ELEMENTARY
CORE Academy
UTAH STATE OFFICE OF EDUCATION & UTAH STATE UNIVERSITY

ELEMENTARY CORE ACADEMY • ELEMENTARY CORE ACADEMY • ELEM

4TH GRADE

2005

PARTICIPANT HANDBOOK

UTAH STATE OFFICE OF EDUCATION

UtahState UNIVERSITY

ELEMENTARY CORE ACADEMY

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Organizations:

Utah State Office of Education (USOE)
Utah State University (USU)
State Science Education Coordination Committee (SSECC)
State Mathematics Education Coordination Committee (SMECC)
Special Education Services Unit (USOE)
WestEd Eisenhower Regional Consortium

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Dear CORE Academy Teachers:

Thank you for your investment in children and in building your own expertise as you participate in the CORE Academy. I hope your involvement helps you to sustain a laser-like focus on student achievement.

Teachers in Utah are superb. By participating in the Academy, you join a host of teachers throughout the state who understand that teaching targeted on the core curricula, across a spectrum of subjects, will produce results of excellence. The research is quite clear: the closer the match of explicit instruction to core standards, the better the outcome on core assessments.

I personally appreciate your excellence and your desire to create wonderful classrooms of learning for students. Thank you for your dedication. I feel honored to associate with you and pledge my support to lead education in ways that benefit all of our children.

Sincerely,

Patti Harrington, Ed.D.
State Superintendent
of Public Instruction

Funding Sources

Appreciation is expressed for the tremendous educational input and monetary commitment of several organizations for the successful delivery of the Elementary CORE Academy. This year's Elementary CORE Academy was developed and funded through a variety of sources. The Utah State Office of Education (USOE), in collaboration with Utah State University (USU) and local school districts of Utah, have supported kindergarten through sixth grade teachers with professional development experiences that will enhance the educational experience for Utah children.

Major funding for the Academy comes from the following sources:

Federal/State Funds:

Utah State Office of Education
Staff Development Funds
Special Education Services Unit

ESEA Title II

Utah Math Science Partnership

WestED Eisenhower Regional Consortium

District Funds:

Various sources including Quality Teacher Block, Federal ESEA Title II, and District Professional Development Funds

School Funds:

Trust land, ESEA Title II, and other school funds
Utah State Office of Education Special Education Services

The state and district funds are allocations from the state legislature. ESEA is part of the "No Child Left Behind" funding that comes to Utah.

Additionally, numerous school districts, individual schools, and principals in Utah have sponsored teachers to attend the Academy. Other educational groups such as the Utah Division of Water Resources, National Energy Foundation, Utah Energy Office, and the Utah Mining Association have assisted in the development and delivery of resources in the Academy.

Most important is the thousands of teachers who take time from their summer to attend these professional development workshops. It is these teachers who make this program possible.

Goals of the Elementary CORE Academy

Overall

The purpose of the Elementary CORE Academy is to create high quality teacher instruction and improve student achievement through the delivery of professional development opportunities and experiences for teachers across Utah.

The Academy will provide elementary teachers in Utah with:

1. Models of exemplary and innovative instructional strategies, tools, and resources to meet newly adopted Core Curriculum standards, objectives, and indicators.
2. Practical models and diverse methods of meeting the learning needs of all children, with instruction implementation aligned to the Core Curriculum.
3. Meaningful opportunities for collaboration, self-reflection, and peer discussion specific to innovative and effective instructional techniques, materials, teaching strategies, and professional practices in order to improve classroom instruction.

Learning a limited set of facts will no longer prepare a student for real experiences encountered in today's world. It is imperative that educators have continued opportunities to obtain instructional skills and strategies that provide methods of meeting the needs of all students. Participants of the Academy experience will be better equipped to meet the challenges faced in today's classrooms.

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Fourth Grade Mathematics and Science Core Curriculum

Utah Elementary Mathematics Core Curriculum

Introduction

Most students enter school confident in their own abilities; they are curious and eager to learn more. They make sense of the world by reasoning and problem solving. Young students are active, resourceful individuals who construct, modify, and integrate ideas by interacting with the physical world as well as with peers and adults. They learn by doing, collaborating, and sharing their ideas. Students' abilities to communicate through language, pictures, sound, movement, and other symbolic means develop rapidly during these years.

- **Mathematics instruction needs to include more than short-term learning of rote procedures.**

Young students are building beliefs about what mathematics is, about what it means to know and do mathematics, and about themselves as mathematical learners. Mathematics instruction needs to include more than short-term learning of rote procedures. Students must use technology and other mathematical tools, such as manipulative materials, to develop conceptual understanding and solve problems as they do mathematics. Students, as mathematicians, learn best with hands-on, active experiences throughout the instruction of the mathematics curriculum.

Recognizing that no term captures completely all aspects of expertise, competence, knowledge, and facility in mathematics, the term *mathematical proficiency* has been chosen to capture what it means to learn mathematics successfully. Mathematical proficiency has five strands: computing (carrying out mathematical procedures flexibly, accurately, efficiently, and appropriately), understanding (comprehending mathematical concepts, operations, and relations), applying (ability to formulate, represent, and solve mathematical problems), reasoning (using logic to explain and justify a solution to a problem), and engaging (seeing mathematics as sensible, useful, and doable, and being able to do the work).

The most important observation about the five strands of mathematical proficiency is that they are interwoven and interdependent. This observation has implications for how students acquire mathematical proficiency, how teachers develop that proficiency in their students, and how teachers are educated to achieve that goal. At any given moment during a mathematics lesson or unit, one or two strands might be emphasized. But all the strands must eventually be addressed so that the links among them are strengthened. The integrated and balanced development of all five strands of mathematical proficiency should guide the teaching and learning of school mathematics.

Instruction should not be based on extreme positions that students learn solely by internalizing what a teacher or book says or solely by inventing mathematics on their own.

The Elementary Mathematics Core describes what students should know and be able to do at the end of each of the K-6 grade levels. It was developed, critiqued, and revised by a community of Utah mathematics teachers, university mathematics educators, State Office of Education specialists, mathematicians, and an advisory committee representing a wide variety of people from the community. The Core reflects the current philosophy of mathematics education that is expressed in national documents developed by the National Council of the Teachers of Mathematics, the American Association for the Advancement of Science, and the National Research Council. This Mathematics Core has the endorsement of the Utah Council of Teachers of Mathematics Association. The Core reflects high standards of achievement in mathematics for all students.

Organization of the Elementary Mathematics Core

The Core is designed to help teachers organize and deliver instruction.

- The INTENDED LEARNING OUTCOMES (ILOs) describe the goals for mathematical skills and attitudes. They are found at the beginning of each grade level, are an integral part of the Core, and should be included as part of instruction.
- A STANDARD is a broad statement of what students are expected to understand. Several Objectives are listed under each Standard.
- An OBJECTIVE is a more focused description of what students need to know and be able to do at the completion of instruction. If students have mastered the Objectives associated with a given Standard, they have mastered that Standard at that grade level. Several Indicators are described for each Objective.
- An INDICATOR is a measurable or observable student action that enables one to assess whether a student has mastered a particular Objective. Indicators are not meant to be classroom activities, but they can help guide classroom instruction.

Guidelines Used in Developing the Elementary Mathematics Core

The Core is:

Consistent With the Nature of Learning

The main intent of mathematics instruction is for students to value and use mathematics as a process to understand the world. The Core is designed to produce an integrated set of Intended Learning Outcomes for students.

Coherent

The Core has been designed so that, wherever possible, the ideas taught within a particular grade level have a logical and natural connection with each other and with those of earlier grades. Efforts have also been made to select topics and skills that integrate well with one another and with other subject areas appropriate to grade level. In addition, there is an upward articulation of mathematical concepts, skills, and content. This spiraling is intended to prepare students to understand and use more complex mathematical concepts and skills as they advance through the learning process.

Developmentally Appropriate

The Core takes into account the psychological and social readiness of students. It builds from concrete experiences to more abstract understandings. The Core focuses on providing experiences with concepts that students can explore and understand in depth to build the foundation for future mathematical learning experiences.

Reflective of Successful Teaching Practices

Learning through play, movement, and adventure is critical to the early development of the mind and body. The Core emphasizes student exploration. The Intended Learning Outcomes are central in each standard. The Core is designed to encourage instruction with students working in cooperative groups. Instruction should include recognition of the role of mathematics in the classroom, school, and community.

Comprehensive

The Elementary Mathematics Core does not cover all topics that have traditionally been in the elementary mathematics curriculum; however, it provides a comprehensive background in mathematics. By emphasizing depth rather than breadth, the Core seeks to empower students rather than intimidate them with a collection of isolated and

The Core is:

- **Consistent**
- **Coherent**
- **Developmentally Appropriate**
- **Reflective of Successful Teaching Practices**
- **Comprehensive**
- **Feasible**
- **Useful and Relevant**
- **Reliant Upon Effective Assessment Practices**
- **Engaging**

eminently forgettable facts. Teachers are free to add related concepts and skills, but they are expected to teach all the standards and objectives specified in the Core for their grade level.

Feasible

Teachers and others who are familiar with Utah students, classrooms, teachers, and schools have designed the Core. It can be taught with easily obtained resources and materials. A Teacher Handbook is also available for teachers and has sample lessons on each topic for each grade level. The Teacher Handbook is a document that will grow as teachers add exemplary lessons aligned with the new Core.

Useful and Relevant

This curriculum relates directly to student needs and interests. Relevance of mathematics to other endeavors enables students to transfer skills gained from mathematics instruction into their other school subjects and into their lives outside the classroom.

Reliant Upon Effective Assessment Practices

Student achievement of the standards and objectives in this Core is best assessed using a variety of assessment instruments. Performance tests are particularly appropriate to evaluate student mastery of mathematical processes and problem-solving skills. Teachers should use a variety of classroom assessment approaches in conjunction with standard assessment instruments to inform instruction. Sample test items, keyed to each Core Standard, may be located on the "Utah Mathematics Home Page" at http://www.usoe.k12.ut.us/curr/math. Observation of students engaged in instructional activities is highly recommended as a way to assess students' skills as well as attitudes toward learning. The nature of the questions posed by students provides important evidence of their understanding of mathematics.

Engaging

In the early grades, children are forming attitudes and habits for learning. It is important that instruction maximizes students' potential and gives them understanding of the intertwined nature of learning. Effective elementary mathematics instruction engages students actively in enjoyable learning experiences. Instruction should be as thrilling an experience for a child as seeing a rainbow, growing a flower, or describing a toad. In a world of rapidly expanding knowledge and technology, all students must gain the skills they will need to understand and function responsibly and successfully in the world. The Core provides skills in a context that enables students to experience the joy of learning.

Intended Learning Outcomes for Fourth Grade Mathematics

The main intent of mathematics instruction is for students to value and use mathematics and reasoning skills to investigate and understand the world.

The Intended Learning Outcomes (ILOs) describe the skills and attitudes students should learn as a result of mathematics instruction. They are an essential part of the Mathematics Core Curriculum and provide teachers with a standard for evaluation of student learning in mathematics. Significant mathematics understanding occurs when teachers incorporate ILOs in planning mathematics instruction.

- **ILOs describe the skills and attitudes students should learn as a result of mathematics instruction.**

By the end of fourth grade students will be able to:

1. **Demonstrate a positive learning attitude toward mathematics.**
   a. Display a sense of curiosity about numbers and patterns.
   b. Pose mathematical questions about objects, events, and processes.
   c. Demonstrate persistence in completing tasks.
   d. Apply prior knowledge and processes to construct new knowledge.
   e. Maintain an open and questioning mind toward new ideas and alternative points of view.
2. **Become mathematical problem solvers.**
   a. Determine the approach, materials, and strategies to be used in setting up a problem.
   b. Model problem situations in a variety of ways.
   c. Develop understanding of new mathematical concepts and vocabulary by answering questions such as: What made you think that? Did anyone think of this in a different way? Where have we seen a problem like this before?
   d. Construct and use concrete, pictorial, symbolic, and graphical models to represent problem situations.
   e. Know when to select and how to use grade-appropriate mathematical tools and methods as a natural and routine part of the problem-solving process.
   f. Build new mathematical knowledge through problem solving.
   g. Solve problems in both mathematical and everyday contexts.
   h. Recognize that there may be multiple ways to solve a problem.

3. **Reason mathematically.**
   a. Draw logical conclusions and make generalizations.
   b. Determine the approach, materials, and strategies to be used in solving problems.
   c. Use models, known facts, and relationships to explain reasoning.
   d. Make precise calculations and check the validity of the results in the context of the problem.
   e. Analyze mathematical situations by recognizing and using patterns and relationships.
   f. Justify answers and solution processes.
4. **Communicate mathematically.**
   a. Represent mathematical ideas with objects, pictures, and symbols.
   b. Express mathematical ideas to peers, teachers, and others through oral and written language.
   c. Engage in mathematical discussions through brainstorming, asking questions, and sharing strategies for solving problems.
   d. Explain mathematical work and justify reasoning and conclusions.
5. **Make mathematical connections.**
   a. Use one mathematical idea to extend understanding of another.
   b. Recognize the role of mathematics in the classroom, school, and community.
   c. Explore problems and describe and confirm results using various representations.
6. **Represent mathematical situations.**
   a. Create and use representations to organize and communicate mathematical ideas.
   b. Represent mathematical concepts using concrete, pictorial, and symbolic models.

Fourth Grade Mathematics Core Curriculum

Standard I: Students will acquire number sense and perform operations with whole numbers, simple fractions, and decimals.

Objective 1: Represent whole numbers and decimals in a variety of ways.

a. Model, read, and write numerals from tenths to 100,000.

b. Write a *whole number* up to 99,999 in *expanded form* (e.g., 76,539 is 7 ten-thousands, 6 one-thousands, 5 hundreds, 3 tens, 9 ones or 70,000+6,000+500+30+9).

c. Identify the place and the value of a given digit in a five-digit numeral, including decimals to tenths.

d. Demonstrate multiple ways to represent numbers by using models and symbolic representations (e.g., 36 is the same as the square of six, three dozen, or 9x4).

e. Identify *square numbers* using models.

Objective 2: Identify relationships among whole numbers and decimals.

a. Identify the number that is 100 more, 100 less, 1,000 more, or 1,000 less than any *whole number* up to 10,000.

b. Compare the relative size of numbers (e.g., 100 is small compared to a million, but large compared to 5).

c. Compare whole numbers up to five digits using the symbols <, >, and =.

d. Identify a whole number that is between two given whole numbers.

e. Order and compare whole numbers and decimals to tenths on a number line.

Objective 3: Model and illustrate meanings of the four operations and describe how they relate.

a. Use models to represent multiplication of a one- or two-digit factor by a two-digit factor (up to 30) using a variety of methods (e.g., rectangular *arrays*, manipulatives, pictures) and connect the representation to an *algorithm*.

b. Recognize that division by zero is not possible (e.g., 6÷0 is undefined).

Standard I:
Students will acquire number sense and perform operations with whole numbers and simple fractions.

c. Select and write a multiplication or division sentence to solve a problem related to the students' environment and write a story problem that relates to a given equation.

d. Represent division of a two-digit *dividend* by a one-digit *divisor*, including whole number remainders, using various methods (e.g., rectangular arrays, manipulatives, pictures) and connect the representation to an algorithm.

e. Demonstrate that multiplication and division are inverse operations (e.g., 3x4=12; thus, 12÷4=3 and 12÷3=4).

f. Describe the effect of place value when multiplying whole numbers by 10 and 100.

Objective 4: Use fractions to communicate parts of the whole.

a. Divide regions and sets of objects into equal parts using a variety of models and illustrations.

b. Name and write a fraction to represent a portion of a unit whole for halves, thirds, fourths, fifths, sixths, eighths, and tenths.

c. Relate fractions to decimals that represent tenths.

d. Determine which of two fractions is greater using models or illustrations.

e. Find equivalent fractions for one-half, one-third, and one-fourth using manipulatives and pictorial representations.

Objective 5: Solve whole number problems using addition, subtraction, multiplication, and division in vertical and horizontal notation.

a. Determine when it is appropriate to use estimation, mental math strategies, paper and pencil, or a calculator.

b. Find the *sum* and *difference* of four-digit numbers and describe the process used.

c. Multiply two- and three-digit factors by a one-digit factor and describe the process used.

d. Divide a two-digit *whole number dividend* by a one-digit *divisor*, with a *remainder* of zero, and describe the process used.

Standard II: Students will use patterns and relations to represent mathematical situations.

Objective 1: Recognize, describe, and use patterns and identify the attributes.

a. Represent and analyze *repeating* and *growing patterns* using objects, pictures, numbers, and tables.

b. Recognize and extend multiples and other number patterns using a variety of methods.

Objective 2: Recognize, represent, and solve mathematical situations using patterns and symbols.

a. Solve equations involving equivalent *expressions* (e.g., 6 x 2 = ☐ x 3 or 6 x ☐ = 9 + 9).

b. Use the <, >, = symbols to compare two expressions involving addition, subtraction, multiplication, and division (e.g., 5 x 49 ÷ 3).

c. Recognize that a given variable maintains the same value throughout an equation or expression (e.g., ☐ + ☐ = 8; ☐ = 4).

d. Demonstrate that changing the order of *factors* does not change the *product* (e.g., 2 x 3 = 6, 3 x 2 = 6) and that the grouping of three or more factors does not change the product (e.g., (2 x 3) x 1 = 6; 2 x (3 x 1) = 6).

e. Demonstrate the distribution of multiplication over addition using a rectangular *array* (e.g., 8 x 14 = 8 rows of 10 plus 8 rows of 4).

Standard II: Students will use patterns and relations to represent mathematical situations.

Standard III:
Students will use spatial reasoning to describe, identify, and create geometric shapes.

Standard III: Students will use spatial reasoning to recognize, describe, and identify geometric shapes.

Objective 1: Describe, identify, and analyze characteristics and properties of geometric shapes.

a. Identify and draw *parallel lines* and *intersecting lines*.

b. Identify and draw lines of symmetry on a variety of *polygons*.

c. Identify and describe *quadrilaterals* (i.e., rectangles, squares, *rhombuses*, *trapezoids*, kites).

d. Identify *right*, *obtuse*, and *acute* angles.

e. Compare two polygons to determine whether they are *congruent* or *similar*.

f. Identify and describe *cylinders* and *rectangular prisms*.

Objective 2: Specify locations and describe spatial relationships using grids and maps.

a. Locate positions on a map of Utah using *coordinates* or *regions*.

b. Give the coordinates or regions of a position on a map of Utah.

Objective 3: Visualize and identify geometric shapes after applying transformations.

a. Identify a *slide* (translation) or a *flip* (reflection) of a geometric shape using manipulatives.

b. Relate *cubes*, *cylinders*, *cones*, and *rectangular prisms* to the *two-dimensional* shapes (*nets*) from which they were created.

Standard IV: Students will understand and use measurement tools and techniques.

Objective 1: Identify and describe measurable attributes of objects and units of measurement.

a. Describe the relationship among *metric* units of length (i.e., millimeter, centimeter, meter), between metric units of volume (i.e., milliliter, liter), and between metric units of weight (i.e., gram, kilogram).

b. Identify a mile as a measure of distance and its relationship to other customary units of length.

c. Describe the relationship among customary units of *capacity* (i.e., cup, pint, quart, gallon).

d. Estimate length, capacity, and weight using metric and customary units.

Objective 2: Determine measurements using appropriate tools and formulas.

a. Measure the length of objects to the nearest centimeter, meter, quarter-inch, foot, and yard.

b. Measure *capacity* using milliliters, liters, cups, pints, quarts, and gallons and measure weight using grams, kilograms, and pounds.

c. Read, tell, and write time to the nearest minute, identifying a.m. and p.m.

d. Read and record the temperature to the nearest degree, in Fahrenheit, using a thermometer.

e. Determine the value of a combination of coins and bills that total $20.00 or less.

f. Count back change for a single-item purchase and determine the amount of change to be received from a multiple-item purchase.

g. Determine possible *perimeters*, in whole units, for a rectangle with a fixed area and determine possible areas when given a rectangle with a fixed perimeter.

Standard IV: Students will understand and use measurement tools and techniques.

Standard V:
Students will collect and organize data to make predictions and identify basic concepts of probability.

Standard V: Students will collect and organize data to make predictions and use basic concepts of probability.

Objective 1: Collect, organize, and display data to make predictions and answer questions.

a. Identify a question that can be answered by collecting data.

b. Collect, read, and interpret data from tables, graphs, charts, surveys, and observations.

c. Represent data using tables, line plots, line graphs, and bar graphs.

d. Identify and distinguish between *clusters* and *outliers* of a data set.

Objective 2: Use basic concepts of probability.

a. Describe the results of investigations involving random outcomes as simple ratios (e.g., 4 out of 9, 4/9).

b. Predict outcomes of simple experiments, including with and without replacement, and test the predictions.

Utah Elementary Science Core Curriculum

Introduction

Science is a way of knowing, a process for gaining knowledge and understanding of the natural world. The Science Core Curriculum places emphasis on understanding and using skills. Students should be active learners. It is not enough for students to read about science; they must do science. They should observe, inquire, question, formulate and test hypotheses, analyze data, report, and evaluate findings. The students, as scientists, should have hands–on, active experiences throughout the instruction of the science curriculum.

- **Science is a way of knowing, a process for gaining knowledge and understanding of the natural world.**

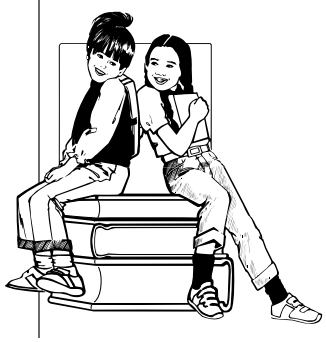
The Elementary Science Core describes what students should know and be able to do at the end of each of the K–6 grade levels. It was developed, critiqued, piloted, and revised by a community of Utah science teachers, university science educators, State Office of Education specialists, scientists, expert national consultants, and an advisory committee representing a wide variety of people from the community. The Core reflects the current philosophy of science education that is expressed in national documents developed by the American Association for the Advancement of Science, the National Academies of Science. This Science Core has the endorsement of the Utah Science Teachers Association. The Core reflects high standards of achievement in science for all students.

Organization of the Elementary Science Core

The Core is designed to help teachers organize and deliver instruction.

The Science Core Curriculum's organization:

- Each grade level begins with a brief course description.
- The INTENDED LEARNING OUTCOMES (ILOs) describe the goals for science skills and attitudes. They are found at the beginning of each grade, and are an integral part of the Core that should be included as part of instruction.
- The SCIENCE BENCHMARKS describe the science content students should know. Each grade level has three to five Science Benchmarks. The ILOs and Benchmarks intersect in the Standards, Objectives and Indicators.



- A STANDARD is a broad statement of what students are expected to understand. Several Objectives are listed under each Standard.
- An OBJECTIVE is a more focused description of what students need to know and be able to do at the completion of instruction. If students have mastered the Objectives associated with a given Standard, they are judged to have mastered that Standard at that grade level. Several Indicators are described for each Objective.
- An INDICATOR is a measurable or observable student action that enables one to judge whether a student has mastered a particular Objective. Indicators are not meant to be classroom activities, but they can help guide classroom instruction.

Eight Guidelines Were Used in Developing the Elementary Science Core

Guidelines

- **Reflects the Nature of Science**
- **Coherent**
- **Developmentally Appropriate**
- **Encourages Good Teaching Practices**
- **Comprehensive**
- **Feasible**
- **Useful and Relevant**
- **Encourages Good Assessment Practices**
- **The Most Important Goal**

Reflects the Nature of Science

Science is a way of knowing, a process of gaining knowledge and understanding of the natural world. The Core is designed to produce an integrated set of Intended Learning Outcomes (ILOs) for students. Please see the Intended Learning Outcomes document for each grade level core.

As described in these ILOs, students will:

1. Use science process and thinking skills.
2. Manifest science interests and attitudes.
3. Understand important science concepts and principles.
4. Communicate effectively using science language and reasoning.
5. Demonstrate awareness of the social and historical aspects of science.
6. Understand the nature of science.

Coherent

The Core has been designed so that, wherever possible, the science ideas taught within a particular grade level have a logical and natural connection with each other and with those of earlier grades. Efforts have also been made to select topics and skills that integrate well with one another and with other subject areas appropriate to grade level. In addition, there is an upward articulation of science concepts, skills, and content. This spiraling is intended to prepare students to understand and use more complex science concepts and skills as they advance through their science learning.

Developmentally Appropriate

The Core takes into account the psychological and social readiness of students. It builds from concrete experiences to more abstract understandings. The Core describes science language students should use that is appropriate to each grade level. A more extensive vocabulary should not be emphasized. In the past, many educators may have mistakenly thought that students understood abstract concepts (such as the nature of the atom), because they repeated appropriate names and vocabulary (such as electron and neutron). The Core resists the temptation to tell about abstract concepts at inappropriate grade levels, but focuses on providing experiences with concepts that students can explore and understand in depth to build a foundation for future science learning.

Encourages Good Teaching Practices

It is impossible to accomplish the full intent of the Core by lecturing and having students read from textbooks. The Elementary Science Core emphasizes student inquiry. Science process skills are central in each standard. Good science encourages students to gain knowledge by doing science: observing, questioning, exploring, making and testing hypotheses, comparing predictions, evaluating data, and communicating conclusions. The Core is designed to encourage instruction with students working in cooperative groups. Instruction should connect lessons with students' daily lives. The Core directs experiential science instruction for all students, not just those who have traditionally succeeded in science classes. The vignettes listed on the "Utah Science Home Page" at http://www.usoe.k12.ut.us/curr/science for each of the Core standards provide examples, based on actual practice, that demonstrate that excellent teaching of the Science Core is possible.

Comprehensive

The Elementary Science Core does not cover all topics that have traditionally been in the elementary science curriculum; however, it does provide a comprehensive background in science. By emphasizing depth rather than breadth, the Core seeks to empower students rather than intimidate them with a collection of isolated and eminently forgettable facts. Teachers are free to add related concepts and skills, but they are expected to teach all the standards and objectives specified in the Core for their grade level.

Feasible

Teachers and others who are familiar with Utah students, classrooms, teachers, and schools have designed the Core. It can be taught with easily obtained resources and materials. A Teacher Resource Book (TRB) is available for elementary grades and has sample lessons on each topic for each grade level. The TRB is a document that will grow as teachers add exemplary lessons aligned with the new Core. The middle grade levels have electronic textbooks available at the Utah State Office of Education's "Utah Science Home Page" at http://www.usoe.k12.ut.us/curr/science.

Useful and Relevant

This curriculum relates directly to student needs and interests. It is grounded in the natural world in which we live. Relevance of science to other endeavors enables students to transfer skills gained from science instruction into their other school subjects and into their lives outside the classroom.

Encourages Good Assessment Practices

Student achievement of the standards and objectives in this Core are best assessed using a variety of assessment instruments. One's purpose should be clearly in mind as assessment is planned and implemented. Performance tests are particularly appropriate to evaluate student mastery of science processes and problem-solving skills. Teachers should use a variety of classroom assessment approaches in conjunction with standard assessment instruments to inform their instruction. Sample test items, keyed to each Core Standard, may be located on the Utah Science Home Page. Observation of students engaged in science activities is highly recommended as a way to assess students' skills as well as attitudes in science. The nature of the questions posed by students provides important evidence of students' understanding of science.

The Most Important Goal

Elementary school reaches the greatest number of students for a longer period of time during the most formative years of the school experience. Effective elementary science instruction engages students actively in enjoyable learning experiences. Science instruction should be as thrilling an experience for a child as seeing a rainbow, growing a flower, or holding a toad. Science is not just for those who have traditionally succeeded in the subject, and it is not just for those who will choose science–related careers. In a world of rapidly expanding knowledge and technology, all students must gain the skills they will need to understand and function responsibly and successfully in the world. The Core provides skills in a context that enables students to experience the joy of doing science.

Fourth Grade Science Core Curriculum

The theme for the fourth grade Science Core curriculum is **Utah natural history**. Students will learn about Utah environments including; weather, water cycle, rocks, fossils, soils, plants and animals. Understanding the concepts of **cycles** is an essential component of science literacy and is introduced at this grade level. Emphasis should be placed on skills to classify many things. Students should come to value and use science as a process of obtaining knowledge based on observable evidence, and their curiosity should be encouraged and sustained as they develop the abilities associated with inquiry in science.

Good science instruction requires that attention be paid to providing students with hands–on science investigations in which student inquiry is an important goal. Their curiosity should be encouraged and sustained. Teachers should provide opportunities for all students to experience many things. Fourth graders should feel the excitement of a rainstorm, hunt for fossils in rocks, observe the patterns in a spider web, and teach their parents to recognize the song of the lark. They should have many opportunities to observe and predict, to infer and to classify. They should come to enjoy science as a process of learning about their world.

Science Core concepts should be integrated with concepts and skills from other curriculum areas. Reading, writing and mathematics skills should be emphasized as integral to the instruction of science. Technology issues and the nature of science are significant components of this Core. Personal relevance of science in students' lives is always an important part of helping students to value science and should be emphasized at this grade-level.

