Is the Earth Flat? And other "Controversial" Science Ideas
Project-Based Learning Unit

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This curriculum unit is recommended for:
6-9 Grade – Science/STEM/STEAM courses (all)

Keywords: STEAM, STEM, Science, PBL, Project Based Learning, Scientist, pseudoscience, research, project, human social groups, mavericks, crackpots, discoverer, discoveries, history, plagiarism, Galileo, Telsa, Doppler, Einstein, global warming

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: This unit is a Project-Based Learning (PBL) Module that teaches students about the interactions of human social groups via team building exercises and the research of historical science discoverers and the difficulties they faces in bringing their ideas to light, especially when they went against the held beliefs of the scientific community, religious leaders, or the community at large. Students will learn to work as a team as they do team building exercises and begin learning about the difference in science and pseudoscience, how to navigate online resources to find valid sources and data, how to distinguish fact versus opinion in their source material, as well as, learning about the historical context around some of our greatest scientists. Student teams will create multimedia presentations to teach their classmates about their assigned scientist, their discovery, and the reasons why the discoverer had hard time getting the scientific community to back their research. Some of the scientists they can chose from include: Galileo, Darwin, Tesla, Hubble, and Doppler. Students will create social media pages for their scientist to show the social group around their lives. They will also create an animation, Prezi, or other presentation medium to show what they have learned about their scientist.

I plan to teach this unit during the coming year in to 30-50 students in STEAM Elective 6-8 grades

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Rationale

Druid Hills Academy is a prekindergarten to eighth grade academy of about 600 students nestled in downtown Charlotte, North Carolina. The students mostly live within walking distance and are comprised of a tight-knit community. They are also students of extreme poverty. This brings with it many struggles that affect their education and developmental growth. Our school is part of a district wide effort to bridge the achievement gap with our low socioeconomic status population. We have many programs in place and collect a lot of data on how each program affects the overall child and their academic growth.

One program is the STEAM Magnet program, of which I am a part. STEAM is part of a push to move from STEM (Science, Technology, Engineering, and Math) education to STE**A**M (A is for Arts) education. The website Stem2Steam (http://stem2steam.org) is a great resource on STEAM education. The object is to push in creativity as students apply math and science with technology via Project Based Learning (PBL) Modules. In addition to adding STEAM as an elective for the middle school students, there is also STEAM enrichment during the day and a K-8 STEAM afterschool program. Our goal is to become a full STEAM magnet school in the next three years, with our students exceeding the expected 15% growth by at least 5% per affected child. I am officially the Technology part of STEAM, but as a long time middle school science teacher, I incorporate all the areas into my students' projects. Cooperative-based learning via projects is a great way to show our students the value of the material they learn about through real world applications. It is also a great way to differentiate for our students in a discrete way.

Teachers have all been taught that students learn certain material better through cooperative learning. The problem is getting the students to be truly engaged with the material instead of being engaged in socializing. What should the teams look like? How do we get students invested in the team concept? Which types of activities are best suited for teams and which size team is appropriate for those activities? Why is one child silent in a particular classroom and bouncing off the wall in another? Is it the expectations of the teachers or is it the structure of the social group that is present? My students are not socially mature for their age and it shows in their behavior. As a group, they are not successful, but many of them can excel if separated from said group. How does the group dynamic influence the individual students' behavior? These are many questions that teachers, veteran and new, struggle with in designing lessons for their classrooms.

This unit will allow teachers to create a positive social structure in their classroom, while students learn about scientists and philosophers and the struggles they went through to share their new knowledge to their community. It will include mini-lessons on teaching students to trust each other, how to structure different types of groups, how to model group work for the students, and will have sample lessons using different types of groups Reflection of students, both in individual work and group work, is a strategy that I already use and it truly helps students create a dialog about how they feel the classroom should look and how they play a role in it!

Students will learn about the challenges that scientists in the past and the future have faced to accomplish their research and discoveries. They will work in groups and individual on similar tasks and reflect on the benefits of having collaborators on a project.

