

NASA / MSU

AstroMath

Project

for Grades K-5

Implementing the New NCTM Mathematics
Curriculum Frameworks Using Astronomy
(preliminary draft edition, Fall 2000)

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<http://ideas.stsci.edu>

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Mathematics Lessons for Grades K-2

- ❑ Identifying and Counting Craters
- ❑ Changing Shadow Patterns
- ❑ Building Space Shuttles
- ❑ Comparing Planet Sizes
- ❑ Space Survey and Falling Stars
- ❑ How many Stars?
- ❑ Things in the Sky
- ❑ Cosmic Coolers

Mathematics Lessons for Grades 3-5

- ❑ Voyage to Venus Mission: Identifying Appropriate Landing Sites
- ❑ Gliding through the Galaxy using Transformations
- ❑ Get an Angle on the Stars
- ❑ Ursa Major Measures
- ❑ Space Survey: Researching Space
- ❑ Stellar Sampling
- ❑ Cosmos Counting
- ❑ Constellation Designer Wanted!

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Preface

The emergence of national education standards in mathematics (NCTM, 2000) and science (NRC, 1996) provide an important vision and framework for improving education for all students. These standards make clear statements about what students should know and be able to do as well as what instructional and assessment strategies should be used to support these goals. As such, these standards serve as a framework for the development of engaging curriculum.

Although nearly all teachers share the “spirit” of the national standards, it is nonetheless difficult to actually implement the “letter” of the standards in today’s classrooms. This is particularly true in grades K-4 where teachers often have a limited formal course work background in the concepts listed in the standards. These teachers desire effective classroom-ready materials that have been classroom field-tested and subjected to expert review for conceptual accuracy and classroom usability. It is for these teachers that the materials developed in this project are designed to support.

The goal of this project is to provide "stand-alone," hands-on classroom lessons that are specifically designed to integrate the early elementary national standards in mathematics (NCTM) and astronomy (NRC NSES) using existing NASA resources. This has been accomplished by bringing together a team of seven master elementary teachers to work with experienced curriculum developers to create unique and useful classroom-ready materials. These materials focus specifically on the thirteen NCTM mathematics standards, integrate the four K-4 astronomy standards listed in the NRC science standards, and make use of engaging NASA space science data. Without question, NASA science resources quickly capture student interest - it is this excitement that has been captured here.

NCTM Mathematics Standards for Grades Pre K-12

<http://standards.nctm.org/>

Standard 1: Number and Operation

Mathematics instructional programs should foster the development of number and operation sense so that all students-

- understand numbers, ways of representing numbers, relationships among numbers, and number systems;
- understand the meaning of operations and how they relate to each other;
- use computational tools and strategies fluently and estimate appropriately.

Standard 2: Patterns, Functions, and Algebra

Mathematics instructional programs should include attention to patterns, functions, symbols, and models so that all students-

- understand various types of patterns and functional relationships;
- use symbolic forms to represent and analyze mathematical situations and structures;
- use mathematical models and analyze change in both real and abstract contexts.

Standard 3: Geometry and Spatial Sense

Mathematics instructional programs should include attention to geometry and spatial sense so that all students-

- analyze characteristics and properties of two- and three-dimensional geometric objects;
- select and use different representational systems, including coordinate geometry and graph theory;
- recognize the usefulness of transformations and symmetry in analyzing mathematical situations;
- use visualization and spatial reasoning to solve problems both within and outside of mathematics.

Standard 4: Measurement

Mathematics instructional programs should include attention to measurement so that all students-

- understand attributes, units, and systems of measurement;
- apply a variety of techniques, tools, and formulas for determining measurements.

Standard 5: Data Analysis, Statistics, and Probability

Mathematics instructional programs should include attention to data analysis, statistics, and probability so that all students-

- pose questions and collect, organize, and represent data to answer those questions;
- interpret data using methods of exploratory data analysis;
- develop and evaluate inferences, predictions, and arguments that are based on data;
- understand and apply basic notions of chance and probability.

Standard 6: Problem Solving

Mathematics instructional programs should focus on solving problems as part of understanding mathematics so that all students—

- build new mathematical knowledge through their work with problems;
- develop a disposition to formulate, represent, abstract, and generalize in situations within and outside mathematics;
- apply a wide variety of strategies to solve problems and adapt the strategies to new situations;
- monitor and reflect on their mathematical thinking in solving problems.

Standard 7: Reasoning and Proof

Mathematics instructional programs should focus on learning to reason and construct proofs as part of understanding mathematics so that all students-

- recognize reasoning and proof as essential and powerful parts of mathematics;
- make and investigate mathematical conjectures;
- develop and evaluate mathematical arguments and proofs;
- select and use various types of reasoning and methods of proof as appropriate.

Standard 8: Communication

Mathematics instructional programs should use communication to foster understanding of mathematics so that all students-

- organize and consolidate their mathematical thinking to communicate with others;
- express mathematical ideas coherently and clearly to peers, teachers, and others;
- extend their mathematical knowledge by considering the thinking and strategies of others;
- use the language of mathematics as a precise means of mathematical expression.

Standard 9: Connections

Mathematics instructional programs should emphasize connections to foster understanding of mathematics so that all students-

- recognize and use connections among different mathematical ideas;
- understand how mathematical ideas build on one another to produce a coherent whole;
- recognize, use, and learn about mathematics in contexts outside of mathematics.

Standard 10: Representation

Mathematics instructional programs should emphasize mathematical representations to foster understanding of mathematics so that all students-

- create and use representations to organize, record, and communicate mathematical ideas;
- develop a repertoire of mathematical representations that can be used purposefully, flexibly, and appropriately;
- use representations to model and interpret physical, social, and mathematical phenomena.

Astronomy Concepts in the National Science Education Standards	
1.	Sky objects have properties, locations, and movements that can be observed and described. [K-4]
2.	The sun provides the light and heat necessary to maintain the temperature of the earth. [K-4]
3.	Objects in the sky have patterns of movement. The sun, for example, appears to move across the sky in the same way every day, but its path changes slowly over the seasons. [K-4]
4.	The earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. [5-8]
5.	Most objects in the solar systems are in regular and predictable motion. those motions explain such phenomena as the day, the year, phases of the moon, and eclipses. [5-8]
6.	Gravity is the force that keeps planets in orbit around the sun and governs the rest of the motion in the solar system. Gravity alone holds us to the earth's surface and explains the phenomena of the tides. [5-8]
7.	The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of Sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day. [5-8]
8.	The sun, the earth, and the rest of the solar system formed from a nebular cloud of dust and gas 4.6 billion years ago. The early earth was very different from the planet we live on today. [9-12]
9.	The origin of the universe remains one of the greatest questions in science. The "big bang" theory places the origin between 10 and 20 billion years ago, when the universe began in a hot dense state; according to this theory, the universe has been expanding ever since. [9-12]
10.	Early in the history of the universe, matter, primarily the light atoms hydrogen and helium, clumped together. Billions of galaxies, each of which is a gravitationally bound cluster of billions of stars, now form most of the visible mass in the universe. [9-12]
11.	Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium. These and other processes in stars have led to the formation of all the other elements. [9-12]

NSES Available On-Line at:

<http://www.nap.edu/readingroom/books/nses/html/>

Adapted from: *Astronomy in the National Science Education Standards*. Journal of Geoscience Education, **48**(1), 39-45, 2000. J.P. Adams and T.F. Slater