under the doc cam and point to parts. Ask students randomly to identify the parts based on their notes and Venn diagrams.	
Show students a reflecting telescope. Point to parts of the telescope and ask students to identify them based on their notes and Venn diagrams.	
Formative Assessment: Using a white board, elicit responses to the following questions. Ask "What kind of 'telescope' are binoculars most like?" Ask "What kind of 'telescope' is your eye most like?" Ask "What kind of 'telescope' is a periscope on a submarine most like?"	
Show some pictures of objects is space taken by the Hubble telescope on the projector. Explain that Hubble is a reflecting telescope. A good source for images is http://apod.nasa.gov/apod/	

Materials:
Gallileoscope or Other Refracting Telescope Reflecting Telescope

Day 8	**Instructional Strategies:** Similarities and Differences, Technology
Ask **"How do doctors look at your bones?"**	
Tell students that astronomers use X-rays to look into space. Visit http://chandra.harvard.edu. Allow students to guide the exploration of the site.	
Ask **"How do we see things in the dark?"**	
Tell students that astronomers use the	

same idea to look into space. Visit http://coolcosmos.ipac.caltech.edu . Allow students to guide the exploration of the site.	
Tell students that astronomers also use radio telescopes to look into the night sky. Visit http://www.nrao.edu/ Allow students to guide the exploration of the site.	

Day 9	**Instructional Strategies:** Summarizing, Graphic Organizers, Similarities and Differences, Providing Recognition, Drawing
Give students biographies of Galileo, Copernicus, and Kepler. Assign students to groups of three, with each student responsible for one astronomer.	
Students should read and highlight their biographies and then work with other members of their group to create a Venn diagram or table summarizing the similarities and differences in the lives and astronomical contributions. Students should share these summaries of information with other groups as groups are finished.	
Formative Assessment: After all groups are finished, each group should take turns contributing to a class Venn diagram. Post this class diagram in the class.	
Close class with a demonstration of the difference between a circular orbit and an elliptical orbit. This can be done using tape and string. Explain to students that mathematical equations can be used to predict the paths of objects in space.	Add **elliptical orbit** to the unit word wall.

Materials:

Poster or Butcher Paper General Art Supplies

Day 10	**Instructional Strategies:** Models, Technology, Note Taking, Experiments, Writing
Display a model of the orbits of the solar system using http://ssd.jpl.nasa.gov/. It's fun to showcase an asteroid like Apophis and Earth as kids are coming in the room.	
Ask **"What do you notice about the orbits of Earth and Apophis?"**	
Ask **"Why do you think that astronomers are tracking asteroids like Apophis?"**	
Ask **"What is an asteroid?"** Have students write their own definitions in their notes and then share. Come to a class definition and write it on the board. Allow students to correct their definitions.	Add **asteroid** to the unit word wall.
Ask **"What do you want to know about asteroids?"** Have students write three questions in their notes.	
Ask **"What is a cannon ball in a swimming pool?"**	
Ask **"What do you think makes the splash of a cannonball bigger or smaller?"**	
Show students several objects. (Large beads work well for smaller objects as a thread can be attached to them to remove them after they are dropped.) Show students a flat bin with flour in it.	
Ask **"What do you think will happen when this object is dropped into the flour?"**	
Give students a lab sheet. Various students will be asked to drop objects from various heights. The lab sheet should have columns for mass, diameter, height dropped, depth of crater, distance of splatter.	
Assignment: Complete lab questions.	

Materials:

25 Lbs Flour	Dry Tempera Paint	Various Objects
Ruler	Thread	

Days 11 & 12	**Instructional Strategies:** Analogies, Note Taking, Models, Research, Providing Recognition, Drawing
Ask **"How is a snowball like a rock?"**	
Write the analogy on the board: "A comet is to an asteroid as a snowball is to a rock."	
Ask **"What is a comet?"** Have students write a definition in their notes and share with a partner. Have students self-check their definitions with their text.	Add **comet** to the unit word wall.
Assign students to read about comets in the student text. Ask **"What is in a comet?"**	
Make a comet model under the doc cam. Let students bash the dry ice with a hammer under strict supervision. Use a hair dryer on a low setting, or better set the comet near a cracked window to simulate one of the tails. Encourage students to check on the comet throughout the day.	Add the parts of a comet to the word wall as they are discussed, including **coma**, **nucleus**, and **tail**. Have students define these in their notes or draw a diagram to explain these parts of a comet.
Ask students to write three questions in their notes that they would like to know the answers to about comets.	
If possible, take students to a computer lab so that they can research the answers to their questions. Help as necessary.	
Assignment: Answer the questions you asked about comets and asteroids. Students will have to share these questions and answers with the class. Give students a day to do any additional research to answer their questions. On the last half of the second day have students present their two best questions and answers to the class. If no students discuss how comets and asteroids have shaped Earth's surface, be prepared to discuss this with students.	

Materials:

Ammonia	Dirt	Water
Dry Ice	Hair Dryer	Gloves
Garbage Bags	Hammer	Towels
Goggles	Pancake Syrup	Spoon and Plate

Day 13	**Instructional Strategies:** Role Playing, Brainstorming, Technology
Ask **"What do you know about stars?"** Allow students to brainstorm in small groups for five minutes. Go around by groups adding information to the board until no new ideas are left.	
Assignment: Students are to pretend to be a teacher and write questions for a video that their students are going to watch. Give students written directions and a rubric for determining their grade after the activity.	
Play video "Life and Death of a Star" Season 1 Episode 10 of *The Universe*	
Homework: Write three questions that the video did not answer about stars. How would you find the answers to these questions?	

Materials:

Video (At the time of writing, it is available at www.hulu.com/watch/95019/the-universe-life-and-death-of-a-star.)

Day 14	**Instructional Strategies:** Analogies, Demonstrations, Summarizing
Have students share their questions and research strategies with each other. Ask **"Are all your questions answerable?"**	
Ask **"How did all the stuff in space become stars and planets anyway?"** Allow students to speculate.	
Put a clear glass bowl with a couple of inches of water in it under the doc cam. Sprinkle a small handful of herbs (summer savory works well) on the water and observe what happens.	
Add pepper to the bowl and watch what happens. Stir the mixture several times	

clockwise and observe what happens.	
Have students read p. 10-13 of *The Practical Geologist* and the section of the student text on the formation of the Solar System.	
Formative Assessment: Ask students to write an analogy comparing one aspect of the theories to something in real life. Tell students they may not use the example you already showed them. Have students share these analogies with the class.	
Assignment: Summarize the theories about how the Solar System formed. Either defend or criticize one of the theories about the formation of the Solar System. Give students a rubric for self-evaluation.	

Materials:

Glass Bowl	Summer Savory
Pepper	Spoon

Day 15	**Instructional Strategies:** Self Evaluation, Writing
Summative Assessment: Give students the notebook evaluation rubrics. Students may use only what they brought to class to evaluate their notebooks. Students will assign themselves a grade and write a paragraph explaining why they deserve the grade they are assigning themselves. Allow no longer than 20 minutes for this activity.	
Summative Assessment: Give students their pretests. Ask them to write a letter to you assigning themselves a subjective grade based on what they feel they have learned. They must explain what they have learned that they didn't know before. Tell them that this grade will count as an assessment grade, but that if you disagree with the grade, you will have a conference with the student so that you can come to an agreement about what the grade should be.	
Assignment: Study for the objective assessment.	

Day 16	
Summative Assessment: Administer the objective post test.	
Conference with any students who did not assign themselves an appropriate grade on the subjective self-assessment.	

Day 17	
Debrief students on the objective post test. Celebrate!	
Allow students to bring a treat . • Moon pies would be fun.	
Allow students to watch a content-appropriate video with no assignment attached. I'll bet they want to watch one about black holes. An alternative would be to explore the constellations and stories about the constellations. *Stellarium* software could be explored.	

Curricular Resources:

Barnes-Svarney, Patricia and Thomas Svarney. *The Handy Geology Answer Book*. Detroit: Visible Ink Press, 2004.

The Complete National Geographic: Every Issue Since 1888. DVD format, 2009.

Dixon, Dougal. The Practical Geologist.

Fraknoi, Andrew, ed. *The Univereo at Your Fingertips: An Astronomy Activity and Resource Notebook.* San Francisco: Astronomical Society of the Pacific, 1995.

http://apod.nasa.gov/apod/

http://chandra.harvard.edu.

http://coolcosmos.ipac.caltech.edu

http://ssd.jpl.nasa.gov/

http://www.nrao.edu/

Liu, Charles. *The Handy Astronomy Answer Book*. Canton, MI: Visible Ink Press, 2008.

Padilla, Michael et al. *Astronomy*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

Rees, Martin, Ed. *Universe: The Definitive Visual Guide*. New York: DK Publishing, 2008.

www.hulu.com/watch/95019/the-universe-life-and-death-of-a-star

www.stargazing.net/naa/scope2.htm,

Unit Name: Water on Earth

Graduate Expectations:

"Describe how humans are dependent on the diversity of resources provided by Earth and Sun." (CDE)

Grade Level Expectation:

"Water on Earth is distributed and circulated through oceans, glaciers, rivers, groundwater, and the atmosphere." (CDE)

Essential Question:

- How is water distributed and circulated on Earth?