Objectives

There are two main objectives for this curriculum unit. The first objective is to help teachers with cooperative learning strategies and "group work" in their classrooms. The strategies and classroom activities are designed as a PBL module that showcases different types of activities for students to do research and design their final product.

The other objective is to teach the students about Human Social Group dynamics while also learning about the history of science discovery and what makes a good scientist. Historical context will also play a role in each scientist that they study.

When studying human social group dynamics, we will look at how groups form, change, interact, as well as, how they work (or do not work) together. Topics that are important for these projects are: Groups: 3/5 vs. 2/3 in groups, one against the group, Power roles in groups, Minorities vs. the group (gender/race/age), etc.

Background Knowledge

There are several Common Core and Essential Standards (Science) that will be covered in this unit. They include: ELA research, Math/Science graphing and analyzing, Scientific methods and theory, and the specific science standards that are related to the work of each scientist. Several Technology standards are also covered. This unit is designed for middle school, but can be adapted for various age groups. The full standards are included in *Appendix 1: Teaching Standards*.

The main component of this project is a research paper, therefore, students will be taught how to research a topic and how to assess sources for validity. They will create research notes and a rough draft, as well as, doing peer editing. Mini-Lessons and resource links are included. Students will also be creating and analyzing graphs related to their topic.

In relation to Human Social groups, there is a lot of research on this subject, and it will be covered briefly here. There are additional resources in the Teacher Resources section of the bibliography. For this unit, there are two components that need background. The first component is the class of students itself. We all know that the makeup of our classroom plays a big role in how successfully our students accomplish goals and learn within our class.

The first thing to look at with our students is where the natural "Power" seems to lie within the group. Is there a student or students that seem to control the whim of the class? Are their students that have power by default, because they refuse to participate at all? The goal in setting up the Engineering groups is to distribute the power evenly and set the groups up to be successful. There is research around creating successful groups for learning and working teams. There is a debate between even and odd numbered groups and how effective they are. Often in a classroom, we look at how many students we have and then divide students into pairs or groups of fours. I typically do this myself, but there is growing evidence that odd numbered groups work together better. This means that groups of three or five students, in theory, will work together better than our typical even numbered groups. For this project, I am designing for "tripod" groups.

If we go back to the issue of Power within the classroom, I often create teambuilding activities for my teams on the first few days that they work together. This lets me see how well they work together, and allows them to reflect on how they work together. It also gives me a chance to rearrange the groups if I see that there is an issue that may not be easily resolved before they begin their project. It is also a good idea to have the roles of a group rotate on a schedule basis, if the groups are for more than one or two class periods. No one child should always been in charge, under most situations. Knowledge that the positions will change throughout the project will remove some of the arguments around the topic, and will hopefully help create a balance of power within the groups.

The second component is the aspect of social groups that needs to be discussed with the students so that they fully comprehend why great science discoveries have not always been seen as such when they were first presented. These discoveries often either went against the common beliefs of the group at large or were discovered by someone outside the group, someone without social standings or without the needed credentials to have their voices heard by the scientific community at the time. There are many examples of this, including Galileo and his discovery that the Earth is not the center of the solar system, at a time where it was "common knowledge" that the Earth was the center of everything and that everything revolved around the Earth. When one individual or minority group pushes against the group as a whole it can be difficult to be heard or accepted, even with overwhelming evidence in your favor. This is often called the herd mentality or majority rules. Many people do not inherently want to go against what the majority of people think. Why is this? One belief is that they do not want to lose face with the rest of the group, or as our students might say: “no one wants to look stupid in front of their friends.” The civil rights movement or women’s’ suffrage movement are great examples of minority social groups pushing against the larger group. In this project, students will be able to explore different examples of major discoveries that were not immediately considered even probable.

