Applying America's Grade Six Mathematics Standards to the National Aeronautics and Space Administration's Concepts: Traveling to the Moon

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Abstract - **The primary focus of this research was to develop a new National Aeronautics and Space Administration's (NASA's) Digital Learning Network (DLN) module that was mathematically based and tied to NASA concepts. This world of interactive learning with NASA's DLN was available to teachers and students to enhance learning about our home planet.**

Objectives of this module applied Grade Six Mathematics Standards of ratio and proportions, scaling, area, and volume to NASA's space vehicle transportation systems that will return to the moon by 2020. The module educated grade six students on how America will send a new generation of explorers to the moon aboard NASA's Orion crew exploration vehicle.

The mathematics team reviewed results of faculty and student research projects to identify sources used in the mathematics preparation of children at the sixth grade level. Educational lessons were produced that incorporated mathematical concepts from the data collected. Thus, this project was designed to build on the curiosity and enthusiasm of children as it relates to the study of mathematics. Appropriate mathematical experiences were designed to challenge young children to explore ideas related to data analysis and probability, measurement, mathematical connections, algebraic concepts, and numerical operations.

The success of this research produced results that allowed six grade students to experience learning linked to NASA exploration in future years. The students also used age-appropriate mathematical calculations to fully understand related processes. Participants in this newly-developed DLN activity aided NASA in calculating the surface areas, obtaining measurements of models, and using proportions to discover how and why NASA scientists have constructed the Orion, Ares I, and Ares V vehicles.

I. Introduction

The Apollo XI was the first manned mission to land on the Moon. Carrying Neil Armstrong, Michael Collins, and Edwin 'Buzz' Aldrin Jr the Saturn V rocket launched on July 16, 1969. On July 20, Commander Neil Armstrong stepped out of the lunar module and took "one small step for man, and one giant leap for mankind." Innovation and improvisation were necessary, but there were five more missions that went on to land on the moon. A return to the moon is now imminent. NASA's Constellation Program is developing a space transportation system that is designed to return humans to the moon by 2020. The program components to be developed include the Orion crew exploration vehicle, the Ares V cargo launch vehicle, the Altair lunar lander and other cargo systems.

The research currently being conducted at NASA research centers through out the nation will hopefully land America back on the Moon by the year 2020. The NASA Office of Education has taken this research and is now using it through the Digital Learning Network™ systems to incorporate ideas of proportional reasoning within Mathematics Standards. This incorporation will be used for future education purposes to instruct America's current middle grade students.

II. NASA Digital Learning Network™

NASA's Digital Learning Network™ (DLN) began in the spring of 2004 with three Hub Sites located at the NASA Glenn, NASA Johnson, and NASA Langley Research Centers. Collectively the three research facilities aim to provide guidance and leadership in the expansion of all NASA Offices of Education.

Outlined in NASA's DLN, the program has goals of fostering the use of interactive technologies as forms of instructional methods that benefits both students and educators. The utilization of these technologies promotes collaborative activities among member institutions in hopes of optimizing learning experiences. Open communication allows users to freely verbalize strengths and weaknesses that can be objectively addressed for a mutual improvement of the software. The DLN provides timely responses to internal and

external technical inquiry issues, content development, delivery, and event scheduling. NASA's DLN also encourages innovation and experimentation, strives to reach targeted populations as well as underserved minorities. Participation in agency-wide infrastructure makes use of both new and old interactive instructional technologies. Contributions to the professional development of internal and external educators deliver face-to-face and distant learning events.

In a world of interactive learning, NASA's DLN is free and available to teachers and students across the country to learn more about our home planet. Digital Learning Network (DLN) Coordinators conduct modules to students across the country at various times convenient to educators throughout the year. The use of past, present, and future NASA mission are incorporated in lessons that provide students with an introduction to NASA's purpose while, at the same time utilizing problem solving skills.

III. Traveling Back To the Moon

In order to understand the communication medium required to create a module, and educate sixth grade students, an Elizabeth City State University (ECSU) student from the mathematics team trained with NASA Langley Research Center's (LaRC's) DLN Coordinators and Assistant Manager. The training assisted to effectively present the module, Magnificent Sun, to several schools across the country using distance-learning equipment housed at NASA LaRC. The conduction of module presentations for sixth grade students allowed team members to practice and develop instructional and presentational skills through distance learning.