Instructional Questions:

- What is the distribution of water on Earth?
- Why can't humans use most of the water on Earth?
- How does water move through the water cycle, through oceans, and over land?
- What are some causes of pollution and what can be done about water pollution?
- Why should we be concerned about water quality?

After Instruction Students Will:

Understand:

- That most of the water on Earth is not drinkable water
- The importance of water conservation

Know:

- Causes and effects of water pollution
- Where drinking water comes from and where waste water goes
- How water is used by modern civilization

Be Able to Do:

- Draw, label, and explain the water cycle
- Explain the effects of droughts and floods
- Determine actions that an individual can take to conserve water
- Research water questions using web resources

Learning Plan (Including Instructional Strategies)

Day 1	
Administer pretest to determine readiness and what students already know.	
Assignment: Give students a printout of the USGS water on Earth information to read. (located at http://ga.water.usgs.gov/edu/earthwherewater.html) Students should write 5 inquiry questions based on what they read.	

Day 2	**Instructional Strategies:** Questions, Lab, Graphic Organizers, Writing
Have students share their inquiry questions in small groups in turn until all questions have been read. Have each group choose the two best questions and put them on chart paper and post them in the room.	Time will have to be made to answer any questions that are not already a part of the instructional unit. Addressing these questions could also be used for enrichment for advanced students.
Give students a copy of the lab. Each student group gets a 1,000 mL of water and test tubes of various sizes. Students will distribute the water in the test tubes according to the distribution of water they read about for homework.	
Students in each group should record the results on a graphic of the test tubes, labeling carefully.	
Formative Assessment: Monitor student groups for errors in measurement.	
Assignment: Write a reflection about what you learned from the lab.	

Materials:

1000 mL Beakers	Test Tubes	Test Tube Racks
mL Measuring Cylinders	General Art Supplies	

Day 3	**Instructional Strategies:** Graphic Organizers, Brainstorming, Note Taking, Projects
Formative Assessment: Have students draw two long bars. Have them divide the first bar into salt water and fresh water. Have students divide the second bar into the divisions for freshwater. Put student graphs under the doc cam and allow students to discuss them.	
Ask **"Why can't humans use most of the**	

water on earth?" Have students place a list of reasons in their notes. Ask students for their reasons one at a time until none are left. Record these reasons on paper and post in the room.	
Ask **"What might affect the water quality in an area?"** Allow students to brainstorm in small groups for four things that might affect water quality. Ask student groups to report out. Record these ideas on the board.	
Ask **"Which of these do you think apply to water where you live?"** Have students compile a list in their notes.	
Ask **"Is there a difference in drinking water quality and outdoor water quality? Explain."**	
Hand out water annual quality report (public water suppliers are required to provide this every year by July 1) to students and read it together.	Add **water quality** to the word wall and have students explain it in their notes.
Show website http://www.epa.gov/safewater/contaminants/index.html to research what is in the report.	
Assignment: Students should start collecting data on their personal water use at home. Give students data sheets to record water use for a period of seven days.	

Day 4	**Instructional Strategies:** Labs, Demonstrations, Discussion, Homework
You will have to have samples of local water (from a stream or lake) collected for class for today. Depending on whether adequate kit supplies can be purchased, some or all of the following can be done as demonstration rather than lab.	
Give students a short article on pH. An age appropriate one can be found at http://ga.water.usgs.gov/edu/phdiagram.html	Add **pH** to the word wall. Have students define it in their notes.
Give students a lab sheet. Students should carry out the instructions to test the pH of the water sample.	

Discuss the results as a class.	
Do a second test with tap water that has been sitting around for a week.	
Have students record their data on a class data sheet.	
Tell students that they are going to test for dissolved oxygen. Ask **"Why would a scientist want to test a body of water for oxygen?"**	
Do a demonstration to test for dissolved oxygen using a dissolved oxygen kit.	
Have students look up eutrophication and reword the definition in their own words in their notebooks. Have students share their definition with a partner.	Add **eutrophication** to the word wall.
Homework: Check the pH of the drinking water at home. Random students from various areas of town should also check the water temperature of the cold water faucet at a specific time under specific conditions.	
Discuss with students characteristics of temperature, turbidity, and hardness.	

Materials:
pH Test Strips Dissolved Oxygen Test Kit Thermometers

Day 5	**Instructional Strategies:** Note Taking, Brainstorming, Demonstration, Identifying Similarities and Differences, Diagrams
Ask **"How is water stored on earth?"** Allow students a few minutes of think time to record their ideas in their notes.	
Have students share their ideas one at a time until there are no ideas left. Record these ideas on the board. Tell students that they are going to study the water cycle today.	
Put the doc cam on a pan of salt water on a hot plate. Ask **"What part of water storage might the water in the pan represent?"**	
Ask **"What might the hot plate represent?"**	

After the water begins to steam, ask **"What process does the steam represent?"**	Have students define evaporation in their notes and put evaporation on the unit word wall.
Place a clear lid over the pan. Ask **"What is happening to the evaporated water when it hits the glass lid?"**	
Ask **"What is this process called?"**	Have students define condensation in their notes and put condensation on the unit word wall.
When the water on the lid becomes too heavy and drips back into the pan, ask **"What is the process called by which condensed water droplets fall?"**	Have students define precipitation in their notes and put precipitation on the unit word wall.
Create a generalization of the water cycle with only these three terms on them.	Have students put this general water cycle in their notes, leaving a lot of room to add other things to the diagram. Add **water cycle** to the unit word wall.
Formative Assessment: Have students draw small pictures on the parts of the water cycle to help them remember them.	
Collect the temperature readings from the class and plot them on a map of the city. Post the map. Collect all classes' temperatures on the same map.	
Have students find an average of the temperature and pH readings for the members of the class. Record this on chart paper next to the map.	
Assignment: Give students a copy of the water cycle from USGS site and one of the explanations. (There are 16 of them, so some students will be repeating.) Students will present the information in these to their classmates in class tomorrow. http://ga.water.usgs.gov/edu/watercyclehi.html	

Materials:

Hot Plate	Pan	Glass Lid
Water	Butcher Paper	Markers
City Map	Water Cycle & Explanations	

Days 6 & 7	**Instructional Strategies:** Providing Recognition, Cooperative Learning, Writing

Have students one at a time, in a logical order, put their part of the water cycle on a large piece of butcher paper. Allow five to ten minutes for students to complete preparations so that students who have the same item may work together. Students should explain their part of the water cycle and then go to the class computer and type one sentence about their section.	
When all students are finished, print a class set of the sentence descriptions and give one to each student. Students should copy the class water cycle into their notes.	This introduces several terms about how water cycles through Earth. Allow students to decide on the terms that should go on the word wall.
Assignment: Write a paragraph describing the water cycle in terms of local geological features. Give students a copy of an area map to help them, if they need it.	

Materials:
Local Maps Butcher Paper Markers

Days 8 & 9	**Instructional Strategies:** Drawing and Artwork, Writing, Role Playing, Storytelling, Projects, Self-Evaluation
Summative Assessment: Students should create a way to teach the water cycle to a younger student. Possibilities might include a story of a raindrop, a child's picture book, a skit to act out the water cycle, illustrations of the most important parts of the water cycle, etc. Encourage students to be creative. The assessment should include a five-question quiz with answers that students should be able to pass after using the teaching tool.	
Give students a rubric by which they will evaluate their assessments.	Remind students to bring their water use data tables tomorrow to class.
If time permits, demonstrate how water carves out a stream.	
Assignment: Evaluate the projects using the rubric tool.	

Materials:
General Art Supplies Stream Formation Apparatus

Day 10	**Instructional Strategies:** Technology, Research, Writing, Diagrams
Ask **"Where does drinking water come**	

from?"	
Ask **"Where does your drinking water come from?"**	
Ask **"What happens to used water after it leaves a house?"**	
Ask **"What happens to the water you use after it leaves your house?"**	
Take students to the computer so that they can do research on these questions to answer them.	While students are in the lab, have them enter their water use data from their tables into a spreadsheet.
Assignment: Answer the four questions using diagrams and / or paragraphs. Be sure to write down the web addresses where you are getting your information. Encourage students to use a web search engine to find information.	
If students finish these questions early, have them research how many gallons per minute the average shower uses, the average flush uses, and the average washing of hands uses. Students might also enjoy "Water Trivia Facts" at http://www.epa.gov/ogwdw000/kids/water_trivia_facts.html , or allow students to research an inquiry question that they haven't been able to answer yet in the unit.	

Day 11	**Instructional Strategies:** Writing
If possible, get guest speakers from the local water facilities to speak to the class. Have students take notes on the day's presentation.	
Assignment: Write a paragraph reflection on what you learned from the guest speaker.	
Make sure students sign a thank you note to the guest speaker(s).	

