What We Always Wanted to Know about the Universe
But Didn't Know How to Find Out

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Overview

How would it feel to have no knowledge about how our universe was created or how our earth was created? This is how I feel that our students look at astronomy. In the scientific world most of my students are walking around without sight, hoping that someone else will answer questions or thinking they do not need to deal with it because it does not affect them. During this age of space exploration the unanswered questions need to be answered and the answered questions need to be reinforced or clarified. Throughout the unit, **"**What we always wanted to know about the universe but didn't know how to find out," the students will expand their horizons, enter into the scientific world and find answers to questions that have never been explained.

Rationale

Before technology erupted in to society astronomy and the study of the universe was present. As far back as A.D. 140, astronomers like Ptolemy, have been studying the stars and planets to find out as much as they could about what is beyond our atmosphere. In the 1500's Copernicus proposed the concept of a heliocentric universe. This discovery enabled the explanation of the daily rotation of the stars and moon observed by the naked eye. This theory was then supported by Kepler, which enabled him to develop his third law – the relationship between the orbital period and the distance planets to the sun. Galileo created telescopes which allowed for further exploration of the stars which then led to the development of Newton's laws, inertia, 2^{nd} law of motion and 3^{rd} law of motion. The trend of theoretical development continued to the present day. Yet there continue to be mixed opinions and emotions about the universe and beyond.

This unit will introduce students to commonly asked questions and their answers. The following questions/concepts will be presented for inquiry and research throughout the unit:

1. Is the universe really expanding and what does that mean to us?
2. What is the life cycle of a star and where does our sun fit into the cycle?
3. What is "Big Bang"?
4. How far away is space? the sun? the next galaxy?

5. How old is the universe?
6. What is a black hole?
7. What is beyond our solar system?
8. Could there be other solar systems with a "planet earth"
9. When will our sun die and why?
10. What is dark matter? Can I touch it?
11. Why is astronomy so complicated?
12. How was the earth created?

The Big Bang Theory and the Age of the Universe and Galaxy formation

How is the formation of the universe explained? What about the formation of galaxies? planets? stars? According to the Big Bang hypothesis the entire universe was packed into a tightly packed sphere of hydrogen, approximately the size of our sun today. Approximately 15 billion years ago this sphere exploded and expanded. Some parts of the explosion moved faster and some moved slower. These parts were clouds of materials. These clouds eventually condensed into billions of galaxies.

The evidence that supports this hypothesis comes from many sources. In 1929, Edwin Hubble, discovered red shifts in the spectra in the galaxies that he studied (Heath Earth Science, p.391). This demonstrates that the universe is expanding. In 1964, Arno Penzias and Robert Wilson detected microwave radiation coming from all over space. This was thought to be an echo of the big bang. The source is thought to be from the cooling of the universe. This is considered Background Radiation. It is also detected by NASA Aircraft and it is found that half of the background radiation was hotter than the other half. This is a result of the Doppler shift as the earth moves through the universe.

Approximately 300, 000 years after the big bang the universe became transparent enough for light to travel through space. Prior to this space was cluttered with matter which was unable to generate light. At this point the dark matter attracted surrounding gases; therefore forming galaxies. There are multiple theories on how the galaxies formed and this theory is just one.

Dark Matter

Dark matter is invisible matter that is thought to make up a very large percentage of the universe. Some forms of dark matter are neutrinos, weakly interactive massive particles (WIMPS) and brown dwarfs. Most dark matter is made of WIMPS. Other support of dark matter is if there were no dark matter gravity the outer parts of the galaxies would be released into space.

Distances in Space

Distances in space are measured primarily by two units, Astronomical Units (AU) and Light Years.

One AU is the average distance between earth and the sun. This equals 149.6 million kilometers. For each planet this distance varies dependent upon its elliptical path. Due to planets' elliptical paths the distance from the sun varies with aphelion and perihelion.

Planet	Average Distance from the Sun (AU)
Mercury	.39 AU
Venus	.72 AU
Earth	1 AU
Mars	1.52 AU
Jupiter	5.20 AU
Saturn	9.54 AU
Uranus	19.19 AU
Neptune	30.1 AU
Pluto	39.5 AU

Light-Years are used due to the enormous distance that needs to be measured in space. It is a standard unit of Astronomical measurement, based on the distance light travels in one year; this is approximately 9.5 trillion kilometers.