- **Personal relevance of science in students' lives is always an important part of helping students to value science, and should be emphasized at this grade level.**

This Core was designed using the American Association for the Advancement of Science's *Project 2061: Benchmarks For Science Literacy* and the National Academy of Science's *National Science Education Standards* as guides to determine appropriate content and skills.

The fourth grade Science Core has three online resources designed to help with classroom instruction; they include *Teacher Resource Book* –a set of lesson plans, assessment items and science information specific to fourth grade; the *Sci-ber Text*—an electronic science text book specific to the Utah Core; and the science test item pool. This pool includes multiple choice questions, performance tasks, and interpretive items aligned to the standards and objectives of the fourth grade Science Core. These resources are all available on the Utah Science Home Page. http://www.usoe.k12.ut.us/curr/science

SAFETY PRECAUTIONS:

The hands–on nature of this science curriculum increases the need for teachers to use appropriate precautions in the classroom and field. Teachers must adhere to the published guidelines for the proper use of animals, equipment, and chemicals in the classroom. These guidelines are available on the Utah Science Home Page.

Intended Learning Outcomes for Fourth Grade Science

The Intended Learning Outcomes (ILOs) describe the skills and attitudes students should learn as a result of science instruction. They are an essential part of the Science Core Curriculum and provide teachers with a standard for evaluation of student learning in science. Instruction should include significant science experiences that lead to student understanding using the ILOs.

The main intent of science instruction in Utah is that students will value and use science as a process of obtaining knowledge based upon observable evidence.

- **Instruction should include significant science experiences that lead to student understanding using the ILOs.**

By the end of Fourth Grade students will be able to:

1. **Use Science Process and Thinking Skills**
   a. Observe simple objects and patterns and report their observations.
   b. Sort and sequence data according to a given criterion.
   c. Make simple predictions and inferences based upon observations.
   d. Compare things and events.
   e. Use instruments to measure length, temperature, volume, and weight using appropriate units.
   f. Conduct a simple investigation when given directions.
   g. Develop and use simple classification systems.
   h. Use observations to construct a reasonable explanation.
2. **Manifest Scientific Attitudes and Interests**
   a. Demonstrate a sense of curiosity about nature.
   b. Voluntarily read or look at books and other materials about science.
   c. Pose questions about objects, events, and processes.
3. **Understand Science Concepts and Principles**
   a. Know science information specified for their grade level.
   b. Distinguish between examples and non-examples of science concepts taught.
   c. Explain science concepts and principles using their own words and explanations.

4. Communicate Effectively Using Science Language and Reasoning

a. Record data accurately when given the appropriate form and format (e.g., table, graph, chart).

b. Report observation with pictures, sentences, and models.

c. Use scientific language appropriate to grade level in oral and written communication.

d. Use available reference sources to obtain information.

Fourth Grade Science Standards

Science Benchmark

Matter on Earth cycles from one form to another. The cycling of matter on Earth requires energy. The cycling of water is an example of this process. The sun is the source of energy for the water cycle. Water changes state as it cycles between the atmosphere, land, and bodies of water on Earth.

Standard I: Students will understand that water changes state as it moves through the water cycle.

Objective 1: Describe the relationship between heat energy, evaporation and condensation of water on Earth.

a. Identify the relative amount and kind of water found in various locations on Earth (e.g., oceans have most of the water, glaciers and snowfields contain most fresh water).

b. Identify the sun as the source of energy that evaporates water from the surface of Earth.

c. Compare the processes of evaporation and condensation of water.

d. Investigate and record temperature data to show the effects of heat energy on changing the states of water.

Objective 2: Describe the water cycle.

a. Locate examples of evaporation and condensation in the water cycle (e.g., water evaporates when heated and clouds or dew forms when vapor is cooled).

b. Describe the processes of evaporation, condensation, and precipitation as they relate to the water cycle.

c. Identify locations that hold water as it passes through the water cycle (e.g., oceans, atmosphere, fresh surface water, snow, ice, and ground water).

d. Construct a model or diagram to show how water continuously moves through the water cycle over time.

e. Describe how the water cycle relates to the water supply in your community.

Science language students should use:

vapor, precipitation, evaporation, clouds, dew, condensation, temperature, water cycle

Standard I:
Students will understand that water changes state as it moves through the water cycle.

Science Benchmark

Weather describes conditions in the atmosphere at a certain place and time. Water, energy from the sun, and wind create a cycle of changing weather. The sun's energy warms the oceans and lands at Earth's surface, creating changes in the atmosphere that cause the weather. The temperature and movement of air can be observed and measured to determine the effect on cloud formation and precipitation. Recording weather observations provides data that can be used to predict future weather conditions and establish patterns over time. Weather affects many aspects of people's lives.

Standard II:
Students will understand that the elements of weather can be observed, measured, and recorded to make predictions and determine simple weather patterns.

Standard II: Students will understand that the elements of weather can be observed, measured, and recorded to make predictions and determine simple weather patterns.

Objective 1: Observe, measure, and record the basic elements of weather.

a. Identify basic cloud types (i.e., cumulus, cirrus, stratus clouds).

b. Observe, measure, and record data on the basic elements of weather over a period of time (i.e., precipitation, air temperature, wind speed and direction, and air pressure).

c. Investigate evidence that air is a substance (e.g., takes up space, moves as wind, temperature can be measured).

d. Compare the components of severe weather phenomena to normal weather conditions (e.g., thunderstorm with lightning and high winds compared to rainstorm with rain showers and breezes).

Objective 2: Interpret recorded weather data for simple patterns.

a. Observe and record effects of air temperature on precipitation (e.g., below freezing results in snow, above freezing results in rain).

b. Graph recorded data to show daily and seasonal patterns in weather.

c. Infer relationships between wind and weather change (e.g., windy days often precede changes in the weather; south winds in Utah often precede a cold front coming from the north).

Objective 3: Evaluate weather predictions based upon observational data.

a. Identify and use the tools of a meteorologist (e.g., measure rainfall using rain gauge, measure air pressure using barometer, measure temperature using a thermometer).

b. Describe how weather and forecasts affect people's lives.

c. Predict weather and justify prediction with observable evidence.

d. Evaluate the accuracy of student and professional weather forecasts.

e. Relate weather forecast accuracy to evidence or tools used to make the forecast (e.g., feels like rain vs. barometer is dropping).

Science language students should use:

atmosphere, meteorologist, freezing, cumulus, stratus, cirrus, air pressure, thermometer, air temperature, wind speed, forecast, severe, phenomena, precipitation, seasonal, accuracy, barometer, rain gauge, components

Science Benchmark

Earth materials include rocks, soils, water, and gases. Rock is composed of minerals. Earth materials change over time from one form to another. These changes require energy. Erosion is the movement of materials and weathering is the breakage of bedrock and larger rocks into smaller rocks and soil materials. Soil is continually being formed from weathered rock and plant remains. Soil contains many living organisms. Plants generally get water and minerals from soil.

Standard III: Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Standard III:
Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 1: Identify basic properties of minerals and rocks.

a. a. Describe the differences between minerals and rocks.

b. Observe rocks using a magnifying glass and draw shapes and colors of the minerals.

c. Sort rocks by appearance according to the three basic types: sedimentary, igneous and metamorphic (e.g., sedimentary—rounded-appearing mineral and rock particles that are cemented together, often in layers; igneous—with or without observable crystals that are not in layers or with or without air holes or glasslike; metamorphic—crystals/minerals, often in layers).

d. Classify common rocks found in Utah as sedimentary (i.e., sandstone, conglomerate, shale), igneous (i.e., basalt, granite, obsidian, pumice) and metamorphic (i.e., marble, gneiss, schist).

Objective 2: Explain how the processes of weathering and erosion change and move materials that become soil.

a. a. Identify the processes of physical weathering that break down rocks at Earth's surface (i.e., water movement, freezing, plant growth, wind).

b. Distinguish between weathering (i.e., wearing down and breaking of rock surfaces) and erosion (i.e., the movement of materials).

c. Model erosion of Earth materials and collection of these materials as part of the process that leads to soil (e.g., water moving sand in a playground area and depositing this sand in another area).

d. Investigate layers of soil in the local area and predict the sources of the sand and rocks in the soil.

Objective 3: Observe the basic components of soil and relate the components to plant growth.

a. Observe and list the components of soil (i.e., minerals, rocks, air, water, living and dead organisms) and distinguish between the living, nonliving, and once living components of soil.

b. Diagram or model a soil profile showing topsoil, subsoil, and bedrock, and how the layers differ in composition.

c. Relate the components of soils to the growth of plants in soil (e.g., mineral nutrients, water).

d. Explain how plants may help control the erosion of soil.

e. Research and investigate ways to provide mineral nutrients for plants to grow without soil (e.g., grow plants in wet towels, grow plants in wet gravel, grow plants in water).

Science language students should use:
mineral, weathering, erosion, sedimentary, igneous, metamorphic, topsoil, subsoil, bedrock, organism, freeze, thaw, profile, nonliving, structural support, nutrients

Science Benchmark

Fossils are evidence of living organisms from the past and are usually preserved in sedimentary rocks. A fossil may be an impression left in sediments, the preserved remains of an organism, or a trace mark showing that an organism once existed. Fossils are usually made from the hard parts of an organism because soft parts decay quickly. Fossils provide clues to Earth's history. They provide evidence that can be used to make inferences about past environments. Fossils can be compared to one another, to living organisms, and to organisms that lived long ago.

Standard IV:
Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.

Standard IV: Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.

Objective 1: Describe Utah fossils and explain how they were formed.

a. Identify features of fossils that can be used to compare them to living organisms that are familiar (e.g., shape, size and structure of skeleton, patterns of leaves).

b. Describe three ways fossils are formed in sedimentary rock (i.e., preserved organisms, mineral replacement of organisms, impressions or tracks).

c. Research locations where fossils are found in Utah and construct a simple fossil map.

Objective 2: Explain how fossils can be used to make inferences about past life, climate, geology, and environments.

a. a. Explain why fossils are usually found in sedimentary rock.

b. Based on the fossils found in various locations, infer how Utah environments have changed over time (e.g., trilobite fossils indicate that Millard County was once covered by a large shallow ocean; dinosaur fossils and coal indicate that Emery and Uintah County were once tropical and swampy).

c. Research information on two scientific explanations for the extinction of dinosaurs and other prehistoric organisms.

d. Formulate questions that can be answered using information gathered on the extinction of dinosaurs

Science language students should use:

infer, environments, climate, dinosaur, preserved, extinct, extinction, impression, fossil, prehistoric, mineral, organism, replacement, trilobite, sedimentary, tropical

Science Benchmark

Utah has diverse plant and animal life that is adapted to and interacts in areas that can be described as wetlands, forests, and deserts. The characteristics of the wetlands, forests, and deserts influence which plants and animals survive best there. Living and nonliving things in these areas are classified based on physical features.

Standard V: Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Standard V:
Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 1: Describe the physical characteristics of Utah's wetlands, forests, and deserts.

a. a. Compare the physical characteristics (e.g., precipitation, temperature, and surface terrain) of Utah's wetlands, forests, and deserts.

b. Describe Utah's wetlands (e.g., river, lake, stream, and marsh areas where water is a major feature of the environment) forests (e.g., oak, pine, aspen, juniper areas where trees are a major feature of the environment), and deserts (e.g., areas where the lack of water provided an environment where plants needing little water are a major feature of the environment).

c. Locate examples of areas that have characteristics of wetlands, forests, or deserts in Utah.

d. Based upon information gathered, classify areas of Utah that are generally identified as wetlands, forests, or deserts.

e. Create models of wetlands, forests, and deserts.

Objective 2: Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environment in which they live.

a. Identify common plants and animals that inhabit Utah's forests, wetlands, and deserts.

b. Cite examples of physical features that allow particular plants and animals to live in specific environments (e.g., duck has webbed feet, cactus has waxy coating).

c. Describe some of the interactions between animals and plants of a given environment (e.g., woodpecker eats insects that live on trees of a forest, brine shrimp of the Great Salt Lake eat algae and birds feed on brine shrimp).

d. Identify the effect elevation has on types of plants and animals that live in a specific wetland, forest, or desert.

e. Find examples of endangered Utah plants and animals and describe steps being taken to protect them.

Objective 3: Use a simple scheme to classify Utah plants and animals.

a. a. Explain how scientists use classification schemes.

b. Use a simple classification system to classify unfamiliar Utah plants or animals (e.g., fish/amphibians/reptile/bird/mammal, invertebrate/vertebrate, tree/shrub/grass, deciduous/conifers).

Objective 4: Observe and record the behavior of Utah animals.

a. Observe and record the behavior of birds (e.g., caring for young, obtaining food, surviving winter).

b. Describe how the behavior and adaptations of Utah mammals help them survive winter (e.g., obtaining food, building homes, hibernation, migration).

c. Research and report on the behavior of a species of Utah fish (e.g., feeding on the bottom or surface, time of year and movement of fish to spawn, types of food and how it is obtained).

d. Compare the structure and behavior of Utah amphibians and reptiles.

e. Use simple classification schemes to sort Utah's common insects and spiders.

Science language students should use:
wetland, forest, desert, adaptation, deciduous, coniferous, invertebrate, vertebrate, bird, amphibian, reptile, fish, mammal, insect, hibernation, migration

Common plants:
sagebrush, pinyon pine, Utah juniper, spruce, fir, oak brush, quaking aspen, cottonwood, cattail, bulrush, prickly pear cactus

Common animals:
jackrabbit, cottontail rabbit, red fox, coyote, mule deer, elk, moose, cougar, bobcat, deer mouse, kangaroo rat, muskrat, beaver, gopher snake, rattlesnake, lizard, tortoise, frog, salamander, red–tailed hawk, barn owl, lark, robin, pinyon jay, magpie, crow, trout, catfish, carp, grasshopper, ant, moth, butterfly, housefly, bee, wasp, pill bug, millipede

K-6 Elementary Mathematics Core Curriculum in Table Format

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
Standard I: **Students will understand simple number concepts and relationships.**	**Standard I:** **Students will acquire number sense and perform simple operations with whole numbers.**	**Standard I:** **Students will acquire number sense and perform operations with whole numbers.**	**Standard I:** **Students will acquire number sense and perform operations with whole numbers and simple fractions.**	**Standard I:** **Students will acquire number sense and perform operations with whole numbers, simple fractions, and decimals.**	**Standard I:** **Students will acquire number sense and perform operations with whole numbers, simple fractions, and decimals.**	**Standard I:** **Students will acquire number sense and perform operations with rational numbers.**
Objective 1: **Identify and use whole numbers.** a. Relate a *numeral* to the number of objects in a set (e.g., ☐ ☐ ☐ = 3). b. Construct models of numbers to 10 with physical objects or manipulatives. c. Make pictorial representations of numbers to 10 (e.g., draw four circles, draw six squares). d. Recognize and write numerals from 0 to 10. e. Manipulate objects to demonstrate and describe multiple ways of representing a number (e.g., 5 can be 3 and 2 more, 5 can also be 2 and 2 and 1).	**Objective 1:** **Represent whole numbers in a variety of ways.** a. Relate number words to the *numerals* that represent the quantities 0 to 10. b. Sort objects into groups of tens and ones and write the numeral representing the set. c. Represent *whole numbers* up to 100 in groups of tens and ones using objects. d. Write a numeral when given the number of tens and ones. e. Write a numeral to 99 in *expanded form* (e.g., 39 is 3 tens and 9 ones or 30+9). f. Use zero to represent the number of elements in the empty set or as a placeholder in a two-digit numeral.	**Objective 1:** **Represent whole numbers in a variety of ways.** a. Relate number words to the *numerals* that represent the quantities 0-100. b. Represent *whole numbers* up to 1,000 in groups of hundreds, tens, and ones using base ten models, and write the numeral representing the set. c. Read and write a three-digit numeral, relating it to a set of objects and a pictorial representation. d. Write a numeral to 999 in *expanded form* (e.g., 539 is 5 hundreds, 3 tens, 9 ones or 500+30+9). e. Identify the place and the value of a given digit in a three-digit numeral (e.g., the two in 281 means 2 hundreds or 200). f. Demonstrate multiple ways to represent numbers using symbolic representations (e.g., thirty is the same as two groups of 15, the number of pennies in three dimes, or 58-28).	**Objective 1:** **Represent whole numbers in a variety of ways.** a. Model, read, and write *whole numbers* up to 10,000 using base ten models, pictures, and symbols. b. Write a *numeral* when given the number of thousands, hundreds, tens, and ones. c. Write a number up to 9,999 in expanded form (e.g., 6,539 is 6 thousands, 5 hundreds, 3 tens, 9 ones or 6000+500+30+9). d. Identify the place and the value of a given digit in a four-digit numeral. e. Demonstrate multiple ways to represent numbers using models and symbolic representations (e.g., fifty is the same as two groups of 25, the number of pennies in five dimes, or 75-25).	**Objective 1:** **Represent whole numbers and decimals in a variety of ways.** a. Model, read, and write numerals from tenths to 100,000. b. Write a *whole number* up to 99,999 in *expanded form* (e.g., 76,539 is 7 ten-thousands, 6 one-thousands, 5 hundreds, 3 tens, 9 ones or 70,000+6,000+500+30+9). c. Identify the place and the value of a given digit in a five-digit numeral, including decimals to tenths. d. Demonstrate multiple ways to represent numbers by using models and symbolic representations (e.g., 36 is the same as the square of six, three dozen, or 9x4). e. Identify *square numbers* using models.	**Objective 1:** **Represent whole numbers and decimals in a variety of ways.** a. Model, read, and write numerals from hundredths to one millions. b. Write a *whole number* up to 999,999 in *expanded form* (e.g., 876,539 = 8 hundred-thousands, 7 ten-thousands, 6 thousands, 5 hundreds, 3 tens, 9 ones or 8x100,000 + 7x10,000 + 6x1,000 + 5x100 + 3x10 + 9). c. Demonstrate multiple ways to represent whole numbers by using models and symbolic representations (e.g., 108=2x50+8; 108=10^2 + 8). d. Classify whole numbers from 2 to 20 as *prime* or *composite* and 0 and 1 as neither prime nor composite, using models. e. Represent repeated factors using *exponents* up to three (e.g., 8=2x2x2=2^3).	**Objective 1:** **Represent whole numbers and decimals in a variety of ways.** a. Change *whole numbers* with *exponents* to *standard form* (e.g., 2^4 = 2^4=16) and recognize that 10^0 = 1. b. Read and write *numerals* from thousandths to one billion. c. Write a whole number to 999,999 in *expanded form* using *exponents* (e.g., 876,539 = 8 x 10^5 + 7 x 10^4 + 6 x 10^3 + 5 x 10^2 + 3 x 10^1 + 9 x 10^0). d. Express numbers in *scientific notation* using positive powers of ten. e. Classify whole numbers to 100 as *prime*, *composite*, or neither. f. Determine the *prime factorization* for a whole number up to 50.

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
Objective 2: Identify simple relationships among whole numbers. a. Develop strategies for *one-to-one* correspondence and keeping track of quantities. b. Compare two sets of objects to determine whether they have the same, fewer, or more elements. c. Order sets of objects from 1 to 9. d. Estimate quantities less than 10.	**Objective 2: Identify simple relationships among whole numbers.** a. Identify the number that is one more or one less than any *whole number* from 1 to 99. b. Use the vocabulary "greater than," "less than," and "equal to" when comparing sets of objects or numbers. c. Order sets of objects and numbers from 0 to 20. d. Use ordinal numbers 1st through 5th (i.e., 1st, 2nd, 3rd, 4th, 5th).	**Objective 2: Identify simple relationships among whole numbers.** a. Identify the number that is one more, one less, ten more, or ten less than any *whole number* up to 100. b. Write number sentences using the terms "greater than," "less than," or "equal to," to compare numbers. c. Order four whole numbers less than 100 from least to greatest and from greatest to least. d. Use *ordinal numbers* 1st through 10th.	**Objective 2: Identify relationships among whole numbers.** a. Use a variety of strategies to determine whether a number is even or odd. b. Identify the number that is ten more, ten less, 100 more, or 100 less than any *whole number* up to 1,000. c. Compare the relative size of numbers (e.g., 31 is large compared to 4, about half as big as 60, close to 27). d. Compare whole numbers up to four digits using the symbols <, >, and =. e. Order and compare whole numbers on a number line.	**Objective 2: Identify relationships among whole numbers and decimals.** a. Identify the number that is 100 more, 100 less, 1,000 more, or 1,000 less than any *whole number* up to 10,000. b. Compare the relative size of numbers (e.g., 100 is small compared to a million, but large compared to 5). c. Compare whole numbers up to five digits using the symbols <, >, and =. d. Identify a whole number that is between two given whole numbers. e. Order and compare whole numbers and decimals to tenths on a number line.	**Objective 2: Identify relationships among whole numbers, fractions, decimals, and percents.** a. Order and compare *whole numbers*, fractions (including mixed numbers), and decimals using a variety of methods and symbols. b. Rewrite mixed numbers and improper fractions from one form to the other. c. Find the least common denominator for two fractions. d. Represent commonly used fractions as decimals and percents in various ways (e.g., objects, pictures, calculators).	**Objective 2: Identify relationships among whole numbers, fractions (rational numbers), decimals, and percents.** a. Find the *greatest common factor* and *least common multiple* for two numbers using a variety of methods (e.g., list of multiples, prime factorization). b. Order and compare *rational numbers*, including mixed numbers, using a variety of methods and symbols. c. Locate positive rational numbers on a number line. d. Convert common fractions, decimals, and percents from one form to another (e.g., 3/4= 0.75 = 75%).

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
Objective 3: **Model and illustrate meanings of the operations of addition and subtraction and describe how they relate.** a. Demonstrate the joining and separating of sets of objects to solve problems. b. Describe the joining or separating of sets with informal language when using models. c. Record pictorially the results from the joining or separating of sets.	**Objective 3:** **Model and illustrate meanings of the operations of addition and subtraction and describe how they relate.** a. Demonstrate the joining and separating of sets with twelve or fewer objects and record the results with pictures or symbols. b. Model two meanings of subtraction: separating of sets ("take away") and comparison of sets ("how many more/fewer") using objects, pictorial representations, and symbols. c. Use correct vocabulary and symbols to describe addition (i.e., add, "and," plus, +, sum), subtraction (i.e., subtract, minus, -, take away, how many more/fewer), and equals (i.e., =, same as). d. Use zero in addition and subtraction sentences.	**Objective 3:** **Model and illustrate meanings of the operations of addition and subtraction and describe how they relate.** a. Demonstrate the joining and separating of sets with eighteen or fewer objects and record the results with pictures or symbols. b. Model three meanings of subtraction: separating of sets ("take away"), comparison of sets ("how many more/fewer"), and missing addends using objects, pictorial representations, and symbols. c. Separate a given set of objects into two, three, five, or ten groups of equal size. d. Model addition and subtraction of two-digit whole numbers in a variety of ways. e. Select an addition or subtraction sentence to solve a problem involving joining or separating of sets with eighteen or fewer objects. f. Recognize that addition number sentences have related subtraction sentences (e.g., 8-5=3, 3+5=8).	**Objective 3:** **Model and illustrate meanings of the operations of addition, subtraction, multiplication, and division and describe how they relate.** a. Model addition and subtraction of two- and three-digit *whole numbers* in a variety of ways. b. Model multiplication of a one-digit *factor* by a one-digit factor using various methods (e.g., repeated addition, rectangular *arrays*, manipulatives, pictures) and connect the representation to an *algorithm*. c. Model division as sharing equally and as repeated subtraction using various methods (e.g., rectangular arrays, manipulatives, number lines, pictorial representations). d. Demonstrate, using objects, that multiplication and division are inverse operations (e.g., 3x4=12; thus, 12÷4=3 and 12÷3=4). e. Select and write an addition, subtraction, or multiplication sentence to solve a problem related to the students' environment, and write a story problem that relates to a given equation. f. Demonstrate the effects of place value when multiplying whole numbers by 10.	**Objective 3:** **Model and illustrate meanings of the four operations and describe how they relate.** a. Use models to represent multiplication of a one- or two-digit *factor* by a two-digit factor (up to 30) using a variety of methods (e.g., rectangular *arrays*, manipulatives, pictures) and connect the representation to an *algorithm*. b. Recognize that division by zero is not possible (e.g., 6÷0 is undefined). c. Select and write a multiplication or division sentence to solve a problem related to the students' environment and write a story problem that relates to a given equation. d. Represent division of a two-digit *dividend* by a one-digit *divisor*, including whole number remainders, using various methods (e.g., rectangular arrays, manipulatives, pictures) and connect the representation to an algorithm. e. Demonstrate that multiplication and division are inverse operations (e.g., 3x4=12; thus, 12÷4=3 and 12÷3=4). f. Describe the effect of place value when multiplying whole numbers by 10 and 100.	**Objective 3:** **Model and illustrate meanings of operations and describe how they relate.** a. Identify the *dividend*, *divisor*, and *quotient* regardless of the division symbol used. b. Determine whether a whole number is divisible by 2, 3, 5, 9, and/or 10, using the *rules of divisibility*. c. Represent remainders as *whole numbers*, decimals, or fractions and describe the meaning of remainders as they apply to problems from the students' environment (e.g., If there are 53 people, how many vans are needed if each van holds 8 people?). d. Model addition, subtraction, and multiplication of fractions and decimals in a variety of ways (e.g., using objects and a number line). e Select or write the number sentences that can be used to solve a two-step problem. f. Model different strategies for whole number multiplication (e.g., partial product, lattice) and division (e.g., partial quotient). g. Describe the effect on place value when multiplying and dividing whole numbers and decimals by 10, 100, and 1,000.	**Objective 3:** **Model and illustrate meanings of operations and describe how they relate.** a. Represent division of a multi-digit *dividend* by two-digit *divisors*, including decimals, using models, pictures, and symbols. b. Model addition, subtraction, multiplication, and division of fractions and decimals in a variety of ways (e.g., objects, a number line). c. Apply *rules of divisibility*. d. Select or write a number sentence that can be used to solve a multi-step problem and write a word problem when given a two-step expression or equation.

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
	Objective 4: **Use fractions to identify parts of the whole.** a. Share sets of up to ten objects between two students and identify each part as half. b. Divide geometric shapes into equal parts, identifying halves and fourths.	**Objective 4:** **Use fractions to identify parts of the whole.** a. Separate geometric shapes and sets of objects into halves, thirds, and fourths using a variety of models and illustrations. b. Specify a region of a geometric shape (e.g., as "___ out of ___ equal parts" when given four or fewer equal parts. c. Represent the unit fractions 1/2, 1/3, and 1/4 with objects, pictures, and symbols.	**Objective 4:** **Use fractions to communicate parts of the whole.** a. Identify the denominator of a fraction as the number of equal parts in the whole region or set. b. Identify the numerator of a fraction as the number of equal parts being considered. c. Divide *regions* and sets of objects into equal parts using a variety of models and illustrations. d. Name and write a fraction to represent a portion of a unit whole for halves, thirds, fourths, sixths, and eighths. e. Determine which of two fractions is greater using models or illustrations.	**Objective 4:** **Use fractions to communicate parts of the whole.** a. Divide regions and sets of objects into equal parts using a variety of models and illustrations. b. Name and write a fraction to represent a portion of a unit whole for halves, thirds, fourths, fifths, sixths, eighths, and tenths. c. Relate fractions to decimals that represent tenths. d. Determine which of two fractions is greater using models or illustrations. e. Find equivalent fractions for one-half, one-third, and one-fourth using manipulatives and pictorial representations.	**Objective 4:** **Use fractions to communicate parts of the whole.** a. Divide regions, sets of objects, and line segments into equal parts using a variety of models and illustrations. b. Name and write a fraction to represent a portion of a unit whole for halves, thirds, fourths, fifths, sixths, eighths, tenths, and twelfths. c. Represent the simplest form of a fraction in various ways (e.g., objects, pictorial representations, symbols). d. Represent mixed numbers and improper fractions in various ways (e.g., rulers, objects, number lines, symbols). e. Rename *whole numbers* as fractions with different denominators (e.g., 5=5/1, 3=6/2, 1=7/7). f. Model and calculate equivalent forms of a fraction and describe the process used.	**Objective 4:** **Use fractions and percents to communicate parts of the whole.** a. Divide regions, sets of objects, and *line segments* into equal parts using a variety of models and illustrations. b. Name and write a fraction to represent a portion of a unit whole for halves, thirds, fourths, fifths, sixths, eighths, tenths, twelfths, and sixteenths. c. Write a fraction or ratio in simplest form. d. Name equivalent forms for fractions (halves, thirds, fourths, fifths, tenths), ratios, percents, and decimals, including repeating or terminating decimals. e. Relate percents less than 1% or greater than 100% to equivalent fractions, decimals, *whole numbers*, and mixed numbers.