Day 12	Instructional Strategies: Labs, Writing, Homework
Demonstrate how water enters the ground using different materials in clear glasses and pouring water over them. Continue pouring water until the soil is saturated.	
Print out and copy data spreadsheets for students.	
Hand out data analysis question sheets.	
Assignment: (Allow students to work on pairs on the data analysis part of the sheet, but students should work alone on the reflection questions and conclusions.)	

Homework: Give students a copy of the graphs of trends in water use from http://ga.water.usgs.gov/edu/totrendbar.html , but without the summary explanations. Students should choose one of the graphs and explain in a paragraph what the graph indicates. To make sure all graphs are covered, you may want to have students draw letters for the graph they are to write about.

Day 13	**Instructional Strategies:** Discussion, Providing Recognition, Summarizing, Technology
Project each graph to the projector screen. Ask students who wrote about that graph to read their paragraphs. Allow a short discussion of each graph.	
Assignment: Divide students into groups of three. Give each group an article or two on water use. Have students read the articles and highlight the important items as individuals. Then, as a group, have students create a summary of the article.	
Visit sites www.dwr.state.co.us/surfacewater/default.aspx to investigate local stream and river conditions and compare them to 100 year averages.	

Materials:
Water Use Articles

Day 14	**Instructional Strategies:** Graphic Organizers, Writing, Homework
Ask **"What is worse, too much water or not enough water?"**	
Students should read in students texts about droughts and floods. Give students an incomplete outline that students should complete as they read and gather information.	
Assignment: Write an essay, using evidence to support your view, answering the question "What is worse, too much water or not enough water?"	
Give students the rubric they will use to evaluate their essays.	
Homework: Read in the student text about pollution of water.	

Day 15	**Instructional Strategies:** Reciprocal Teaching, Identifying Cause and Effect
Remind students that their essays will be due tomorrow.	This activity requires a little extra work, identifying magazine articles for students. If time permits, you may want to offer students the option of finding their own articles and then having on hand several articles for students who fail to find their own articles.
Give students reading level appropriate articles about water pollution.	Define **pollution** as a class and put the word on the unit word wall.
Assignment: For the article, identify the causes of the pollution, the effects of the pollution, and the possible solutions to the problem of the pollution.	
After about 30 minutes, have students pair with other students and share their article's content. Remind students that they will be reporting to the class on another student's article – NOT their own.	
Repeat this process at least two more times. Bring the class together.	
Formative Assessment: Call on students randomly to report on another student's article.	

Materials:
Level-Appropriate Magazine Articles

Day 16	**Instructional Strategies:** Discussion, Writing, Self-Evaluation
Allow students to discuss in groups a) what is worse, a drought or a flood and b) what should be done about water pollution.	Roles for group should be clearly defined so that every student is accountable for participation. Have a list of prompting questions ready for students who get stuck in discussion limbo – these can be on index cards that can be drawn randomly.
Assignment: All students must complete a discussion log for the group discussion.	
Formative Assessment: Every few minutes, stop discussions so that students can reflect for a few sentences on their logs. Allow two or three students to share each time.	
Students should spend the last five minutes reviewing their essays and using the rubric to evaluate them.	

Day 17	**Instructional Strategies:** Self-Evaluation, Writing
Summative Assessment: Give students the notebook evaluation rubrics. Students may use only what they brought to class to evaluate their notebooks. Students will assign themselves a grade and write a paragraph explaining why they deserve the grade they are assigning themselves. Allow no longer than 20 minutes for this activity.	
Summative Assessment: Give students their pretests. Ask them to write a letter to you assigning themselves a subjective grade based on what they feel they have learned. They must explain what they have learned that they didn't know before. Tell them that this grade will count as an assessment grade, but that if you disagree with the grade, you will have a conference with the student so that you can come to an agreement about what the grade should be.	
Assignment: Study for the objective assessment.	

Day 18	
Summative Assessment: Administer the objective post test.	
Conference with any students who did not assign themselves an appropriate grade on the subjective self-assessment.	

Day 19	
Debrief students on the objective post test.	
Celebrate: Taste tests of different types of water – Is water just water or not???	

Materials:

Mineral Water	Tap Water	Bottled Water
Distilled Water	Spring Water	Well Water
Lots of Little Paper Cups		

Curricular Resources

Barnes-Svarney, Patricia and Thomas Svarney. *The Handy Geology Answer Book*. Detroit: Visible Ink Press, 2004.

The Complete National Geographic: Every Issue Since 1888. DVD format, 2009.

Daily Warm-Ups: Earth Science. Portland, Maine: Walch Publishing, 2002.

http://education.usgs.gov/

http://ga.water.usgs.gov/edu/index.html

http://www.epa.gov/ogwdw000/kids/water_trivia_facts.html

http://www.epa.gov/safewater/contaminants/index.html

Kardos, Thomas. *Easy Science Demos & Labs*. Portland, ME: Walch Publishing. 2003.

Luhr, James, Ed. *Earth: The Definitive Visual Guide*. New York: DK Publishing, 2003.

Padilla, Michael et al. *Earth's Waters*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

www.dwr.state.co.us/surfacewater/default.aspx

Unit Name: Weather on Earth

Graduate Expectations:

"Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system." (CDE)

Grade Level Expectation:

"Weather is a result of complex interactions of Earth's atmosphere, land, and water, that are driven by energy from the sun, and can be predicted and described through complex models." (CDE)

Essential Question:

- How does weather form, and how can weather be predicted?

Instructional Questions:

- How are elements of the weather measured?
- How does the sun drive weather on Earth?
- What can a weather map tell you and how do you read it?
- Why does weather vary over short periods of time?
- What are various types of severe weather and how can you stay safe?

Weather on Earth C. Gongaware

After Instruction Students Will:

Understand:

- How the sun's energy drives weather on Earth
- How wind forms and why weather changes over time
- That the water cycle contributes to weather

Know:

- The difference between ordinary weather and storms
- The appropriate actions to take during a storm
- The vocabulary used to communicate about the weather

Be Able to Do:

- Use a weather model to interpret and predict the weather.
- Build and use devices to measure data about the weather
- Diagram and explain weather fronts

Learning Plan (Including Instructional Strategies)

Day 1	
Administer pretest to determine readiness and what students already know.	
Begin recording the outside temperatures and barometric pressure for class each day using a website with real time data. www.wunderground.com and http://www.nws.noaa.gov/predictions.php are both good sites.	

Day 2	**Instructional Strategies:** Note Taking, Brainstorming, Summarizing, Technology, Demonstrations
Ask **"What is a good definition for weather?"** Give students three minutes to compose a definition and write it in their notes. Have students share their definitions in groups of three or four and come up with a better definition.	
Have groups share their definitions for weather. Make a list of the components from the definitions. Create a class definition for weather and have students add it to their notes.	If students do not come up with a scientific definition, prompt them to include correct terms. Add **weather** to the unit word wall.
Create with the class a list of terms that students might need to discuss weather. If students get stumped, ask them to imagine a weather forecaster.	
Make sure that at the least the list includes the terms atmosphere, low pressure, high pressure, front, temperature, wind, humidity, evaporation, precipitation, condensation, cloud, and storm.	Students may come up with many more than these. Highlight these terms, but do not ask students to define them yet or add them to the word wall.
Ask **"Does air have mass?"** Ask **"How could you prove that it does or does not using a balloon?"**	
Formative Assessment: Have students summarize their conclusion in their notes. Ask random students to read their conclusions.	

Ask **"What is air made up of?"** Students should record their ideas in their notes. Have several students volunteers share.	
Ask **"How much of the air around us is oxygen? How could you prove that your idea is true?"**	
Students may need to be made aware that fires need oxygen to burn. Show a clip of a fire being put out by "venting the compartment." Ask **"Why did the fire go out?"**	The end of the episode "Fire in Space" of the classic *Battlestar Gallactica* is good for this.
Discuss that fires need oxygen to burn.	
Demonstrate the percent of oxygen in the air.	
Make a list with student input of the ingredients of the atmosphere.	
Assignment: Write a good definition for atmosphere. Explain why Earth's atmosphere is so important.	

Materials:

Video Clip	Pie Plate	Small Candle
Matches	Water	Graduated Cylinder

Day 3	**Instructional Strategies:** Note Taking, Experiments, Discussion
Formative Assessment: Have students comment on each other's definitions of atmosphere and explanations and pairs.	
	Add **atmosphere** to the unit word wall.
Formative Assessment: Pass around several balls of approximately the same size (ping pong, golf, rubber, and steel). Ask students to list the balls on their white boards from most dense to least dense. Give students time to answer the question and have them hold up their answers. Ask some students to justify their answers.	
Ask **"What is density?"**	If students have trouble articulating this, remind them about pumice floating on water.
Take a balloon from the freezer and put it under a lamp. Ask **"What do you think is going to happen as the balloon gets warmer?"** Allow students to speculate.	
Observe the balloon as it warms up. Have	

students record their observations in their notes.	
Formative Assessment: Ask students to use their one- two- cards to show whether the air in the balloon is more or less dense than it was in the freezer.	
Demonstrate the effects of cooling air with the Learning Lesson: Crunch Time at http://www.srh.weather.gov/jetstream/atmos/ll_flow.htm . Have students record their observations in their notes.	
Ask **"Have any of you ever taken a bag of chips high into the mountains? What happened to it?"** Allow students to respond. If no students has experienced this phenomenon, explain what happens.	
Ask **"What else besides temperature might affect the density of air?"**	
Ask **"Does altitude affect air pressure?"**	
Show students an aneroid barometer. Explain what it does. Ask students "How would you measure changes in air pressure?"	Note: There are many articles on barometers available. You may want to have a selection of articles at different reading levels available for students. Having four articles makes it easy to create good groups for Day 4.
Homework: Read articles on aneroid barometer and mercury barometer. Highlight important points for class tomorrow.	