There are other units used for astronomical measurement but AU and light-years will be focused on primarily in this unit.

What is the life cycle of a star in relation to the sun?

The life cycle of stars can be seen in a diagram called the Hertzsprung - Russell diagram (H-R). This diagram plots the stars according to spectral type and luminosity. Where it is in its life cycle will determine where a star can be found in the H-R diagram. Stars are separated into four main groups: main sequence stars, giants, super giants, and white dwarfs.

Presently the sun can be found among the main sequence stars. The sun is of average size and age. In regards to star formation and the sun, as a star is

forming there are many nuclear fusions occurring. This is what fuels the star to form. As the fusion is occurring it forms an outward force and inward force that allow the star to remain stable and reach equilibrium. This balance has allowed our star to maintain equilibrium for approximately 5 billion years. Due to our sun's currently being in the main sequence and average our sun can last approximately 5 billion more years.

Expansion of the Universe

Expanding is a term that can be very confusing when relating it to space. The expansion of space is not space expanding into something else; it is stretching and drawing everything further apart. Think of this as a large piece of rubber and the solar system drawn on it. As it was stretched from each side all the planetary objects move farther away from each other. This is not only occurring in our solar system but in space as a whole at the same rate. Although space is expanding the objects in space, such as planets, are not getting larger. This is a result of gravitational forces that hold them together. The expansion can be measured by astronomers making observations of the locations in space and by measuring redshifts. Redshifts are shifts in the spectrum towards the redder longer wavelengths when the objects are moving farther away. The more shift the faster it is moving. This is similar to the Doppler Effect and sound. It is estimated that yearly each section of space is expanding by 0.01 light-years.

Life Cycle of a star

A star begins as a nebula which is made up of dust and gas. Gravity causes the dust and gas to come together. The gas pressure of a protostar tries to reach equilibrium with the gravitational constant. Depending on the temperature and the density either a brown dwarf will be formed or nuclear fusion begins. At this point the protostar becomes a star. The protostar continues to contract until it reaches its stable state. The mass of the star determines whether it is going to glow hot blue or white or if it is cooler and glows yellow or orange. The hotter the star the sooner it will become stable. This allows the star to become a main sequence star. The next step in a stars' life cycle is for it to become a red giant. The star becomes unstable again and the center begins to contract. Yet it is so hot that its outer layers expand. A fusion reaction starts occurring in the outer layers of the star. The star expands farther and becomes a red giant. Although, a red giant is larger, it is less massive. When the red giant's core is no longer able to support the weight of its outer layers it collapses and becomes a white dwarf. Occasionally the dwarf will flare up and becomes nova. The nova is a bright light that lasts a few years. As a white dwarf cools the core may collapse. If the core

collapses the pressure and temperature within the core rise and the star flares up into an intensely bright object called a super nova. This can be brighter than an entire galaxy. If the white dwarf collapses the star is now a brown dwarf. Our sun is currently a main sequence star. (Expand upon the sun)

Unit Information

The students will be prepared for cosmological concepts upon completion of the stellar and solar astronomy instruction using a Heath Earth Science text, Spaulding and Namowitz. Using their prior knowledge the students will be reintroduced or introduced to the concepts/questions stated above. Their prior knowledge will be tested using a pre-test format to determine the strengths and weaknesses of each student.

This unit is designed to reinforce or introduce my students to concepts relating to the Universe. It is designed for students in grades 10th-12th, enrolled in Earth and Space Science class. . The population of students is primarily mainstream with special needs students included. Due to the vast range of ages and skill levels the topics and activities need to be adaptable.

This unit will fulfill the Pittsburgh Public Schools requirements in Earth Space Science. According to the scope and sequence, report period three is "Astronomy." This unit will cover many of the required topics.

Objectives

After completing this curriculum unit the students will be able to:

1. Define and use several units that express distances in space.
2. Compare the physical and chemical properties of the sun with those of other stars.
3. Discuss the different ways in which star brightness is measured and how it relates to the distance of stars.
4. Define and describe the properties of giant, super giant, and dwarf stars and give examples of each.
5. Name and describe kinds of variable stars.
6. Discuss the characteristics of pulsars.
7. Describe the formation of novas, supernovas, neutron stars, and black holes.
8. Name, describe, and give examples of types of galaxies and quasars that occur in the universe.