Knowledge of the National Standards for School Mathematics was needed for creating a math module for this research. A survey was conducted by the NASA Explorer Schools project that assessed the top ten academic standards needs of schools across the nation. Using this data, it was determined that calculating ratios and proportions, area, and problem solving were mathematical areas that needed to be addressed the most in new module development. The DLN used a standard template for module continuity when developing a module. After careful review of necessary standards the DLN managers made final decisions on the use of the module based in development rubrics that contain all the required information to educate future viewer.

IV. Instructional Objectives

A. *Student Objectives*

Upon completion of this digitized lesson students will be expected to successfully fulfill the student objectives outlined. Students will be able to use proportional reasoning to analyze and compare the sizes of past NASA launch systems to those in the future. This comparison will allow students to use standards provided by the NCTM for American standards of Mathematics, and also develop a sense of NASA's advances in technology as year's progress. Students will also apply the proper area formulas for various geometric shapes; and estimate the area of complex geometric shapes using provided graphs.

B. *Terms Covered*

Major terms for the conduction of this research were compiled from the definitions taken from the National Council of Teachers of Mathematics (NCTM) standards. The following terms were utilized in conjunction with their preceding definitions:

- ratio - the relationship/comparison between two or more things
- proportion – an equation that states that two ratios are equal
- scale factor – the number that is multiplied to make objects the same size
- diameter – straight line joining two points on the circumference of a circle that passes through the center of the circle
- radius – a straight line extending from the center of a circle to its edge or from the center of a sphere to its surface.
- proportional reasoning – the concept of ratio that is directly related to the ideas of rational numbers, percents, and proportions.

V. National Council of Teachers of Mathematics Standards

Noted in the National Council of Teachers of Mathematics Principles and Standards, proportional reasoning is fundamental to much middle school mathematics. Proportional reasoning permeates the middles grade curriculum and connects a great variety of topics. The study of proportional reasoning in the middles grades should enable students to do the following:

- work flexibly with percents to solve problems
- understand and use ratios and proportions to represent quantitative relationships; and
- develop, analyze, and explain methods for solving problems involving proportions such as scaling and finding equivalent ratio.

Reasoning and solving problems involving proportions play a central role in the mathematical processes emphasized in the NCTM Principles and Standard. The concept of ratio is fundamental to being about to reason proportionality.

The NCTM provides educators with a set of focal points contributing to the objectives of grade six mathematics. These topics are the recommended content emphasis for sixth grade level. It is essential that these focal points be addresses in contexts that promote problem solving, reasoning, communication, making connections, and designing and analyzing representations.

VI. Focal Points

A. Numbers and Operations

The development and understanding of and fluency with multiplication and division of fractions and decimals are the main components of the number and operations focal point. Within this objective students use the meaning of fractions, multiplication, and division, and the inverse relationship between multiplication and division to make sense of procedures for multiplying and dividing fractions. The use of the relationship between fractions and decimals is applied to understand and explain the procedures for multiplying and dividing decimals. Students use common procedures to multiply and divide fractions and decimals efficiently and accurately. They multiply and divide fractions and decimals to solve problems, including multistep problems and problems involving measurement.

B. Numbers and Operations

Students use simple reasoning about multiplication and division to solve ratio and rate problems. By viewing equivalent ratios and rates as deriving from, and extending, pairs of rows in the multiplication table, and by analyzing simple drawings that indicate the relative sizes of quantities, students extend whole number multiplication and division to ratios and rates. Thus, they expand the repertoire of problems that they can solve by using multiplication and division, and they build on their understanding of fractions to understand ratios. Students solve a wide variety of problems involving ratios and rates.

C. Algebra

The writing, interpreting, and using of mathematical expressions and equations is utilized and the basic concept of the algebraic focal point. With the algebraic focal point, students use simple reasoning skills about multiplication and division to solve ratio and rate problems. By viewing equivalent ratios and rates as deriving from, and extending, pairs of rows in the multiplication table, and by analyzing simple drawings that indicate the relative sizes of quantities, students extend whole number multiplication and division to ratios and rates. Thus, they expand the repertoire of problems that they can solve by using multiplication and division, and they build on their understanding of fractions to understand ratios. Students solve a wide variety of problems involving ratios and rates.