Materials:

Balloon 2-Liter Bottles Hot Water

Day 4	**Instructional Strategies:** Identifying Similarities and Differences, Cooperative Learning, Models
In groups students should create a Venn diagram comparing the mercury barometer and aneroid barometer.	Add **density** to the word wall.
Divide class into groups of three. Give each group a set of instructions for making a barometer. The following websites have instructions that will provide a variety of barometers:	

http://kids.earth.nasa.gov/archive/air_pressure/barometer.html http://www.srh.weather.gov/jetstream/atmos/ll_pressure.htm http://www.srh.weather.gov/jetstream/atmos/ll_pressure2.htm http://starryskies.com/try_this/baro1.html Student groups should monitor these barometers over the next two weeks and observe the weather on those days as well.	
If any students are interested, a thermometer can be constructed as well. This is nice for advanced students, as they will have to create a scale to measure the temperature based on known temperatures. http://www.josepino.com/science/howto_thermometer	If students construct a thermometer, these should be monitored as well.
Show students an aneroid barometer and a liquid barometer. Explain why mercury is no longer used in thermometers and barometers. Monitor these instruments with the student created barometers and thermometers.	
Assignment: Give students the article about using Atmospheric Pressure to forecast the weather. A good source is http://weather.about.com/od/weatherinstruments/a/barometers.htm	

Materials: Will vary based on the instruments that the students are creating.

Day 5	**Instructional Strategies:** Demonstration, Discussion. Models
Demonstrate cold air and warm air movement using two canning jars. A description of the demonstration is available in *Discover*! *Weather*.	
Ask **"How does this explain how a hot-air balloon stays up in the air?"** Allow students think time before asking for responses.	

Ask **"Why would hot air rise above cold air?"** (Encourage students to use density in their explanations.)	
Ask **"How does this explain how wind forms?"** Give students time to think.	
Show students a balloon and blow it up and tie it off. Ask **"What will happen when I put a small hole in the balloon? Why?"**	
Ask **"Where does air move from and where does it move to?"**	Define wind in student notes and put **wind** on the unit word wall.
Remind students why Earth's plates move. If necessary, show them the lava lamp again. Explain that the air on Earth moves the same way.	
Demonstrate convection currents using Demo 38 of *Easy Science Demos and Labs*	This demonstration can also be done using baby food jars, food coloring, and liquid, but it is hard to hold the jars together and not get water everywhere.
Ask **"What two things do you need to know about wind to understand what it is doing?"** (speed and direction) Make weather vanes http://www.galaxy.net/~k12/weather/makevane.shtml and anemometers http://www.sercc.com/education_files/anemometer.pdf in groups of three for Day 6.	
Formative Assessment: Have students answer on exit cards the following questions: Is warm air less dense or more dense than cold air? Does air move from areas of high pressure to low pressure or from areas of low pressure to high pressure?	

Materials:

Pencils	Straight Pins	Straws
Small Paper Cups	Index Cards	Tape
Push Pins	Quart Canning Jars	Incense
Matches	Ice	

Day 6	**Instructional Strategies:** Labs, Note Taking, Graphic Organizers, Writing
Clear up any misconceptions discovered	

on the formative assessment.	
Give students data sheets and stop watches.	
Students will collect wind direction and wind speed at various locations around the school using their wind vanes and anemometers. Have a student mark out N, S, E, and W using a compass.	
Explain to students about different types of winds. Include both local winds and global winds.	
Assignment: Students should complete an outline of the lecture. Provide students with an incomplete outline before the lecture.	
Give students the option of a diagram that they can label instead of or in addition to the outline.	Add **Coriolis Effect**, **Prevailing Westerlies**, **Polar Easterlies**, **Horse Latitudes**, **Doldrums**, **Trade Winds**, and **Jet Streams** to the unit word wall.
Homework: Write a paragraph answering the question: Why would you want to take data about wind if you were building an office building? Give students a rubric for evaluating their paragraphs.	

Day 7	**Instructional Strategies:** Analogies, Note Taking, Demonstrations, Writing
Formative Assessment: Give students a non-graded matching quiz over the different winds.	
Ask students to review the water cycle with each other in pairs.	
Ask **"How does the water cycle contribute to weather?"** Allow students to think and write down two ideas in their notes. Discuss as a class.	
Ask **"What is the amount of water vapor in the air called?" "What about the percentage of water vapor compared to what the air could hold?"**	Add **humidity** and **relative humidity** to the unit word wall.
Ask **"Is it easier to dissolve something in warm water or cold water? How could you compare that to air containing moisture?"**	

Formative Assessment: Have students write an analogy comparing warm water and warm air. Allow random students to read their analogies.	
Show students the psychrometer. Have them read in their texts how a psychrometer works and what it is used for. Demonstrate the psychrometer. A table for calculating the relative humidity is at http://www.miamisci.org/hurricane/psychrometer.html .	
Demonstrate how high and low pressure affect cloud formation using a demonstration that Steve Spangler does. He performed this on Ellen and it can be viewed at http://www.youtube.com/watch?v=ODImMpGFUa4	Make sure that you discuss with the students that the high pressure creates heat (you can inflate a bicycle tire to show this). Then the pressure is released, the hot air hits the cold air, and condensation takes place on the particles in the air.
Homework: Write a paragraph answering the following: Where in the atmosphere is air the warmest? Justify your answer.	

Materials:

2 L Bottle	Water	Rubbing Alcohol
Bicycle pump	Thermometer	Gauze or Cotton Balls

Adapter for 2 L Bottle (a 3/8" drill bit created a hole in the lid that worked for me)

Day 8	**Instructional Strategies:** Cooperative Learning, Drawing, Notetaking, Labs, Writing
Allow students to share their various ideas in groups of three or four and to decide on a best idea to put forth for the group.	
Have all groups share their ideas. If students do not bring up closeness to Earth, altitude, and land and water, ask them about them.	
Review convection, conduction, and radiation as heat sources.	Have students draw pictures or define these three words and add **convection**, **conduction**, and **radiation** to the unit word wall.
Formative Assessment: ask students to give examples of conduction, convection, and	

radiation at random. Have students explain their reasoning. If students are stuck, propose a scenario and have them classify it.	
Ask **"What heats faster, water or land?"** Give students a lab sheet. Have them record their hypotheses and reasons for choosing their hypotheses.	
Help students describe the conditions of the experiment.	
Conduct the experiment and collect the data. (Heat the two substances under a high watt bulb with thermometers suspended in each substance.)	
Homework: create line graphs of the heating and cooling of the substances. Write out the conclusion for the lab and answer the question: How does this help explain why it is cooler at a lake?	

Materials:

Beakers	Water	Sand
Thermometers	Hooks	Lamp
High Wattage Bulb	Timer	

Day 9	**Instructional Strategies:** Drawing, Similarities and Differences
Students are to read in their texts about the different types of clouds.	Define cloud and add the three main classes of clouds, **cirrus**, **stratus**, and **cumulous** to the unit word wall. Students may want to add **cumulonimbus** as well
Assignment: Each student should use a white crayon and black paper to draw models of each kind of cloud. Descriptions should be written on paper and glued on to the sheets. Post a few in the room each day.	
Show students the U.S. Post Office cloud stamps. A search of Google Images yields several options.	
Ask **"What kinds of precipitation falls from clouds?"** Elicit the common types of precipitation.	
Assignment: Create a table comparing the similarities and differences of the common types of precipitation.	

Materials: Black Construction Paper White Crayons

Day 10	**Instructional Strategies:** Labs, Cooperative Learning
Give student groups (no more than three in a group) various-sized funnels and unmarked cylinders. Tell students that they have to make a rain gauge that accurately measures fallen rain in millimeters.	
Students have to solve the problem of marking the cylinder appropriately. This may actually take more than one day as students try different things.	
The student lab sheet should keep track of all the processes, even the wrong ones. Emphasize that the process of solving the problem is more important that actually solving the problem.	
Formative Assessment: Call on groups to report on their processes to the class as they are working.	
If it rains during the unit, allow the students to put out their rain gauges to collect and measure rain.	
If any groups finish early, ask them to devise a way to measure snowfall and to measure hail fall.	