9. Discuss the big-bang hypothesis and present the evidence for it.

Strategies

At the beginning of this unit the students will complete a pre-test to determine their prior knowledge regarding the concepts stated. The pre-test will be used to determine placement in groups and topics to be assigned. After the pre-test I will begin my lesson by reintroducing or introducing the concepts/questions stated. I will then assign each student a concept or question to answer. The students are required to initially work independently on researching their topic. This will be completed using web and text resources and an "organized note sheet" compiled prior to the project/unit as a guide and a brainstorming activity. Each group will also be given appropriate information to give them a better understanding of their topic. After completion of the research the students will get together in their group to compare notes and information to create a 40 minute presentation. The presentation will be presented using technology based software programs, include citations of work, accurate data and by following a rubric. Along with the presentation there will also be an end-product. Each group using the compiled information will produce a 10 page paper explaining the steps to answer the problem, their final answer and any mathematical computations need to prove the question and a presentation to teach the class the concept/question. They will also be required to turn in all notes taking information. After all of the presentations are completed, the students will complete a post-test to determine learned information and growth. The lessons and activities will be in accordance with the National Teaching and Learning Standards adopted for the state of Pennsylvania (See Appendix A).

Classroom Activities

Day 1

Overview and Prior Knowledge of Universal Concepts
(ST# 1-3 RWSL# 3, 5 and 7)

The students will complete the Universal concepts pre-test to determine their prior knowledge (see Appendix B). Once they have completed the pretest, we will discuss the requirements of the unit and its outcomes. The students are to discuss the rubric (see APPENDIX C) and its explanation. When the teacher discusses the rubric, each student will receive a copy of it and each category will be discussed and clarified as needed. The students will then receive a description of the assignment (see APPENDIX D). This description it will state the daily requirements as well as the final product information. A list of resources will be

given to each student to ensure the information is valid and reliable. At this time students will be given the information to complete "easy-bib" to create a works cited page. The students will now be assigned the topic to be researched.

Days 1-4

Research Procedures, Breakdown and Organization of Materials (ST# 3-6 RWSL# 1-5 and 7)

Prior to students beginning their research, a review of the requirements, rubric, daily requirements and assignment description will be conducted. At the beginning of each class there will be a question and answer session to clarify technical issues, identify or elaborate on specific concepts, and ensure the proper research is being conducted.

Independently each student will conduct research on the subject assigned according to prior knowledge and pre-test results. The resources each student should use can be found on the Web site and book list related to cosmological concepts. Each day the students will be required to turn in an organized note sheet, a list of resources used and a list of questions to be answered the following day prior to the next research session.

Days 5

Collaboration of Materials and Completion of Research (ST# 1-6 RWSL# 1-5 and 7)

Each student will individually organize information. Dependent upon the source the information may have some variations. The information must be grouped according to subtopics of the information that was assigned. If additional research is required, a teacher facilitated search will be conducted to pinpoint the location of specific material needed.

Day 6-8

Cooperative Small Groups Relating to Assigned Topics / Final Product Compilation
(ST# 1-6 RWSL# 1-7)

Utilizing cooperative small group roles and rules previously used in class (if cooperative small groups were never used, utilize other instruction techniques or research methods for cooperative small groups) the students will share information researched and compiled.

1. Assign students roles (note taker, task master, time keeper, secretary). Each day the roles will be switched to ensure all student participation.
2. Each day the students will begin with the newly assigned roles and share and organize specific topic organization.
3. At the end of each day the students will explain what organization was completed and what progress was made.
4. Each day the rubric requirements will be reviewed.
5. Throughout the organization the students will also arrange the information into research paper format, using the following topics as a guide.
    a. Narrative process of obtaining the information
        i. Obstacles that were encountered
        ii. Helpful hints for research of this type
    b. The final answer to the originally stated question
    c. Mathematical computations used to help solve/answer the question
    d. Citations of work / bibliography

Days 9-11

Presentation Preparation
(ST# 1-6 RWSL# 1-7)

After completion of the research and organization of the materials, the students will develop a 40-minute presentation. The objective of the presentation will use technology based software programs, include citations of work, and accurate data, and follow a rubric. The presentation is to teach the class the concept/question that was unanswered. The students will use Microsoft Power Point to present the information. Each group will be required to produce at least 20 slides and no more than 25 slides. Each slide should concentrate on content

not bells and whistles. The presenters of the group will each need to present for approximately 8-10 minutes, depending on the number of group members.

