Pfrazier Lassi Lesson Plan 1:

HOW MUCH? (grades 5-8)

80 minutes

1. ***Standards and Safety Materials:***

WSS

1. SC4.1.9 Students investigate physical phenomena commonly encountered in daily life, including light, heat, electricity, sound, and magnetism.

2. SC4.1.5 Objects in the Sky: Students describe observable objects in the sky and their patterns of movement.

NGSS

MS-ESS1-3.	**Analyze and interpret data to determine scale properties of objects in the solar system.**
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). (MS-ESS1-3)

CCSS Math

CCSS.Math.Content.4.NBT.A.2

Read and write multi-digit whole numbers using base-ten numerals, number names, and expanded form. Compare two multi-digit numbers based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons.

CCSS.Math.Content.6.NS.C.5

Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.

CCSS.Math.Content.6.NS.C.7

Understand ordering and absolute value of rational numbers.

B. Safety Concerns: Minimal Safety Concerns with regular class activity

C. Materials: How Much is a Million book; At least 4-6 sets of 25 color astronomy pictures on cardstock to order; Relative Size of Things & Scale of Things activity page; Photos: http://physics.uwyo.edu/~aschwortz/LASSI/files/Scale_cards.pdf

2. *Objectives:*

A. Students will be able to **list and identify** how to **write** large numbers with many '0's and in exponential powers of 10.

B. Students will be able **choose** and **apply** powers of 10 through astronomical distances

C. Students will be able to **compare** and **examine** astronomical objects and their size and distances.

3. *Connections, Misconceptions, and Crosscutting Concepts:*

A. Real world connections: Real pictures of objects in Universe; Astronomical use of very large and very small numbers; Recognition of truly how big 'millions, billions,' etc. are and intro to astronomical numbers like parsec, light year

B. Student connections: Writing large powers of 10 in two common forms and why the exponents help; Wonder at the enormity of large and tiny numbers; Ability to converse about large numbers and large subjects!

C. Misconceptions: Exponents are hard and only really for algebra and formulas; The Universe is beyond comprehension; Astronomy is all about outer space and planets; Often students forget to count the '0' included in the '10' of exponential powers of 10! (1 followed by # of '0's.

D. Crosscutting Concepts:

Patterns

- Patterns can be used to identify cause-and-effect relationships. (MS-ESS1-1)

Systems and System Models

- Models can be used to represent systems and their interactions. (MS-ESS1-2)

Scale, Proportion, and Quantity

- Natural objects exist from the very small to the immensely large. (5-ESS1-1)

E. Academic Language: Astronomical; Exponent(ial); Size; Distance;

4. *Catch/Engagement*

https://www.youtube.com/watch?v=0TgLtF3PMOc- Kindergarten count to 100 dance to remember fun

http://www.youtube.com/watch?v=MKkK87E46I4- How Much is a Million
David M. Schwartz (Author), Steven Kellogg (Illustrator)

5. *Pretest-* included (verbs highlighted on actual test)

6. *Activity/ Exploration:*

Part 1: Lecture

X- Finish book and review;

Y- Video: https://www.youtube.com/watch?v=0fKBhvDjuy0
discuss video: How many exponents of 10? (40) smallest? largest? , model a couple easy pictures in order left to right like read a book. Group students in preferably groups of 3-4.

"Now, here is a stack of 25 photos. Hand out the photos (mixed up!). Please do your best to **examine** and order these objects from left to right as you read a book on your desks."

Part 2: Lab

M- Attempt to **compare and order** the photos on tables w/o much help.

N- As finish, hand out "The Scale of Things" and "Relative Activity". Judge when to stop everyone in order to move on. Read through with students. Particularly emphasize vocabulary that students must alternate **writing** powers of 10 in expanded and exponential notation. "Reminder- What is 10^2? How many '0's are there?" 10^6? 1 followed by 6 '0's"!" Ask how they will determine the exponent to use? The 'Relative Activity' sheet can also help them **identify** any objects they may be unclear about on the photos. Fill in the blanks on "Scale of Things" as you **choose** and **apply** your growing knowledge. Use the Model the first few blanks and ask for repeat back of plan.