Strategies

This unit will focus on cooperative learning for most of the activities. It is a Project-Based Learning module that is designed to allow them to work on a large project, while having mini-lessons on the related topics. Students will work on webquests, cloze activities, read articles in jigsaw groups, create mini-presentations, and ultimately create a multimedia project on their scientist. Students will also participate in a Socratic Seminar on at least one controversial topic.

Students will work on a Project-Based Learning (PBL) module discussing the history of science discovery and the controversies surrounding them. Students will work via rubrics and checklists, and will write reflections based on their learning, teamwork, and needs. This may be accomplished via a class blog. Students will be on “Engineering Teams” and each student will have a defined role on the team. Embedded in the unit will be mini-lessons on: 1) Fact versus Opinion, 2) Why Do we need to Collaborate as Scientists? 3) How do our group dynamics affect our Outcomes? 4) How have social dynamics of human social groups affected Science and our knowledge base as a larger community? They will also have mini-lessons tied to the research part of the project, as well as, on the creative component of their presentation. There are many opportunities within the unit to have students present their findings or results. My advice is to give the students options and vary their selections. Perhaps a “Presentation Option” Rubric at the beginning of the unit, where they check off each type of presentation they use during the project. Groups will receive bonus points on the final project if they utilize ALL the available options over the course of the unit.

Students will create a presentation discussing their chosen Scientist and the controversy surrounding his discovery/work. They will follow a rubric with check-ins and complete daily group and individual goal logs. They will also take a pre- and post-test on both how well they work in groups as well as the science objectives that are included.

Classroom Activities

There are several Mini-lessons and full class lessons included in this unit. The idea is that each class is begun with a "Reflective question" related to the last class, followed by a mini-lesson that is related to the portion of the project that they are working on. Each mini-lesson should be no more than 10 minutes. If the class period is long, it might be appropriate to have another mini-lesson in the middle of the lesson to break up the time. Use the resources as you need them. I have created the mini-lessons in pairs to facilitate the 90 minute class period.

Lessons and Mini-Lessons

Mini-lesson: What is a Scientist?

Have students draw what they think a scientist looks like. Give no other directions. Most students will draw a white man with glasses, crazy hair, and a lab coat (or they will draw their teacher). Our goal is to have them see themselves as scientists, and ultimately draw themselves later in the unit. Have them discuss why they drew what they drew. Ask them if THEY think they are scientists. Ask them what they think makes someone a scientist. Draw a brainstorming web on chart paper. Save it to hang on the wall later. Then have students watch a short 5-8 minute video about "What is a scientist?" A great video to use is What is a Scientist?, but there are many online to choose from. Students will then complete a webquest on "What is a Scientist?" There are many available on line, or you can create your own to fit your students abilities.

Mini-Lesson: Why do we need to Collaborate as Scientists? Team Building

This is a team-building activity, and different activities can be done throughout the unit to help strengthen your teams. Many activities would be appropriate. There are two that I like to use often. The first challenge is the "Spaghetti and Marshmallow Challenge" where each group is given only spaghetti and marshmallows. They are then instructed to build the tallest tower that can stand on its own. Variations can be done, where teams are also give different types of tape and string to help reinforce their structures. The second simple challenge is the "House of Cards" where students are given a deck of playing cards and instructed to build the tallest tower. I let them bend the cards (if they ask) but they cannot cut the cards in any way. In both activities instruct the groups to work together and be creative. Often groups will start out working independently as they brainstorm and then come together to share designs. This is actually great, as long as you can get them to come together to build the final design. Ultimately, anything that they can work together as a challenge can be done as a competition.

Mini-Lesson: Collaborating Roles

Now that the students have started working together as a team, students will learn about why scientists work in teams instead of by themselves. Groups will be assigned at this time, and initial roles given. Students will then do a group activity to practice their roles. Any simple lab activity will work for them to practice their roles. Students should understand that these initial roles will rotate during the project! Each child will get an opportunity to fill each role. My best groups rotate the jobs themselves, but I usually change them every other class or every other activity. As previously discussed, our goal is to have an odd number of team members, so each student will have more than one role. I usually do groups of three. In that scenario, the student roles are as follows.