Materials:

Funnels	Water	Rulers
Volume	Measuring Devices	Tape
Markers		

Day 11	**Instructional Strategies:** Graphic Organizers, Experiments, Writing, Diagrams, Mnemonic Devices
Ask **"What two words could you use to describe the temperature of an air mass?"**	
Ask **"What two words could you use to describe the moisture content of an air mass?"**	
Create a table that combines these student	As an alternative to putting the words on

descriptions. Introduce the terms maritime, polar, continental, tropical. Ask students to fill in the table with the combinations of words that match the student descriptions. Explain that these are the four basic types of air masses.	the word wall, put a diagram with images representing the words on the word wall with the words included.
Using a small fish tank or small plastic bin and divide the container into two compartments. Put warm water, dyed red into one side, and put cold water, dyed blue, into the other side.	
Ask **"What do you think is going to happen when I lift the divider?"**	
Have students write in their notebooks their hypothesis and their reasoning.	
Lift the divider. Allow students to observe.	
Students should then reflect on their hypotheses in their notes.	
Ask **"How is this experiment like what happens with air masses?"**	Have articles prepared on the different types of fronts for students to reference.
Assignment: Read about the different types of fronts. Draw and label a diagram for each type of front. Create a way to remember at least one type of front that you will share with your classmates tomorrow.	
Formative Assessment: Exit Card with question: How would you change the experiment to demonstrate an occluded front?	

Materials:

Container Divider Hot Water
Cold Water

Day 12 & 13	**Instructional Strategies:** Diagrams, Note Taking, Discussion
Give students a copy of a weather map. Ask them to write as many things down as they can about the map that they have learned over the past three weeks.	Add **stationary front**, **occluded front**, **warm front**, and **cold front** to the unit word wall.
Ask students in turns to explain one thing about the map they know. Using the doc cam, record these on the map.	Encourage students to add to their diagrams of the fronts as they need to.
Draw a counterclockwise around an "L"	

on the map and draw a clockwise circle around the "H" on the map. Remind students that wind moves from areas of high pressure to areas of low pressure.	
Explain that when air is circling in to an area of low pressure (L) it is called a cyclone; when air is circling out from an area of high pressure (H) it is called an anticyclone. Have students label these on the map.	Add **cyclone** and **anticyclone** to the unit word wall. Point out to students that if they put an arrow on the bottom of the "C" in cyclone it will show the direction of rotation of the wind.
Discuss the map in detail. Students should be able to come up with a lot of analysis.	
Summative Assessment: Give students a new and complex weather map with a data sheet for some city. Students are to write a complete weather analysis for the city based on the map and the data. Give students a rubric for evaluation. Students will have until the end of the second day to complete the evaluation.	
On the beginning of the second day, take some time to examine the barometer and temperature graphs of data collected over the past weeks. Encourage student discussion.	

Materials:
Weather Maps and Table Data

Day 14 - 17	**Instructional Strategies:** Identifying Similarities and Differences, Brainstorming, Projects, Artwork, Writing, Performing
Ask **"What are the similarities and differences between ordinary weather and a storm?"**	
Create a class definition of storm and post it in the classroom.	Add storm to the unit word wall.
Have students brainstorm a list of storms.	
Project: Become an expert on a storm. Complete two of the following: Create an informational poster about your storm.	Give students rubrics for evaluation of these projects. Some students may want to work in pairs. This is probably a good project for pairs.

Create a tri-fold brochure explaining storm safety for various locations. Create a radio spot explaining safety procedures and record it. Be a reporter and report on a famous storm for a newspaper or for a TV station. Create an informational Power Point presentation about your storm.	
Allow students to research their storms in the library for the first two days. Do not allow students to print material other than photos. Students should take notes.	Also have students research the weirdest weather fact they can find. They will use these after the post-test is debriefed.

Materials:
Student Audio Recording Equipment Student Video Recording Equipment
General Art Supplies

Day 18 - 19	**Instructional Strategies:** Self Evaluation, Writing, Projects, Peer Teaching
Student presentation of projects.	
Summative Assessment: Give students the notebook evaluation rubrics. Students may complete notebook evaluations at home. Students will assign themselves a grade and write a paragraph explaining why they deserve the grade they are assigning themselves. Allow no longer than 20 minutes for this activity.	
Summative Assessment: Give students their pretests. Ask them to write a letter to you assigning themselves a subjective grade based on what they feel they have learned. They must explain what they have learned that they didn't know before. Students may complete these at home. Tell them that this grade will count as an assessment grade, but that if you disagree with the grade, you will have a conference with the student so that you can come to an agreement about what the grade should be.	
Assignment: Study for the objective assessment.	

Day 20	
Summative Assessment: Administer the objective post test.	
Conference with any students who did not assign themselves an appropriate grade on the subjective self-assessment.	

Day 21	

Debrief students on the objective post test. Celebrate!	
Share weirdest weather facts. Each fact will go on the board under "Weird," "Weirder," or Weirdest." The finder of the weirdest fact wins a prize.	

Curricular Resources:

The Complete National Geographic: Every Issue Since 1888. DVD format, 2009.

Daily Warm-Ups: Earth Science. Portland, Maine: Walch Publishing, 2002.

Discover! Weather. Dayton, OH: Milliken Publishing, 1999.

Lyons, Walter A. *The Handy Weather Answer Book*. Canton, MI: Visible Ink Press, 1997.

Padilla, Michael et al. *Weather and Climate*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

http://kids.earth.nasa.gov/archive/air_pressure/barometer.html

http://www.galaxy.net/~k12/weather/makevane.shtml

http://www.josepino.com/science/howto_thermometer

http://www.miamisci.org/hurricane/psychrometer.html .

http://www.nws.noaa.gov/predictions.php

http://www.sercc.com/education_files/anemometer.pdf

http://starryskies.com/try_this/baro1.html

http://www.srh.weather.gov/jetstream/append/lessonplans.htm (a really great site for lots of lesson plans)

http://weather.about.com/od/weatherinstruments/a/barometers.htm

http://www.youtube.com/watch?v=ODImMpGFUa4

www.wunderground.com

What Do You Mean it Doesn't Revolve Around *Me*?

Earth Systems Science Curriculum and Learning Plans for Middle Grades

Today we are going to learn …

- What makes good curriculum
- What instructional units are included in the curriculum and learning plans and how they are laid out
- How the instructional plan worked for *The Solar System* unit

Margaret Mitchell wrote the end first.

What can we learn from Margaret Mitchell?

What makes good curriculum?

- Like Margaret Mitchell, we must begin with the end in mind – “backwards design.”

- For most teachers, the end is defined by state standards.
- Once we know the end, we can formulate overarching essential questions for an instructional unit.
- From the overarching essential questions, we can create instructional questions.

These questions refine the learning goals – what we want students to **know**, **understand**, and **be able to do**.

- Once we have learning goals that can be clearly articulated to students, we must determine how we will measure student learning.

- The assessments we use:
  - **Summative** (after learning has taken place)
  - **Formative** (assessment during learning that may alter instruction)

- Only after determining the learning goals can we plan learning experiences and instruction that will be meaningful for students.

- We must become familiar with instructional strategies that increase student learning, and even more importantly, we must plan to *USE* those instructional strategies.

Earth Systems Science

- Nine Instructional Units

The Colorado State standards for Earth Systems Science, newly revised and adopted for the 2010 school year:

- Plates and Geologic Events
- Earth's Crust
- The Geologic Record
- The Solar System
- Earth in Space
- Water on Earth
- Weather on Earth
- Climate
- Natural Resources

- The Colorado State standards for Earth Systems Science, newly revised and adopted for the 2010 school year:
  - Major geologic events such as earthquakes, volcanic eruptions, mid-ocean ridges, and mountain formation are associated with plate boundaries and attributed to plate motions.
  - Complex interrelationships exist between Earth's structure and natural processes that over time are both constructive and destructive.
  - Geologic time, history, and changing life forms are indicated by fossils and successive sedimentation, folding, faulting, and uplifting of layers of sedimentary rock.
  - The solar system is comprised of various objects that orbit the Sun and are classified based on their characteristics.
  - The relative positions and motions of Earth , Moon, and Sun can be used to explain observable effects such as seasons, eclipses, and Moon phases.
  - Water on Earth is distributed and circulated through oceans, glaciers, rivers, ground water, and the atmosphere.
  - Weather is a result of complex interactions of Earth's atmosphere, land and water, [sic] that are driven by energy from the sun, and can be predicted and described through complex models.
  - Earth has a variety of climates defined by average temperature, precipitation, humidity, air pressure, and wind that have changed over time in a particular location.
  - Earth's natural resources provide the foundation for human society's physical needs. Many natural resources are nonrenewable on human timescales, while others can be renewed or recycled.