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
	Objective 5: **Solve whole number problems using addition and subtraction in horizontal and vertical notation.** a. Compute addition and subtraction facts to twelve. b. Add three whole numbers with sums to twelve.	**Objective 5:** **Solve whole number problems using addition and subtraction in vertical and horizontal notation.** a. Use a variety of methods and tools to facilitate computation (e.g., estimation, mental math strategies, paper and pencil, calculator). b. Compute accurately with basic number combinations for addition and subtraction facts to eighteen. c. Add three *whole numbers* with *sums* to eighteen. d. Find the sum of two-digit whole numbers and describe the process used.	**Objective 5:** **Solve whole number problems using addition, subtraction, multiplication, and division in vertical and horizontal notation.** a. Use a variety of methods and tools to facilitate computation (e.g., estimation, mental math strategies, paper and pencil, calculator). b. Find the sum of any two *addends* with three or fewer digits, including monetary amounts, and describe the process used. c. Find the *difference* of two-digit *whole numbers* and describe the process used. d. Find the *product* for multiplication facts through ten times ten and describe the process used.	**Objective 5:** **Solve whole number problems using addition, subtraction, multiplication, and division in vertical and horizontal notation.** a. Determine when it is appropriate to use estimation, mental math strategies, paper and pencil, or a calculator. b. Find the sum and difference of four-digit numbers, including monetary amounts, and describe the process used. c. Multiply two- and three-digit *factors* by a one-digit factor and describe the process used. d. Divide a two-digit *whole number dividend* by a one-digit *divisor*, with a *remainder* of zero and describe the process used.	**Objective 5:** **Solve problems using the four operations with whole numbers, decimals, and fractions.** a. Determine when it is appropriate to use estimation, mental math strategies, paper and pencil, or a calculator. b. Use estimation strategies to determine whether results obtained using a calculator are reasonable. c. Multiply up to a three-digit *whole number* by a one- or two-digit whole number. d. Divide up to a three-digit whole number *dividend* by a one-digit *divisor*. e. Add and subtract decimals with digits to the hundredths place (e.g., 35.42+7.2; 75.2–13.45). f. Add, subtract, and multiply fractions. g. Simplify *expressions*, without *exponents*, using the *order of operations*.	**Objective 5:** **Solve problems using the four operations with whole numbers, decimals, and fractions.** a. Determine when it is appropriate to use estimation, mental math strategies, paper and pencil, or a calculator. b. Use estimation strategies to determine whether results obtained using a calculator are reasonable. c. Multiply up to a three-digit *factor* by a one- or two-digit factor including decimals. d. Divide up to a three-digit *dividend* by a one- or two-digit *divisor* including decimals. e. Add and subtract decimals to the thousandths place (e.g., 34.567+3.45; 65.3-5.987). f. Add, subtract, multiply, and divide fractions and mixed numbers. g. Solve problems using ratios and proportions. h. Simplify *expressions*, with *exponents*, using the *order of operations*.

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
					Objective 6: **Model and illustrate integers.** a. Identify, read, and locate *integers* on a number line. b. Describe situations where integers are used in the students' environment.	**Objective 6:** **Model, illustrate, and perform the operations of addition and subtraction of integers.** a. Recognize that the sum of an *integer* and its opposite is zero. b. Model addition and subtraction of integers using manipulatives and a number line. c. Add and subtract integers.
Standard II: **Students will identify and use patterns to represent mathematical situations.**	**Standard II:** **Students will identify and use patterns and relations to represent mathematical situations.**	**Standard II:** **Students will identify and use patterns and relations to represent mathematical situations.**	**Standard II:** **Students will use patterns and relations to represent mathematical situations.**	**Standard II:** **Students will use patterns and relations to represent mathematical situations.**	**Standard II:** **Students will use patterns and relations to represent and analyze mathematical situations using algebraic symbols.**	**Standard II:** **Students will use patterns, relations, and functions to represent and analyze mathematical situations using algebraic symbols.**
Objective 1: **Identify and sort objects according to common attributes.** a. Sort objects into groups by color, shape, size, number, or other *attributes*. b. Identify which attribute was used to sort objects into a group. c. Find multiple ways to sort and classify a group of objects.	**Objective 1:** **Recognize and represent patterns with one or two attributes.** a. Sort and classify objects by one or two *attributes*. b. Identify, create, and label simple patterns using manipulatives, pictures, and symbolic notation (e.g., ABAB. . ., □ ○ △ □ ○ △ . . .). c. Identify patterns in the environment. d. Identify horizontal and vertical patterns on hundreds charts. e. Use patterns to establish skip counting by twos to 20 and by fives and tens to 100. f. Count backward from 10 to 0 and identify the pattern.	**Objective 1:** **Recognize and represent patterns having multiple attributes.** a. Sort, classify, and label objects by three or more *attributes*. b. Identify and label repeating and *growing patterns* using objects, pictures, and symbolic notation (e.g., ABAABBAAABBB...). c. Identify repeating and growing patterns in the environment. d. Construct models and skip count by twos, threes, fives, and tens and relate to repeated addition.	**Objective 1:** **Recognize and create patterns with given attributes.** a. Create and extend *repeating* and *growing* patterns using objects, numbers, and tables. b. Record results of patterns created using manipulatives, pictures, and numeric representations and describe how they are extended.	**Objective 1:** **Recognize, describe, and use patterns and identify the attributes.** a. Represent and analyze repeating and growing patterns using objects, pictures, numbers, and tables. b. Recognize and extend multiples and other number patterns using a variety of methods.	**Objective 1:** **Recognize, analyze, and use patterns and describe their attributes.** a. Analyze and make predictions about patterns involving *whole numbers*, decimals, and fractions using a variety of tools including organized lists, tables, objects, and variables. b. Extend patterns and describe a rule for predicting the next element.	**Objective 1:** **Recognize, analyze, and use multiple representations of patterns and functions and describe their attributes.** a. Analyze patterns on graphs and tables and write a generalization to predict how the patterns will continue. b. Create tables and graphs to represent given patterns and algebraic *expressions*. c. Draw a graph from a table of values or to represent an equation. d. Write an algebraic expression from a graph or a table of values.

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
Objective 2: Identify and use patterns to describe numbers or objects. a. Use patterns to count orally from 1 to 20 and backward from 10 to 0. b. Identify simple patterns in the environment. c. Predict what comes next in an established pattern and justify thinking. d. Duplicate, extend, and create simple patterns using objects and pictorial representations.	**Objective 2: Recognize and represent relations using mathematical symbols.** a. Recognize that "=" indicates a relationship in which the quantities on each side of an equation are equal. b. Recognize that symbols such as □, △, or ◇ in an addition or subtraction equation represent a missing value that will make the statement true (e.g., □ + 3 = 6, 5 +7 = △, 4 = 5 – ◇). c. Demonstrate that changing the order of *addends* does not change the *sum* (e.g., 3+2=5 and 2+3=5).	**Objective 2: Recognize and represent relations using mathematical symbols.** a. Recognize that "≠" indicates a relationship in which the quantities on each side are not of equal value. b. Recognize that symbols such as □, △, or ◇ in an addition or subtraction equation represent a value that will make the statement true (e.g., □ +3=6, 5+7=△, 7=9-◇). c. Demonstrate that changing the order of *addends* does not change the *sum* (e.g., 3+2+7=12, 7+3+2=12) and that changing the grouping of three or more addends does not change the sum (e.g., (2+3)+7=12, 2+(3+7)=12).	**Objective 2: Recognize and represent mathematical situations using patterns and symbols.** a. Recognize that symbols such as □, △, or ◇ in an addition, subtraction, or multiplication equation, represent a value that will make the statement true (e.g., 5+7=△, □-3=6, ◇=2x4). b. Solve equations involving equivalent expressions (e.g., 6+4 = □+7). c. Use the >, <, and = symbols to compare two *expressions* involving addition and subtraction (e.g., 4+6 □ 3+2; 3+5 ◇ 16-9). d. Demonstrate that grouping three or more *addends* does not change the *sum* (e.g., 3+(2+7)=12, (7+3)+2=12) and changing the order of *factors* does not change the *product* (e.g., 3x7=21, 7x3=21). e. Use a variety of manipulatives to model the *identity property of addition* (e.g., 3+0=3), the *identity property of multiplication* (e.g., 7x1=7), and the *zero property of multiplication* (e.g., 6x0=0).	**Objective 2: Recognize, represent, and solve mathematical situations using patterns and symbols.** a. Solve equations involving equivalent expressions (e.g., 6x2= □x3 or 6x□=9+9). b. Use the <, >, = symbols to compare two expressions involving addition, subtraction, multiplication, and division (e.g., 5x4◇9÷3). c. Recognize that a given variable maintains the same value throughout an equation or expression (e.g., □+□=8; □=4). d. Demonstrate that changing the order of *factors* does not change the *product* (e.g., 2x3=6, 3x2=6) and that the grouping of three or more factors does not change the product (e.g., (2x3)x1=6; 2x(3x1)=6). e. Demonstrate the distribution of multiplication over addition using a rectangular *array* (e.g., 8x14=8 rows of 10 plus 8 rows of 4).	**Objective 2: Represent, solve, and analyze mathematical situations using algebraic symbols.** a. Recognize a variety of symbols for multiplication and division including x, •, and * as symbols for multiplication and ÷, ⌐, and a fraction bar (/ or -) as division symbols. b. Recognize that a variable (◇, n, x) represents an unknown quantity. c. Solve one-step equations involving *whole numbers* and a single variable (e.g., n÷7=3). d. Recognize that the answer to a multiplication problem involving a factor of zero is equal to zero (e.g., 0x45=0). e. Use expressions or one-step equations to represent real-world situations. f. Use the *associative*, *commutative*, and *distributive properties* to compute with whole numbers.	**Objective 2: Represent, solve, and analyze mathematical situations using algebraic symbols.** a. Recognize that a number in front of a variable indicates multiplication (e.g., 3y means 3 times the quantity y). b. Solve two-step equations involving *whole numbers* and a single variable (e.g., 3x+4=19). c. Recognize that "≈" indicates a relationship in which the quantities on each side are approximately of equal value (e.g., π ≈3.14). d. Recognize that an *exponent* can be represented in the following ways: 4^3 or 4^3. e. Evaluate *expressions* and formulas, substituting given values for the variables (e.g., 2x+4; x=2; therefore, 2(2)+4=8). f. Recognize that if the *product* is zero, then one or more *factors* equal zero (i.e., if ab=0 then either a=0 or b=0 or a and b=0).

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
Standard III: **Students will identify and create simple geometric shapes and describe spatial relationships.**	**Standard III:** **Students will describe, identify, and create and simple geometric shapes and describe spatial relationships.**	**Standard III:** **Students will describe, identify, and create geometric shapes and describe spatial relationships.**	**Standard III:** **Students will use spatial reasoning to describe, identify, and create geometric shapes.**	**Standard III:** **Students will use spatial reasoning to recognize, describe, and identify geometric shapes.**	**Standard III:** **Students will use spatial reasoning to recognize, describe, and identify geometric shapes and principles.**	**Standard III:** **Students will use spatial and logical reasoning to recognize, describe, and identify geometric shapes and principles.**
Objective 1: **Identify and create simple geometric shapes.** a. Identify circles, triangles, rectangles, and squares. b. Combine shapes to create *two-dimensional* objects. c. Draw circles, triangles, rectangles, and squares. d. Recognize circles, triangles, rectangles, and squares in the students' environment.	**Objective 1:** **Describe, identify, and create simple geometric shapes.** a. Identify, name, draw, create, and sort circles, triangles, rectangles, and squares. b. Identify circles, triangles, rectangles, and squares in the students' environment. c. Recognize that combining simple geometric shapes can create more complex geometric shapes.	**Objective 1:** **Describe, identify, and create geometric shapes.** a. Identify, name, draw, sort, and compare circles, triangles, and *parallelograms*. b. Identify and name spheres, cones, and cylinders. c. Find and identify familiar geometric shapes in the students' environment. d. Determine whether a circle, triangle, square, or rectangle has a *line of symmetry*.	**Objective 1:** **Describe, identify, and create geometric shapes.** a. Identify and draw *points*, *lines*, *line segments*, and *endpoints*. b. Identify and draw *lines of symmetry* on triangles, squares, circles, and rectangles. c. Determine whether an angle is *right*, *obtuse*, or *acute* by comparing the angle to the corner of a rectangle. d. Classify polygons (e.g., *quadrilaterals*, pentagons, hexagons, octagons) by the number of sides and corners. e. Identify, make, and describe cubes (e.g., a cube has 6 square *faces*, 8 *vertices*, and 12 *edges*).	**Objective 1:** **Describe, identify, and analyze characteristics and properties of geometric shapes.** a. Identify and draw *parallel lines* and *intersecting lines*. b. Identify and draw lines of symmetry on a variety of *polygons*. c. Identify and describe *quadrilaterals* (i.e., rectangles, squares, *rhombuses*, *trapezoids*, kites). d. Identify *right*, *obtuse*, and *acute* angles. e. Compare two polygons to determine whether they are *congruent* or *similar*. f. Identify and describe *cylinders* and *rectangular prisms*.	**Objective 1:** **Describe, identify, and analyze characteristics and properties of geometric shapes.** a. Identify and draw *perpendicular* lines. b. Draw, label, and describe rays and describe an angle as two rays sharing a common endpoint. c. Label an angle as acute, *obtuse*, *right*, or *straight*. d. Identify and describe *equilateral*, *isosceles*, *scalene*, *right*, *acute*, and *obtuse* triangles. e. Identify the *vertex* of an angle or the *vertices* of a polygon. f. Compare *corresponding angles* of two triangles and determine whether the triangles are *similar*. g. Identify and describe *pyramids* and *prisms*.	**Objective 1:** **Identify and analyze characteristics and properties of geometric shapes.** a. Identify the *midpoint* of a *line segment*. b. Identify concave and *convex polygons*. c. Identify the center, *radius*, *diameter*, and *circumference* of a circle. d. Identify the number of *faces*, *edges*, and *vertices* of *pyramids* and *prisms*.

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
Objective 2: Describe simple spatial relationships. a. Visualize how to fit a shape into a design. b. Use and demonstrate words to describe position with objects (i.e., on, over, under, above, below, top, bottom, up, down, in front of, behind, next to, beside). c. Use and demonstrate words to describe distance with objects (i.e., far, near).	**Objective 2: Describe simple spatial relationships.** a. Use and demonstrate words to describe position (i.e., between, before, after, middle, left, right). b. Use and demonstrate words to describe distance (i.e., closer, farther).	**Objective 2: Describe spatial relationships.** a. Create and use verbal or written instructions to move within the environment. b. Find and name locations using coordinates (A, 1). c. Identify shapes in various orientations (e.g., △ and ▽).	**Objective 2: Describe spatial relationships.** a. Give directions to reach a location. b. Use coordinates (A, 1) or regions to locate positions on a map. c. Demonstrate and use horizontal and vertical lines.	**Objective 2: Specify locations and describe spatial relationships using grids and maps.** a. Locate positions on a map of Utah using coordinates or regions. b. Give the *coordinates* or *regions* of a position on a map of Utah.	**Objective 2: Specify locations and describe spatial relationships using coordinate geometry.** a. Locate points defined by ordered pairs in the first *quadrant*. b. Write an ordered pair for a point in the first quadrant. c. Specify possible paths between locations on a *coordinate grid* and compare distances of the various paths.	**Objective 2: Specify locations and describe spatial relationships using coordinate geometry.** a. Graph points defined by ordered pairs in all four quadrants. b. Write the ordered pair for a point in any quadrant.
			Objective 3: Visualize and identify geometric shapes after applying transformations. a. Demonstrate the effect of a slide (translation) or flip (reflection) on a figure, using manipulatives. b. Determine whether two polygons are *congruent* by sliding, flipping, or turning to physically fit one object on top of the other. c. Identify *two-dimensional* shapes (*nets*) that will fold to make a cube. d. Create a *polygon* that results from combining other polygons.	**Objective 3: Visualize and identify geometric shapes after applying transformations.** a. Identify a *slide* (*translation*) or *flip* (*reflection*) on a figure using manipulatives. b. Relate *cubes*, *cylinders*, *cones*, and *rectangular prisms* to the *two-dimensional* shapes (*nets*) from which they were created.	**Objective 3: Visualize and identify geometric shapes after applying transformations.** a. Identify a *slide* (*translation*) or *flip* (*reflection*) on a figure across a line. b. Demonstrate the effect of a *turn* (*rotation*) on a figure using manipulatives. c. Relate *pyramids* and *prisms* to the *two-dimensional* shapes (*nets*) from which they were created.	**Objective 3: Visualize and identify geometric shapes after applying transformations.** a. *Turn* (*rotate*) a shape around a point and identify the location of the new vertices. b. *Slide* (*translate*) a polygon either horizontally or vertically on a coordinate grid and identify the location of the new vertices. c. *Flip* (*reflect*) a shape across either the x- or y-axis and identify the location of the new vertices.

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
Standard IV: **Students will understand and use simple measurement tools and techniques.**	**Standard IV:** **Students will understand and use simple measurement tools and techniques.**	**Standard IV:** **Students will understand and use measurement tools and techniques.**	**Standard IV:** **Students will understand and use measurement tools and techniques.**	**Standard IV:** **Students will understand and use measurement tools and techniques.**	**Standard IV:** **Students will understand and apply measurement tools and techniques.**	**Standard IV:** **Students will understand and apply measurement tools and techniques.**
Objective 1: **Identify measurable attributes of objects and units of measurement.** a. Identify clocks and calendars as tools that measure time. b. Identify a day, week, and month on a calendar. c. Identify pennies, nickels, dimes, and quarters as units of money.	**Objective 1:** **Identify measurable attributes of objects and units of measurement.** a. Identify the appropriate tools for measuring length, weight, capacity, temperature, and time. b. Identify the values of a penny, nickel, dime, and quarter. c. Estimate the length of an object by comparing to a nonstandard unit (e.g., How many new pencils wide is your desk?).	**Objective 1:** **Identify measurable attributes of objects and units of measurement.** a. Sequence a series of events of a day in order by time (e.g., breakfast at 7:00, school begins at 9:00). b. Identify the name and value of a penny, nickel, dime, quarter, and dollar. c. Estimate length, *capacity*, and weight using customary units.	**Objective 1:** **Identify and describe measurable attributes of objects and units of measurement.** a. Recognize the two systems of measurement: *metric* and *customary*. b. Describe the relationship between metric units of length (i.e., centimeter, meter). c. Describe the relationship among customary units of length (i.e., inch, foot, yard) and the relationship between customary units of *capacity* (i.e., cup, quart). d. Estimate length, capacity, and weight using metric and customary units.	**Objective 1:** **Identify and describe measurable attributes of objects and units of measurement.** a. Describe the relationship among *metric* units of length (i.e., millimeter, centimeter, meter), between metric units of capacity (i.e., milliliter, liter), and between metric units of weight (i.e., gram, kilogram). b. Identify a mile as a measure of distance and its relationship to other *customary* units of length. c. Describe the relationship among customary units of *capacity* (i.e., cup, pint, quart, gallon). d. Estimate length, capacity, and weight using metric and customary units.	**Objective 1:** **Identify and describe measurable attributes of objects and units of measurement.** a. Describe the relationship among *metric* units of length (i.e., millimeter, centimeter, meter, kilometer). b. Describe the relationship among *customary* units of weight (i.e., ounce, pound). c. Identify the correct units of measurement for *volume*, *area*, and *perimeter* in both metric and customary systems. d. Estimate length, volume, weight, and area using metric and customary units. e. Convert units of measurement within the metric system and convert units of measurement within the customary system.	**Objective 1:** **Identify and describe measurable attributes of objects and units of measurement.** a. Compare a meter to a yard, a liter to a quart, and a kilometer to a mile. b. Identify *pi* as the ratio of the *circumference* to *diameter* of a circle. c. Explain how the size of the unit used in measuring affects the precision. d. Estimate length, volume, weight, and area using *metric* and customary units.

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
Objective 2: **Use appropriate techniques and tools to determine measurements.** a. Compare two objects (e.g., shorter/longer, heavier/lighter, larger/smaller, more/less). b. Find the length of an object using nonstandard units (e.g., pencils, paper clips). c. Name the days of the week in order. d. Sort pennies, nickels, dimes, and quarters.	**Objective 2:** **Use appropriate techniques and tools to determine measurements.** a. Compare objects, using nonstandard units, according to their length, weight, or volume (e.g., pencils/length, books/weight, boxes/volume). b. Read and tell time to the nearest hour. c. Name the days of the week, months of the year, and seasons in order. d. Determine the value of a set of the same coins that total 25¢ or less (e.g., a set of 14 pennies equals 14¢, a set of 5 nickels equals 25¢, a set of 2 dimes equals 20¢).	**Objective 2:** **Use appropriate techniques and tools to determine measurements.** a. Compare and order objects, using nonstandard units, according to their length, weight, or capacity. b. Measure length using inches and feet, weight using pounds, and *capacity* using cups. c. Determine the value of a set of up to five coins that total $1.00 or less (e.g., two quarters and one dime equals 60¢; three dimes, one nickel, and one penny equals 36¢). d. Read, tell, and write time to the hour and half-hour. e. Use a calendar to determine the day of the week and date. f. Determine the *perimeter* of a square, triangle, and rectangle by measuring with nonstandard units.	**Objective 2:** **Use appropriate techniques and tools to determine measurements.** a. Measure the length of objects to the nearest centimeter, meter, half-inch, foot, and yard. b. Measure *capacity* using cups and quarts, and measure weight using pounds. c. Determine the value of a combination of coins and bills that total $5.00 or less and write the monetary amounts using the dollar sign and decimal notation. d. Identify the number of hours in a day, the number of days in a year, and the number of weeks in a year. e. Read, tell, and write time to the quarter-hour. f. Identify any given day of the month (e.g., the third Wednesday of the month is the 18th). g. Read and record the temperature to the nearest ten degrees using a Fahrenheit thermometer. h. Estimate and measure the *perimeter* and area of rectangles by measuring with nonstandard units.	**Objective 2:** **Determine measurements using appropriate tools and formulas.** a. Measure the length of objects to the nearest centimeter, meter, quarter-inch, foot, and yard. b. Measure *capacity* using milliliters, liters, cups, pints, quarts, and gallons and measure weight using grams, kilograms, and pounds. c. Read, tell, and write time to the nearest minute, identifying a.m. and p.m. d. Read and record the temperature to the nearest degree, in Fahrenheit, using a thermometer. e. Determine the value of a combination of coins and bills that total $20.00 or less. f. Count back change for a single-item purchase and determine the amount of change to be received from a multiple-item purchase. g. Determine possible *perimeters*, in whole units, for a rectangle with a fixed *area* and determine possible areas when given a rectangle with a fixed perimeter.	**Objective 2:** **Determine measurements using appropriate tools and formulas.** a. Measure length to the nearest 1/8 of an inch and to the nearest centimeter. b. Measure *volume* and weight using *metric* and *customary* units. c. Measure angles using a protractor. d. Calculate *elapsed time* within a.m. or p.m. time periods. e. Read and record the temperature to the nearest degree (above and below zero) when using a thermometer with a Celsius or Fahrenheit scale. f. Calculate the *perimeter* of rectangles and triangles. g. Calculate the *area* of squares and rectangles using a formula.	**Objective 2:** **Determine measurements using appropriate tools and formulas.** a. Measure length to the nearest one-sixteenth of an inch and to the nearest millimeter. b. Estimate and measure an angle to the nearest degree. c. Calculate the *circumference* of a circle using a given formula. d. Calculate *elapsed time* across a.m. and p.m. time periods. e. Calculate the *areas* of triangles, rectangles, and *parallelograms* using given formulas. f. Calculate the *surface area* and *volume* of right, rectangular prisms using given formulas.

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
Standard V: **Students will collect and draw conclusions from data and understand basic concepts of probability.**	**Standard V:** **Students will collect and draw conclusions from data and understand basic concepts of probability.**	**Standard V:** **Students will collect and draw conclusions from data and understand basic concepts of probability.**	**Standard V:** **Students will collect and organize data to make predictions and identify basic concepts of probability.**	**Standard V:** **Students will collect and organize data to make predictions and use basic concepts of probability.**	**Standard V:** **Students will collect, analyze, and draw conclusions from data and apply basic concepts of probability.**	**Standard V:** **Students will collect, analyze, and draw conclusions from data and apply basic concepts of probability.**
Objective 1: **Collect, organize, and display simple data.** a. Collect, organize, and record data using objects and pictures. b. Represent data in a variety of ways (e.g., graphs made from people, *pictographs*, bar graphs) and interpret the data (e.g., more people like red than blue).	**Objective 1:** **Collect, organize, and display simple data.** a. Collect physical objects to use as data. b. Collect, represent, and interpret data using tables, tally marks, *pictographs*, and bar graphs.	**Objective 1:** **Collect, organize, and display simple data.** a. Gather data by vote or survey. b. Sort, classify, and organize data in a variety of ways. c. Use a variety of methods to organize, display, and label information, including keys, using *pictographs*, tallies, bar graphs, and organized tables. d. Report information from a data display.	**Objective 1:** **Collect, organize, and display data to make predictions.** a. Collect, read, represent, and interpret data using tables, graphs, and charts, including keys (e.g., pictographs, bar graphs). b. Make predictions based on a data display.	**Objective 1:** **Collect, organize, and display data to make predictions and answer questions.** a. Identify a question that can be answered by collecting data. b. Collect, read, and interpret data from tables, graphs, charts, surveys, and observations. c. Represent data using tables, line plots, line graphs, and bar graphs. d. Identify and distinguish between *clusters* and *outliers* of a data set.	**Objective 1:** **Formulate and answer questions using statistical methods to compare data.** a. Formulate a question that can be answered by collecting data. b. Collect, compare, and display data using an appropriate format (i.e., *line plots*, bar graphs, pictographs, circle graphs, line graphs). c. Identify minimum and *maximum* values for a set of data. d. Identify or calculate the *mean*, *mode*, and *range*. e. Propose and justify inferences based on data.	**Objective 1:** **Design investigations to reach conclusions using statistical methods to make inferences based on data.** a. Design investigations to answer questions by collecting and organizing data in a variety of ways (e.g., bar graphs, line graphs, frequency tables, stem and leaf plots). b. Collect, compare, and display data using an appropriate format (i.e., bar graphs, line graphs, *line plots*, circle graphs, scatter plots). c. Compare two similar sets of data on the same graph and compare two graphs representing the same set of data. d. Recognize that changing the scale influences the appearance of a display of data. e. Develop and evaluate inferences and predictions based on data.

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
Objective 2: **Determine the likelihood of events.** a. Describe events encountered in books read as possible or not possible. b. Describe events as likely or unlikely (e.g., It is likely to snow today. It is unlikely an elephant will be in school).	**Objective 2:** **Determine the likelihood of an event.** a. Compare events to decide which are more likely, less likely, and equally likely. b. Relate past events to future events (e.g., The sun set about 6:00 last night, so it will set about the same time tonight).	**Objective 2:** **Determine the likelihood of an event.** a. Predict events that will be the same in one day or one week. b. Predict the outcome when there are only two possible outcomes (e.g., tossing a coin).	**Objective 2:** **Identify basic concepts of probability.** a. Describe the results of events using the terms "certain," "equally likely," and "impossible." b. Predict outcomes of simple activities (e.g., a bag contains three red marbles and five blue marbles. If one marble is selected, is it more likely to be red or blue?).	**Objective 2:** **Use basic concepts of probability.** a. Describe the results of investigations involving random outcomes as simple ratios (e.g., 4 out of 9, 4/9). b. Predict outcomes of simple experiments, including with and without replacement, and test the predictions.	**Objective 2:** **Apply basic concepts of probability.** a. Describe the results of investigations involving random outcomes using a variety of notations (e.g., 4 out of 9, 4/9, 4:9). b. Recognize that outcomes of experiments and samples are fractions between 0 and 1. c. Predict the probability of an outcome in a simple experiment.	**Objective 2:** **Apply basic concepts of probability.** a. Write the results of a probability experiment as a fraction, ratio, or percent between zero and one. b. Compare experimental results with anticipated results (e.g., experimental: 7 out of 10 tails; whereas, anticipated 5 out of 10 tails). c. Compare individual, small group, and large group results for a probability experiment.