These roles will be determined by the activity. When doing research ALL team members will be Data Recorders, but there will still be a Leader, Time Keeper, and Materials Manager.

Leader	Ultimately responsible for how the group works together. Only students that can ask teacher questions during the activity. If groups report daily to the teacher, this student will be the one reporting at that meeting, while the team continues to work.
Time Keeper	Watches the clock to make sure time is being used wisely. If group gets off task reminds them of the time.
Data Recorder	Records collected data, meeting notes, etc. In charge of the groups project documents (papers, flash drives, etc.). When doing research ALL group members will be writing, but the official recorder will keep track of everything.
Lab Technician	During a hands on activity, functions as the experimenter if there is only one or decides on.
Materials Manager	Responsible for making sure needed materials are retrieved and returned and the area is clean at the end of the class. Facilitates the clean-up of the group versus cleaning everything up alone.

Mini-Lesson: Fact versus Opinion

It is important for our students to be able to recognize when material that is presented is fact or is someone's opinion. It can often be hard to do, especially in our information hungry world. There are many lessons available online that could be tweaked to meet your needs, but I am including my favorite way to teach the concept.

Students will begin by answering the prompt "Give three facts and one opinion about yourself." Write "Fact" and "Opinion" on the board. Ask students to describe each and have them write their descriptions by the vocabulary. Next, ask students to share some facts and opinions from their journal entries. Discuss whether each is example is fact or opinion. For example, if the student said "I am 12 years old," that is a fact. Or if the student says, "I am funny," that is an opinion. This is where you can distinguish between technical things like "If everyone believes the opinion, does it become a fact?" (No, it doesn't).

Students will then get into groups of three or four. Each group will receive a part of a newspaper. The groups will be instructed to find two examples of fact and two examples of opinion in a single article of the newspaper. They will be instructed to underline facts and to circle opinions. The groups will then cut out their article and hand it in. After you have collected all of the articles, project them onto the board using the document camera and LCD projector. Discuss as a class whether each is example is a true example of either fact or opinion. During the course of these discussions about the particular examples also talk about how this skill is a useful one to have in order to make informed decisions while voting. This is also a good opportunity to talk about bias in newspapers and other sources.

As an extension, students can write a persuasive paragraph or essay on a topic of their choice (favorite shoe, soft drink, best friend, etc.) Students need to have three main points, and support each point with facts. They also need a conclusion. Students need to peer edit. Students will post their persuasive writing onto the class blog, and will create an online animation to include in their blog post. Presentations of these products would also be a good idea. An adaptation of this would be to have students pick different "candidates" and have a class debate. The blog and animation could also be used in the debate.

Mini-Lesson: How do you research and use appropriate resources?

Our students love to use search engines to research information. The problem is that they often plagiarize the material directly from the source or use unreliable sources to find their information. Our first goal is to get students to understand that they cannot simply copy and paste someone else's words without creating a citation to accompany them.

There is nothing incorrect about quoting another person, but it is not fair to them to use their words and claim them as your own. It is a serious offense that can have severe consequences.

Our second goal is to teach students to use sources correctly. In researching the topic, myself, I found a plethora of online lessons on the topic. Choose the one that is best for your students. Some of my favorite ones can be found online at Scholastic at http://www.scholastic.com/teachers/top-teaching/2010/11/reliable-sources-and-citations. Your media specialist is also an excellent resource in this area and often times will gladly teach your students about research for you!

Lesson: Science or Pseudoscience?

This lesson may take more than one class period. Students will watch a video on Pseudoscience ("Pseudoscience", The Eyes of Nye, Season 1, Episode 2). They will then take an online quiz, *Real science or pseudoscience: do you know the difference?* Available at: http://dsc.discovery.com/tv-shows/curiosity/topics/real-science-pseudoscience-quiz.htm. After taking the quiz, student groups will research and present one of the following Science/Pseudoscience arguments: 1) Astrology vs. Astronomy, 2) "Is Friday the 13th really unlucky?", or 3) Science or Superstition?