VII. Connection to Focal Points

A. Numbers and Operations

Problems that involve areas and volumes, calling on students to find areas or volumes from lengths or to find lengths from volumes or areas and lengths, are especially appropriate. These problems extend the students' work in grade 5 on area and volume and provide a context for applying new work with equations.

B. Algebra

Students use the commutative, associative, and distributive properties to show that two expressions are equivalent. They also illustrate properties of operations by showing that two expressions are equivalent in a given context. Sequences, including those that arise in the context of finding possible rules for patterns of figures or stacks of objects, provide opportunities for students to develop formulas.

C. Measurement and Geometry

Problems that involve areas and volumes, calling on students to find areas or volumes from lengths or to find lengths from volumes or areas and lengths, are especially appropriate. These problems extend the students' work in grade 5 on area and volume and provide a context for applying new work with equations

VIII. Conclusion

The implementation of the NASA Digital Learning Network™ provided an interactive element of learning. It gave insight into NASA's new mission of placing an individual back on the moon within the allotted time frame while simultaneously incorporating the National Council of Teacher of Mathematics standards or proportional reasoning within the created lesson. Both teachers and students alike found it to be a great way to learn, and applauded it in its successful incorporation of two very different elements.

IX. Future Work

Due to the importance of the new missions, a new module supporting the newest exploration efforts had to be developed. Developing an educational module requires a great deal of research, knowledge of current NASA missions/explorations, and the ability to formulate the module to target various age groups. Suggestions for the future research of this project are to gear this module to students in the lower grades, finding the National Mathematics Standards that are required for their particular grade level and apply those mathematical concepts to teach the information provided in the module. The same method can be applied for those students in higher-grade levels to target the mathematical concepts that are needed and required. Acknowledging the negative outcomes through a range of implementations of module also needs to be examined. This testing will examine effectiveness so that it is as thorough as possible and beneficial to students and various other users.

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REFERENCES

RESEARCH PAPER LINKS

[1] " Achievement on SOL Mathematics Tests at Camelot Elementary School in Chesapeake, Virginia ", Retrieved February 20, 200 from the World Wide Web, Spencer P. Weeks Jamieson, Tiwana Walton, Chelsea Goins, Illiana Thomas and TreAsia Fields, http://nia.ecsu.edu/ur/0708/teams/math/0708mathresearchpaper.pdf

[2] "Traveling Back to the Moon with NASA's Digital Learning Network." Retrieved September 14, 2008, form the World Wide Web, Tiwana Walton, http://nia.ecsu.edu/ur/0809/08summerinternships/walton/Walton__T_Technical%20Report.pdf.

NASA'S DIGITAL LEARNING NETWORK™ LINKS

[3] "About the Digital Learning Network™", Retrieved March 24, 2008 from the World Wide Web, http://dln.nasa.gov/dln/content/about/

[4] "Constellation Program, Apollo," Retrieved, January, 20, 2009 from the World Wide Web, http://www.nasa.gov/missions/past/index.html

[5] "NASA Digital Learning Network," Retrieved February 12, 2009 from the World Wide Web, http://dln.nasa.gov/dln.

[6] "NASA Langley Research Center Office of Education", Retrieved March 1, 2009 from the World Wide Web, http://www.nasa.gov/centers/langley/education/index.html

[7] "Audience Guidelines" Retrieved, June 17, 2008 from the World Wide Web, http://dln.nasa.gov/dln/content/guidelines/audienceguidelines.pdf

NCTM EDUCATION RESOURCES

[8] National Council of Teachers of Mathematics, 2000 "Principal Standards for School Mathematics".

[9] Hynes, M. E. (1997). Mission Mathematics, Linking Aerospace and the NCTM Standards 5-8. The National Council of Teachers of Mathematics, Inc.

[10] Odaffer, Charles, Cooney, Dossey, Schielack 2005 "Mathematics for Elementary School Teachers" (pp.349-383)

[11] National Council of Teachers of Mathematics, 2000 "Curriculum Focal Points".