Mathematics Glossary

acute angle	An angle with a measure less than 90º.
addend	Any number being added. In 32+4=36, 32 and 4 are *addends*.
algorithm	A step-by-step method for computing.
area	The measure, in square units, of the inside of a plane figure.
array	An arrangement of objects in equal rows.
Associative Property	Changing the grouping of three or more *addends* does not change the *sum*. Changing the grouping of three or more *factors* does not change the *product*.
attribute	A characteristic of an object, such as color, shape, size, etc.
capacity	The maximum amount that can be contained by an object. Often refers to measurement of a liquid.
chord	Any *line segment* that joins two *points* on a circle.
circumference	The *perimeter* of a circle.
cluster	Data that are grouped together.
Commutative Property	Changing the order of the *addends* does not change the *sum*. Changing the order of the *factors* does not change the *product*.
composite number	A number greater than 0 that has more than two different factors. The number 9 is a *composite number* because it has three *factors*: 1, 3, and 9.
concave polygon	A *polygon* with one or more diagonals that have points outside the polygon.
cone	A solid bounded by a circular base and a curved surface with one *vertex*.
congruent	Having exactly the same size and shape.
convex polygon	A *polygon* with all interior angles measuring less than 180º. All diagonals of a *convex polygon* are inside the figure.

coordinate grid	A *two-dimensional* system in which the *coordinates* of a point are its distances from two intersecting, usually *perpendicular*, straight lines called axes.
coordinates	An ordered pair of numbers that identify a point on a coordinate plane or grid.
corresponding angles	Angles in the same position from one line to another.
cube (solid figure)	A regular solid with six congruent square faces.
customary system	A system of measurement used in the U.S. The system includes units for measuring length, capacity, and weight.
cylinder	A three-dimensional figure with two circular bases that are *parallel* and *congruent*.
diameter	A *chord* that goes through the center of a circle.
difference	The amount that remains after one quantity is subtracted from another.
Distributive Property	When one of the *factors* of a *product* is a *sum*, multiplying each *addend* before adding does not change the *product*. For example: 6x(2+3)=(6x2)+(6x3)
dividend	A number that is divided by another number.
divisor	The number by which another number is divided.
e.g.	This abbreviation means "for example." When used in the Core, *e.g.* is not limited to the examples given.
edge	The *line segment* where two *faces* of a solid figure meet.
elapsed time	The amount of time that passes between two times.
endpoint	A point at either end of a *line segment*, arc, or a point at one end of a *ray*.
equilateral triangle	A triangle with all sides the same length.
expanded form	A way to write numbers that shows the place value of each digit. 263 = 200 + 60 + 3 or 263 is 2 hundreds, 60 tens, and 3 ones.
exponent	The number that tells how many equal *factors* there are.

expression	A variable or combination of variables, numbers, and operation symbols that represents a mathematical relationship. 6, 2 + 3, x, x + 4, and x + 2y are all *expressions*.
face	A plane figure that serves as one side of a solid figure. The *faces* of a *cube* are squares.
factors	The *whole numbers* that are multiplied to get a *product*. In 6x3=18, 6 and 3 are factors of 18.
flip	A transformation creating a mirror image of a figure on the opposite side of a line. A *flip* is also called a *reflection*.
greatest common factor	The greatest number that is a *factor* of every number in a set of numbers. 3 is the *greatest common factor* of 9 and 15.
growing pattern	A pattern that grows or increases.
horizontal line	A line that is *parallel* to the horizon. A *horizontal line* is straight across.
i.e.	This abbreviation means "that is to say." When used in the Core, *i.e.* is limited to the specific examples given.
Identity Property of Addition	If you add zero to a number, the *sum* is the same as that number. For example, 8+0=8.
Identity Property of Multiplication	If you multiply a number by one, the *product* is the same as that number. For example, 18x1=18.
integers	*Whole numbers* and their opposites.
intersect	To meet or cross.
isosceles triangle	A triangle that has exactly two *congruent* sides.
least common multiple	The least common multiple of a set of two or more numbers. For example, the *least common multiple* of 3 and 5 is 15.
line	A set of connected points continuing without end in both directions.
line of symmetry	A line that divides a figure into two *congruent* halves that are mirror images of each other.
line plot	A graph showing frequency of data on a number line.

line segment	A part of a line with two *endpoints*.
mean	A number found by dividing the sum of two or more numbers by the number of *addends*. The *mean* is often referred to as the average.
metric system	A system of measurement based on tens. The basic unit of length is the meter. The basic unit of mass is the gram. The basic unit of *capacity* is the liter.
midpoint	The point on a *line segment* that divides it into two *congruent* segments.
mode	The number that appears most frequently in a set of numbers. There may be one, more than one, or no mode.
net	A *two-dimensional* shape that can be folded into a three-dimensional figure is a *net* of that figure.
numeral	A symbol used to represent a number.
obtuse angle	An angle with a measure greater than 90^{o} and less than 180^{o}.
obtuse triangle	A triangle with one *obtuse angle*.
one-to-one correspondence	The relationship between the spoken word and the written symbol.
Order of Operations	A set of rules that tells the order in which to compute.
ordinal number	A *whole number* that names the position of an object in sequence. First, second, and third are *ordinal numbers*.
outlier	A number in a set of data that is much larger or smaller than most of the other numbers in the set.
parallel lines	Lines in the same plane that are always the same distance apart.
parallelogram	A *quadrilateral* with two pairs of *parallel* and *congruent* sides.
perimeter	The distance around a figure.
perpendicular	Forming *right angles*.

pi	The ratio of the *circumference* of any circle to its *diameter*, approximately equal to 3.14.
pictograph	A graph that uses pictures to show data.
plane	A flat surface that extends infinitely in all directions.
point	An exact location in space represented by a dot.
polygon	A closed plane figure made by *line segments*.
prime factorization	A way to show a number as the *product* of *prime factors*. The *prime factorization* of 12 is 2x2x3.
prime number	A *whole number* greater than 0 that has exactly two different *factors*, 1 and itself. 5 is a *prime number* because its only *factors* are 1 and 5.
prism	A three-dimensional figure that has two *congruent* and *parallel* faces that are *polygons*. The rest of the faces are *parallelograms*.
product	The answer to a multiplication problem. For example, 6x3=18, 18 is the *product* of 6x3.
pyramid	A polyhedron whose base is a *polygon* and whose other *faces* are triangles that share a common *vertex*.
quadrants	The four sections of a *coordinate grid* that are separated by the axes.
Quadrilateral	A four-sided *polygon*.
quotient	The answer to a division problem.
radius	The segment, or the length of the segment, from the center of a circle to any point on the circle.
Range	The difference between the greatest number and the least number in a set of numbers.
rational number	A number that can be expressed as a ratio of two non-zero *integers*.
ray	A part of a line that has one *endpoint* and goes on forever in one direction.
rectangular prism	A *prism* with six rectangular faces.
reflection	A transformation creating a mirror image of a figure on the opposite side of a line. A *reflection* is also called a *flip*.

region	A part of a plane.
remainder	In *whole number* division, when you have divided as far as you can without using decimals, what has not been divided yet is the remainder.
repeating pattern	A pattern of a group of items that repeats over and over.
rhombus	A *parallelogram* with all four sides equal in length.
right angle	An angle that measures exactly 90º.
right triangle	A triangle that has one 90º angle.
rotation	The transformation that occurs when a figure is turned a certain angle and direction around a point. A rotation is also called a turn.
Rules of Divisibility	Patterns that make it easier to tell whether one number is *divisible* by another.
scalene triangle	A triangle that has no *congruent* sides.
scientific notation	A form of writing numbers as the *product* of a power of 10 and a decimal number greater than or equal to 1 and less than 10.
similar figures	Figures that have the same shape, but not necessarily the same size.
slide	A transformation that slides a figure a given distance in a given direction. A *slide* is also called a *translation*.
square number	A number that is the result of multiplying an *integer* by itself. Any *square number* of dots can be arranged in a square array.
standard form	A number written with one digit for each place value. The *standard form* for the number three thousand three is 3,003.
straight angle	An angle with a measure of 180º.
sum	The answer to an addition problem. In 32+4=36, 36 is the *sum*.
surface area	The total *area* of the *faces* (including bases) and curved surfaces of a solid figure.
translation	A transformation that slides a figure a given distance in a given direction. A *translation* is also called a *slide*.

trapezoid	A *quadrilateral* with one pair of *parallel* sides and one pair of sides that are not parallel.
turn	The transformation that occurs when a figure is turned a certain angle and direction around a point. A *turn* is also called a *rotation*.
two-dimensional	A figure that has length and width, but not height. Having *area*, but not *volume*. The image on a movie screen is two-dimensional.
vertex	The point at which two *line segments*, *lines*, or *rays* meet to form an angle.
vertical line	A line that has right angles to the horizon. A *vertical line* is straight up and down.
vertices	Plural of *vertex*.
volume	The number of cubic units it takes to fill a figure.
whole number	Any of the numbers 0, 1, 2, 3, 4, 5, and so on.
Zero Property of Multiplication	The *product* of any number and zero is zero. For example, 8x0=0.

Facilitated Activities

What the Early Native Americans Didn't Know

Background Information

Early Native Americans had many stories that helped explain circumstances they didn't understand. To satisfy their wonderment they made up legends and myths about these circumstances and passed them on through the ages. Some myths and legends told why there was thunder and lightning. Others told why bears did not have tails and why snakes did not have legs. Today we use process and thinking skills to explain unusual happenings. We encourage even the young to investigate this fascinating world of wonders. This activity will look at a short Native American legend and how we can explain what was observed.

Instructional Procedures

1. Read the following legend:

   Native Americans often told legends of a thunder beast. It was considered a monster. However, it was an animal they had never seen. All they saw were their huge bones lying on the mountainsides. They named it a thunder beast because they thought it had something to do with the thunder and the rain. It was very curious because the only time they found these huge bones was right after a huge rainstorm. Even though they had never seen this animal, they knew it must exist because they saw evidences of its bones. To explain this, they told a legend about the thunder beast.

   Adapted from *Supermonsters,* by Daniel Cohen

2. Answer these questions:

   a. Why did the early Native Americans create a legend about the thunder beast?

      (They found the bones of a huge animal that they never saw and explained it by telling a legend about it.)

   b. With the knowledge you have about fossils, uplift, and erosion, how do you explain why the bones were found on the mountainside right after a rainstorm?

      (The bones were from animals that lived millions of years ago and their remains were buried in sediments and preserved. Mountains were later formed with the bones inside. When it rained, these bones were finally exposed.)

c. What kind of reading is this and why?

(It is a legend because it is a story told without evidence of it ever happening.)

d. Why is it important for us to investigate strange happenings?

(By investigating, we find the explanation to satisfy our curiosity.)

Resources

Book

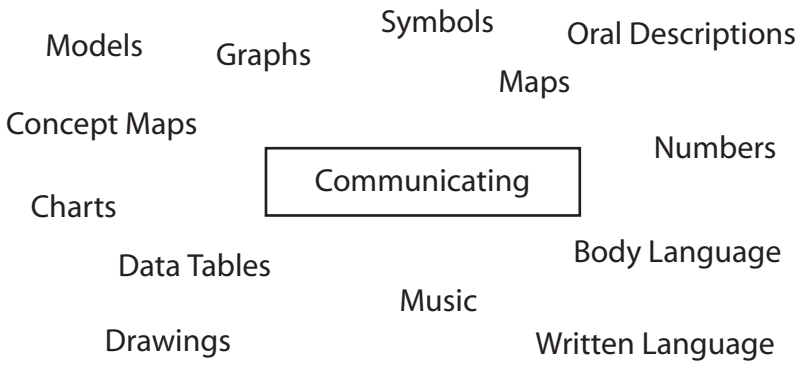
Supermonsters, by Daniel Cohen; ISBN 0671622196

Communicating– Giving and Following Directions

Background Information

Learning to use the tools of communicating helps students to be able to make good decisions about how to communicate observations and ideas effectively.

Here are some tools that could be used to communicate:



When you describe an object to someone, your purpose is better served if your communication is effective. Some tips in communicating effectively are:

1. Describe only what you observe (see, smell, hear, and taste), rather then what you infer about the object.
2. Make descriptions brief and use precise language.
3. Communicate information accurately using a variety of qualitative and quantitative observations.

   Qualitative observations are those made about the characteristics or qualities.

   Quantitative observations are those made about quantity—number and amount.
4. Consider the point of view of the person(s) you are working with.
5. Allow feedback to determine the effectiveness of your communication.
6. Construct an alternative description if necessary.

Research Basis

Rezba, Sprague, & Fiel (2003). *Learning and Assessing Science Process Skills*, Kendall/Hunt Press, 32-28.

National Research Council (2001). *Classroom Assessment and the National Science Education Standards*. Washington, DC: National Academy Press

Liem, Tiek. (1987). *Invitations to Science Inquiry*, Lexington, MA: Ginn Press

Instructional Procedures

Materials

- ❑ *Activity Rubric*

1. Work with a partner.
2. Select an object in the room to describe to your partner without letting your partner know what the object is.
3. Mentally plan your description.
4. Verbally describe the object to your partner.
5. Have your partner try to guess what object you have described.
6. After your partner guesses and the object has been identified, your partner complete the *Activity Rubric*.
7. Discuss the results of the rubric. Switch roles and follow the same procedure.
8. After you have done the activity twice, chose an activity that you participated in today and write a description in your Academy journal.

Curriculum Extensions/Adaptations/Integration

Instead of just describing an object, practice giving directions to a partner. To begin, think of a procedure you might want someone to follow.

Examples:

- How to plant a seed.
- How to tie a shoe.
- How to wash and dry your hands.
- How to make a paper airplane.

1. Choose a partner.
2. Gather the all materials needed for the chosen task.
3. Sit behind your partner so s/he can't see you.
4. Mentally plan how you will communicate the directions.

5. Give precise directions to your partner and have him/her follow the procedures without asking any questions. Your partner must do exactly what you say.
6. When the task is completed, have your partner evaluate the quality of your directions using the *Extension Rubric*.

Materials

- ❑ *Extension Rubric*

Resources

Web sites

http://www.plainfield.k12.in.us/hschool/webq/webq43/shannon.htm

md.essortment.com.communicationte_rqmd.htm

www.hhmi.org/coolscience/inchsquare/index.html

www.webofroses.com/scouting/communicating.html

Name _____

Activity Rubric

Criteria	Yes	Needs Improvement
Described only what s/he directly observed through the senses.		
Made descriptions brief by using precise language.		
Used qualitative and quantitative observations.		
Considered partner's point of view.		
Provided feedback to the receiver.		
Constructed an alternative description if necessary.		

Name _____

Extension Rubric

Criteria	Yes	Needs Improvement
Presented directions/information in an organized way.		
Made the descriptions/steps brief.		
Used precise language.		
Communicated information accurately.		
Considered partner's point of view.		

The Sun, the Wind, and the Rain

Background Information

The Sun, the Wind and the Rain will be introduced as the Invitation to Learn activity. This book contains concepts on rock formation, weathering, erosion, and elements of weather.

Research Basis

Dickinson, V.L. (1997) Journal of Science Teacher Education, 8.

"Elementary teachers can use their strengths in language arts to deliver more effective science instruction."

Dickinson, V.L., & Young, T.A. Department of Teaching and Learning, Washington State University.

"Science and language arts goals and objectives complement one another. Science can be used to provide common experiences about which students can communicate both orally and through written work. Language arts can provide tools for recording and communicating results of inquiry."

Instructional Procedures

Materials

- ❑ Plastic tub for sand
- ❑ Wet sand
- ❑ Small plastic cups
- ❑ Plastic utensils
- ❑ Paper towels
- ❑ *The Sun, the Wind and the Rain*

1. As students arrive, assign them to a "work station" containing a pile of wet sand, small cups, and plastic utensils. Instruct them to make a sand castle or other formation.
2. When the entire group has had a few minutes to construct their "castle," and as students to take their seats, pose the following questions:
   - Is this the first time you've made a sand castle?
   - Where did you make one before?
   - Have you been to the ocean or beach?
   - Why is there sand close to the ocean?
   - Where did the sand come from?
   - Do we make real houses out of sand?
   - Why not?

3. Read *The Sun, the Wind and the Rain*. Ask the students if they think these same things could happen to their sand castles if they were left outside.
4. Tell the class that the next unit of study will be the effects of weathering and erosion.

Resource

Book

The Sun, the Wind and the Rain, by Lisa Westberg Peters; ISBN 0-590-44555-3

Math Standard IV-1 & 2 Activities

How Low Can You Go?

Standard IV:
Students will understand and use measurement tools and techniques.

Objective 1:
Identify and describe measurable attributes of objects and units of measurement.

Objective 2:
Determine measurements using appropriate tools and formulas.

Intended Learning Outcomes:
4. Communicate mathematically.
5. Make mathematical connections.
6. Represent mathematical situations.

Content Connections:
Science ILO 1 & 4

Math Standard IV

Objectives 1 & 2

Connections

Background Information

The tool that measures temperature is the thermometer. The scale used by most scientists is the Celsius scale, named after Anders Celsius. He developed the scale where zero degrees is the point at which water turns to ice, and one hundred degrees is the point at which water boils. This unit of temperature is known as *degrees Celsius* (˚C). The thermometer you will use is glass with a narrow tube of red-colored alcohol. The liquid alcohol *expands* as it gets hot and *contracts* as heat is lost. Alcohol is a suitable liquid for student thermometers because it will not freeze until it is well below the freezing point of water. To use a thermometer, place the bulb of the thermometer in the liquid to be measured. If you are measuring the temperature of the air, hold the thermometer so that the bulb is not touching any surface. After a few seconds (for liquids) or minutes (for the air), read the temperature by looking to see to which marked line the top of the column of red alcohol has reached.

Research Basis

Moscovici, H. (1999). *Shifting from Activitymania to Inquiry Science—What Do We Need to Do?*

This paper concentrates on what science educators can do to support the shift toward inquiry science in the elementary classroom. Inquiry is discussed as a central part of the methods courses.

Assessment Suggestions

- Provide a list of locations and objects such as in a refrigerator or the temperature of freshly prepared hot chocolate. Next to each, identify two significantly different temperatures in degrees Celsius. Have students select the more reasonable temperature and explain why they made their selection.
- Provide a data table of collected temperature changes over time. Have students correctly plot a line graph on a provided graph form.
- Move about the class with two cups of water of different temperatures. Invite individual students to estimate the temperatures of each cup, then correctly use a thermometer to accurately measure the temperatures.

Invitation to Learn

Just prior to the activity, put out a set of three labeled cups (A, B, and C) for each group. Pour 100 ml of room-temperature water into all of the A and C cups. Pour 100 ml of ice-cold water into the B cups. You may want to place each set of cups in a basin for flood control.

Ask students to share what they think when you say the word *hot* or the word *cold*. Where in the world is it generally hot? Where is it generally cold? How can you tell if something is hot or cold? Point out the cups of water you have prepared. The students' task is to use their fingers to determine any differences in temperatures between the three cups. Tell them that each group will work together to put the cups in order from warmest to coldest.

1. Each person will have one turn only and will use only one finger. The finger will be put into each cup in order, first into cup A, into cup B, and then into cup C.
2. When everyone is finished, they are to collaborate, arrange the cups in order from warmest to coldest, and be ready to report out loud the three letters in the order they have decided.
3. Not all groups may agree on the order. Whether or not they do, have the groups repeat the procedure with a new finger. They should return the cups to the original order A, B, C. This time have students test in reverse order, placing their finger first into cup C, into cup B, and then into cup A.
4. Discuss the results, highlighting any discrepancies between the results of the first and second tests.

5. Ask students how they might determine the temperature of the water in each cup with greater accuracy than their fingers.

Instructional Procedures

Part I

1. Introduce the thermometer as a way of measuring temperature. Explain that the standard unit for measuring temperature in the metric system is the degree Celsius (˚C). Hold up a thermometer and explain how it works and how they are to use it (see Background Information). Distribute the thermometers and have the students carefully measure the temperature of the water in each of the three labeled cups from the Invitation to Learn. Have students record the three temperatures in their journal. They may be surprised to discover that the temperatures of cups A and C are the same. Discuss why they seemed to be different temperatures when they tested using their fingers.
2. Have students dispose of the water in cups A and C, but retain the cold water in cup B. Place 100 ml of hot water in cup A. Have students measure the temperatures of the water in each of the two cups. Have them record the temperatures in their journal, identifying cup A as "hot water" and cup B as "cold water." Invite students to estimate what the temperature of the water will be if they mix equal amounts of the hot and cold water. Have them write their estimate in their journal, identifying cup C as "mixture of hot and cold water." Have them then mix the two cups into cup C. Instruct them to gently stir the water with the thermometer and then measure the temperature of the mixed water. Students record the actual temperature in their journals next to their estimate. Invite students to explain why the temperature of the mixture was between the hot and cold temperatures.
3. Students create a vertical number line in their journals that shows 0˚ C at the bottom and 50˚ C at the top, then plot their recorded temperatures on to the number line labeling each as "hot water," "cold water," and "mixed hot and cold water." Next, measure the temperature of the air and have them record that temperature on their number line.

   Optional: Invite one student in each group to measure their body temperature by placing the bulb of the thermometer under his/her tongue and holding it there, mouth closed, for one

Materials

For each group:

- ❑ 6 ice cubes
- ❑ Set of three 9-oz. clear plastic cups (labeled A, B, and C)
- ❑ Celsius thermometer
- ❑ 100-ml beaker
- ❑ 15 ml of table salt
- ❑ Basin for flood control (optional)
- ❑ Colored pencils
- ❑ Stirring stick (small straw)

For the class:

- ❑ 2 liters of ice water
- ❑ 2 liters of hot water (40-50˚ C)
- ❑ 4 liters of room-temperature water
- ❑ Bucket or access to a dump sink
- ❑ *Cold Water Graph*

minute. Have a partner read the thermometer while it is still in place. Students record "body temperature" on their number line (approximately 37˚ C). After students have placed thermometers in their mouths, wash the thermometers in a mild bleach solution and then rinse with clear water.

Part II

1. Provide each group with a 9-oz. clear plastic cup, a thermometer, a stir stick (short straw), and a 100-ml beaker. You may want to place these items in a basin for flood control. Conduct an investigation to find out how cold room-temperature water will become in ten minutes with two ice cubes.
   a. Students measure 100 ml of room temperature water into the clear cup, then create a two-column data table in their journal, one labeled "minutes" and the other labeled "temperature." Each column should have eleven rows. Number the minutes column zero through ten.
   b. Students measure the starting temperature of the water and record it in the temperature column in the zero-minutes row of the data table in their journal.
   c. Deliver two ice cubes to the empty beaker of each group.
   d. Tell the students when the teacher says "go," they should carefully add the ice cubes to the cup of water and slowly stir the water with the straw. Have them measure and record the temperature each time a minute is called out. Continue for ten minutes.
   e. After the ten-minute investigation is concluded, distribute a copy of the *Cold Water Graph* to each student.
   f. Guide students to complete the graph. Instruct students to select a colored pencil for marking the graph.
   g. Make sure they plot each point where the temperature and minute lines intersect, creating a line graph.
2. During a second session, have students repeat the procedure. However, during the second investigation students will **not** stir the ice in the water.
   a. Students create a second data table in their journals.
   b. When they plot the line graph on the *Cold Water Graph,* have them select a *different* colored pencil so that the second line will be different from the first line.

3. During a third session, have students repeat the procedure, this time stirring the ice in the water.
   a. Before beginning, have students add 15 ml of salt to the water.
   b. They should stir the salt into the water until it dissolves, then begin timing.
   c. When they plot the third line graph on the *Cold Water Graph,* have them select a *different* colored pencil so that the third line will be different from the first two graphed lines.
4. Discuss the varied results of the three investigations. Help students connect variables in the procedure to the results achieved.

Curriculum Extensions/Adaptations/Integration

- Students research the origins of the Fahrenheit and Celsius systems. Compare the freezing and boiling points of both systems.
- Use the Internet to monitor the daily temperature of two different locations for five consecutive days. Students develop a strategy to compute the average temperature at each location and compare the two.
- Practice taking temperatures. Make a list of locations and/or materials. Estimate what the temperatures at these locations or of these materials might be, then use a thermometer to measure the actual temperatures.

Resources

Books

FOSS Measurement, by Lawrence Hall of Science, UCB, (available at http://www.delta-education.com/fossgallery.aspx?subID=&menuID=2); Item #WX542-2005, ISBN 0-87504-766-1

Measure Up! Experiments, Puzzles, And Games Exploring Measurement, by Sandra Markle; ISBN 0-689-31904-5

Temperature, by Rebecca Olien; ISBN 0-7368-2619-X

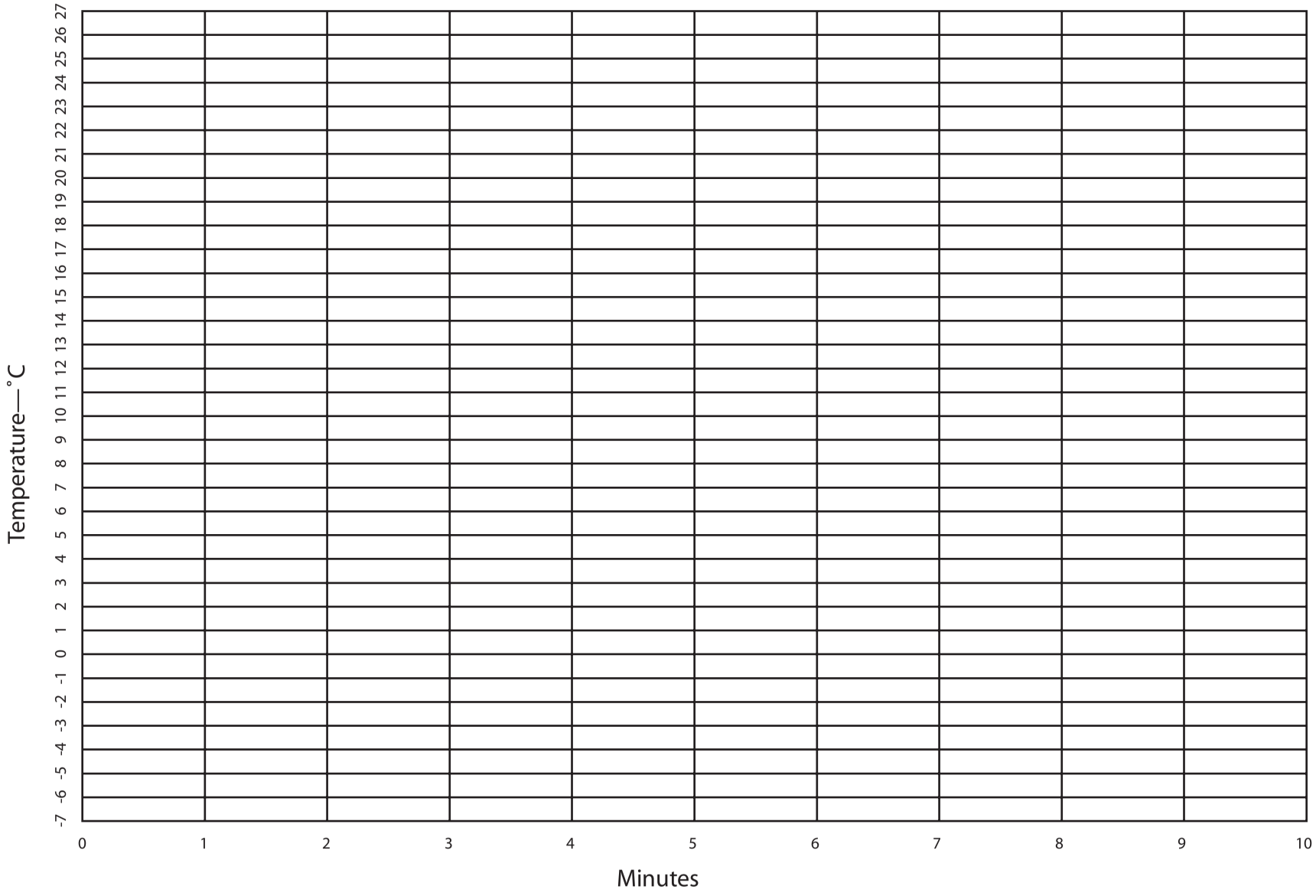
Thermometers, by Adele Richardson; ISBN 0-7368-2519-3

Family Connections

- Students use the newspaper or television weather report to record the highs and lows where they live for a week. Create a line graph showing the changes during the week. Draw two lines on the same graph, one for the high temperatures and one for the low temperatures.
- Students use a thermometer to record temperatures in various locations in their home. Record findings on a data table.
- Students place a thermometer in their refrigerator for approximately ten minutes. With a timer that tracks minutes, and a paper to record temperatures, remove the thermometer from the refrigerator and begin recording the temperature every ten seconds for one and a half minutes. Create a line graph showing the change in temperature over time.

Name _____

Cold Water Graph



Setting the Standard

Math Standard IV

Objectives 1 & 2

Connections

Standard IV:
Students will understand and use measurement tools and techniques.

Objective 1:
Identify and describe measurable attributes of objects and units of measurement.

Objective 2:
Determine measurements using appropriate tools and formulas.

Intended Learning Outcomes:
4. Communicate mathematically.
5. Make mathematical connections.
6. Represent mathematical situations.

Content Connections:
Science ILO 1 & 4

Background Information

To facilitate communication, there is a need for a standard unit of measurement. The *foot* has been used for centuries, dating back to the ancient Greek empires. In 1670, the *meter* was established as one 10-millionth of the distance along a meridian from the equator to the North Pole. Today a meter is defined as 1,650,763.73 wavelengths of light emanating from a specific isotope of kyrpton. In other words, the meter is an exact unit of measurement agreed upon by scientists throughout the world. In 1795, France was the first country to adopt the metric system. The meter (m) is divided into smaller parts. One-hundredth of a meter is a *centimeter* (cm).

Mass is a measure of the amount of stuff (matter) in an object. *Weight* is how we measure mass on Earth. In outer space, you may be weightless, but you are still made up of the same amount of stuff. An object's mass remains constant no matter where in the universe it is placed. However, its weight may change, depending on the strength of the gravitational pull of its location. Defining mass in terms of weight is the most efficient way for elementary students to begin comprehending these important ideas.

The standard unit of mass in the metric system is the *gram* (g). The gram is defined as the mass of a cubic centimeter of water at 4˚ C at standard atmospheric pressure. One paper clip is about 1 g. A nickel is about 5 g.