- Each unit consists of
  - The unit name
  - State Graduate Expectation and Grade Level Expectation
  - The Essential Question and Instructional Questions
  - The learning goals (what students will understand, know, and be able to do after instruction)
  - A learning plan for each day of the unit
  - A list of curricular resources

Day 3	**Instructional Strategies**: Visuals, Providing Recognition, Brainstorming, Note Taking, Summarizing, Writing
Turn on the lava lamp. Check student maps. Place a couple of the good ones under the doc cam for other students to see.	
Remind students of the Essential Question. Ask **"How do you think plates might move?"** and have students record their thoughts in their notebooks. Allow guided discussion of this for a few minutes.	
Read in the textbook about convection currents in the mantle.	
Ask **"How is a lava lamp like the convection currents in the mantle? How could this cause the plates of the crust to move?"** Allow student discussion. Have students record in their notes what a convection current is and how they think it might move Earth's plates. Allow several students to read their responses.	Add **convection current** to the word wall. A Venn diagram may help students identify similarities and differences.
Ask **"What do you think happens along the boundary where two plates meet?"**	Place the words **divergent boundary**, **convergent boundary**, and **transform boundary** on the word wall. Have students define these words using pictures in their notes.
Read about each of the boundaries in the textbook. Have students mark the boundaries on their world maps as divergent, convergent, or transform.	
Formative Assessment: After reading about each boundary, ask students to explain using their hands what happens to plates at plate boundaries.	
Formative Assessment: Have students answer the question "How do plates of Earth's crust move?" on exit cards.	
Assignment: Summarize what the three different types of plate boundaries are in a paragraph. Remind students that they will be creating a poster tomorrow, and that if they want any special supplies, they will need to bring them.	

Materials:
Lava Lamp

Day 3	
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Materials:
Lava Lamp

Activities, instructions, and teaching suggestions appear in sequential progression in both the left and right cells of the table.

The strategies use appear in the top c

Questions to facilitate student learning appear in green.

Key terms are in bold in the right-side cells.

A materials list appears at the end of each plan segment.

Assessments, assignments, and homework are in cells that span the table.

The Solar System Unit

- Space … the final frontier.

The Importance of Pretesting …

How far away is the moon from Earth? How far away is Mars from Earth?

IDK

Not very far.

1. 300 miles
2. 23,000 miles

Moon is very far from earth. Mars and earth are next to each other.

Earth – 5000 miles.
Mars –10,000 miles

???

Moon = 4,000 miles
Mars 4,329 miles

4,000,000 light years
2,000 light years

Far enough

The Importance of Pretesting ..

What can happen to a star as it gets old?

Cause a supernova. Turn into a black hole.

It runs out of gas and forms a shooting star.

It can explode and form a star nursery.

It gets brighter.

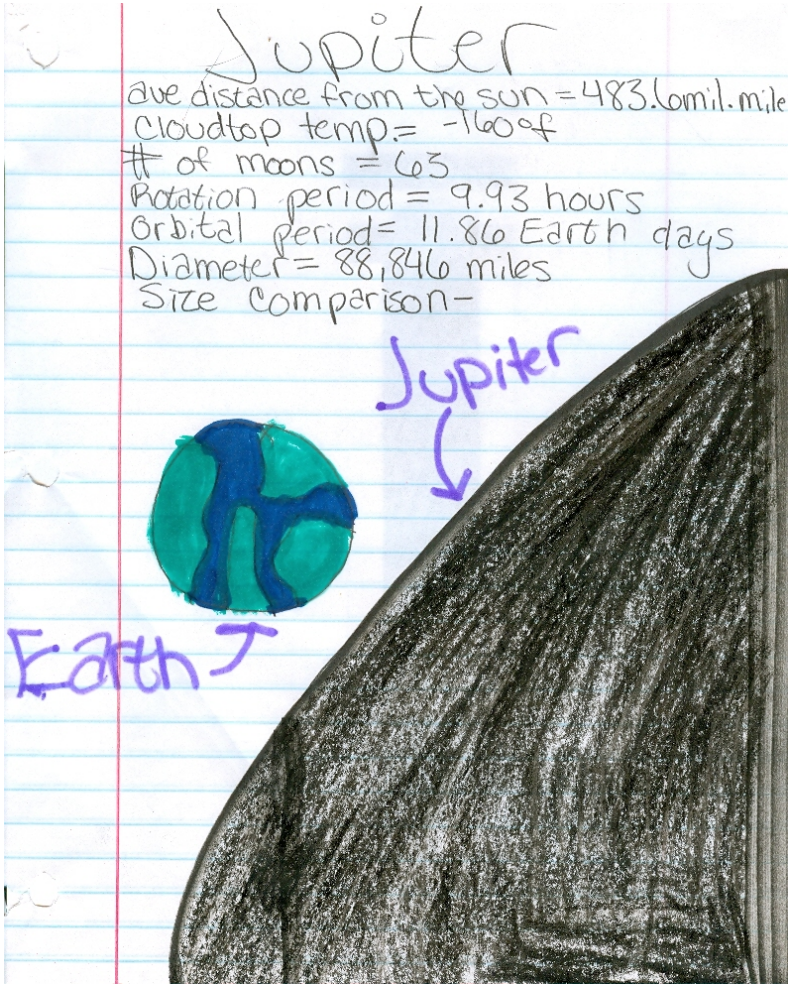
It will become a asteroid.

It explodes

It falls to its doom.

It turns into a black hole.

Student Notes Pages Sample

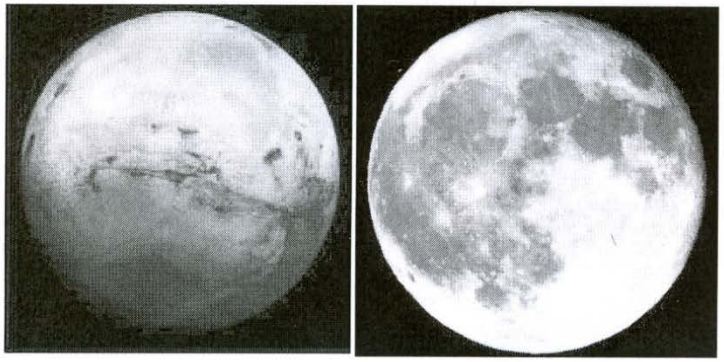


Sample Assignment:

Your friend just got an e-mail, and he sends you an e-mail, all excited about what he just read.

To: yourname@e-mail.com
From: theirname@e-mail.com
Subject: Mars as big as the moon in the sky!!!!!

Hey, I just got an e-mail that Mars will be close enough that it will look as big as the moon in the sky August 27th. How awesome is that? It will be like having two moons. Bring your telescope over.