Each group will be given a box with a background article, vocabulary, an experiment or activity to complete, with discussion questions. Each group will create a presentation and explain their findings. Ideas for the articles and activities may be found at Science or Pseudoscience in the bibliography.

Cooperative Activity: Science or Pseudoscience? You decide

Students will be given handouts of different colors. They will find the other students with the same color to form a group. Each group has a different article/case study and discussion questions (articles available; Pseudoscience, 2013). They will work together to create a presentation of the given material and answers to the questions. After the presentations, the entire class will vote to decide whether they think each scenario is valid science or pseudoscience. Students should have 15-20 minutes for the group work and 5 minutes each for their presentation. The voting and post-activity discussion times will vary. An extension activity would be to have students create a blog post reflection about why it is important to be able to distinguish between the two.

Mini-Lesson: The dangers of pseudoscience

Students will first watch a short clip of *Mermaids* from the Animal Planet (Mermaid Mockumentary). Students will then write a reflection entry addressing the question: "Knowing that Animal Planet created this pseudoscience documentary for fun, are such “documentaries” all in good fun or harmful?” After writing and discussing, students will be given articles about these types of documentaries. Each group will read and summarize each article to share and discuss with the class.

Mini-Lesson: You are a Maverick: How do you get people to accept your idea?

Why do we watch television shows that we know may or may not be valid science? Because they are interesting and it is nice to ponder “What if?” about the world around us. Now it is the students’ turn. In their teams, give each team a topic that may or may not be valid, scientifically. Have them plan and present a presentation to get their classmates to agree with them. This is another persuasive writing topic that they can create various multimedia products to get their point across. There are several related resources in the bibliography that you might use to intro the idea.

Mini-Lesson: Rubric for Maverick or Crackpot/Assign Scientist:

It is up to the teacher when they want to assign the rubric and explain the actual project. It can be done early on or right before they begin working on it. Everyone has different ideas on this. I am partial to having my students know what the project will be about and what we are working towards, but keeping the details under wrap until they are doing the individualized part of the project. Up until this point, the lessons have been similar for all of the students. At this point, as they start to research THEIR scientist, each group can receive what they need instead of everyone receiving the same instruction.

At this point, it is also very important for there to be Team Meetings at the beginning and end of class, to set goals and assign tasks. Some meetings may be whole class, while others are just for their teams. In the latter, the teacher will meet with each group at some point during the class to assess progress and/or will rotate which groups are met with at the beginning of class and which groups are met with at the beginning. Teams should be taking notes and writing goals daily.

Science Mavericks versus Crackpots Project Outline

You can create a rubric to fit the needs of your students, but here is an overview of the project components. Student teams will create a research paper and multimedia project about their given scientist. They will discuss the life and historical context around their scientist, as well as, the basics of the scientist’s research and discoveries. They will also discuss the reasons why their scientist was not taken seriously when the research was presented originally and under what circumstances was the research finally validated? As previously discussed, students will already have a list of possible media project components, but I would add “Creating a Scientist Social Media Page” as a component for the final project. Students can then show the relationships between their scientist and their peers via a medium that they are familiar with. You may want to require a social media page as part of the final project, in addition to another multimedia component.

There are many scientists that could be used for this project, but I am including the list I would personally give the students to choose from. I am also including links to additional lists in the bibliography, if you would like a more comprehensive list to choose from. Make sure to include a couple of “crackpots” on your list!