Day 12

Preliminary Presentation Information
(ST# 1-3, 5-6 RWSL# 3, 5-7)

Prior to the presentation, appropriate presentation rules should be addressed. Appropriate note taking and organization of presented materials will be reviewed. The notes will be used to identify concepts that were not answered correctly on the pre-test.

Days 13-24

Presentations
(ST# 1-3, 5-6 RWSL# 3, 5-7)

Each group will prepare to present the information and setup the appropriate computer and projector and ensure each group member is prepared.

While the groups are setting up their presentation, the spectators will gather note taking materials and prepare to observe the presentation.

Day 24

At-Home Activity
(ST# 1-6 RWSL# 1-5 and 7)

After the students observe all presentations, the students will prepare for the post-test, by studying the presented materials. Any questions that remain should be documented to be asked in class the following day.

Day 25

Review of Universal Concepts Previously Approached
(ST# 1-6 RWSL# 1-5 and 7)

After all presentations and a brief review of the concepts the students will complete a post-test (see APPENDIX E). Once the post-test has been completed, outcomes and growth of knowledge will be discussed. Individual and group grades will be presented and a wrap up of the unit will be conducted.

Materials Needed

Days 1-4

Pre-tests
Pens/pencils
Lined paper
Computer for each student

Days 6-12

Pens/pencils
Lined paper
Computer for each group
Printer
Floppy disks

Days 13-24

Pens/pencils
Lined paper
Computer for each group
Projector
Floppy disks

Day 25

Post-tests
Pens/pencils
Lined paper

Bibliography

Reading Materials

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The Elegant Universe. Ed. Lauren Aguirre. 1996. NOVA. 17 Apr. 2004 <http://www.pbs.org/wgbh/nova/elegant/>.

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APPENDIX A

Standards

The following standards are used by the Pittsburgh Public Schools. In accordance to Science and Technology and Reading Writing, Speaking and Listening standards.

Science and Technology (ST)

1. All students explain how scientific principles of chemical, physical and biological phenomena have developed and relate them to real-world situations.
2. All students demonstrate knowledge of basic concepts and principles of chemical, physical, biological and earth sciences.
3. All students explain the relationship among science technology and society.
4. All students develop and apply skills of observation, data collection, analysis, pattern recognition, prediction and scientific reasoning in designing and conducting experiments and solving technological problems.
5. All students evaluate advantages, disadvantages and ethical implications associated with the impact of science and technology on current and future life.
6. All students demonstrate basic computer literacy, including word processing, software applications, and the ability to access the global information infrastructure, using current technology.

Reading Writing, Speaking and Listening (RWSL)

1. All students use effective research and information management skills, including locating primary and secondary sources of information with traditional and emerging library technologies.
2. All students read and use a variety of methods to make sense of various kinds of complex texts.
3. All students respond orally and in writing to information and ideas gained by reading narrative and informational text and use the information and ideas to make decisions and solve problems.
4. All students analyze and make critical judgments about all forms of communication, separating fact from opinion, recognizing propaganda,

stereotypes and statements of bias, recognizing inconsistencies and judging the validity of evidence.

5. All students exchange information orally, including understanding and giving spoken instructions, asking and answering questions appropriately, and promoting effective group communications.
6. All students compose and make oral presentations for each academic area of study that are designed to persuade, inform or describe.
7. All students communicate appropriately in business, work and other applied situations.

APPENDIX B

Pre-test

Name _____ Date _____ Period ____

Directions: This pre-test is designed to get an idea of what you already know about the study of cosmology and cosmological concepts. Answer all questions to the best of your ability. Use additional paper if needed.