Part 3: Reading: "Let's read the "Relative size of Things" and practice reading exponential numbers aloud!

Part 4: Discussion: What was confusing? Are you amazed?! Share some of the incredible words you have learned. What do you wonder about?

7. *Review/Essential Questions/Explanation:*

A. Low Level: How many powers of 10 could you **list? Orally?** Do large numbers surprise you? Can you **discriminate** the differences and the vast arrays of space?

B. Middle Level: Can you **discriminate** the differences and the vastness of space? What do you **question**?

C. High Level: Do you **value** the study of astronomy? Would you enjoy **developing** the theories and science it involves?

8. ***Assessments (Post-Test)/Evaluation:***

A. Formative – Completion of “The Scale of Things”

B. Post-test- included below (verbs highlighted on actual test)

C. Summative- MAP test and Math180 SMI (tri-annual)

9. ***Timeline:*** A. Catch – 10 minutes (could split the book into 2 days – so this is really 5 each)

B. Pre-Test-10 minutes

C. Activity- 45 minutes (will carry into second day)

D. Review and Post-test -15 minutes

10. ***Enrichment/Elaboration:***

Scientific Notation; Write the numbers from ‘Scale of Things’ in Scientific ***Notation***, Try the decimal objects (look them up and write their sizes in decimal value and negative scientific notation.

11. ***IEP Accommodations/Differentiation/Diversity:***

Take more time with headphones and listen to whole book again and possibly the video; fill in the actual numbers, have them write only the exponents; Cut down on the number of photos to order; Or simply find the very common ones and discuss or write the names; Look at Google earth and try to zoom in and out like the video.

HOW MUCH? Pretest/Posttest

1. What is the name of the largest number you can name? Write it with numbers then with words. YES please spell it all correctly. (for example: 3,422 / three thousand four hundred twenty two).

2. How far away do you think objects in the sky are? Other galaxies? The sun? /Other stars? Other planets in our solar system? Our moon?

3. Look back at #2: Are the 5 items **list**ed in order of closet to farthest from earth? If yes, say ‘yes’. If no, rewrite them in **order** from closest to farthest from the earth. If you can, name other celestial objects in our universe.

4. **Rewrite** this number in exponential form/Exponential notation?

   100,000,000,000

5. **Examine** these objects and name them as best you can:

Relative Sizes of Things

1.The N atom is about 100,000 times larger than the proton
2.The Molecule is about 10 times larger than the N atom
3.The DNA strand is about 10 times larger than the Molecule
4.The Virus is about 10 times larger than the DNA molecule
5.The bacteria is about 10 times larger than the cold virus
6.The pollen grain is about 100 times larger than the bacterial.
7.The dust mite is about 10 times larger than the pollen grain.
8.The small patch of skin is about 10 times larger than the dust mite
9.The bench is about 100 times an arm patch of skin.
10. The ballpark is about 100 times larger than the bench 11. The city is about 1000 times larger than the park.

12. The river valley is about 100 times larger than the city.
13. Greenland's long dimension is 100 times bigger than a river valley.
14. The earth is about 10 times larger than Greenland's long dimension.
15. Jupiter is about 10 times larger than the Earth
16. The sun is about 10 times larger than Jupiter
17. The inner solar system from sun to Earth's orbit is about 100 times the diameter of the sun.
18. The Sun to the outer reaches of the solar system is about 100 times the distance from earth to sun.
19. The size of the solar system is a small dark dot in this photo of the Orion Nebula (about 100 times smaller).
20. The Orion nebula is about 1/10 the size of the great Carina nebula
21. The Carina nebula is lost, about 1/10 the width of a spiral arm in our Galaxy.
22. The width of a spiral arm is about 1/10 the width of a large galaxy
23. A cluster of galaxies is 100 to 1000 times the size of a galaxy.
24. A super cluster of galaxies is 100 times the size of a cluster of galaxies.
25. A super cluster of galaxies is 1/10 this simulation...a big chunk of the universe.