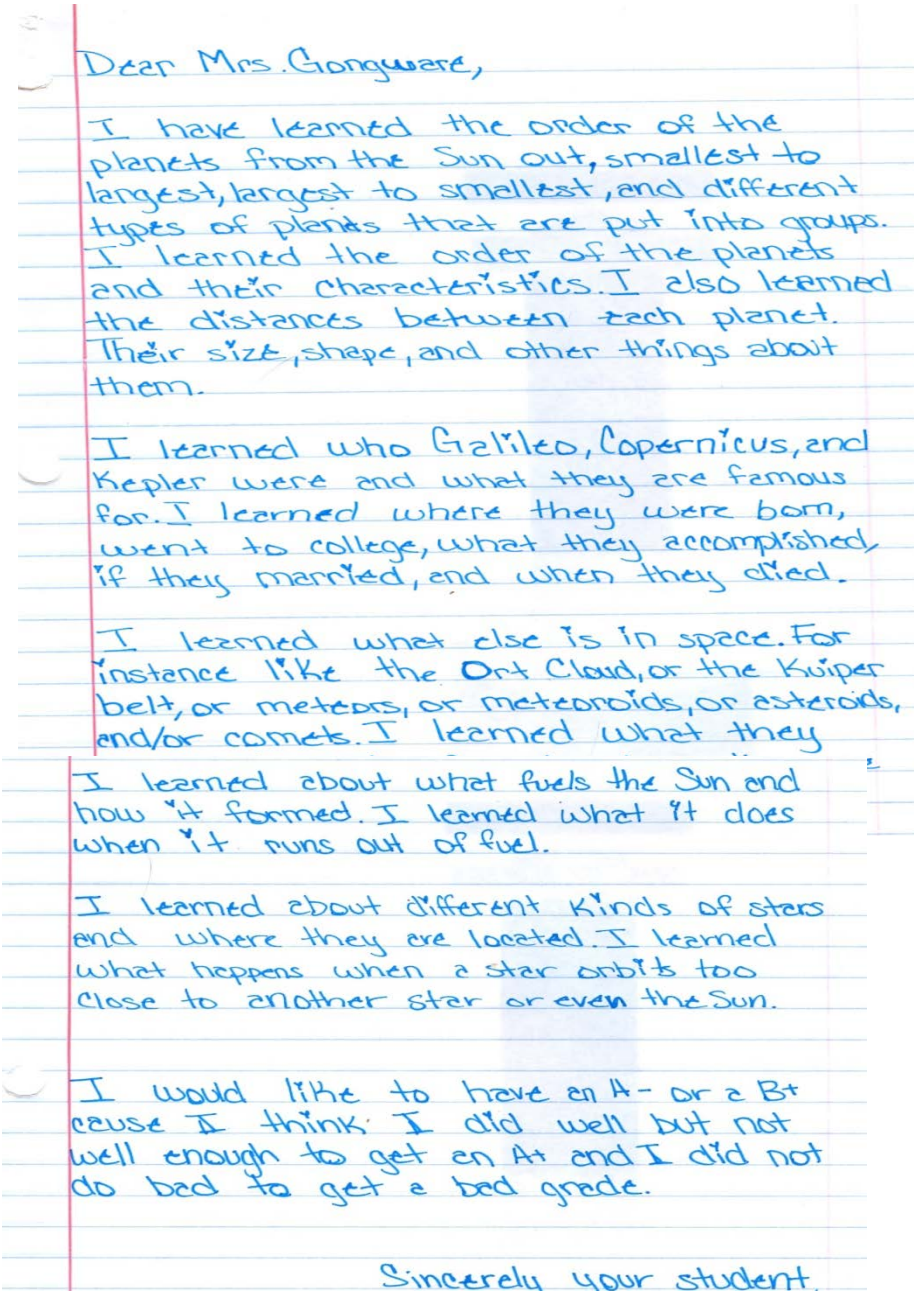


In an e-mail to your friend, explain why this is a hoax and couldn't possibly happen. (You must have at least three valid reasons to get all the points.)

Pre- and Post- Test Data

Student Self-Assessment Letter Samples

These four students went from pre-test scores of 1.25, 2.25, 1.5, and 1.63 to post-test scores of 2.86, 3.63, 3, and 3.38.



Dear Mrs. Gongware,

I have learned the order of the planets from the Sun out, smallest to largest, largest to smallest, and different types of plants that are put into groups. I learned the order of the planets and their characteristics. I also learned the distances between each planet. Their size, shape, and other things about them.

I learned who Galileo, Copernicus, and Kepler were and what they are famous for. I learned where they were born, went to college, what they accomplished, if they married, and when they died.

I learned what else is in space. For instance like the Ort Cloud, or the Kuiper belt, or meteors, or meteoroids, or asteroids, and/or comets. I learned what they

I learned about what fuels the Sun and how it formed. I learned what it does when it runs out of fuel.

I learned about different kinds of stars and where they are located. I learned what happens when a star orbits too close to another star or even the Sun.

I would like to have an A- or a B+ cause I think I did well but not well enough to get an A+ and I did not do bad to get a bad grade.

Sincerely your student.

Student Self-Assessment Letter Samples

These four students went from pre-test scores of 1.25, 2.25, 1.5, and 1.63 to post-test scores of 2.86, 3.63, 3, and 3.38.

Dear Mrs. Gongaware,
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I learned who Galileo, Copernicus, and Kepler were and what they were famous for.
…
I learned what else is in space. I learned what [comets and asteroids] are made out of and where they are located and if they can do damage. I learned about what fuels the Sun and how it formed. I learned what it does when it runs out of fuel…
I woul like to have an A- or a B+ cause I think I did well but not well enough to get an A+.

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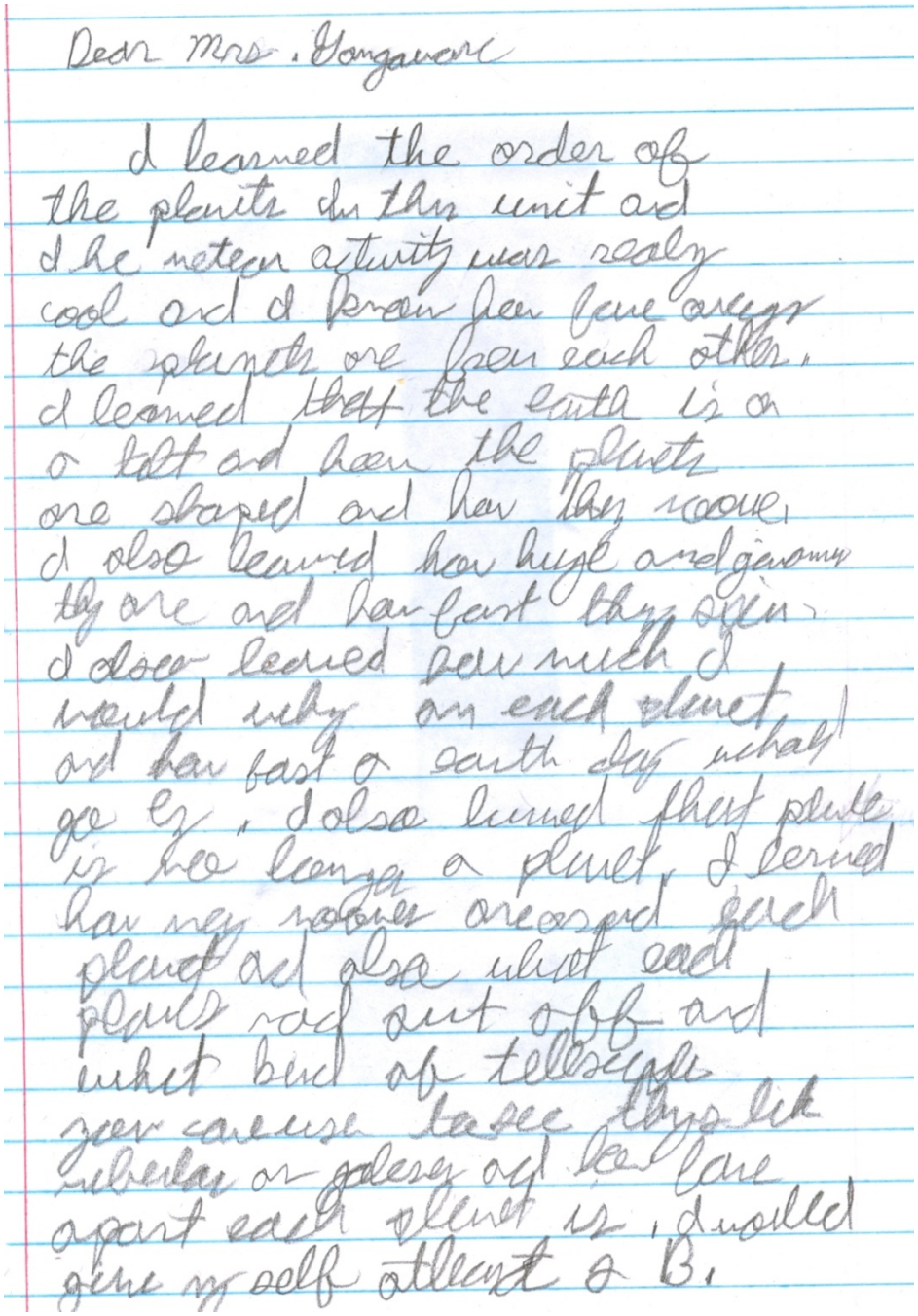

Dear Mrs. Hongsermeier

I learned the order of the planets in the unit and the meteor activity was really cool and I know how we know the planets are from each other. I learned that the earth is an oblate and how the planets are shaped and how they revolve. I also learned how huge and gaseous they are and how fast they spin. I also learned how much I would weigh on each planet and how fast a earth day is what I go by. I also learned that pluto is no longer a planet, I learned how my names are assigned each planet and also what each planet would rank out of 8 and what kind of telescope you can use to see them like uranus or galaxy and how far apart each planet is. I would give myself atleast a B.

Student Self-Assessment Letter Samples

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Dear Mrs. Gongaware

I learned the order of the planets in this unit and the meteor activity was really cool and I know how far away the planets are from each other. I learned that the Earth is on a tilt and how the planets are shaped and how they move. I also learned how huge and ginormous they are and how fast they spin. I also learned how much I would weigh on each planet and how fast an Earth day would go by. I also learned that Pluto is no longer a planet. I learned how many moons are around each planet and also what each planet is made out of and what kind of telescope you can use to see things like nebulas or galaxies and how far apart each planet is. I would give myself a B.