13. Is the universe expanding and what does that mean to us?

14. Explain the life cycle of a star. Where does our sun fit into the cycle?

15. What is Big Bang?

16. How far away is space? the sun? the next galaxy?

17. How old is the universe?

18. What is a black hole?

19. What is beyond our solar system?

20. Could there be other solar systems with a “planet earth”?

21. What is dark matter?

22. Why is astronomy so complicated?

APPENDIX C

Rubric

Oral Presentation Rubric: Cosmology Rubric

Teacher Name: **Ms. Keyser**

Student Name: _____

CATEGORY	4	3	2	1
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
Collaboration with Peers	Almost always listens to, shares with, and supports the efforts of others in the group. Tries to keep people working well together.	Usually listens to, shares with, and supports the efforts of others in the group. Does not cause "waves" in the group.	Often listens to, shares with, and supports the efforts of others in the group but sometimes is not a good team member.	Rarely listens to, shares with, and supports the efforts of others in the group. Often is not a good team member.
Vocabulary	Uses vocabulary appropriate for the audience. Extends audience vocabulary by defining words that might be new to most of the audience.	Uses vocabulary appropriate for the audience. Includes 1-2 words that might be new to most of the audience, but does not define them.	Uses vocabulary appropriate for the audience. Does not include any vocabulary that might be new to the audience.	Uses several (5 or more) words or phrases that are not understood by the audience.
Preparedness	Student is completely prepared and has obviously rehearsed.	Student seems pretty prepared but might have needed a couple more rehearsals.	The student is somewhat prepared, but it is clear that rehearsal was lacking.	Student does not seem at all prepared to present.
Stays on Topic	Stays on topic all (100%) of the time.	Stays on topic most (99-90%) of the time.	Stays on topic some (89%-75%) of the time.	It was hard to tell what the topic was.

APPENDIX D

Group Planning -- Research Project: Cosmology Research Paper

Teacher Name: **Ms. Keyser**

Student Name: _____

CATEGORY	4	3	2	1
Delegation of Responsibility	Each student in the group can clearly explain what information is needed by the group, what information s/he is responsible for locating, and when the information is needed.	Each student in the group can clearly explain what information s/he is responsible for locating.	Each student in the group can, with minimal prompting from peers, clearly explain what information s/he is responsible for locating.	One or more students in the group cannot clearly explain what information they are responsible for locating.
Quality of Sources	Researchers independently locate at least 2 reliable, interesting information sources for EACH of their ideas or questions.	Researchers independently locate at least 2 reliable information sources for EACH of their ideas or questions.	Researchers, with some adult help, locate at least 2 reliable information sources for EACH of their ideas or questions.	Researchers, with extensive adult help, locate at least 2 reliable information sources for EACH of their ideas or questions.
Plan for Organizing Information	Students have developed a clear plan for organizing the information as it is gathered and in the final research product. All students can independently explain the planned organization of the research findings.	Students have developed a clear plan for organizing the information in the final research product. All students can independently explain this plan.	Students have developed a clear plan for organizing the information as it is gathered. All students can independently explain most of this plan.	Students have no clear plan for organizing the information AND/OR students in the group cannot explain their organizational plan.
Ideas/Research Questions	Researchers independently identify at least 4 reasonable, insightful, creative ideas/questions to pursue when doing the research.	Researchers independently identify at least 4 reasonable ideas/questions to pursue when doing the research.	Researchers identify, with some adult help, at least 4 reasonable ideas/questions to pursue when doing the research.	Researchers identify, with considerable adult help, 4 reasonable ideas/questions to pursue when doing the research.

APPENDIX E
Note taking worksheet

Q Notes

Name	Date
Topic	Class/Subject

Overview: Q Notes combines two well-known and powerful methods: SQ3R and Cornell Notes. I call it "Q Notes" because you can only write Q-uestions in the left-hand margin; when you prepare for a Q-uiz, the Q-uestions serve as CUES to remind you what you must know. When using these notes to study, fold the **right-edge** of the paper over so that it lines up with the dotted line. You should then only be able to see your questions in the Q-column. Use these to Q-uiz yourself.

Directions: Turn the titles, subheadings, and topic sentences into questions in this column.	**Directions: In this area, you write the answers to the questions. Use bullets and dashes to help organize your ideas. Also, use symbols and abbreviations to help you take notes more efficiently.**

Down here you should review, retell, or reflect on what you read so far.

***See bibliography page for source.**

APPENDIX F

Post-test

Name _____ Date _____ Period ____

Directions: Write the answers to the following questions in the spaces provided. If you need additional space additional paper will be supplied.

23. Is the universe expanding and what does that mean to us?

24. Explain the life cycle of a star. Where does our sun fit into the cycle?

25. What is Big Bang?

26. How far away is space? the sun? the next galaxy?

27. How old is the universe?

28. What is a black hole?

29. What is beyond our solar system?

30. Could there be other solar systems with a “planet earth”?

31. What is dark matter?

32. Why is astronomy so complicated?

33. How was the earth created?