TRIAL BY JURY – THE GREAT SOLAR SYSTEM DEBATE: TEACHER GUIDE

Subject: Earth Science
Grade Level: Middle School
Last Updated: October 27, 2008

Case Summary

Does the Earth stand still while everything revolves around it? The courtroom is noisy with chants of heresy, and arguments. The judge enters … The lawyers for Copernicus, Ptolemy are ready to deliberate. Which view of the solar system is valid?

Credits

This case was written by Dericka Y. Deloney (teacher, Columbia Middle School, Decatur, GA), and Aron Barbey (PhD candidate, Psychology, Emory University, Atlanta, GA), fellows of the Emory University PRISM program.

Learning Objectives

Upon completion of the case, students will be able to:

1. Identify Copernicus, Galileo, Ptolemy and Kepler. Explain their respective contributions to astronomy.
2. Identify and chart the phases of the moon.
3. Compare and contrast the geocentric and heliocentric views of the solar system.
4. Define orbit and explain how planets in our solar system stay in orbit.

Georgia Performance Standards

S6CS1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science. (NSES Content Standard A)

S6CS5. Students will use the ideas of system model, change, and scale in exploring scientific and technological matters.

S6E1: Students will explore current scientific view of the universe and how those views evolved. (NSES Content Standard D)

a. Relate the Nature of Science to the progression of basic historical scientific theories (geocentric and heliocentric) as they describe our solar system and the Big Bang as it describes the formation of the universe.

b. Explain that gravity is the force that governs the motion in the solar system.

Assessment

At the end of the case, students will pass in their box charts, which will be graded based on completeness and clarity. Even though we go over these periodically in class, knowing that they will be passing the box charts in encourages students to listen and efficiently take notes.

For their final assessment, students create either handouts or posters to use in presenting an argument for or against the geocentric or heliocentric view of the solar system based on the lawyer's evidence to the rest of the class. The class serves as the jurors and spectators. These must include both written and illustrated components.

Overall grading for the case is based on their combined grades for their box charts and products. Grading will be based on a 5-point scale (5=excellent, 4=very good, 3=good, 2=fair, 1=poor) that will be converted into a percentage and from there into total points depending on the weight of the assignment, for each of three criteria:

- Accuracy and depth of product components; attention to grammar and mechanics
- Individual contribution/participation within the team
- Individual research ability and effort – online, print, investigative questioning

The second and third criteria (participation, individual effort) will be judged not only by facilitator observations, but by student evaluations to be completed at the end of the case (See sample evaluation in ***Student Materials***).

Implementation Strategy

This case was designed to take place over two 60-minute and four 110-minute class sessions. It consists of a mock courtroom with a background scene of a starry night and music playing from the sound track "Star Wars." Two facilitators or even a single teacher can facilitate this case, because rather than placing a facilitator with every group, the students spend time brainstorming with their group and then as a whole class.

Implementation for this case differs from that of our others in the respect that students will work in pairs, trios or groups of four (really, whatever combination) so that there are eight groups per class. After role-playing, students will complete the box chart with facts, questions, hypothesis, and learning issues. Individuals will be responsible for making a model of both the Geocentric and Heliocentric view of the solar system. Students can be creative in the materials they will use for this is a homework assignment.

The brainstorming session described below typically involves students reading, discussing and taking notes in their groups in 15-20 minute blocks. Next, they reconvene as a whole class to volunteer their observations, questions, hypotheses and learning issues (learning issues are things that students say they need to know or look up to define unknown terms, answer their questions, and/or test their hypotheses) at the end of every 10-minute block. While the students brainstorm, facilitator(s) should float from group to group, checking progress and helping students think through questions or mental roadblocks.

Implementation Schedule

Day 1 (Monday) 60 minutes total

- Role-play (~ 10 minutes)
- Small groups appoint reader, scribe, timekeeper, and reporter.

- Brainstorm and construct group box chart; individuals also make own box chart (This keeps middle schooler students busy) (~ 20 minutes)
- Facilitator meets with each group to check on progress and to ask probing questions. (~ 10 min each)
- Whole group discussions on facts, reporter from each group will take turns presenting. If class agrees it's a pertinent fact then all will record on their box charts. (~ 30 minutes)
- HW – Review box charts, add more questions, hypothesis, and learning issues (LI).