A word about metric symbols: The notations for metric measurement, *m* for meter, *cm* for centimeter, *g* for gram, *ml* for milliliter, etc. are universally recognized scientific *symbols*. They are not

considered abbreviations, and therefore each is written *without* a period. This is in contrast to the abbreviations for feet (ft.), inches (in.), ounces (oz.), etc., which are abbreviations followed by periods.

Research Basis

Donovan, M.S., Bransford, J.D., & Pellegrino, J.W., eds. (2001). "Key Findings" in *How People Learn: Bridging Research and Practice*. Committee on Learning Research and Educational Practice, National Research Council. (available at http://www.nap.edu/html/howpeople2/ch2.html)

Grotzer, T. *The Keys to Inquiry*. Project Zero, Harvard School of Education (available at http://hea-www.harvard.edu/ECT/Inquiry/inquiry1.html)

Marzano, R.J., Pickering, D.J., & Pollock, J.E. (2001). "Cooperative Learning" in *Classroom Instruction That Works: Research-Based Strategies for Increasing Student Achievement*. Association for Supervision and Curriculum Development.

Assessment Suggestions

- Provide a set of objects that you have previously measured and determined their weight. Have students list the objects. Next to each, have them record the estimated weight. Students weigh the objects and record the measured weight, within a reasonable margin of error.
- As students work on projects involving weight, move around the classroom observing. Invite individual students to demonstrate the process of assembling the balance and determine the weight of a "found" object from the classroom.

Invitation to Learn

Hold up a straw and tell students that they are going to measure the tops of their tables using a straw as the tool for measure. Pass out straws to each student giving half of the groups shorter straws and half of the groups longer straws. Have students measure the tops of their desks or tables, length and width. Allow students to use whatever method they can devise to accurately measure to the nearest whole straw. Have each group report their measurements, recording the data on the board. Make sure to write the number and the unit (straws). Ask students to look at the data and to comment on what they see. They may suggest that other students are wrong, that the tables or desks are different sizes, or that the straws are different lengths. Have students compare the suggested variables until they determine that the straws were different. Indicate the need for a standard unit of measurement.

Materials

For each student:

- ❑ Drinking straw (Half of the straws for the class should be shortened by cutting off 3 cm of length.)

Introduce the meter and centimeter (see Background Information). Hand out meter sticks or meter tapes and invite students to measure the length and width of the table or desk in centimeters.

Instructional Procedures

Part I

Materials

For each group:

- ❑ Primary balance
- ❑ Set of objects (steel washer, plastic chip, wooden square)

For the class:

- ❑ Paper clips: 4 boxes of 100 standard and 4 boxes of 100 jumbo

1. Show students a set of objects (steel washer, plastic chip, and wooden square). Challenge students to put the objects in order from lightest to heaviest.
   a. Distribute a set of objects to each group. Let students place the objects in order. Have each group report on their decision and write the results on the board. Discuss any discrepancies.
   b. Tell students that there is a tool that can be used to compare the weight of the objects more accurately. Hold up a balance.
   c. Demonstrate how to assemble and use the balance and use the slider to make the empty balance level.
   d. Choose two objects other than the ones they are using to demonstrate that the heavier object of the two will make one side of the balance go down.
   e. Students use the balance to determine more accurately the order of the weight of the three objects that they previously judged by feel.
   f. Ask them if they would like to make any corrections to their previously reported findings.
2. Use paper clips as a unit for weighing objects.
   a. Model the procedure by placing an object in one cup of the balance and then counting out paper clips until the balance is once again level. Report that the object weighed ____ paper clips.
   b. Students weigh their steel washer using paper clips.
   c. Deliver a cup of paper clips to each group.
   d. Give half of the groups a cup of 100 standard paper clips and give the other half of the groups a cup of 100 jumbo paper clips.
   e. Have the groups weigh their washers and report their results.
   f. Write the results on the board, making sure to write the number and the unit (paper clips). Discuss why the weights are different, similar to the discussion of the straws from the Invitation to Learn.

Part II

1. Introduce the metric standard of measuring weight, the *gram* (g).
   a. Hold up a gram weight and explain that the weight of this special cube is exactly one gram. Hold up and identify the 5-g, 10-g, and 20-g weights.
   b. Have students return the sets of paper clips and distribute a set of gram weights.
   c. Students weigh each of the previous objects using grams.
   d. Have them create a data table in their journal, listing in one column the objects and in the second column the measured weight of each object.
   e. Provide other objects for students to weigh and record.
   f. Students create a bar graph comparing the weights of various objects.

Materials

For each group:

- ❏ Primary balance
- ❏ Set of gram weights (1-g, 5-g, 10-g, and 20-g)

For the class:

- ❏ Paper clips: 4 boxes of 100 standard and 4 boxes of 100 jumbo

Part III

1. Hold up an apple or an orange. While this object will fit in the cup of the balance, it is too heavy to weigh using the gram weights.
   a. Create a 100-g weight by measuring out 100 g of aquarium gravel and placing it in a small Ziploc® bag.
   b. Distribute materials and have students create the 100-g weight.
   c. Students use the new weight in conjunction with the gram weights to measure other objects in the room.
   d. Students record their measurements in their journal on the data table.
   e. As a follow up, collect ten of the prepared 100-g weights. Place them together in a larger plastic bag. Introduce the newly created 1000-g weight as 1 *kilogram* (kg).

Materials

For each group:

- ❏ Primary balance
- ❏ Set of gram weights (1-g, 5-g, 10-g, and 20-g)

For each student:

- ❏ 2”x 3” Ziploc® bag

For the class:

- ❏ 5 lbs. aquarium gravel
- ❏ Apple or orange

Curriculum Extensions/Adaptations/Integration

- Students measure the weight of a small dry sponge, then soak the sponge to capacity with water and weigh again. Students write a math problem that expresses the weight of the water that the sponge held.

  Create a cloth rag that weighs the same as the dry sponge. Soak the rag to capacity and weigh it. Compute the weight of the water it held.

  Compare the holding capacity of the sponge to the rag.
- Read *How Big Is a Foot?* Students write a similar story about another unit of measurement.
- Students research other units of linear measurement, such as hand, rod, league, chain, cubit, fathom, cable, furlong, mil, ell, and report on how long each unit is and what was measured with that unit historically.

Resources

Books

FOSS Measurement, by Lawrence Hall of Science, UCB, (available at http://www.delta-education.com/fossgallery.aspx?subID=&menuID=2); Item #WX542-2005, ISBN 0-87504-766-1

How Big Is a Foot?, by Rolf Myller; ISBN 0-440-40495-9

Measuring Penny, Loreen Leedy; ISBN 0-8050-5360-53

Weighing and Measuring, Terry Jennings; ISBN 0-8172-3963-4

Balances, Adele Richardson; ISBN 0-7368-2516-9

Family Connections

- Students make a list of containers of packaged food. Next to each, estimate its weight in grams. After estimating, use the advertised metric weight on the label to record the actual weight of the food. There will be some discrepancy because weight listed is the net weight, excluding the weight of the container.

"Space" Exploration

Standard IV:
Students will understand and use measurement tools and techniques.

Objective 1:
Identify and describe measurable attributes of objects and units of measurement.

Objective 2:
Determine measurements using appropriate tools and formulas.

Intended Learning Outcomes:
4. Communicate mathematically.
5. Make mathematical connections.
6. Represent mathematical situations.

Content Connections:
Science ILO 1 & 4

Math Standard IV

Objectives 1 & 2

Connections

Background Information

Volume can be described as the space occupied by something. Matter occupies space, whether it is solid, liquid, or gas. The standard metric unit for measuring volume is the *liter*. One liter is made up of 1000 *milliliters*. One milliliter is equivalent to a cubic centimeter. The symbol *ml* is used to represent milliliters. Because liquids conform to the shape of the container in which they are placed, it is fairly easy to measure their volume using containers with milliliter markings. Three useful tools are a graduated cylinder (tall narrow tube with milliliter markings), a beaker (a relatively wider cup with markings on the side and a spout on the rim), and a syringe (basically a graduated cylinder with a plunger stem in one end and a small funnel-like spout at the other end).

Research Basis

Donovan, M.S., Bransford, J.D., & Pellegrino, J.W., eds. (2001). "Key Findings" in *How People Learn: Bridging Research and Practice*. Committee on Learning Research and Educational Practice, National Research Council. (available at http://www.nap.edu/html/howpeople2/ch2.html)

Grotzer, T. *The Keys to Inquiry*. Project Zero, Harvard School of Education (available at http://hea-www.harvard.edu/ECT/Inquiry/inquiry1.html)

Marzano, R.J., Pickering, D.J., & Pollock, J.E. (2001). "Cooperative Learning" in *Classroom Instruction That Works: Research-Based Strategies for Increasing Student Achievement*. Association for Supervision and Curriculum Development.

Assessment Suggestions

- Create an assessment cup from a 9 oz. clear plastic cup. Measure and mark three lines on the side of the cup labeled A, B, and C. Make one cup for each student or group of students. Students fill the cup to the A level, then measure and record the volume. Students repeat the process for the B level and the C level. Determine the accuracy of their measuring skills by checking to see if their volumes are correct within an allowable margin of error.
- As students work on projects involving volume, move around the classroom observing. Invite individual students to demonstrate the process of determining volume. Correct and modify as needed.

Invitation to Learn

Materials

For each group:

- ❑ 14 oz. (approximate) clear plastic cup
- ❑ 32 oz. water bottle, as a water source
- ❑ Plastic basin for flood control (a clear plastic shoe box or small cat litter box)

For the class:

- ❑ 8 plastic vials (similar to plastic pill bottles)—4 small and 4 large
- ❑ Cloth or paper towels
- ❑ Centimeter cube or a 1-ml measuring spoon

Hold up an empty 14 oz. clear plastic cup and have students measure how much water the cup can hold when it is completely full. The unit for measuring that they will use is a small plastic vial.

1. Demonstrate how to do this by pouring water from a water bottle into the small plastic vial until the vial is completely full. Do all pouring over the basin to catch any spills.
2. Pour the contents of the vial into the cup and repeat until the clear plastic cup is completely full. Keep track of exactly how many "vials" it takes to fill the plastic cup completely.
3. One person from each group picks up a basin, an empty plastic cup, and a bottle of water. Distribute one vial to each group, giving half the groups a larger vial and half the groups a smaller vial.
4. After students complete the measuring, have one person from each group report the number of "vials" it took to fill the cup completely full.
5. Write their reports on the board. It should be apparent that there are two differing sets of results. Point out the discrepancies and ask the students to explain (two different sizes of vials were used). Help students understand the need for a common unit of measurement.
6. Hold up a cubic centimeter cube or a 1-ml spoon to show the standard unit of the *milliliter*.

7. Students pour the water from the cup back into the water bottle. Pour any "floods" back into the water bottle and use cloth or paper towels to dry any spills on the table.

Instructional Procedures

Part I

1. Introduce a 100-ml beaker and explain its usefulness in measuring amounts of water in a container. When the beaker is filled to the 100-ml line it holds exactly 100 milliliters.
2. One student from each group picks up a bottle of water and a basin with a 100-ml beaker. Each group carefully fills their beaker to the 100-ml line.
3. One person from each group pours their 100-ml of water into the 1-liter container at the front of the class. As each student pours in their water, have the class count by 100's out loud. Do not tell them that it is a 1-liter container yet.
4. Have some groups refill their beaker until exactly ten portions have been placed in the container. There are now 1,000 milliliters of water in the container. This new unit of measure is a *liter*.
5. Lead a discussion with the class about their experience with liters. Most will refer to a 2-liter bottle of soda.
6. Pour the liter of water you have collected into the empty soda bottle. Refill the liter and add it to the soda bottle to fill it to the level where it is as full as it would be in the grocery store.
7. Discuss connections. Students clean up and return materials.

Part II

1. Explain that everything takes up space. The amount of space occupied by something is its *volume*. Your body takes up space and an orange takes up space. If we measure the amount of space these things occupy, we are measuring volume. Liquids are easy to measure because you can pour them into measuring container, like a beaker.
2. Fill a 14 oz. clear plastic cup approximately half full of water. The water is occupying space that we are going to measure in milliliters. The lines on a beaker do not allow for as precise of a measurement as you would like, so you are going to use narrower containers.

Materials

For each group:

- ❏ 100-ml beaker
- ❏ 32 oz. water bottle, as a water source
- ❏ Plastic basin for flood control (a clear plastic shoe box or small cat litter box)

For the class:

- ❏ 1-liter container (a 1-liter beaker or a 32 oz. bottle with metric markings)
- ❏ Cloth or paper towels
- ❏ Empty 2-liter plastic soda bottle

Materials

For each group:

- ❏ 50-ml graduated cylinder
- ❏ 50-ml syringe (optional)
- ❏ 14 oz. (approximate) clear plastic cup
- ❏ 32 oz. water bottle, as a water source
- ❏ Plastic basin for flood control (a clear plastic shoe box or small cat litter box)

For the class:

- ❏ Cloth or paper towels

3. Show students a syringe and a graduated cylinder. (If you do not have syringes, graduated cylinders will suffice.) Demonstrate the use of a syringe by using the plunger to push out all of the air. Submerge the tip of the syringe into the cup of water and pull up the plunger until it stops at the pin.

   The syringe is now completely full and holds exactly fifty milliliters. You may want to demonstrate accidentally pulling large air bubbles into the syringe. Tell them that if they are to be accurate and ensure that there are no air bubbles. If it happens, have them push out the air and water and try again. Also explain that the syringe is not a toy. Students are not to squirt water for any other purpose than directed.
4. Once you have successfully withdrawn 50-ml of water, expel it into the water bottle and have students keep track of how much you have removed.
5. Draw out a second unit of 50-ml. As you expel it into the water bottle, students note that the second unit makes 100 total milliliters. At this point there is less than 50 remaining milliliters, so we must use the graduated cylinder to continue measuring.
6. Pour the remaining water into the graduated cylinder. Demonstrate how to read the graduated cylinder, similar to reading a thermometer.
7. Add the amount of water in the cylinder to the 100-ml you have already drawn out. The combined total is the total volume of water that was in the cup.
8. Have one student from each group pick up a bottle of water, a basin, a 14 oz. clear plastic cup, a syringe, and a 50-ml graduated cylinder.
9. Observe students as they take turns measuring volumes. There will not be a common result since the amount of water in the cup will vary by group. The important concept is the process of using the tools.
10. After practicing, students return all of the water to the water bottle, return the equipment, and dry off any splashes on the table.

Part III

1. Show students sets of a variety of containers. Explain that their task is to fill the containers completely full and measure the volume of water in each container.
2. Students create a data table in their journal that has a column for the object, a column for an estimated volume, and a column for the measured volume.

3. Students evaluate the containers one at a time, estimating the volume of the container and recording their estimate.
4. Have them fill the container to capacity, measure the volume, and record the measured volume. Monitor students as they work on this project in groups.
5. After students have completed five or six different estimates and measurements, have them measure the capacity of an empty soda can. Point out that the label indicates the volume of soda is 355-ml. Ask them to confirm the full volume of the can.
6. Help students work through the problem of the syringe not fiting into the opening of the can. Model how to fill the can, pour the contents into a larger cup, and then measure the volume.
7. Students will discover that the can holds about 375-ml. Discuss why this is different from the indicated volume of soda.
8. As a follow up, students create a bar graph showing the various full volumes of each container.

Materials

For each group:

- ❑ Set of various small containers for measuring capacity (e.g., portion cup, film canister, a variety of plastic cups, cans, etc.)
- ❑ Empty 12 oz. soda can
- ❑ 32 oz. water bottle, as a water source
- ❑ Plastic basin for flood control (a clear plastic shoe box or small cat litter box)

For the class:

- ❑ Cloth or paper towels

Curriculum Extensions/Adaptations/Integration

- Students write a letter addressed to the customer service department of the soda company asking them to explain the discrepancy between the advertised volume and their measured volume. Students who have already determined the need for air space may write a response letter to such inquiries.
- Determine the volume of solid objects using the displacement chamber activity *How Big Is a Hand?* from the 2004 Elementary CORE Academy.
- Students line up the various containers in order of capacity.
- Students research other units of volume measurement, their origins, and uses.

Resources

Book

FOSS Measurement, by Lawrence Hall of Science, UCB, (available at http://www.delta-education.com/fossgallery.aspx?subID=&menuID=2); Item #WX542-2005, ISBN 0-87504-766-1

Family Connections

- Make a list of various containers of liquid food. Next to each item, students record the number of milliliters of liquid food advertised on the label of the container. Students may also measure liquid in containers and compare actual volume to listed volume.

Science Standard IV-1 & 2 Activities

Making Good Impressions

Standard IV:
Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.

Objective 1:
Describe Utah fossils and explain how they were formed.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
3. Understand Science Concepts and Principles
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Math III-3, Visual Arts I-1 & 2, Language Arts VIII-6

Science Standard IV

Objective 1

Connections

Background Information

There are three types of impression fossils:

- *Imprints*—impressions of parts of organisms left in soil or sediment before it hardens, such as plants, leaves, fish, and feathers.
- *Traces*—impressions that show the activities of ancient life such as footprints, teeth marks, tracks, trails, burrows, body outlines, or a dragging tail.
- *Molds* and *casts* (oysters, clams, shelled fish, trilobites):

  molds—Spaces in rock that have the shapes and impressions of the remains of living things that once occupied those spaces.

  casts—Form when minerals or rock particles fill the spaces in molds having the same shapes and impressions of the living things or its remains.

Research Basis

Shapiro, E.S. (1996). *Academic skills problems: direct assessment and intervention*. ISBN 1-57230-093-0

This textbook has excellent information about Direct Instruction, which is one of the methods used in this activity. It explains what Direct Instruction is and provides research that shows how it is a very effective way of teaching.

National Academy Press. (200). *Inquiry and the National Science Education Standards, A Guide for Teaching and Learning*. 2101 Constitution Avenue, NW, Washington, DC 20418. ISBN 0-309-06476-7.

This guide is devoted to the use of the Inquiry method of teaching, which is also used in this activity.

Assessment Suggestions

- Students may be evaluated by the model they create, the diagram they draw, and the explanation they write in their journals.

Invitation to Learn

Materials

- ❑ Fossils, replicas, or pictures of five or six the following: Imprints (leaves, fish, feathers, etc.); Traces (footprints, tracks, teeth marks, dragging tail mark, skin prints, etc.); Casts and molds (oysters, clams, trilobites, etc.).

Tell the students that they are going to be learning about impression fossils today. (You may want to define impression for them at this time.) Have a few of the different impression fossils mixed up in five or six piles (imprints—leaves, fish, feathers; traces—footprints, tracks, teeth marks; casts—clams, oysters, trilobites). Have groups of students around each pile so they can look at them. Tell them that there are three types of impression fossils in the pile. They are to look at the fossils and group them by how they look. When they are done, discuss the three types of impression fossils—imprints, traces, and molds and casts. Have students group them accordingly if they haven't already. Describe each type of impression fossil and tell students that they are going to make each one today.

Instructional Procedures

Part I

Materials

For each student:

- ❑ Plaster of paris
- ❑ School milk carton or bottle
- ❑ Modeling clay
- ❑ Paper cup
- ❑ Craft stick
- ❑ Water
- ❑ Shell with a lot of detail

1. Put about a half a stick of modeling clay in the bottom of a school milk carton (or similar type of container). Push the clay down so it is flat on the bottom of the carton. (The carton needs to have the top part cut off.)
2. Make a dinosaur footprint (or any print they would like) in the modeling clay. Make sure it is deep.
3. Pour 1/4 cup of water into a paper cup.
4. Slowly pour 1/2 cup of plaster of paris into the water, stirring with a craft stick as you pour. The mix should have the consistency of a milk shake.
5. Pour the plaster of paris on top of the footprint. Level the plaster out by lightly tapping the bottom of the carton on the desk.

6. While the plaster is still wet, place the shell, ribbed side up (bowl-side down), in the plaster.
7. While the students are waiting for the plaster to harden, have them predict what their footprint impressions will look like. Have them tell why the impression of the footprints will look the way they predict. Have students explain why the footprint in the plaster is like a trace fossil.

Note: **Never pour plaster down the sink drain.** Always discard extra plaster in the garbage.

Part II

1. After the plaster has hardened, put a thin layer of baby powder over the shell and on the plaster that is exposed.
2. Make more plaster the same way as described in Part I.
3. Pour the plaster on top of the shell. Tap the carton lightly on the desk to level off the plaster.
4. While the plaster is still wet, put the green leaf on it, vein side down. Make sure no edges of the leaf are curled up. All parts of the leaf should be stuck to the plaster.
5. While the students are waiting for the plaster to harden, have them predict what their shell impressions will look like. Have them tell why the impression of the shell will look the way they predict. Have students explain why the shell in the plaster is like a cast and mold fossil.
6. When the plaster is hard, cover the leaf and plaster with baby powder.
7. Make more plaster and cover the leaf.
8. Put aside until the next day.

Part III (the next day)

1. The next day, with the milk carton in front of the students, ask the students these questions:
   - Which types of impression fossils did we make? (trace, mold and cast, and imprint)
   - Which is the trace? (footprint)
   - Which is the mold and cast? (shell)
   - Which is the imprint? (leaf)

Materials

For each student:

- ❑ Baby powder
- ❑ Plaster of paris
- ❑ Paper cup
- ❑ Craft stick
- ❑ Green leaf
- ❑ Water

Materials

For each student:

- ❑ Milk carton with the fossils and plaster for each student
- ❑ Paper towel

For the teacher:

- ❑ Hammer
- ❑ Screwdriver
- ❑ Fossils from the Invitation to Learn.

- What is the definition of each?
  - Trace impressions are the activities of the organisms as they lived.
  - Mold and cast impressions are when organisms are buried and decayed and the hole is filled with sediments showing the size and outside impressions of the organisms.
  - Imprints are thin organisms that are left in sediment before it hardens, showing the outside impressions of the organism.
- Why must these fossils be covered or filled with sediments after the impressions have hardened? (If they weren't covered, then weathering and erosion would have destroyed them. When they are buried in sediments, they are preserved for millions of years.)

2. Put a paper towel down on the desk of each student. Place the milk carton on the paper towel.
3. Have the students tear the milk carton paper off, exposing the plaster and clay.
4. Peel the clay off, exposing the footprint.
5. Lay the plaster on its side.
6. Find the lines where you can see the different pourings of plaster. Place the screwdriver point on one of the lines. Tap the screwdriver lightly with the hammer. The plaster should break open. Do the same thing at the other line.
7. The three fossils are now exposed—the footprint, the shell and shell impression, and the leaf. (The top part won't show anything. It was only a covering.) Peal off the leaf to see the leaf impression.
8. Talk to the students about each impression fossil.
9. Have the students compare each type of fossil they made with the real fossils they looked at during the Invitation to Learn.
10. Have the students come up with conclusions as to what they have learned.

Curriculum Extensions/Adaptations/Integration

- Show how the mold and cast of the shell is similar to flipping an object in math and that it is a three-dimensional shape.
- Provide peer tutoring or work in cooperative groups to mix and pour the plaster. This helps special needs learners and minimizes clean-up efforts.
- Students make a diagram and write an explanation of what they did and learned in a science notebook.

Resources

Web sites

Bryce Canyon National Park website:
http://www.nps.gov/brca/geodet/geodet_paleontology.html

Fossil kits may be purchased from Nasco Science:
www.enasco.com

Family Connections

- There are many places in Utah where parents can take their children to learn more about dinosaurs and fossils. A family fieldtrip to a dinosaur museum or a fossil quarry is a great learning opportunity.
- There are many dinosaur kits, models, books, videos, and games that can be enjoyed together as a family.
- Students share the projects they have completed at school with their family members.

What Did You Find?

Science Standard IV

Objective 2

Connections

Standard IV:
Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.

Objective 2:
Explain how fossils can be used to make inferences about past life, climate, geology, and environments.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
3. Understand Science Concepts and Principles
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Language Arts VII, VIII; Social Studies I

Research Basis

Fountas, I. C., Pinnell, G. S. (2001). Guiding Readers and Writers Grades 3-6. *Teaching Comprehension, Genre, and Content Literacy*, Chapter 15.

Literature study contributes to student learning in five ways: expanding reading comprehension strategies, learning to think critically, appreciating the aesthetic qualities of literature, developing communication skills, and extending writing skills.

Marzano, R.J., Pickering, D.J., & Pollock, J.E. (2001). *Classroom Instruction That Works: Research-Based Strategies for Increasing Student Achievement,* Chapter 3.

Summarizing and note-taking are two of the most useful academic skills for students to cultivate. They provide students with tools for identifying and understanding the most important aspects of what they are learning.

Assessment Suggestions

- K-W-L chart in student journals
- *Science Writing Rubric*

Invitation to Learn

Have students say the tongue twister, "She sells seashells by the seashore" three times as fast as they can. Tell them that it is about Mary Anning, who grew up in the early 1800's on the coast of England. She collected shells to sell in her father's souvenir shop. When she was only 12 years old, she discovered her first fossil skeleton. It was a dolphin-

like reptile called an Ichthyosaur. She found many other marine fossils during her life that are now displayed in museums all over the world.

Instructional Procedures

1. Students make a K-W-L chart in their journal.
2. List things that they know about dinosaurs and fossils in the "K" column.
3. Write questions about dinosaurs or fossils in the "W" column that they would like to find answers to (e.g., Why did the dinosaurs and other prehistoric organisms become extinct?).
4. Read information from the *Dinosaur Track Pack* and *The Story of Sue* handout.
5. Students list what they learned in the "L" section of the chart.
6. Students meet in small groups and share what they learned from their reading.
7. Share an example of what a report about the history of dinosaurs would look like.
8. Students write a 300-word (one page) report about the history of dinosaurs. It should include information that students learned from their research.

Materials

- ❏ *Dinosaur Track Pack*
- ❏ *The Story of Sue* handout
- ❏ Science journal
- ❏ *Science Writing Rubric*

Curriculum Extensions/Adaptations/Integration

- Students use the Internet to search for information about other paleontologists, such as Othniel Charles Marsh who made many discoveries in the 1860's.
- Students illustrate their reports with their own drawings or pictures from the Internet.
- Some students may need to sit up close to see the pictures and other items in the *Dinosaur Track Pack*.
- Students may work in groups or with a partner to read *The Story of Sue*.

Resources

Books

Geology Rocks!: 50 Hands-On Activities to Explore the Earth, by Cindy Blobaum; ISBN 1-885593-29-5

The Dragon in the Cliff: A Novel Based on the Life of Mary Anning, by Shelia Cole; ISBN 0688101968

Dragon in the Rocks: A Story Based on the Childhood of the Early Paleontologist, Mary Anning, by Marie Day; ISBN 1895688388

The Fossil Girl: Mary Anning's Dinosaur Discovery, by Catherine Brighton; ISBN 0761314687

Ichthyosaurus and Little Mary Anning, by Brooke Hartzog; ISBN 0823953262

Mary Anning and the Sea Dragons, by Jeannine Atkins; ISBN 0374348405

Mary Anning: The Fossil Hunter, by Dennis Brindell Fradin; ISBN 0382394860

Rare Treasure: Mary Anning and Her Remarkable Discoveries, by Don Brown; ISBN 0395922860

Stone Girl, Bone Girl: The Story of Mary Anning, by Laurence Anholt; ISBN 0531301486

Web site

The Field Museum has the story of Sue, along with pictures and online activities. www.fieldmuseum.org

Family Connections

- Take a family fieldtrip to one of the many places where fossils have been found or displayed in museums throughout the state of Utah.
- As a family, create a fossil and shell collection in the home from visits family members have made to a seashore.
- Read books together about dinosaurs, fossils, and famous paleontologists.

The Story of Sue

Sue is a funny name for a dinosaur, especially a Tyrannosaurus Rex. She lived nearly 67 million years ago, according to what scientists believe. When she died, her body was covered by mud and sand. Over time, the hard parts of her body were replaced by minerals.

Sue's fossil remains were discovered in 1990, near Faith, South Dakota. The person who discovered them was with a team of fossil hunters. She stayed behind while they went into town to fix a flat tire on their trunk. As she hiked over to some sandstone bluffs nearby, she saw the fossil bones sticking out of the ground. When her team returned, they decided to name it Sue, in her honor.

It took five years to sort out who owned the land and had the rights to claim Sue's remains. It was finally decided that they belonged to a rancher who owned the property Sue was found on. He decided to sell Sue at a public auction. The new owner was The Field Museum in Chicago. With the help of several sponsors, Sue was purchased for $8.4 million- the most ever paid for a fossil.

Each of Sue's 200 plus bones had to be carefully removed from the surrounding layers of rock and soil. It took over 25,000 hours of work by many individuals to clean and repair her bones for display at the museum.

Sue is the largest, most complete, and best preserved T. Rex fossil ever discovered. She stands 13 feet high at the hips and is 42 feet long, from head to tail. It is estimated that she would have weighed nearly 7 tons when she was alive. Her head alone was 5 feet long, and some of her teeth measured 12 inches!