Student Self-Assessment Letter Samples

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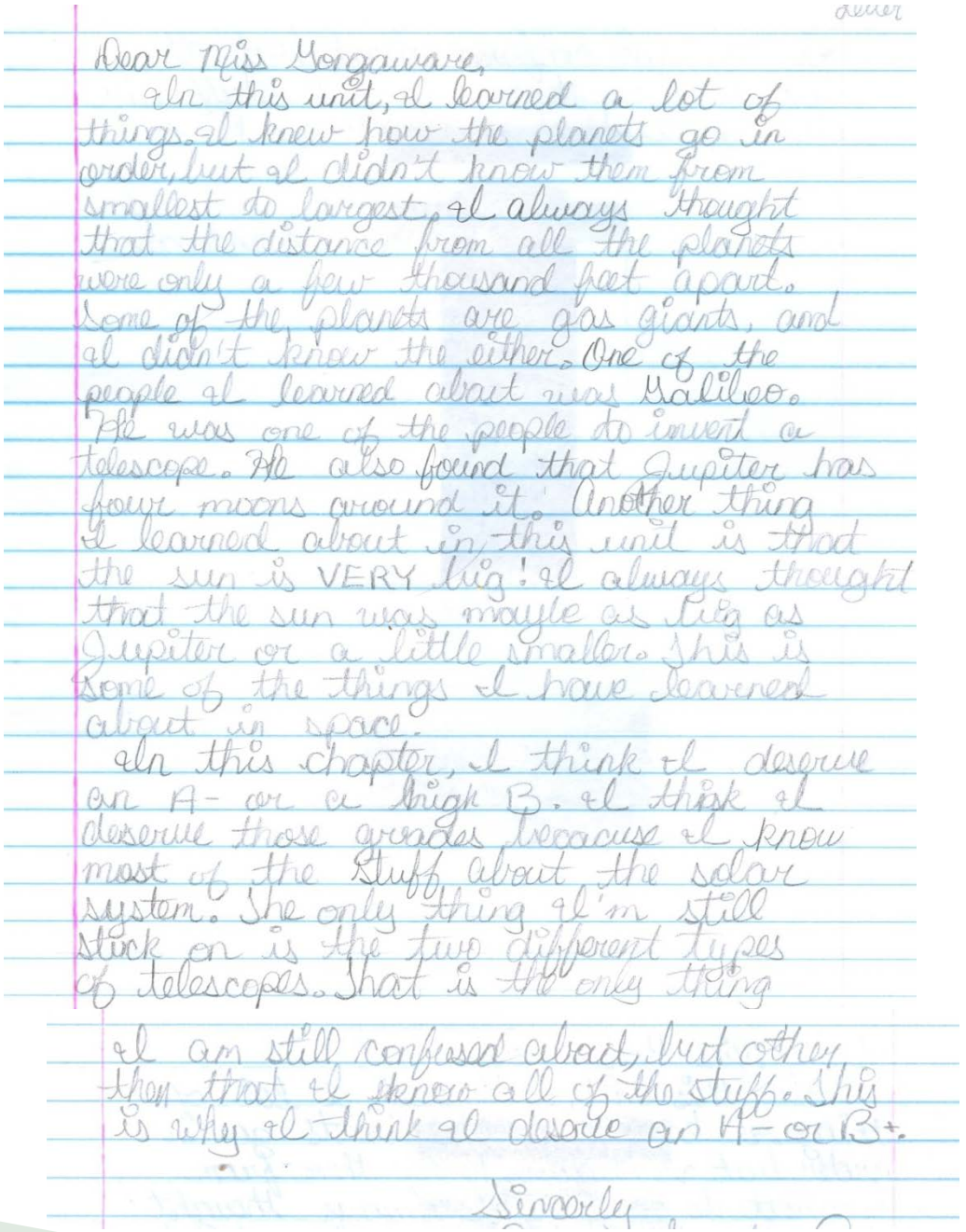

Dear Miss Gongaware,

In this unit, I learned a lot of things. I knew how the planets go in order, but I didn't know them from smallest to largest. I always thought that the distance from all the planets were only a few thousand feet apart. Some of the planets are gas giants, and I didn't know the either. One of the people I learned about was Galileo. He was one of the people to invent a telescope. He also found that Jupiter has four moons around it. Another thing I learned about in this unit is that the sun is VERY big! I always thought that the sun was maybe as big as Jupiter or a little smaller. This is some of the things I have learned about in space.

In this chapter, I think I deserve an A- or a high B. I think I deserve those grades because I know most of the stuff about the solar system. The only thing I'm still stuck on is the two different types of telescopes. That is the only thing I am still confused about, but other then that I know all of the stuff. This is why I think I deserve an A- or B+.

Sincerely,

Student Self-Assessment Letter Samples

These four students went from pre-test scores of 1.25, 2.25, 1.5, and 1.63 to post-test scores of 2.86, 3.63, 3, and 3.38.

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Student Self-Assessment Letter Samples

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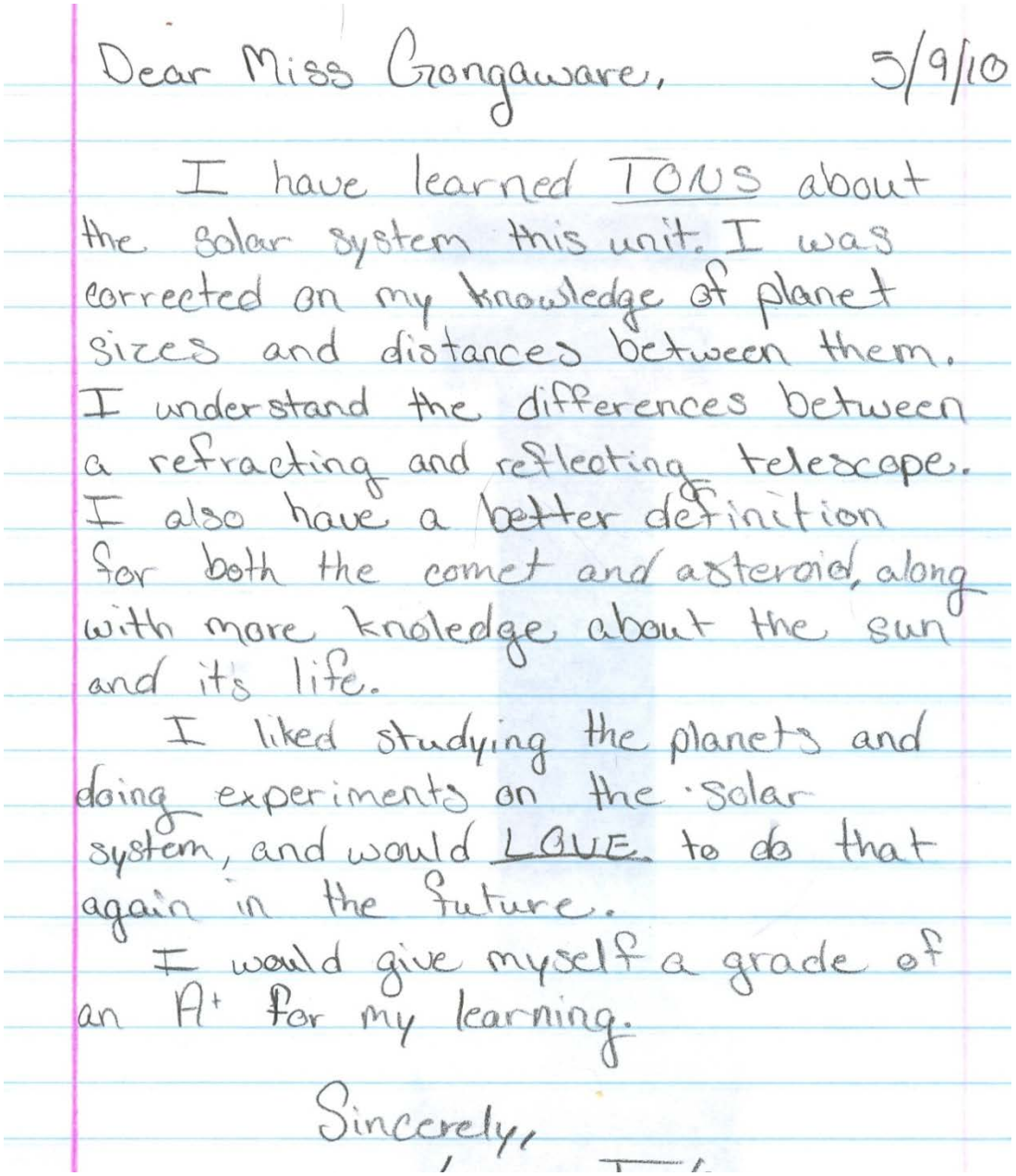

Dear Miss Grongaware, 5/9/10

I have learned TONS about the Solar System this unit. I was corrected on my knowledge of planet sizes and distances between them. I understand the differences between a refracting and reflecting telescope. I also have a better definition for both the comet and asteroid, along with more knoledge about the sun and it's life.

I liked studying the planets and doing experiments on the solar system, and would LOVE to do that again in the future.

I would give myself a grade of an A+ for my learning.

Sincerely,

Student Self-Assessment Letter Samples

These four students went from pre-test scores of 1.25, 2.25, 1.5, and 1.63 to post-test scores of 2.86, 3.63, 3, and 3.38.

Dear Miss Gongaware,

I have learned TONS about the solar system in this unit. I was corrected on my knowledge of planet sizes and distances between them. I understand the differences between a refracting and reflecting telescope. I also have a better definition for both the comet and asteroid, along with more knowledge about the Sun and its life.

I liked studying the planets and doing experiments on the solar system, and would LOVE to do that again in the future.

I would give myself a grade of an A+ for my learning.

In Closing …

- Curriculum is a living document, and should be reverse engineered from the expected results
- A learning plan should include tasks, questions, assessments, and appropriate teaching strategies
- Students can take more responsibility for their own learning if they are asked to do so and given the tools to do so