Day 2 (Tues/Wed) 110 minutes total

- Continue reviewing box charts with whole group following Day 1 guide: questions, hypothesis, and LI (~15 min)
- Divide learning issues within small groups that can be found in textbook. (~5 min)
- Prior to online or any other research, utilize textbook (REF) as a primary resource for answering learning issues (~ 10 min)
- Have students with same LI, group together to discuss their findings and to give an example to ensure understanding of all. (~ 10)
- LI experts will report their understanding to small then whole group. Everyone summaries the experts notes in their LI log including the source. (~ 30 min)
- Add any new LI in different color ink if any.
- Small group divide remaining LI for Internet and other sources for investigation.
- Computer lab: Complete researching learning issues (~20 minutes)
- Reconvene and discuss findings in expert groups then in small and whole group (~30 min.).
- HW – Create models demonstrating the Geocentric and Heliocentric views of the solar system.

Day 3 (Thurs/Fri) 110 minutes total

- Use homework as a model while discussing the views of the solar system.
- Group members analyze the models and give designer feedback. (~ 20 min)
- Role-play scene 2.
- Repeat Day 1 & 2 itinerary
- Task for small groups in support of Galileo's claim:
    - Student's look at phases of the moon charts for one month via the Internet (http://www.schoolsobservatory.org.uk/cgi-bin/lunarmon.cgi) or hardcopy, taking note of the cycle.
    - Students can draw diagrams to show how the sun, Earth, and Venus are aligned as Venus passes through its phases (http://www.astro.cornell.edu/academics/courses/astro201/venus_phase.htm) or http://www.calvin.edu/academic/phys/observatory/images/venus/
    - Compare this to moon phases. Discuss how the phases are related.

- Using a corrugated cardboard, sheet of paper, a 30 cm string, and two pushpins about 10cm from each other. Tie ends of string together and place around pins. Move pencil around the inside of the string keeping it nice and tight, label sketch. Predict what would happen when pen distances are changed. Then move pens 5 cm apart and repeat. Students discuss how changing the distance affects the ellipse's shape. Have student do the same with only one pin. Discuss the differences.
- Students compare the solar system as viewed by Copernicus and today. Discuss the differences.

Day 4 (Monday) 60 minutes total

- Lawyers' present closing remarks to jury. Jury makes verdict based on evidence. (~40 min.)
- Case evaluation, wrap-up

Case Notes

1. There were two facilitators, and 4 to 5 small groups. This was the first PBL with research involved; therefore, it went a lot slower than expected.

What worked:

2. The role-play and props were great. After students stumbled over the pronunciation of the names, they delved into questioning.
3. Students were very creative with their models of the theories; viewing pictures found on the Internet assisted greatly in the development of the models.
4. Students were assigned roles such as recorder, reader, timekeeper, and reporter. They used large chart paper, as well as individual box charts. After 15 minutes, the reporters from each group shared box chart information.
5. The entire class had the same learning issues (LI), the small groups divided the LI for research and presenting back to group. The experts of the LI reported to entire class, and if an expert from another group wanted to add information, they were allowed.
6. Weeks later in reviewing for final exam students recalled quite a bit from this case in comparison to other lessons taught.

Improvements needed:

7. Students have to learn how to put information in their own words and how to dig deeper if there is something still unclear to them. More probing from facilitators is needed while students are researching and developing questioning skills.
8. Maybe some questioning techniques should, summarizing of small articles, and quick note taking should be taught at beginning of semester.
9. For deeper understanding of different types of telescopes, have an activity comparing reflection to refraction using.
10. Assign only one LI per student in small group, inform them that they will become the expert, and then group these experts to discuss findings and to make blueprints, models or examples before going back to group to teach. With this format, I believe students will be more engage knowing that they have to actually teach their peers, and research says that you learn more once you teach the concept. In addition, peers sometimes learn better from each other.

11. Assign all students to bring in certain materials to make models in class. School has very limited supply.

Didn't work:

12. Didn't get to do all the activities for day 3, just discussed, because of time it took for them to do research and discuss.
13. Showed animation of Kepler's Law http://honolulu.hawaii.edu/distance/sci122/Programs/p11/ellipse.html instead of student doing activity. Next time do both, for deeper understanding.

14. The Prentice Hall Earth Science Explorer (2002) text was a minor source for research, while several Internet links were used. Hardcopies had to be made of articles from the Internet, due to computer lab unavailability.

Facilitator Guide:

Case: Trial by Jury: The Great Solar View Debate Scene 1
Is Ptolemy's or Copernicus Theory Correct?
Student's Box Chart