Science Writing Rubric

	Excellent	Fair	Needs Improvement
Organization & Presentation	Main ideas are clearly presented. Ideas are presented in an appropriate order. Ideas are supported by information and logic. Appropriate conclusions are based upon evidence presented. Effective use of models, diagrams, charts, and graphs.	Main ideas are presented to some extent. Ideas are not presented in an order that adds clarity. Some ideas are supported by information and logic. Conclusions do not follow from ideas presented. Some appropriate use of models, diagrams, charts, and graphs.	No main idea presented. Ideas are presented in an order that distracts from clear communication. Ideas are not supported by information and are illogical. Inappropriate conclusions are presented No use of models, diagrams, charts, and graphs.
Use of Science Language	Consistent use of appropriate science language and terminology.	Partial use of appropriate science language and terminology.	Inaccurate use of science language and terminology.
Science Content	Accurate. Connected to big ideas in science.	Mostly accurate. Connections to big ideas are not clear.	Inaccurate. Not connected to big ideas in science.
Information Sources	Multiple sources. Wide range of resource types. Reliable sources. Current sources.	Two or more sources. Two types of resources. Some reliable sources. Some current sources.	One source (often personal knowledge or text only). Narrow range of resources. Unreliable sources. Out of date sources
Conventions	Generally error free in regard to sentence structure, punctuation, capitalization, spelling, and standard usage.	Sentence structure, punctuation, capitalization, spelling, and standard usage errors are noticeable, but do not seriously impair readability.	Errors in sentence structure, punctuation, capitalization, spelling, and standard usage impair readability.

What Was A Brontosaurus?

Most adults were taught in school that the Brontosaurus was one of the largest dinosaurs to ever live. It was a plant-eating animal that lived in swampy areas to find the food it needed. The name Brontosaurus means "Thunder Lizard."

Today, scientists have learned that the Brontosaurus as a new species of dinosaur never really existed. The mistake was made by O. C. Marsh, a famous paleontologist, who had already found the same type of dinosaur earlier and named it Apatosaurus. Another mistake that was made concerned the skull that was put with the Brontosaurus bones. It actually belonged to another type of dinosaur called Camarasaurus.

The images that appeared in paintings, movies, signs, and postage stamps were all misleading because they showed the wrong head shape for the dinosaur that was called Brontosaurus.

It was also discovered that large dinosaurs like the Apatosaurus did not like muddy, swampy land. Their fossil remains have been found near dry flood plains instead.

That is why very few people talk about a dinosaur named Brontosaurus today.

Dino Detectives

Science Standard IV

Objectives 1 & 2

Connections

Standard IV:
Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.

Objective 1:
Describe Utah fossils and explain how they were formed.

Objective 2:
Explain how fossils can be used to make inferences about past life, climate, geology, and environments.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Math III- 2; Language Arts VIII-6

Background Information

The land now called Utah has been in and out of water for billions of years. The sandy soil deposits in the Uintah Mountains are from one billion year old flood plain sediments. The rock of Mount Timpanogos contains layers from five hundred million-year old ocean coral reefs. The colors of Bryce Canyon come from mineral deposits of ancient lakes. The red sandstones of Arches and Zion National Parks are fossilized sand dunes from an ancient desert. Indeed, the past environments have been varied. The lands of present-day Utah have been host to every type of animal life known to man. Fossils lay out the story of the ever-changing varieties of plant and animal life. Indications of swamps with massive conifers that are now petrified, ancient seas inhabited by trilobites, and marine corals now fossilized and found high in the Wasatch Mountains tell us much has changed throughout the eons of time.

Research Basis

Protheroe, N. (2004). Effective Teaching, *Principal*, pp. 58-60.

Nonlinguistic representations include graphic organizers, pictures and pictographs, mental pictures, concrete representations, and kinesthetic activities. "Generating mental pictures of information enhances recall and understanding."

Marzano, R.J., Pickering, D.J., & Pollock, J.E. (2001). *Classroom Instruction That Works: Research-Based Strategies for Increasing Student Achievement*, Chapter 6.

Explicitly engaging students in the creation of nonlinguistic representations has been shown to stimulate and increase activity in the

brain. This is accomplished by creating graphic representations, making physical models, generating mental pictures, drawing pictures and pictographs, and engaging students in kinesthetic activity.

Assessment Suggestions

- Student maps may be collected and checked for accuracy in placing symbols for fossils in the approximate area in which they would be located.
- The UTIPS Web site (www.utips.org) has a multiple-choice and essay test for Standard IV, Objectives 1 & 2. These tests may be downloaded and printed or taken online.

Invitation to Learn

Ask several students to bring you one of their shoes before the lesson begins. Mix the shoes up and set them at the front where the other students can see them. Tell the rest of the class that they are going to be detectives and determine who the shoes belong to. Ask students to guess who the owner is as you hold up the shoes. Explain that they are going to be Dinosaur Detectives today as they search for clues about what prehistoric life was like in Utah.

Instructional Procedures

1. Display an overhead *Utah Counties Map*.
2. Give each student a blank *Utah Counties Map*.
3. Using the *Utah Fossil Locality Information,* tell students about each county that fossils have been found in, what type of fossils they were, etc.
4. Students use symbols and/or colors to mark these locations on a blank *Utah Counties Map*.
5. Model how to design symbols and mark the maps on the overhead map.
6. Students create a legend for the map to serve as a key to their symbols or colors.

Materials

- ❑ *Utah Counties Map* overhead
- ❑ *Utah Counties Map*
- ❑ *Utah Fossil Locality Information*
- ❑ Overhead projector
- ❑ Colored pencils or crayons

Curriculum Extensions/Adaptations/Integration

- Write a report on the way Utah environments have changed over time. The report could be attached to the map the students made and pasted in their science journal.

- Students may work with a peer-tutor or in a group to design the symbols and legends and fill in the map together.
- Using cardboard and salt dough, students design a 3D map of Utah as it may have looked millions of years ago when dinosaurs lived here.

Resources

Book

Dinosaurs of Utah and Dino Destinations, by Pat Bagley and Gayen Wharton; ISBN 1566846013

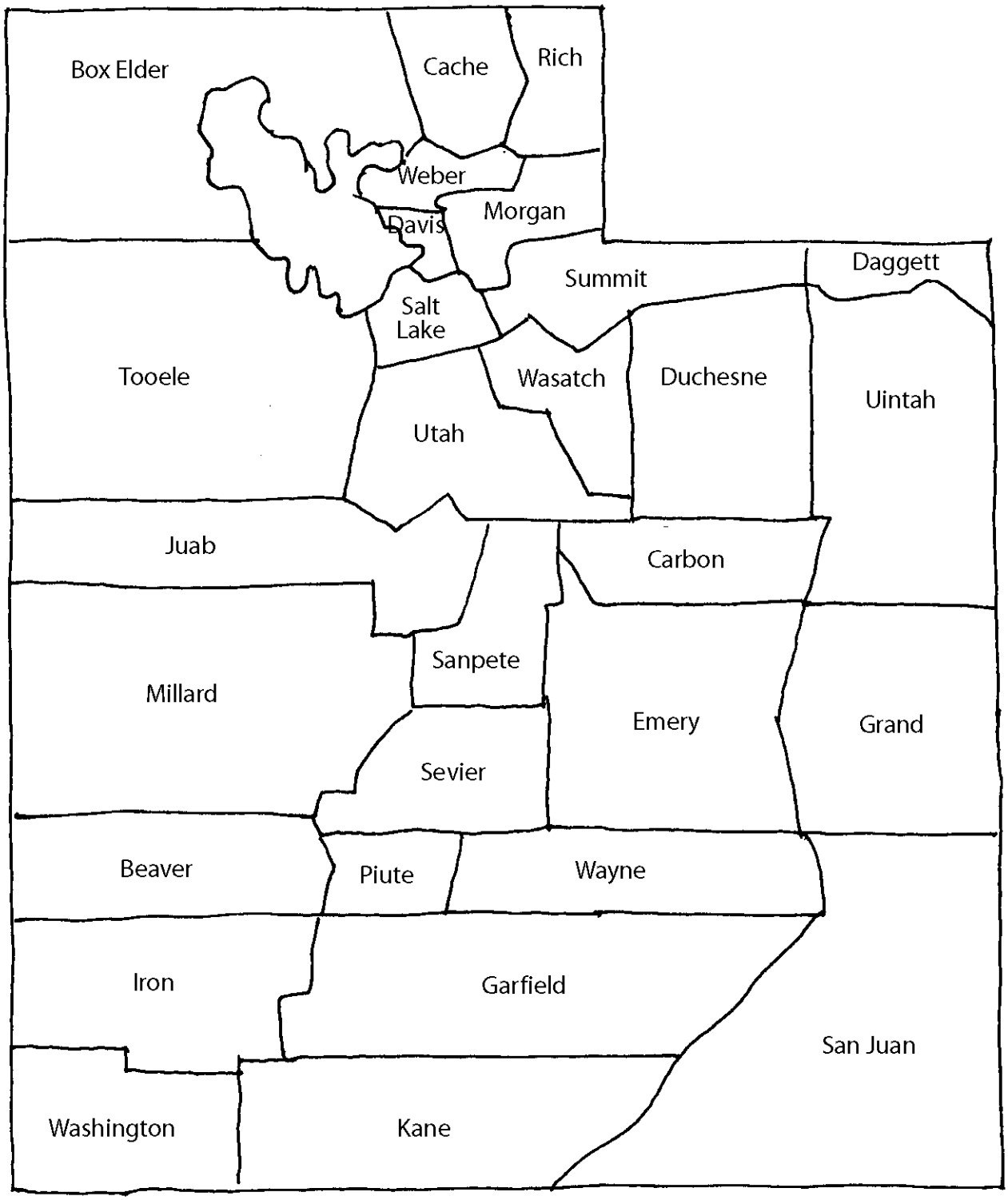
Web site

State of Utah: http://www.utah.com/dinosaur/index.htm

Family Connections

- Visit one of the many sites in Utah where prehistoric fossils have been found.
- Take a trip to one of the museums where fossils are on display for the public.
- Students share the maps they made with their family members.
- There are many dinosaur kits, models, books, videos, and games that can be enjoyed as a family.

Utah Counties Map



Utah Fossil Locality Information

The following places are where fossil (clues) have been found in Utah:

Eastern Uintah County—fossils of Allosaurus (Utah State Fossil), Stegosaurus, Brachiosaurus, and Diplodocus indicating tropical climate; Dinosaur National Monument.

Emery County—Utah Raptor (relatively new discovery); Cleveland-Lloyd Quarry. There are also leaf fossils from the Cretaceous Period

Carbon County—massive coal deposits, a fossil fuel, indicating ancient swamps and tropical vegetation.

Western Millard County—Trilobites of many varieties in abundance near Antelope Springs indicating ancient shallow ocean during the Paleozoic Era.

Weber County—Ogden Canyon has fossils of plants, seashells (gastropods and brachiopods), and corals from the Mississippian and Devonian Periods.

Wayne County—Abundant oyster shells west of Caineville.

Washington, Kane, Grand, Garfield, and Emery Counties—These counties form a strip of land on which petrified wood is found. Ancient swamps with massive trees that may have been flooded and covered with silica-rich volcanic ash from an eruption that leveled the forests could account for these fossils.

Box Elder and Cache Counties—Trilobite, sea shell, and fish fossils.

Iron County—Oyster shell fossils from the Cretaceous Period.

Salt Lake County—Sea urchin fossils in Emigration Canyon. Other marine fossils.

San Juan County—Marine fossils near Chicken Corner Trail.

Sanpete and Wasatch Counties—A variety of marine fossils in the Green River Formation.

Sevier County—Plant fossils in the Cretaceous Period Black Hawk Formation.

Summit and Tooele Counties—Horn Coral.

Science Standard V-3 Activities

Amiable Amphibians

Standard V:
Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 3:
Use a simple scheme to classify Utah plants and animals.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests

Content Connections:

Science Standard V

Objective 3

Connections

Background Information

Amphibians are a group of cold-blooded animals that includes frogs, toads, newts, and salamanders. They typically spend part of their life in water, part on land. They are distinct from reptiles in that their eggs must be laid in moist conditions and their soft skins have no scales. The larvae usually live in the water, while the adult lives on the land and is generally four-legged and carnivorous. The process of metamorphosis, hatching from eggs into gilled larvae that later develop into land-loving adults with lungs, is a distinct characteristic of amphibians.

Eighteen different kinds of amphibians can be found in Utah. There are eight toads, nine frogs (two of which are not native), and only one salamander. Amphibians exhibit a wealth of amazing adaptations that help them survive, including many protective and warning colors, poisonous secretions to avoid being eaten, many types of feet for various means of travel such as climbing, swimming and even gliding, and natural anti-freeze in their blood to keep them from freezing.

Frogs and toads are not exactly the same. Frogs have bulging eyes, webbed feet, and powerful hind legs useful for jumping great distances. Toads are more at home on land, however, they return to the water to lay their eggs. Toads have shorter hind legs than frogs and move in short hops. Because escape from predators is difficult, toads have poison glands on both sides of their necks. If an animal bites a toad, the animal may get sick from the poison.

This activity is further work in the classification of Utah animals, specifically amphibians. Studying them provides practice in classifying animals in Utah by physical characteristics. The word "dichotomy" means "division into two." A dichotomous key reduces the task of identifying something into a series of questions that are based on physical

features. Each set of questions eliminates others, eventually leading to the name of the mystery item.

Fourth graders do not need to know specific animals, but a general knowledge of them is helpful. Some of the more common species in Utah are:

- Woodhouse's Toad
- Canyon Tree Frog
- Great Basin Spadefoot Toad
- American Bullfrog (not native)
- Northern Leopard Frog
- Red-Spotted Toad
- Boreal Chorus Frog
- Tiger Salamander (Utah's only salamander)

Research Basis

Adams, D., & Hamm, M. (1998). *Literacy in Science, Technology and the Language Arts: An Interdisciplinary Inquiry*. Connecticut: Bergin and Garvey, p.10.

This text deals with science and mathematics inquiry processes as tools that enable students to gather and discover data for themselves through the process of scientific inquiry. As information is observed and identified, recording it becomes an integral part of the process and leads to integration in language arts.

"By constructing their own knowledge in a meaningful context, children can gain a conceptual understanding and develop the means for integrating language and science knowledge into their personal conceptions. To really learn the skills of language and science, students must follow a learning cycle: explore new phenomena, construct their own understandings, examine, represent, solve, transform, apply, prove, and communicate."

Lemlech, J.K. (June 2001). *Curriculum and Instructional Methods for the Elementary and Middle School*. New Jersey, Prentice Hall.

This text covers how children learn, delivery of instruction, implementing curriculum and professional growth. It explores the "how' and "what" in preparing instruction. There is emphasis on interdisciplinary use of journals, cooperative learning, and a variety of other strategies to teach in all subjects.

The science journal is "a practice manual, a workbook that allows students to wrestle with ideas in a manner that is comfortable and productive for them as individuals. Journals created in this manner allow

teachers to see how a student thinks and where to aim instruction to assist individual and class development."

Martin, D. (2000). *Elementary Science Methods: A Constructivist Approach*. California: Wadsworth Thomson Learning, pp 79, 83.

This text is for college students preparing to teach elementary science using the constructivist theory to learn methodology for teaching inquiry and other science processes. It is also an introduction to National Science Standards and how to identify developmentally appropriate science material for grades. The text identifies learning styles and how to adapt science instruction to meet the needs of all students.

Text remarks concerning teaching classification (emphasis added):

"Classifying objects by considering relationships that are subordinate to a larger group as a whole is called class inclusion and is a skill that is learned in the early concrete operational stage of cognitive development. It is important to note that the ability to sort (or classify) does not come spontaneously to children; they must be exposed to the phenomenon. They must be encouraged to do many sorting activities using many different kinds of things to gain experience in the skill of classification. … Hierachical (sub-groups with two or more sub-groups) systems of classification require higher levels of cognitive skills."

Assessment Suggestions

- The quiz at the beginning of instruction is a good pre-assessment for this activity.
- As students categorize their amphibian cards, it will be easy to see who understands division of animals by characteristics. Some will only categorize; other students will begin to use dichotomous keys.
- On a large map of Utah, assign each student to plot the habitat location of an amphibian specie. They will need to draw their animal and correctly show its physical characteristics. They might need to duplicate their picture for more than one location. Display the map next to their classification charts.

Invitation to Learn

Teach a short song to the students. It is sung to the tune of "Are You Sleeping?"

Classifying, Classifying
What's it got?
What's it got?
Let's identify it
Come on and just try it
"Have," "Have not"
"Have," "Have not"

Try singing it as a round. Discuss what the song is about and define classification and identifying animal groups with dichotomous keys.

Instructional Procedures

Materials

- ❑ *Amphibian True/False* handout
- ❑ *Amphibian Information Cards*
- ❑ *Characteristics of Frogs and Toads* chart
- ❑ *Dichotomus Key For Common Utah Amphibians* handout
- ❑ *Envelope Journal Instructions* handout
- ❑ *Utah's Amphibians and Reptiles* Booklet
- ❑ Chart paper
- ❑ Small cards for game (2" x 2"), blue, green, red (more blue than others)

Optional:

- ❑ Party favor "blowers"
- ❑ Straws

Ask the following oral True/False questions and have students answer with the "Thumbs Up, Thumbs Down" game (Up=True, Down=False) to pre-assess prior knowledge for this investigation:

- Frogs live in all Utah environments. (T)
- Toads can give you warts. (F)
- Frogs can leap farther than toads. (T)
- All frogs are nocturnal. (F)
- Toads have moist skin (F)
- Some toads live in Utah's deserts (T)
- Toads must live near water. (F)
- Toads are poisonous. (T)
- Amphibians lay eggs. (T)
- Frogs have rough, dry skin. (F)

1. Frogs and toads are amazing! Have students cut apart the *Amphibian Information Cards* and read about the different amphibians that live in Utah.
2. Have each student organize the cards in some way on the paper provided. Leave this direction open so that the activity allows for some inquiry to take place. Tell them to be prepared to explain to the group their system of organization. Students record this system in their science journals.

3. Discuss systems within tables. Display all the charts.
4. Review the similarities and differences between frogs and toads. (Use the *Characteristics of Frogs and Toads* chart as a reference, but have students do this individually and copy information in their journals.) Allow time to adjust the organization of their cards if they wish to change.
5. Review the concept of a dichotomous key (see background information). Be sure students understand that even though all their charts are different, one isn't right and the other wrong. We are using a system that is used by scientists to communicate information in a similar way so that all scientists understand the information. This system is called a dichotomous key. Identify the charts within the group that use dichotomous keys.
6. Tell students there is a different dichotomous key. This type helps to identify the names of amphibians based on their physical characteristics, but also helps us learn the animal's name.
7. Practice one together that models this kind of key for students. (See sample within lesson.)
8. Students work together to "key" out their amphibian cards. Teacher should be available to answer questions and correct any misconceptions.
9. Create an *Envelope Journal* for their amphibian cards to go into their science journals.

Curriculum Extensions/Adaptations/Integration

- Using the *Amphibian Information Cards*, underline or highlight only pertinent information that special needs students might need to complete the activity. This allows them to do a minimum of reading for task.
- Have special needs students do a Venn Diagram of the similarities and differences between frogs and toads, rather than a dichotomous key. (See research for explanation.)
- Play a version of "How Many Frogs Can Live in this Pond?," a Project WILD Activity. This helps students use kinesthetic learning, as well as logic, to process information about frog adaptations and survival. (The game may be requested from Project WILD (801) 538-4719.)
    1. Game is played by having 3 sets of colored cards, with at least one for each student. Blue is dragonflies, green is frogs/toads, red is herons. There should be a high ratio of dragonflies to everyone else.

2. Dragonflies can run forwards, backwards, sideways.
3. Frogs have party favor blowers and can only hop two-footed forwards.
4. Herons have straws and take only giant steps.
5. Set up a perimeter. Everyone begins on the perimeter's edge. At the signal, frogs/toads look for food (dragonflies) and herons look for food (frogs/toads) within the borders.
6. Food is captured by frogs blowing out "tongues" and touching dragonflies, who are then "eaten" and out. Herons hold straws in their mouths and touch frogs/toads, who are "eaten" and out.
7. Play several rounds and see what happens to the different species.
8. Switch roles until everyone has had an opportunity to be an amphibian!

- Create mini-journals for amphibian classification (see *Envelope Journal* handout).

Resources

Books

Project WILD, (801) 538-4719) has publications, *Growing Wild* and *Nature's Call* issues about amphibians. They also have an "Amphibian and Reptile" trunk with information/books/videos available to teachers who have attended a Project WILD training.

Reptiles and Amphibians: A Golden Guide, by Herbert S. Zim and Hobart M. Smith; ISBN 1-58238-131-3

Web sites

http://dwrcdc.nr.utah.gov This web site is provided by the Division of Wildlife Resources as a resource on plants and animals of Utah.

http://www1.teleport.com/~dstroy/frogland.shtml "Frogland" fun and interesting site with basic information, trivia, etc.

http://cgee.hamline.edu/frogs "Thousand Friends of Frogs" interactive and informative site.

Family Connections

- Have students take home the *Amphibian True/False* handout and see how much their family knows about Utah's frogs and toads.
- Have students walk home from school as if they were a toad one day (with short hops) and another day like frogs (big long leaps). Which is easier? Why?
- At home, think like a frog. Notice what you eat for dinner. Are there things you eat that would be difficult to enjoy if you could only use your tongue? Remember, you have to swallow it whole!

Amphibian True/False

- Frogs live in all Utah environments.
- Toads can give you warts.
- Frogs can leap farther than toads.
- All frogs are nocturnal.
- Toads have moist skin
- Some toads live in Utah's deserts
- Toads must live near water.
- Toads are poisonous.
- Amphibians lay eggs.
- Frogs have rough, dry skin.

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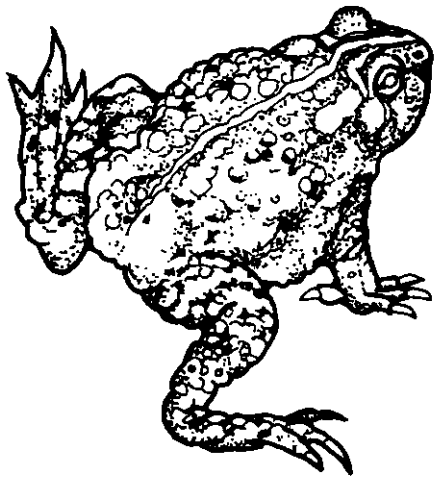
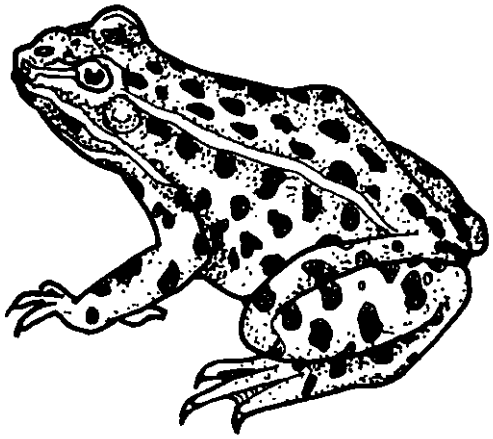
- Toads are poisonous.
- Amphibians lay eggs.
- Frogs have rough, dry skin.

Amphibian Information Cards

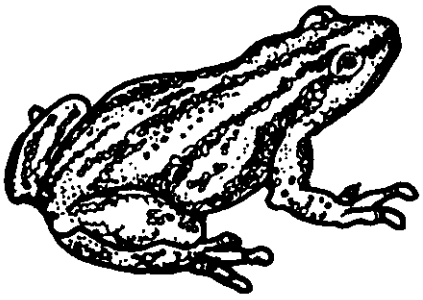
Great Basin Spadefoot Toad
Small, 1 1/2-2 1/2 inches.
Common throughout Utah.
Rough, warty skin. Grayish green.
Wedge-shaped spade on each hind foot. Bump between eyes.
Light stripes on sides.



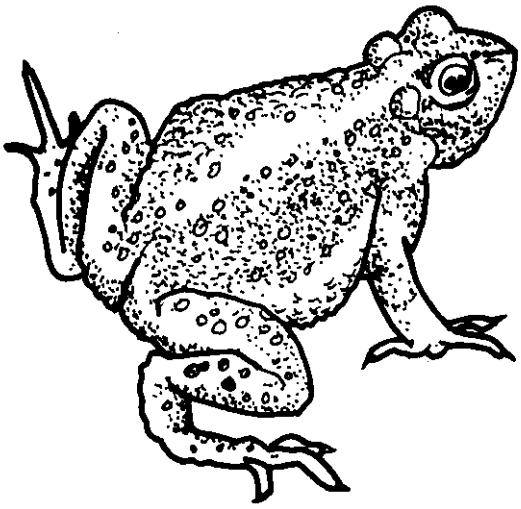
Woodhouse's Toad
2 1/2-4 inches long.
Common throughout Utah. Nocturnal.
Head ridge. Prefers deep soft soil for burrowing. Rough, warty skin.
Color varies, but usually dark with irregular spots.



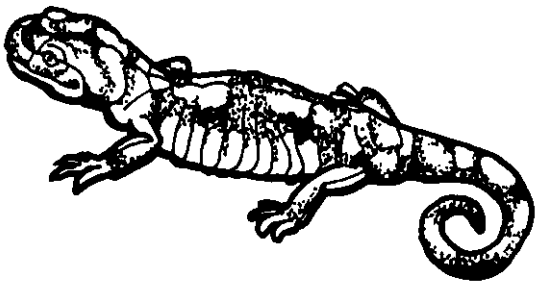
Northern Leopard Frog
Medium-sized, up to 5 inches long.
Lives near cattails and other aquatic vegetation throughout Utah.
Slim, long-legged. Moist skin with green or brownish-colored back with dark spots.



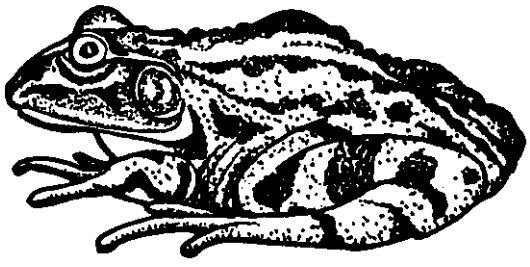
Boreal Chorus Frog
Small, 3/4-1 1/2 inches long.
Lives in grassy areas, damp marshes, woodlands, river swamps. Seldom seen. Moist skin, greenish gray/brown colored. Three stripes on back.
Dark stripe that runs through eye all the way across back.



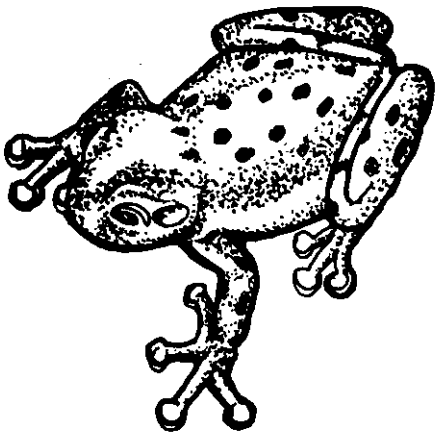
Red Spotted Toad
Small, 1-1/2-2 1/2 inches long.
Found in southern Utah; climb and live among rocks near water. Rough, dry skin with many red or orange warts.
Nocturnal



Tiger Salamander
Grows up to 13 inches in length.
Short legs, feet, not webbed feet.
Found in ponds, reservoirs, lakes, rain pools, and streams. Except in West Desert, rarely seen.
Dark with yellow or pale green "tiger-like" markings.



American Bullfrog
Largest frog in Utah.
NOT native, taking over habitats.
Usually green.
Moist and smooth skin.
Distinctive spot/eardrum.



Canyon Tree Frog
Small, less than 2.5 inches.
Found in southern Utah.
Like bottom of rocky canyons.
Does not often climb trees–prefers ground.
Nocturnal.
Moist, smooth skin.

Characteristics of Frogs and Toads

	Frog	Toad
Skin	Moist, secretes mucus	Rough, “warty”
Legs	Powerful, long legs	Short hind legs
Feet	Webbed feet	Usually no webbing
Moves	Jumps great distances	Moves in short, quick hops
Lives	Near water, lays eggs in water	Prefers land, returns to water to lay eggs

Dichotomous Key for Common Utah Amphibians

1a. Adult with long tail.	It is a **Tiger Salamander**
1b. Adult without tail.	**Frogs and Toads** Go to 2

2a. Skin rough and warty.	It is a **Toad**
2b. Skin moist and smooth.	It is a **Frog** Go to 3

3a. Red, spotty warts on tan or gray body.	It is a **Red Spotted Toad**
3b. No red spotty warts, but still warts.	Go to 4a

4a. Spadefoot (a wedge-shaped shovel on back toes), light stripes on side.	It is a **Great Basin Spadefoot Toad**
4b. No spadefoot, irregular spots.	It is a **Woodhouse's Toad**

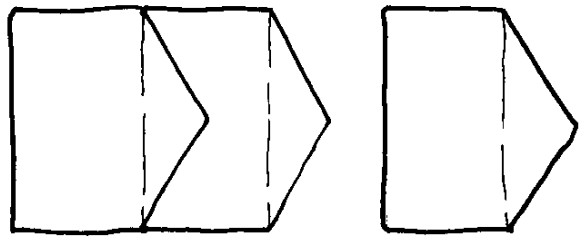
5a. Large, over 5 inches long.	It is an **American Bullfrog**
5b. Not large, less than 5 inches long.	Go to 6

6a. Three stripes on back with a dark one through eye.	It is a **Boreal Chorus Frog**
6b. Has both spots and/or stripes.	Go to 7

7a. Has large, irregular, dark spots, greenish color.	It is a **Northern Leopard Frog**
7b. Can have spots, has big toepads.	It is a **Canyon Tree Frog**

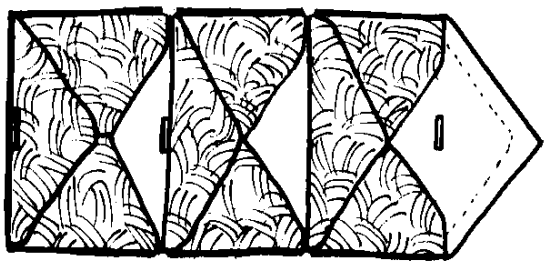
Envelope Journal Instructions

1.