Name: Date:

The Scale of Things

Objectives:

- Learn general names of large/small scale objects
- Experiment with relative size relationships
- Practice order-of-magnitude estimation
- Practice problems with powers of ten

Materials

- ☐ Size comparison images

Cross-Discipline Extension Activities

Below are links to various cross-discipline activities that are extensions of this topic.

Biology
A Cloud in the Hand: http://www.flinnsci.com/media/396251/es10108.pdf
Chemistry
Scanning Electron Microscope Solves a Mystery: http://www.acs.org/content/dam/acsorg/education/resources/highschool/chemmatters/chemmatters-december-2003.pdf
Physics/Physical Science
Metric Mania http://sciencespot.net/Pages/classmetric.html
Earth/Geology/Environmental Science
The Quest for a Clean Drink: http://www.acs.org/content/dam/acsorg/education/resources/highschool/chemmatters/chemmatters-april-2008.pdf
Math
Cryotesting the James Webb Space Telescope: http://spacemath.gsfc.nasa.gov/Grade67/7Page70.pdf Exploring Power-laws: Meteor impacts: http://spacemath.gsfc.nasa.gov/weekly/10Page112.pdf Measuring Stratospheric Ozone with SAGE-III: http://spacemath.gsfc.nasa.gov/weekly/10Page109.pdf
Engineering
English to Metric Conversions http://sciencespot.net/Pages/classmetric.html Be a Scanning Probe Microscope: http://www.tryengineering.org/lesson-plans/be-scanning-probe-microscope?lesson=97

Introduction

Astronomical distances are, well, astronomical. It can be difficult to comprehend how far away even our nearest stellar neighbors are, let alone our nearest galactic neighbors or the size of the Universe. At the same time, many of the astronomer's fundamental tools depend on physics on the smallest scales — those of the atom and smaller. How can we get a handle on these scales?

Activity

(Calculators are discouraged)

1. There are several laminated cards on the table. In groups of three to four, examine the images. See how many things you can name (list them below), and if you can put them in some kind of order. Your answers do not need to be perfect here.

2. Fill out the following, using rough order-of-magnitude estimations and scientific notation (e.g. 1,000,000 = 1×10^6, and 0.000 000 01 = 1×10^{-8})

The Universe (not pictured!) is _______ times larger than
a super cluster of galaxies, which is _______ times larger than
a cluster of galaxies, which is _______ times larger than
a spiral galaxy, which is _______ times larger than . . .

The Universe is ________________ times larger than a spiral galaxy.

. . . a spiral arm in a galaxy, which is _______ times larger than
a large nebula, which is _______ times larger than
a small nebula, which is _______ times larger than
the Solar System (the Sun to Pluto), which is _______ times larger than . . .

A spiral arm is ________________ times larger than the Solar System.

. . . the inner Solar System (the Sun to Earth), which is _______ times larger than
the Sun, which is _______ times larger than
Jupiter, which is _______ times larger than
The Earth, which is _______ times larger than . . .

The inner Solar System is ________________ times larger than the Earth.

. . . Greenland, which is _______ times larger than
a river valley, which is _______ times larger than
a city, which is _______ times larger than
a ballpark, which is _______ times larger than . . .

Greenland is ________________ times larger than a ball park.

. . . a bench, which is _______ times larger than
an arm skin, which is _______ times larger than
a dust mite, which is _______ times larger than
a pollen grain ,which is _______ times larger than
a bacterium, which is _______ times larger than . . .

A bench is ________________ times larger than a bacterium.

. . . a cold virus, which is _______ times larger than
a DNA strand, which is _______ times larger than
a molecule, which is _______ times larger than
a nitrogen atom, which is _______ times larger than
a proton.

A cold virus is ________________ times larger than proton.
Finally, a super cluster is ____________________ times larger than the proton.