Scientist(s)	**Claim**
Darwin	Life has adapted and changed over time. This has created diversity through natural selection. (vs. Creationism)
Galileo	Earth is not center of universe, Earth is not flat (vs. Earth as center, with heaven and hell above and below)
Pasteur	Microorganisms cause disease. First Pasteurize milk. (Germ Theory)
Telsa	Many claims about Energy/Electricity. AC power came from his original patents.
Giorgio A. Tsoukalos	Ancient Aliens Theorist
Wegener	Plate Tectonics
William Harvey	Circulation of blood in the body
Al Gore and Dr. Virginia Van Sickle-Burkett	Global Warming/Climate Change
Doppler	Optical Doppler Effect
Karl F. Gauss	Non-Euclidean geometry
R. Goddard	Rocket Powered Spaceships

Appendix 1: Teaching Standards

Science as Inquiry (grade 6-8) – Science Methodology imbedded in the content
Traditional laboratory experiences provide opportunities to demonstrate how science is constant, historic, probabilistic, and replicable. Although there are no fixed steps that all scientists follow, scientific investigations usually involve collections of relevant evidence, the use of logical reasoning, the application of imagination to devise hypotheses, and explanations to make sense of collected evidence. Student engagement in scientific investigation provides background for understanding the nature of scientific inquiry. In addition, the science process skills necessary for inquiry are acquired through active experience. The process skills support development of reasoning and problem-solving ability and are the core of scientific methodologies.

English Language Arts Standards » Science & Technical Subjects » Grade 6-8
http://www.corestandards.org/ELA-Literacy/RST/6-8

Key Ideas and Details

CCSS.ELA-Literacy.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-Literacy.RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

CCSS.ELA-Literacy.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure

CCSS.ELA-Literacy.RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6–8 texts and topics*.

CCSS.ELA-Literacy.RST.6-8.5 Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.

CCSS.ELA-Literacy.RST.6-8.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

Integration of Knowledge and Ideas

CCSS.ELA-Literacy.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

CCSS.ELA-Literacy.RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

CCSS.ELA-Literacy.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Range of Reading and Level of Text Complexity

CCSS.ELA-Literacy.RST.6-8.10 By the end of grade 8, read and comprehend science/technical texts in the grades 6–8 text complexity band independently and proficiently

Annotated Bibliography

Beatty, William. "Ridiculed science mavericks vindicated." Ridiculed science mavericks vindicated. http://amasci.com/weird/vindac.html (accessed November 1, 2013).

This site should be used as the main resource for creating the list of scientists and discoveries for your students. It has several quotes from famous scientists and mathematicians, as well as, extensive links to their research.

"Bill Nye Rips Religion In Science: There is no Controversy." The Inquisitr News. http://www.inquisitr.com/793578/bill-nye-religion-science/ (accessed November 25, 2013).

Recently, Bill Nye has come out in defense of the teaching of evolution in schools and the ongoing debate among many religious groups that there is controversy between science and religion. He explains that there is not a controversy.

STANFORD UNIVERSITY NEWSLETTER ON TEACHING. "Cooperative Learning: Students Working in Small Groups." SPEAKING OF TEACHING. http://www.stanford.edu/dept/CTL/Newsletter/cooperative.pdf (accessed August 20, 2013).

This is another great article on the benefits of cooperative learning groups.

"Do Mundane Things. Get Your Ideas Accepted by Working Behind Enemy Lines, and Don't be a Martyr.." Whats the PONT. http://whatsthepont.com/2013/08/15/do-mundane-things-get-your-ideas-accepted-by-working-behind-enemy-lines-and-dont-be-a-martyr/ (accessed November 10, 2013).

This website is a great starting point to get students interested in learning about how to get people to take their ideas seriously. Parts are written tongue-in-cheek, but as a whole it is a great resource for them.

"Curiosity - Quiz." Discovery Channel. http://dsc.discovery.com/tv-shows/curiosity/topics/real-science-pseudoscience-quiz.htm (accessed September 25, 2013).

This quiz is to be given to students after the pseudoscience mini-lesson. It can be printed out or completed online.

Wikimedia Foundation. "Flat Earth." Wikipedia. http://en.wikipedia.org/wiki/Flat_Earth (accessed November 09, 2013).