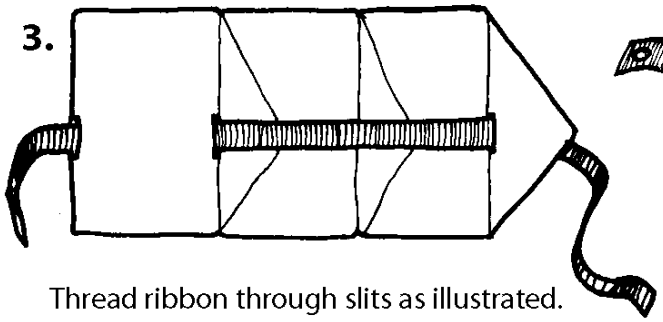
Glue flap of envelope to the back of another. Do this for each pocket of the journal.

2.



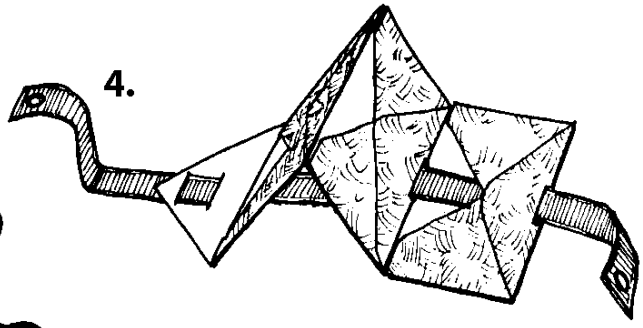
Make slits or cuts the size of the ribbon you will use. (See illustration.)

3.



Thread ribbon through slits as illustrated.

4.



Decorate envelopes and label.
Use to store classification cards in journal.

Classifying Conundrum

Science Standard V

Objective 3

Connections

Standard V:
Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 3:
Use a simple scheme to classify Utah plants and animals.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests

Content Connections:

Background Information

This activity should be used after introducing the concept of structure and function of a dichotomous key. Students will have practiced on common and simple items such as candy, shoes, etc. They should then begin to generalize that information by identifying plant characteristics from different environments, and be able to communicate that information in different ways.

The word "dichotomy" means "division into two." A dichotomous key reduces the task of identifying something into a series of questions that are based on physical features. Each set of questions offers opposing answers from which to choose. As students make choices and eliminate others, they will eventually discover the name of the mystery item.

Throughout this lesson, students will make observations and record them in a science journal. They will also spend time in cooperative learning groups in a variety of ways to ask questions and discuss the information they learn.

The plants used in your investigations should include (but not be limited to) the ones on the Science wordlist for Standard 5:

cottonwood	Utah juniper	*Sego lily	*Bristle cone pine
quaking aspen	pinyon pine	*Douglas fir	
bulrushes	cattails	Blue spruce	
sagebrush	prickly pear	Gamble's oak (oak brush)	

*common but not in 4th grade core curriculum list

Research Basis

Nesbit, C., Hargrove, T., Harrelson, L., (Winter, 2004). Implementing Science Notebooks in the Primary Grades. *Science Activities, 40*(4), 2.

This article details the process teachers can use to teach how to use science notebooks. It highlights the benefits associated with using notebooks, and provides connections to National Science Standards.

"Data from science notebooks provide the teacher with a true record of each student's thinking and level of understanding over the course of the investigation. This information can prove to be extremely insightful as teachers begin to understand how each student thinks, where their strengths and weaknesses lie, and why they make the mistakes they make. This information should be used to improve classroom practice, correct misconceptions, and guide the students toward developing a deeper understanding of content. The science notebook can be used as a tool to measure students' understanding of a variety of areas including, but not limited to, science, mathematics, and writing."

Shlomo, S. (1999). *The Handbook of Cooperative Learning Methods*. Westport, Connecticut, Praeger Publishers, 226.

This text defines and discusses cooperative learning and outlines a variety of ways to use this strategy in different curriculum areas.

"While students conduct their inquiry individually, in pairs, and in small groups, they gather a great deal of information from a variety of sources. Interpretation of their combined findings is a process of negotiation between each student's personal knowledge and the new knowledge acquired, and between each student and the ideas and information contributed by other members of the group. This promotes ability to organize, confirm, and consolidate their findings and thus to make sense of them."

Adams, D., & Hamm, M. (1998). *Literacy in Science, Technology, and the Language Arts: An Interdisciplinary Inquiry*. Westport, Conneticut: Bergin & Garvey. p. 129.

This text deals with science and mathematics inquiry processes as tools that enable students to gather and discover data for themselves through the process of scientific inquiry.

"Most science educators today agree that science can best be viewed as a continuous process of trying to discover order in nature and looking for consistent patterns of the universe through systematic study. It guides the inquirer to a variety of sources, revealing previously undetected patterns. These undiscovered openings can become sources of new questions that can deepen and enhance inquiry. Science is a way of thinking and asking questions."

Assessment Suggestions

- Observe and note student responses to the leaves they examine. Review the characteristics of leaves and plants if necessary. For special needs students, provide simplified ways of writing down data (such as circling the kind of leaves they see from illustrations).
- Provide additional information for students who are ready to learn more about a more diverse selection of Utah plants.
- Play relay game for a quick assessment of class understanding of Utah plant identification. (See Curriculum Extensions.)
- Students design an individual field guide to the Utah plants that they have studied during this activity. Their guides should include the characteristics they learned about, such as leaf shape, bark color and texture, and the branching pattern of leaves. They should also include environments where this plant might be found. They should include a drawing of their plants, or perhaps leaf prints and bark rubbings. (See *Field Guide Project Rubric*.)
- Collect science journals and review recorded information to assess/correct student understanding.

Invitation to Learn

Before starting the lesson, put on something unique you don't usually wear such as a funny hat, odd glasses, or something outrageous on your head like a pan. Start talking to the students about something not specifically on the topic, acting like nothing is different. When students react to you with giggles or comments, innocently ask, "What?" "Is something the matter?" When they identify what is different, they might say, "You've got that pan on your head!" "Oh, so this *thing* is different? What is another name for *thing* (attribute, characteristic)? If they can't think of any, have them look it up in the thesaurus/dictionary. "You're right! When something is different, we notice it and need to identify it so we can communicate our discovery with others. This pan makes me different, just like characteristics make many "things" different...Like Utah plants!"

Instructional Procedures

1. Ask students what characteristics they might use to identify Utah plants. List these on the board and accept all answers (e.g., size, color, texture, etc.).
2. How could these characteristics be used to identify plants? List the ideas in another column on the board. Example of responses:

   Look at the shape of the leaves—round, oval, long, etc.

   Look at the number of leaves on a stem.

   Look at the stem (Is it woody?).

   Look at the color.

   Does it have needles?
3. If possible, take students outside and collect an assortment of leaves. If this is not a possibility, use collections that you have acquired. These leaves can be preserved by laminating them for use from year to year.
4. Divide the students into groups to study the assortment of leaves.
5. Students record their observations. Encourage them to answer questions such as:

   What are the differences between the leaves?

   What do the leaves have in common?

   Do any leaves have edges that look like teeth on a saw blade?

   Do any leaves have hair-like structures?

   What do the leaves feel like?

   Can you trace the veins on the leaves? What do they feel like?

   If there are needle-like leaves, are the needles in clusters?

   What color are the leaves?

   Compare the leaves—size, shape, structure.
6. Have students group leaves into three piles that show which environment they might live in—wetlands, forests, or deserts.
7. Record this information in their science journals.
8. Share these lists with the class. (Remember, many of these plants can live in all of the environments. If a student can give a logical answer for his/her choices, it should be accepted.)

Materials

- ❑ Several sets of plants representing species found in Utah OR
- ❑ Student collected sets of plants
- ❑ Sets *Plant Round Cards*
- ❑ Field guides or materials to assist student investigations

For each student:

- ❑ 4 paper bags
- ❑ 2 large brads
- ❑ *Plant Classification Journal* handout
- ❑ *Plant Identification Terms* handout
- ❑ *Field Guide Project Rubric*
- ❑ *Leaves Diagram* handout

9. Can we use this information to create a dichotomous key to identify any of the plants in your piles? Review again how this occurs if students are not familiar with the system. (Use the *Leaf Dichotomous Key* as a guideline. Remember, let students do the creating. Their key may look different from the example. Encourage the use of "has" and "has not.")
10. Students share the keys within their groups. Teacher should identify and correct any misconceptions.
11. Make a *Plant Classification Journal* and store in your science journal.
12. Use the *Plant Round Cards* to practice using the information you observed and recorded. Fill in the blanks with some of the Utah plants you investigated. Take turns reading your cards. The student whose card matches the previous question becomes the next to read. Continue until play can go no further.

Curriculum Extensions/Adaptations/Integration

- *Plant Classification Journal*.
- Relay Race
    1. Line up in teams and place a pile of leaves at a predetermined distance in front of each team. Tell the students that you're going to call out the name of a Utah plant and then say, "Go!"
    2. At the signal, the first student in each team should run to the pile of leaves, find the leaf that comes from that plant, and hold it up. Each team gets one point for each leaf correctly identified. The team with the most points wins.
    3. After each round, players put the leaves back in the piles and go to the end of their team's line.

       (If working with students who might have difficulty with this activity, adapt it to use pictures instead of names of plants, or play as a matching game.)

Resources

Books

Is it Red? Is it Yellow? Is it Blue?, by Tana Hoban; ISBN 0688070345

Is it Rough? Is it Smooth? Is it Shiny?, by Tana Hoban; ISBN 088038239

Is it Larger? Is it Smaller?, by Tana Hoban; ISBN 068815282

Crinkleroots Guide to Knowing Trees, by Jim Agnosty; ISBN 0027058557

Plants of the Rocky Mountains, by Linda J. Kershaw; ISBN 1-55105-088-7

Rocky Mountain Tree Finder, by Tom Watts; ISBN 0912550058

Rocky Mountain Plants and Animals Coloring Book, by Dot Barlowe; ISBN 048640456

Easy Field Guide To Common Desert Cactus, by Richard and Sharon Nelson; ISBN 0-935810-15-3

Trees: A Golden Guide, by Herbert S. Zim and Alexander C. Martin; ISBN 1-58238-133-X

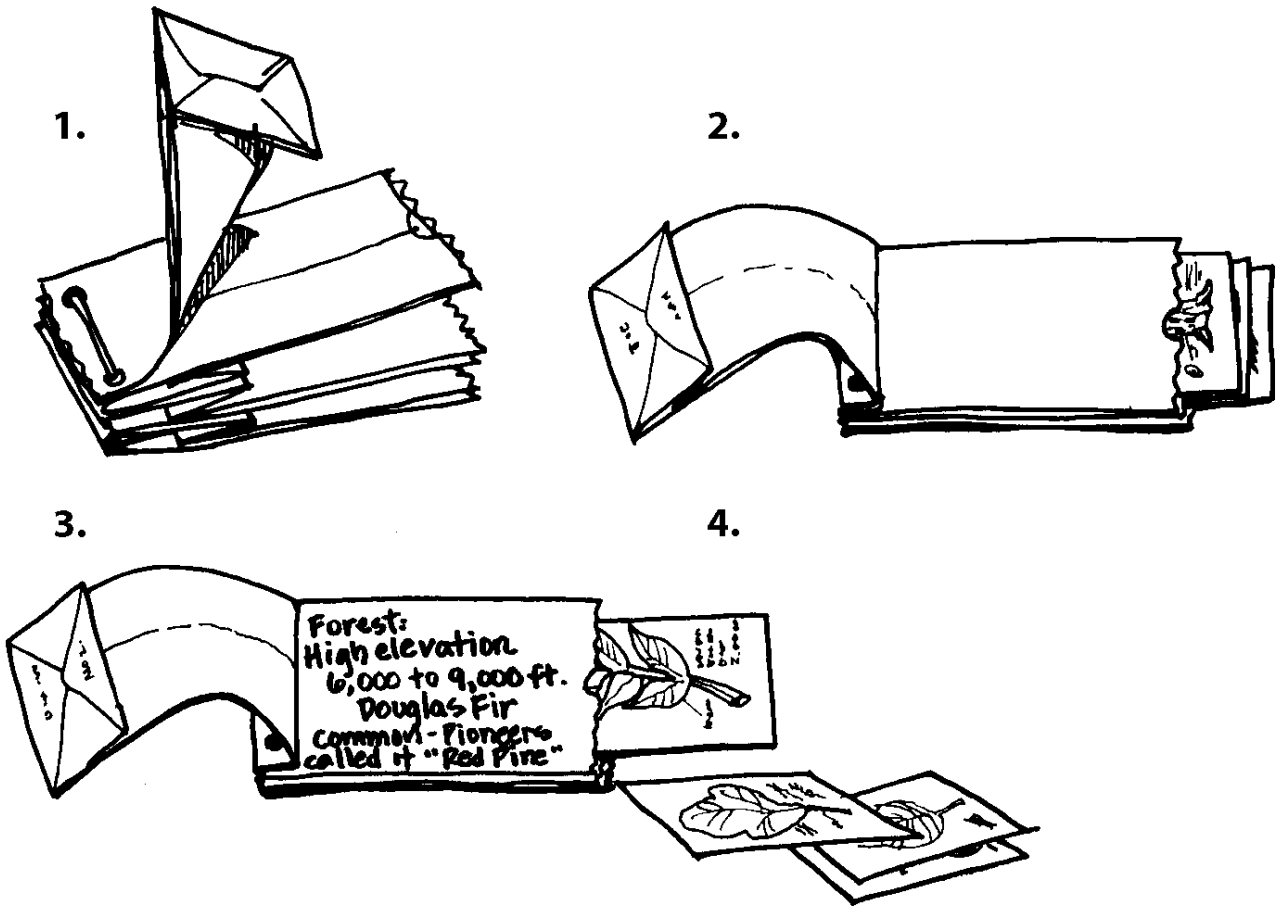
Family Connections

- Make a tally sheet with the three environments listed. For a few days, or over the weekend, have students keep track of how many plants they see in their daily activities, on television, in the newspaper, or driving in the car. Which column has the most? Why do they think this happens?
- Either on the walk home from school, or in their own yard, have students try to find at least three of the different types of plants discussed. This is only *observing*, not *collecting*, especially if it belongs to someone else!

Plant Classification Journal

Students need at least four paper bags.

1. Alternate the direction of the top bag, so that its bottom is on top of all the other bags, but next to their bottoms, stacked on top of each other.
2. Holding the one side of the bags, fold over approximately 1/2" and punch two holes on the fold. Use brads to hold the bags together.
3. The pockets created can be used to store plant samples. The pages that the sacks create are used to write information.
4. The writing should list the characteristics of the plant that is in the pocket. It can also list other data, questions or vocabulary.



Plant Identification Terms

In order to identify plants, there are some terms you should know to help describe characteristics of plants:

Leaves can be arranged on the stem in different ways:

 **Opposite**	 **Alternate**	 **Whorled**	 **Simple**	 **Lanced-Shaped**
 **Round**	 **Oval**	 **Toothed**	 **Compound**	 **Hairy**

Name _____ Total Score: _____/20 points possible

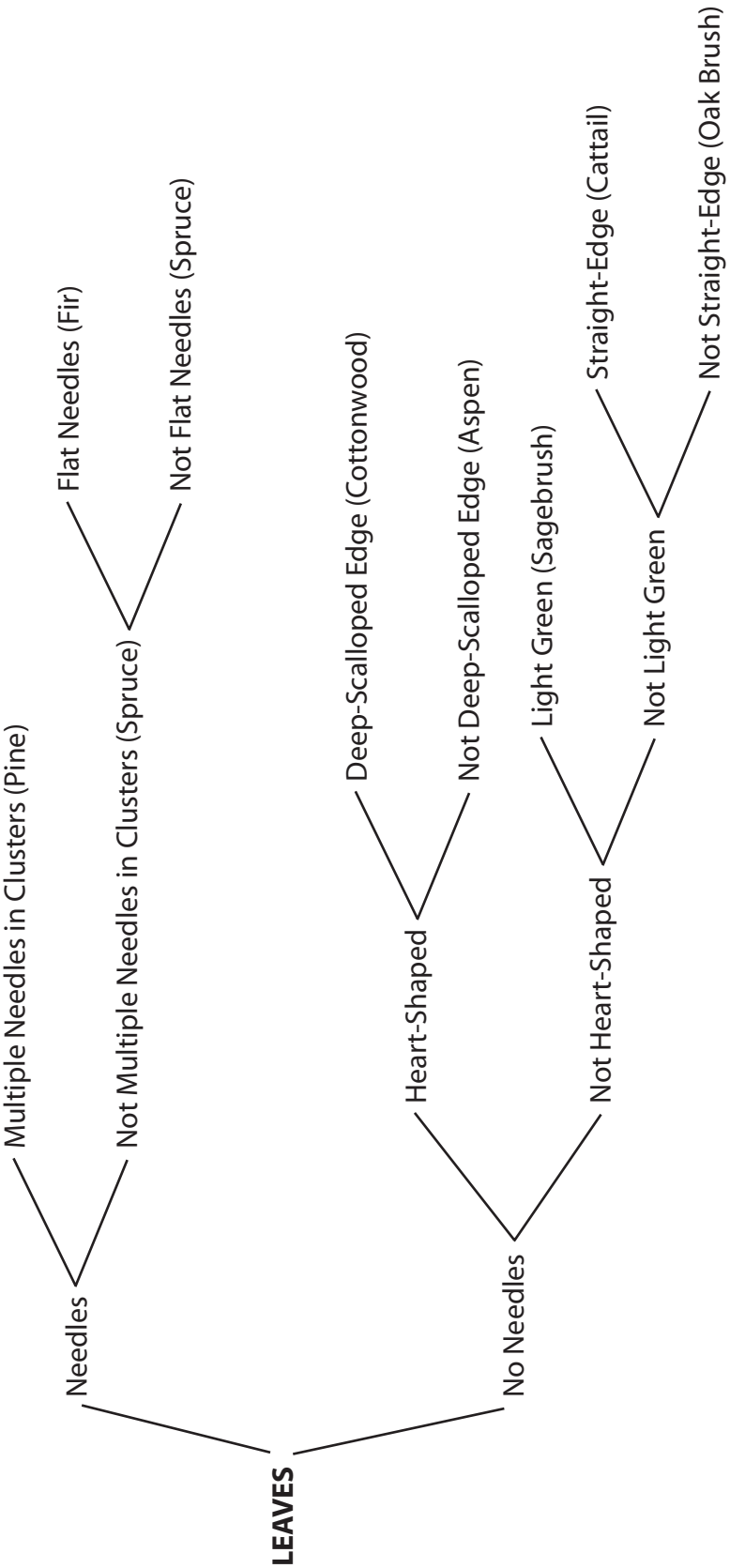
Field Guide Project Rubric

	4. You/ve Got It!	3. Almost There!	2. Getting Close!	1. Take Another Look!
Following Instructions	I described eight Utah plants in my field guide with three accurate facts.	I described at least seven Utah plants in my field guide, or some of my facts are incorrect.	I described six or less Utah plants in my field guide, and have few or many incorrect facts.	I described five or less plants and have incomplete facts.
Readability	I wrote the field guide and used neat handwriting throughout.	I wrote the field guide using neat handwriting most of the time.	My handwriting could have been neater.	My handwriting was difficult to read. I did not have a final draft.
Mechanics	I proofread my paper and fixed all spelling and punctuation errors.	I proofread most of my paper and fixed spelling and punctuation errors.	I proofread little and have many spelling or punctuation errors.	I did not proofread my paper.
Science	I have three or more accurate statements about Utah plants.	I have two accurate statements of structure or behavior.	I have two or less statements of only structure or behavior.	I have one statement of accurate structure or behavior.
Illustrations	My illustrations are careful, colorful, detailed, and accurate.	My illustrations are careful, but need more detail or color for accuracy.	My illustrations are missing important features, or lack detail or care.	My illustrations appear hurried and need more care.

Plant Round Cards

I have a _____ with furry leaves. Who has a plant with needles?	I have a _____. Who has a plant with serrated edges?	I have a _____. Who has a plant that's a conifer (evergreen)?	I have a _____. Who has a plant that is usually found in the wetland?
I have a _____. Who has a plant that is usually found only in the desert?	I have a _____ Who has a plant with compound leaves?	I have a _____ Who has a plant that usually is found in the forest?	I have a _____. Who has a plant that lives above 6,000 feet?
I have a _____. Who has a plant that is deciduous (loses its leaves)?	I have a _____. Who has a plant that has round leaves?	I have a _____. Who has a plant with simple leaves?	I have a _____. Who has a plant with lobed leaves?

Leaf "Dichotomous Key"



Math Standard I-3 & 5 Activities

Operation

Standard I:
Students will acquire number sense and perform operations with whole numbers, simple fractions, and decimals.

Objective 3:
Model and illustrate meanings of the four operations and describe how they relate.

Intended Learning Outcomes:
1. Demonstrate a positive learning attitude toward mathematics.
2. Become mathematical problem solvers.

Content Connections:

Math Standard I

Objective 3

Connections

Background Information

W.F. Lindgren said, "Mathematics is a language. Reading a mathematics text is somewhat like reading Tolstoy's *Anna Karenina* in the original Russian. No matter how excellent the math instruction is, if the students do not know and understand the meaning of the vocabulary they will not learn what is necessary."

One of the basic skills needed to understand the meanings of the four operations is a thorough understanding of math vocabulary. Math requires a specialized set of vocabulary, just as subjects such as technology, music, art, and science do. Students must comprehend math vocabulary if they are going to be able to reason and communicate mathematically.

Research Basis

Hougue, M.D. (2003). *Enriching Math Vocabulary–Measuring up to the PSSA*, Slippery Rock University of Pennsylvania, Online at www.tec.iup.eud/mhougue/literary

This article discusses the premise that students lacking an understanding of math vocabulary are handicapped in their efforts to learn mathematics.

Raiker, A. (2002). Spoken Language and Mathematics. *Cambridge Journal of Education*.

Rubenstein, R. & Thompson, D. (2002). Understanding and Supporting Children's Mathematical Vocabulary Development. *Teaching Children Mathematics*.

The previous sources were quoted extensively and provide additional information on the importance of developing strong math vocabulary skills in our students.

Assessment Suggestions

- Observing the students during the activity outlined in step 6 provides you with information about the students' level of understanding.
- Make a formal written test using the missing operation problems.
- Assign a problem solving activity and have students format their answers using math vocabulary and concepts.

  Example: There are 36 students in our class. We need to make 9 groups. How many students will be in each group?

  This is a division problem because we have a large group that needs to be separated into smaller equal groups. The dividend is 36 and we divide it using the divisor, which is 9. The quotient is 4, so there will be 4 students in each group.
- You can adapt the math writing for students who struggle with writing by having them illustrate and label each part of the problem. Higher level students can write and solve their own problems.

Invitation to Learn

Dress up in a doctor costume for math class and use your acting abilities to become Dr. Mathemator—an operation specialist! Introduce your students to the vocabulary for each operation in a fun and engaging way. A suggested script is below, but use your own personality and imagination to make this work for you.

> "Hello! I am Dr. Mathemator and I am ready to operate! Who was it that needed an operation? Aha! Are you the one that needs brain surgery? Over there, do you need a new liver? I know I have a spare one somewhere! Oh, you are definitely in need of _____ (looking confused) Why are you looking so puzzled and laughing at me? Am I in the wrong class? Is this *not* Surgery 101? What class is this? Math? Well then I am in luck, this class will be just fine for me. There are lots of operations to be done in math! You don't believe me? We might not do brain surgery, but we will do addition, subtraction, multiplication, and division, and they are all operations! So—it is time to begin!

Instructional Procedures

This lesson includes vocabulary for all four operations. You would not teach these all at once, but rather teach each set of vocabulary as you introduce the operation throughout the year. After teaching each set you can also use them for a review.

1. Advanced preparations:
   - Copy the *Operation Vocabulary Cards* onto cardstock, cut them apart, and laminate. Put a large chart paper on the board.
   - Make your "Operation" box—make a head and attach to one end, cover with a blue shop towel that has a slit down the center, and place your cards in the box. (Similar to the Operation game.)
2. Remember to ham this up to make it fun! Use the pliers to reach into your patient (box) and search around until you find the operation sign (+ - x ÷). Pull it out and say, "Aha! Here is our first operation! What is it?"

   Place the sign on the large chart paper. "That is a fine operation! But what exactly does it do? Let's see what we can find in here to help us understand _____ (name of operation) better." Call up some assistants, give each a surgical mask and have them reach inside patient to pull out a card. Place each card on the chart and discuss it.
3. Make sure students understand the "big idea" of each operation.

   Addition—get them all

   Subtraction—take away or compare

   Multiplication—total of equal groups, repeated addition

   Division—separate into equal groups, repeated subtraction
4. Teach students some memory devices to help them remember key vocabulary.

   Journaling Activity: Write vocabulary words your students have problems with and think of memory devices to help them remember.

   Addends—"Addends, addends, add them at the end" (like a jumprope rhyme).

   Subtrahend—on the bottom like a submarine, crawl on floor as you repeat "I am the subtrahend, I am on the bottom."

Materials

- ❑ Chart for each operation
- ❑ Doctor costume and 5-6 surgical masks for your assistants
- ❑ Operation box (shoe box, shop towel, and head)
- ❑ Pliers
- ❑ *Operation Vocabulary Cards*
- ❑ *Operation Song* overhead
- ❑ Krypto games
- ❑ *On Beyond A Million*
- ❑ Flip Flash Math Vocabulary

Minuend—I am the number that gets diMINished, or made smaller. Pass out licorice sticks—have them take a bite and say I just diminished this, it is smaller."

Factor—We don't "fear factors"–they let us multiply!

5. Teach students the *Operation Song* to help them remember the meaning of each operation and the vocabulary associated with it. To help students remember the inverse operations, divide class into four parts, assign them to sing one operation's verse, then have them pair up with their inverse (addition-subtraction) (muliplication-division) and sing both verses together.
6. Place each of the operation signs on one wall of your room. Pass out missing operation problem cards. Have students decide which operation they would use to solve their problem and go stand under that sign. Have them solve their problems to make sure their choice is correct. Switch cards and repeat.

Curriculum Extensions/Adaptations/Integration

- *Vocabulary Krypto*—Play the familiar Krypto game with a twist! Students must explain their solutions using math vocabulary.

  Example: I multiplied the factor 3 by the factor 8 which gave me a product of 24. I used the divisor 6 to get the quotient 4. One bonus point is awarded for each correct vocabulary word they use.

- Have advanced learners search for new and unique vocabulary words and make their own math dictionaries to write those words in. Write a sentence for each word that provides a context clue to the meaning of the word.

  Example: Factor—I multiplied the factors 2 and 4 to get 8. Students can interview older students taking advanced math classes, look on the Internet, or read books such as *On Beyond a Million* and *G is for Google*.

- Use Flip-Flash Math Vocabulary sets for practice and assessment

Resources

Book

On Beyond A Million, by David Schwartz; ISBN 0440411777

G Is for Googol: A Math Alphabet Book, by David Schwartz; ISBN 1883672589

Additional Media

Flip Flash Math™ Vocabulary Grades 4-5, (available from http://www.enasco.com); Item # TB21722T

Krypto®, (available from http://www.enasco.com); Item # TB17786T

Operation Song

(Sung to the tune of "Are You Sleeping?")

Operations, operations, there are four, there are four
Addition and subtraction, multiplication, and division
There are four, there are four

In addition, in addition, Get them all, get them all
Add up all the addends, order doesn't matter
Get the sum, get the sum

In subtraction, in subtraction, take away, or compare
Find out what is left and you will get the difference
Minuend, subtrahend

Multiplication, multiplication, put together, equal groups
Multiply the factors, you will get the product
Equal groups, get them all

In division, in division, Split the dividend, equally
You will get the quotient, sometimes a remainder
Divide it up, equal groups

Operation Vocabulary Cards

Addition	**+**
addend	**sum**
put together	**plus**
total	**combine**
get it all	**increase**
additional	**inverse of subtraction**

Subtraction	**–**
minuend	**subtrahend**
difference	**inverse of addition**
subtract	**take away**
minus	**less than**
how many left?	**how many more?**
difference	**decrease**

Multiplication	**x**
factor	**product**
times	**multiples**
count bys	**inverse of division**
multiply	**equal groups**
repeated addition	**double, triple, etc.**

Division	**÷** $\frac{a}{b}$ $\sqrt{}$
dividend	**divisor**
quotient	**inverse of multiplication**
divide	**divide by**
share equally	**split**
repeated subtraction	**quotient of**
cut up into	**part**

There's More Than One Way to Get to St. George!