Facts	Questions?
1. Copernicus' sketches and notes have been checked by fellow experts who agree with his theory. 2. Copernicus made celestial observations from a turret situated on the protective wall around the cathedral. 3. Copernicus was born February 19, 1473. 4. The state is here to imprison astronomer Copernicus, the son of a wealthy merchant who is charged a spreading vicious fallacies against the state. 5. Docket number 2345. 6. Copernicus accused Ptolemy's theory of being hogwash.	**If I were there I would ask…** 1. Why was it hard to believe something new? 2. Was Copernicus married? 3. Why others couldn't see what Copernicus sees? 4. Did Copernicus wear glasses? 5. Where was Copernicus when he made these observations?
Hypothesis **Ideas to solve the case** 1. I believe that Ptolemy view is correct b/c Copernicus did not have any visible proof (but he really did—sketches/model). 2. I think that Copernicus theory is	**Learning issues** 1. What are fallacies? 2. What are Copernicus' and Ptolemy's theories? 3. What is a proponent? 4. What theory do we live by today? 5. What is H O G W A S H ? 6. What is the Ptolemy/Copernicus' academic background? 7. What is heresy and is it a crime?

true b/c he said that fellow experts agree with his theory.	8. What exactly was CO-PERN-I-CUS trying to prove wrong about (P)Tolemy's theory? 9. Where is Thorn, Poland? 10. What is a solar system? Is there more than one solar system? 11. What is celestial? 12. What is a turret? 13. What is the bare eyeball? 15. who invented the telescope? 16.what is a scientific theory? 17. How did they come up with the theory? 18. How could Copernicus make various observations with the naked eye.

Learning Objective Guide: Case Name: Trial By Jury: The Great Solar Debate
Scene# 1 from students

1. **Learning Objective: What are fallacies?**

The information I found is: (In your own words) A false or mistaken ideas and its not a crime.

The source of this information is (web address, book w/author and edition pages, textbook pages): 0Webster, Miriam (1998). Miriam Webster's Dictionary. Springfield, MA: Miriam Webster Co.

2. **Learning Objective:** What are Copernicus' and Ptolemy's theories?

The information I found is: (In your own words)

Copernicius theory sun-centered universe, all planets and objects orbits around the sun. Heliocentric Theory.
Ptolemy's theory – Earth was stationary and the movement of the planets & other objects were orbiting around Earth. Geocentric Theory.

The source of this information is (web address, book w/author and edition pages, textbook pages): Exline, Joseph. (2002). Prentice Hall, Science Explorer Earth Science. Page 672. Chapter 20 The Solar System. Needham, MA.

3. **Learning Objective:** What is a turret?

The information I found is: (In your own words)
A little tower or an ornamental structure at an angle of a larger structure.

The source of this information is (web address, book w/author and edition pages, textbook pages): 0Webster, Miriam (1998). Miriam Webster's Dictionary. Springfield, MA: Miriam Webster Co

4. **Learning Objective:** What is celestial?

The information I found is: (In your own words) Relating to the open sky.

The source of this information is (web address, book w/author and edition pages, textbook pages): _____

5. Learning Objective: What is Proponent? Proponent is a supporter.
The information I found is: (In your own words) One who argues in support of the cause.

The source of this information is (web address, book w/author and edition pages, textbook pages): _____

Learning Objective:

6. What exactly was CO-PERN-I-CUS trying to prove wrong about (P)Tolemy's theory?

The information I found is: (In your own words):

It stated that everything orbits around the earth

7. **Learning Objective:** What is H O G W A S H ?

The information I found is: (In your own words) Worthless nonsense

The source of this information is (web address, book w/author and edition pages, textbook pages): young American dictionary on line

7. Learning Objective: Which theory do we live by today

The information I found is: (In your own words) Copernicus theory.

The source of this information is (web address, book w/author and edition pages, textbook pages): __last page of the science book

8. Learning Objective: What is a scientific theory?

The information I found is: (In your own words)
An idea that is the best explanation of many observations and help make new predictions

The source of this information is (web address, book w/author and edition pages, textbook pages): _____

9. Learning Objective: What is a scientific law?

The information I found is: (In your own words) A scientific law is an explanation that describes some parts of the world or universe of some predictions

The source of this information is (web address, book w/author and edition pages, textbook pages): _____

Facilitators push students toward these questions for their Learning Issues:

1. What are scientific theories?
2. What is astronomy? What instruments do they use?
3. What is Ptolemy's theory?
4. How many planets are in this planetary system?
5. What is the name of Ptolemy's model?
6. Design a model of Ptolemy's theory.
7. What were the three incorrect ideas stated in The Copernican Revolution?
8. Why did Copernicus use his bare eyes for his observations?
9. What are epicycles? Why are they important?
10. What is the Copernicus System known as today?
11. How many planets are in this system? List them in order from the Sun.
12. Design a model of Copernicus' Theory with labels.
13. How does Earth's motion differ in each system?
14. How does the motion of planets differ in each system?
15. Construct a Venn diagram comparing the two models for the court.

Key Terms

Geocentric	Heliocentric	Ellipse
Inertia	Newton's Laws	Gravity
Orbit	Astronomers	Telescope
Type lenses	Moon phases	

Resources

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