Basic information about the “Flat Earth Society” and their beliefs that many scientific theories have not fully been proven or are completely false.

"Is how to engage with the crackpot at the scientific meeting an ethical question? | Doing Good Science, Scientific American Blog Network." Is how to engage with the crackpot at the scientific meeting an ethical question? | Doing Good Science, Scientific American Blog Network. http://blogs.scientificamerican.com/doing-good-science/2012/05/31/is-how-to-engage-with-the-crackpot-at-the-scientific-meeting-an-ethical-question/ (accessed May 25, 2013).

"ALEX Lesson Plan: Fact vs. Opinion." ALEX Lesson Plan: Fact vs. Opinion. http://alex.state.al.us/lesson_view.php?id=29359 (accessed November 10, 2013).

Example of a complete “Fact vs. Opinion” lesson plan that covers several days. There are many similar lessons available online, but this one gives a timeline on each part of the activity, which is wonderful.

"Lesson Plans - Secondary Teachers - History of Science - Table of Contents." Lesson Plans - Secondary Teachers - History of Science - Table of Contents. http://web.clas.ufl.edu/users/ufhatch/pages/05-SecondaryTeaching/NSF-PLANS/contents.html (accessed November 24, 2013).

"Pseudo-science activity." Pseudo-science activity. http://www.stemwedel.org/Pseudo-science_activityF04.html (accessed November 24, 2013).

This activity is an example of one way to do the Pseudoscience activity in the unit. I have adapted it to fit the PBL model, but the articles given would fit will with my version of the lesson.

Clar, Justin, and Terri Cornelison. "SCIENCE OR PSEUDOSCIENCE: YOU DECIDE." SPICE: Science Partners in Inquiry-based Collaborative Education. http://www.spice.centers.ufl.edu/pseudoscience%20module/PseudoScienceModule_FIANAL.pdf (accessed October 10, 2013).

Create lesson plans that you may want to use when creating your Science/Pseudoscience lesson plan. This lesson plan covers several classes and in done as several whole class lessons. I made it a jigsaw activity, where each group researches the given topic and presents it to the class. The ideas in this version would be great way to scaffold the lesson to meet the needs of your students.

Bunyi, Angela . "Identifying Reliable Sources and Citing Them." Scholastic Teachers. http://www.scholastic.com/teachers/top-teaching/2010/11/reliable-sources-and-citations (accessed November 24, 2013).

This site has several lesson plans on helping students learn to navigate the internet to find and use resources for their projects.

Ridgeway, Cecilia L. *Framed by gender: how gender inequality persists in the modern world*. New York: Oxford University Press, 2011.

"STEM to STEAM." STEM to STEAM. http://stemtosteam.org/ (accessed November 24, 2013).

"Scientific breakthroughs by mavericks." Physics Forums RSS. http://www.physicsforums.com/showthread.php?t=50260 (accessed October 10, 2013).

"Skeptic: Examining Extraordinary Claims and Promoting Science." Skeptic (eSkeptic) Wednesday, December 26th, 2012. http://www.skeptic.com/eskeptic/12-12-26/ (accessed November 11, 2013).

"Sociology of Science." Sociology of Science. http://vserver1.cscs.lsa.umich.edu/~crshalizi/notabene/sociology-of-science.html (accessed November 10, 2013).

"The Back Page.": When worldviews collide: science and religion face off again. http://www.aps.org/publications/apsnews/200604/backpage.cfm (accessed November 25, 2013).

"The CRACKPOT Page." The CRACKPOT Page. http://www.physics.smu.edu/scalise/www/misc/crackpot/ (accessed November 25, 2013).

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Dedicated to all the Flat Earthers, Circle Squarers, Angle Trisecters, Cube Halvers, Perpetual Motion Mechanics, UFO and Elvis sighters, and all the other true believers who adamantly refuse to accept mathematical or physical proof that their convictions are untenable.

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