Standard I:
Students will acquire number sense and perform operations with whole numbers, simple fractions, and decimals.

Objective 5:
Solve whole number problems using addition, subtraction, multiplication, and division in vertical and horizontal notation.

Intended Learning Outcomes:
1. Demonstrate a positive learning attitude toward mathematics.
2. Become mathematical problem solvers.
3. Reason mathematically.

Content Connections:
Social Studies

Math Standard I

Objective 5

Connections

Background Information

In *Lessons for First Grade*, 2000, Stephanie Sheffield quotes a first grade teacher:

"If you followed the rules and put the numbers in the right places, you got the answer right. To be truthful, arithmetic never made much sense to me. In fact, it never occurred to me that the facts I learned and the algorithms I performed were supposed to make sense."

As both students and teachers, the majority of us have bought into the theory that there is only one right way to do math, and that was to simply memorize the algorithm shown to us. This is not true, in fact there are many different ways to DO math as long as we reach the correct answer. This lesson explores teaching students alternative ways to do the four operations, with the underlying message being that there are many ways to get to the correct answer, and that as long as you understand the meaning of the operation and how it works, you can use the strategy that best suits you and the problem you are working on. It is critical for students to develop adequate conceptual understanding and computational fluency so they are able to accurately complete problems using a variety of methods. Prior knowledge of the meanings of the four operations and mastery of the basic facts is essential for the success of this lesson.

Research Basis

Russell, S. J. (1999). *Developing Fluency—Relearning to Teach Arithmetic Study Guide*
Dale Seymour Publications

This text explains the importance of helping students develop a sound understanding of how and why the standard algorithms work, and provides alternative methods for doing the operations.

Herrera, T. & Myers, F.A. (2000). *The Mystery of Mastery: A Rationale*
ENC Online

This text provides ideas and lesson plans for developing conceptual understanding.

Assessment Suggestions

- Observe students and/or have them write about their attitudes toward math to assess whether having the freedom to use different methods has helped them develop more positive attitudes.
- Collect samples of student work to assess their progress.
- Do a survey of which methods students prefer and make a graph to show data. Discuss pros and cons of each method.
- Use formal written assessments using problems appropriate for each operation.

Invitation to Learn

Materials

❑ *Map of Utah*

1. Pass out a *Map of Utah* to each student.
2. Put students into small groups and ask them to find a way to get to St. George from the state capitol. Encourage them to try and find a route they think will be unique.

   Journaling Activity—Have participants work in groups to find several different routes and record them in their journals.
3. Have each group choose a reporter and share their route with the class.
4. Discuss how we all ended up in the correct place, even though we didn't all get there exactly the same way. Explain that this is true for many areas of our lives and amazingly, it is also true for math. Ask how many of them think that there is only one right way to do math. Have them do a subtraction problem requiring regrouping and see if they all do it the same way. Is it accurate to say that they could have done that problem several different ways as long as they did one really important thing? The answer is yes,

there are lots of ways to do that problem, but what is that one critical thing you must all do the same? Get the correct answer!

So, just as there are many ways to get to St. George, there are many ways to do math *as long as we end up with the correct answer.*

Instructional Procedures

This lesson includes an activity for each of the four operations. Teach each part as you work on that specific operation. Remind students of the big idea, "there is more than one way to get to St. George and to do math" as you present each lesson.

Addition...It's Magic!

To reinforce conceptual understanding, teach/review expanded form addition, which visually shows what is happening when you regroup in addition and encourages students to use their mental math skills.

Materials

- ❑ Copy of the painting "Melancholia' by Albrecht Durer
- ❑ *Ben Franklin and the Magic Squares*

$$\begin{array}{r} 345 \\ +\ 186 \\ \hline \end{array} \qquad \begin{array}{r} 300 + 40 + 5 \\ +\ 100 + 80 + 6 \\ \hline 400 + 120 + 11 \end{array}$$

Add these mentally

$400 + 120 = 520 + 11 = 531$

This activity provides fourth graders the opportunity to practice addition in a way that engages and interests them. Adapted from Magic Squares, by Ivars Peterson in *Muse*, Nov/Dec 2003.

1. Present background information on magic squares.

   Do you have a lucky number? In ancient China, people believed that a special arrangement of nine numbers in a square was especially lucky. They engraved this pattern on stones and medallions worn as charms to ward off evil or bring good fortune. They thought it was lucky because of a legend that told of a divine turtle that appeared in a Chinese river over 4,000 years ago. This turtle had a magic square on its back. Since then, many cultures have had their own version of magic squares and the influence they were supposed to have in people's lives.

2. Many well known people have also been fascinated with magic squares. Show "Melancholia" by the German artist Albrecht Durer and see if the class can find a magic square in it.

3. Benjamin Franklin used to make up magic squares when he got bored listening to political speeches. Share the book, *Ben Franklin and the Magic Squares*.
4. So what are magic squares and how do they work? Let's find out. Show this magic square on the board or overhead.

4	9	2
3	5	7
8	1	6

Use addition to see if you can find the magic in this square. When you add the numbers in the rows, columns, and diagonals you get the same sum...15. That is the magic constant. In order to be a true magic square, you must always get the magic constant.

5. Here are three more examples. Two of them are true magic squares, and one is not. Use your addition skills to discover which square is the imposter.

4	9	8
11	7	3
6	5	10

15	1	11
5	9	13
7	17	3

5	20	18
28	15	2
12	8	25

Journaling Activity—Have students work in groups to create a magic square of their own. Share results with whole group so they have several more examples.

Subtraction Around the World

The following is an excerpt from *Relearning to Teach Arithmetic* by Susan Jo Russell:

"When all computation was done by hand, it was important to reduce the computation process to the smallest number of steps. Imagine what it was like to keep records for a small business not only before the advent of calculators and computers, but before even adding machines were available. People who needed to do many calculations again and again wanted as many pencil and paper shortcuts as possible.

Which of these paper and pencil shortcuts were chosen to be taught in public schools is, in part, a matter of historical accident. At other times in our history and in other countries, the schools have taught algorithms different from those considered standard in American education. Although many of us assume that what we've been taught must be the best algorithms, this is not necessarily true from a mathematical point of view and certainly not from a pedagogical one."

Many students, parents, and teachers are astounded to learn that not everyone on earth subtracts exactly as we do. This lesson introduces a few of the different methods of subtraction used around the world.

Adequate conceptual understanding of the meaning and use of the subtraction process is an important prerequisite skill in order for this lesson to work. This lesson is ideally suited to those students who are able to accurately compute with the standard subtraction algorithm and are ready to handle the challenge of learning some new and different methods.

Materials

- ❑ Globe
- ❑ Pictures of cities and/or people from Europe, Russia, and China
- ❑ Charts with three different algorithms

1. Invite several students to come to the front of the room. Spin the globe and have them close their eyes and put their fingers anywhere on the globe when it stops. Point out the places they have picked and explain that if we were able to visit a math class in those areas we might be astounded to see that 10-year old students there are doing math differently than we are.
2. Show the pictures of each area and its location on the globe as you briefly introduce each type of subtraction.

   In Europe, students can subtract numbers without ever having to regroup.

   In Russia, students subtract from left to right (the opposite of us).

   In China and other Oriental countries, they don't subtract at all, they change the problems into addition!

   Today we are going to see examples of problems using the methods from these three countries. You will most likely not be able to accurately use any of these after just one exposure to them. But, if you think a method looks interesting, you are encouraged to practice it on your own. Who knows...you just might find an alternative method that works better for you than the standard algorithm you are used to!
3. Introduce European Method

$$\begin{array}{r} {}^{1}3{}^{1}6\overset{1}{2} \\ -\ 1\overset{2}{9}\overset{1}{8}7 \\ \hline \end{array}$$

   Start in the ones column. You can't subtract 7 from 2, so make the 2 a 12. You also have to add one to the bottom number in the tens column which is 8, and make it a 9. Now you can subtract 7 from 12 and write the answer of 5 in the ones place in the answer. Now look at the tens column. You can't subtract 9 from 6, so make the 6 a 16. You also have to make the 1 in the hundreds column into a 2. Now subtract 9 from 16 and the answer 7 in the

tens place. Now look at the hundreds column, you can subtract 2 from 3 so write the answer of 1 in the hundreds place.

Journaling Activity—Write an explanation of how and why you think this method works.

4. Introduce Russian Method

$$\begin{array}{r} 362 \\ -\ 187 \\ \hline \end{array}$$

With this method, you start on the left in the hundreds column. 3 subtract 1 is 2, but before you write down the 2, you must look at the tens column and see if there is going to be a problem (subtrahend larger than minuend). There is, so you write down a 1 instead of a 2. Move to the tens column. You can't subtract 8 from 6 so you do the following procedure: decide how much more you need to add to 8 to make it 10....it's 2. So add 2 to the 6 to make it 8. But, before you write that down in the tens place, look at the ones column to see if there is going to be a problem. There is, so instead of writing down the 8, reduce it by 1 and write a 7. Now move to the ones column. You can't subtract 7 from 2, so do the following procedure: decide how much more you need to add to 7 to make it a 10...it's 3. Add 3 to the 2, you get 5 so write 5 in the ones place.

Journaling Activity—Try a problem with 0 using this method and see what happens. Can you explain what you would need to do differently and why?

5. *Introduce the Oriental strategy*—Change subtraction to addition!

$$\begin{array}{r} 362 \\ -\ 187 \\ \hline \end{array} \qquad \begin{array}{r} 362 \\ +\ 812 \\ \hline 1174 \\ +\quad 1 \\ \hline \not{1}175 \end{array}$$

Cross out the digit in the highest place, leaving 175.

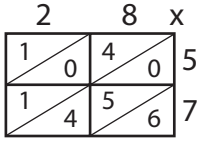
Change the subtraction problem into an addition problem by replacing each digit in the subtrahend with difference between that number and 9. For example: The difference between 1 and 9 is 8, so you write 8 in the hundreds place. The difference between 8 and 9 is 1, so you put 1 in the tens place. The difference between 7 and 9 is 2 so you put 2 in the ones place. Now add. When you finish, drop the 1 in the largest place and add 1 to the ones place.

Journaling Activity—Which, if any, of these methods do you think would be a good alternative to our standard algorithm and why?

Multiplication...A Great Invention!

1. Share information on the background of lattice multiplication with class. Explain terms and ideas as needed and/or explain in your own words.

   The lattice method of multiplication appeared in the first printed arithmetic book, printed in Italy in 1478. Lattice multiplication and variations of the standard long 2-digit multiplication algorithm used today were introduced in Europe by Fibonacci (show picture). He was an Italian whose father was a diplomat. He traveled widely with him and was educated in North Africa where he learned the Hindu-Arabic number system (the system we use today) from a Moorish teacher. He was convinced that this number system was superior to the systems used in Europe and when he returned to Italy he wrote a book called *Liber Abacci* explaining the new system. The book became very influential in convincing Europeans to switch to the Hindu Arabic number system from the old Roman Numeral System (show chart) they were using. Before this number system was introduced, multiplication was very difficult and could only be done by a few people using counters. The Hindu-Arabic number system was much better suited to multiplication than the old Roman Numeral System and made multiplying fairly simple and accessible to many more people. This allowed people to keep better track of the increasingly large amounts of products and goods they were dealing with.
2. Show the lattice to students. Tell them that this is the same arrangement we use to do lattice multiplication and it might help them remember it better.
3. Pass out the graph paper and have students draw their boxes and diagonals. If this is difficult, make lattice boxes on the computer and run them off.
4. Demonstrate the lattice multiplication process. Use the red pencil to record products and the blue to record sums. 28 x 57 = _____



Materials

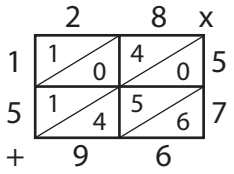
- ❏ 1/2" graph paper
- ❏ Globe—Show location of different countries discussed in Background Information
- ❏ Picture of Fibonacci
- ❏ Chart of Roman numerals
- ❏ Piece of garden lattice
- ❏ Red and blue colored pencils
- ❏ Dice

Multiply each partial product and record it as shown above, putting one digit in each section of the box.

5 x 8 = 40
5 x 2 = 10
7 x 8 = 56
7 x 2 = 14

5. Add the numbers on the diagonals. It helps to extend the diagonal lines just slightly, and put a + sign outside the bottom left hand corner of the box. You must start on the bottom right so you can carry to the next diagonal if necessary. Record your sums at the bottom of each diagonal.

6 + nothing = 6
0 + 4 + 5 = 9
4 + 0 + 1 = 5
1 + nothing = 1



Start with the top left number and write them down, 1596. Your answer is 1,596.

6. Now do 65 x 29, which requires regrouping.

Division...Why Does It Take So Long?

This lesson introduces a "short division" process for students who have the ability to use a "shortcut" when dividing 2 and 3 digit dividends by 1 digit divisors. Students who have been taught both methods can choose which strategy to use on which problem. You will see students alternate between the two processes depending on which works better for them on that problem. We experimented with different classes to see if learning short division before or after long division was more effective. For the majority of students, it worked best to teach long division first, then they understood and appreciated the short division process more.

The rationale behind this method is this: "From first grade, students have learned to add and subtract from right to left starting with the ones place. The long division form attempts to teach students to work from left to right, which goes counter to all previous learning. Also students must master a series of steps (divide, multiply, subtract, bring down, remainder) which uses several difficult math concepts and is often confusing, especially the bring down step. Short division eliminates that step and the only step the students use is to divide the number and find how many are left over."

1. Share *Remainder of One* to review concept of "how many left over."

2. Teach short division method as follows, using counters to demonstrate.

Materials
- ❑ Counters
- ❑ Graph paper
- ❑ Multiplication charts
- ❑ Number lines
- ❑ *A Remainder of One*

Write problem in division box format, spacing numbers slightly apart.

$$3\overline{)\,7\;{}_{1}3}\quad 2\;4\ \text{R}1$$

Ask: How many groups of 3 are there in 7? xxx xxx x (2)
Write the 2 on top in the quotient place.

Ask: How many were left over? (1)
Place the 1 slightly below and to the left of the next digit—3.
Explain that this is just like the carrying they did in addition and multiplication, and the 3 is now a 13.

Ask: How many groups of 3 are there in 13? xxx xxx xxx xxx x (4)
Write the 4 on top in the quotient place.

Ask: Were there any left over? (Yes—1.) Is there another digit in the dividend? (No.) Then the 1 is a remainder.
Write it as R1 in the quotient place.

Check: Your quotient was 24 R1. Check with x and +.
24 x 3 = 72 + 1 = 73

Curriculum Extensions/Adaptations/Integration

- Advanced learners may enjoy experimenting with inventing their own methods.
- Struggling learners can be exposed to the different methods, but may be better served by using only one method.
- Students make their own Chinese magic square medallions using Sculpey® III oven bake clay. Have students shape Sculpey III into medallion shapes, carve a magic square onto it, make a hole for ribbon, bake following package directions, then paint and hang them with ribbon.

Materials
- ❑ Sculpey III
- ❑ Ribbon
- ❑ Acrylic paints

- Do magic squares online at scienceforkids.org MatheMUSEments section
- Encourage advanced learners to continue making their own magic squares. Challenge them to try 4 x 4 squares and even larger. Ben Franklin is famous for an 8 x 8 one!
- Advanced learners might enjoy looking up more information about Fibonacci and some of the other math concepts he is credited with. They could also look up other great mathematicians and learn more about their discoveries and methods.

- Teach both the lattice and standard algorithm. When students miss a problem using one method, have them rework it using the other method.
- For students who are still struggling with understanding the meaning of multiplication try playing the game "Circles and Stars." This reinforces the understanding of multiplication being repeated addition and its commutative property. Students work in partners. Partner A rolls two dice. S/he chooses one die to represent the number of circles s/he will draw, and the other to represent how many stars s/he will draw in each circle. Partner B repeats the activity. The game continues for seven rounds. They total the stars at the end using multiplication and the player with the highest total wins.
- Partial product multiplication is also helpful to develop students' conceptual understanding of the multiplication process.

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  347        300 + 40 + 7      5 x   7 =   35
x   5      x            5     5 x  40 =  200
                               5 x 300 = 1500
```

Encourage students to use mental math to add the products
1500 + 200 = 1700 + 35 = 1735

Resources

Books

Teaching Arithmetic: Lessons for First Grade, by Stephanie Sheffield; ISBN 0941355349

Ben Franklin and the Magic Squares, by Frank Murphy; ISBN 0375806210

Math Homework that Counts, Grades 4-6, by Annette Raphel; ISBN 0-941355-27-6

A Remainder of One, by Elinor Pinczes; ISBN 0-618-25077-8

Article

Magic Squares, by Ivars Peterson, in *Muse*, Nov/Dec 2003.

Organization

National Council of Teachers of Mathematics, http://illuminations.nctm.org

Additional Resources

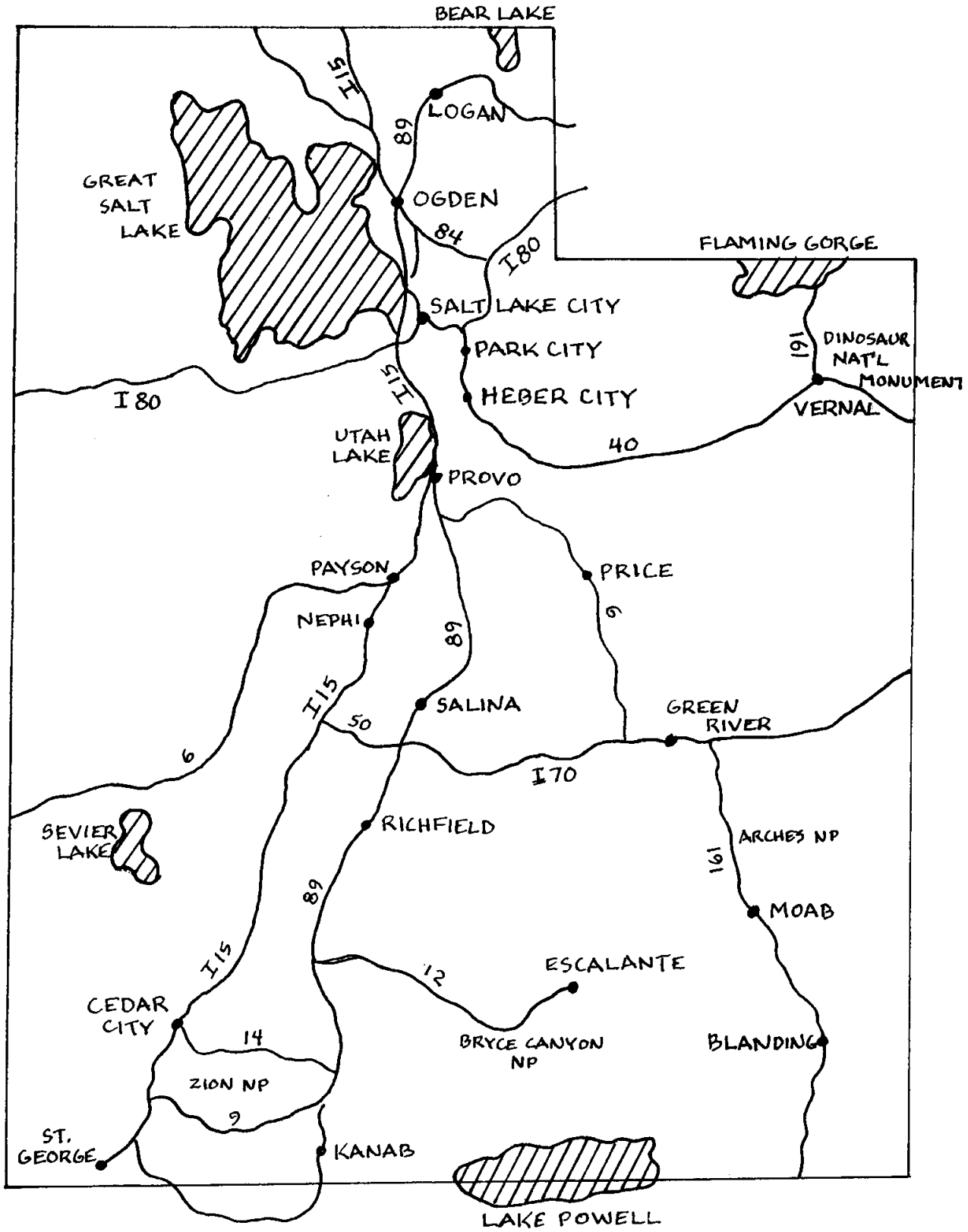
Dixie Blackinton, Weber State University, dblackinton@weber.edu

Diane Pugmire, Weber State University, dpugmire@weber.edu

Sculpey® III Basic Color Set, (available from Dick Blick Art Materials, http://www.dickblick.com or (800) 723-2787); Item #33218-1019

Name _____

Map of Utah



Math Standard V-1 Activities

Graphin' and Glyphin' Utah Weather

Standard V:
Students will collect and organize data to make predictions and use basic concepts of probability.

Objective 1:
Collect, organize, and display data to make predictions and answer questions.

Intended Learning Outcomes:
5. Make mathematical connections.
6. Represent mathematical situations.

Content Connections:
Science II-1

Math Standard V

Objective 1

Connections

Background Information

Utah's climate is variable. In the southwestern regions crops like cotton can be grown, while in the higher elevations of northern Utah, only grasses and cereal grains are cultivated. We experience almost every weather phenomena with the exception of hurricanes. The climate in the most populated parts of the state is generally temperate, with daytime temperatures that are warm and not too hot in the summer. Winter temperatures are cold but seldom extreme. Snowfall in the valleys does not accumulate extensively, while in the mountains snow builds to great depths, providing water for domestic use. Most of Utah is considered a desert with less than 10 inches of precipitation a year, while the mountainous regions receive significantly more.

The Great Basin is a region between rivers and lakes that is bordered on the west by the Sierra Nevada and the Cascade Mountain Ranges and on the east by the middle Rocky Mountains and the Colorado Plateau. The basin encompasses most of the state of Nevada, while Utah is dominated by the Wasatch Mountains and the Colorado Plateaus of the central portion of the state. The Great Basin is cut off from the westerly flow of Pacific moisture by the Sierra and Cascade Mountains. As the moist air masses from the ocean move west, they cool and lose much of their precipitation before they cross Nevada. As a result, Nevada is the driest state in the nation. The dry steppe climate is typical of large basins, where the potential for evaporation exceeds precipitation throughout the year.

Utah's distinct geography defines its unique climate. Utah is the second driest state. By the time the air masses reach the Basin's eastern edge they get another lift, creating extra moisture and highland climates that support Utah's most populous region along the Wasatch Front. High-

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level, low pressure systems affecting our state's weather in the spring and fall are often referred to as "Great Basin" or "Nevada" lows. These lows bring the most significant amounts of precipitation every year.

Glyphs are a way to pictorially represent information. These nonverbal representations help students collect and interpret data in a visual format. The idea of glyphs comes from ancient hieroglyphics. They bring a creative and fun method to data collection and analysis into the classroom.

This activity uses glyphs as a way to visually represent information about Utah weather.

Research Basis

Heidorn,P.B. (1999). Image Retrieval as Linguistic and Nonlinguistic Visual Model Matching. *Library Trends, 48*(2), pp.303-325.

The article reviews the research on how people use models of images in an information retrieval environment. The article describes the human use of images (nonverbal representations) as predating human language and explains that language evolved out of a need to communicate about the world. Verbal language is limited in that it is dependant on a shared experience or shared vocabulary. Some aspects of our mental models are not easily described using words. For example, our brains perceive millions of color indexes and we only have relatively few color names. Some iconic representations are simple and some can be more complex. Our mental models have many aspects including color and shape. These images can be more complex than verbal representations. Some images are content- based, while others are concept-based. It has been suggested that nonlinguistic representations may be used in conjunction with linguistic representations as determined by the task.

Assessment Suggestions

- *Rubric for Glyphs and Graphs*
- Teacher observation

Invitation to Learn

Ask students to draw a picture of themselves enjoying an outdoor activity in July and in January. "How will I know which picture is January and which picture is July?" Share and discuss with the class possible indicators of these seasons. Clarify any confusion that may exist. Invite individual students to share their drawings.

Instructional Procedures

This activity requires advanced preparation. The day before you make the glyphs with your students, complete the first step of this activity.

1. Using the *Utah Weather Map*, invite the students to select a specific city from across the state. You may choose to assign these locations to assure that a statewide representation is available for analysis. You may also wish to print a transparency of the *Utah Weather Map* for use on an overhead projector.
2. Glyphs (symbols used to convey meaning) are easy to create and help students with step-by-step process skills. To introduce glyph-making use an overhead projector and model what you want students to do. Post the selected glyph shape for students to see. Read aloud each survey question, adding your own picture detail to the glyph shape after each question. Seeing the glyph being made will help students understand the construction process. After students have heard all the survey questions and watched you use your answers to create a glyph, they will be ready to begin their own glyphs.
3. Provide each student a copy of the *Utah Weather Glyph* worksheet and each pair of students the *Utah Weather Map*. Post the *Weather Glyph Questions* transparency on an overhead projector.
4. Review the background information with the students. You may wish to emphasize that this activity will allow them to see the differences in the types of weather throughout the state.
5. Have the students cut out the pattern following the directions on the *Weather Glyph Questions* transparency. Students should check with the teacher before cutting the line for the size of the sun in question one. It is recommended that students use a black marker to add the glyphs for average January temperature.
6. Invite students to add the remaining details to their glyphs to show their answers to the questions. Students can also personalize their glyph if it does not interfere with the interpretation of the data.
7. Once the glyphs are complete, have the students display them in a central location. Ask them to describe how these glyphs could be sorted to collect the data from them. You may choose to write these suggestions on a chalk or white board. As an extension, students can create displays using their own ideas.

Materials

- ❏ *Rubric for Glyphs and Graphs*
- ❏ *Utah Weather Glyphs* worksheet
- ❏ *Weather Glyph Questions* transparency
- ❏ *Utah Weather Map Cities*
- ❏ *Utah Weather Map* transparency
- ❏ Crayons/colored pencils and scissors for each student
- ❏ Tape

Optional:

- ❏ Large topographic Utah map

8. Display the *Utah Weather Map* on the overhead projector. Have the students organize the glyphs by their locations on the map and tape them to the wall.
9. Review the *Weather Glyph Questions* with students and have them verbally describe what information is available from the glyphs to provide an overview of Utah weather patterns. Ask the students to describe what physical geographic features may be influencing the climate at various locations.
10. Using another wall (or white board), form a basic outline for a bar graph. Ask the students to organize the cities with a 50-60° range in high and low temperature in one bar, those with 61-70° ranges on the second bar, and those locations with 71° or higher degree ranges in high and low temperatures in the third bar.
11. Ask the following questions: What similarities do they notice about the cities that are in the same category? Does the geography of the locations determine the climate? Does the weather define what kinds of jobs are available in that community? Why would someone consider the weather of a particular area when deciding to start a business or move their business to a new area?
12. Ask students to determine if their city's climate would encourage or discourage them from certain types of agriculture and activities. Why would it be possible to grow apples in some parts of Utah, but not others? What types of risks do farmers face with regard to the weather? What things can farmers do to work with the weather? Can you ski everywhere in Utah? How about hiking in March? How does the weather affect our daily choices about activity? How does it affect wildlife? Record these answers on a chart in a journal.
13. Relate to students the importance of determining the climate before planting a garden or crop, raising livestock, planning outdoor activities, and dressing.
14. Have pairs of students present their glyph information in another graphical form not previously shown, such as a pie chart or line graph or pictograph.

Curriculum Extensions/Adaptations/Integration

- Place the glyphs in a basket. Ask each student to select one glyph from the basket, and using the data from the glyph, list the items s/he would pack if traveling to that city today. What activities would s/he be able to do? For example, if the weather is 50°F (10° C) and rainy, a student might list a jacket, blue jeans, a sweatshirt, and an umbrella. S/he may suggest indoor activities. If it's 80°F (27°C) and sunny, the list might include shorts, a T-shirt, a tennis racket, and a bathing suit, and going for a swim. Remind students to consider the daytime and evening temperatures when packing for their trips.
- Ask students to gather data about the city they live in for a one-week period of time. They may use the *Weather Data Analysis* and *Data Charts for Weather Forecasting* handouts to record their data. Challenge them to create line graphs using their data.
- Invite students to research weather conditions for cities in other parts of the world. Have them create glyphs for these cities, and then list what types of advantages and disadvantages that area may have if they were trying to grow a crop or raise livestock.
- Students can create displays with the glyphs using their own ideas about graphing and charting.

Resources

Book

Weather Detectives, by Mark Eubanks; ISBN 1-58685-412-7

Web sites

Utah Drought Conditions
www.water.utah.gov/droughtconditions/default.asp

Utah Climate Summaries (specific state locations)
www.wrcc.dri.edu/summary/climsmut.html

Utah Current Weather Conditions
http://web.ksl.com/TV/weather/index.php

Utah's premier site for state wide current and forecast weather
http://www.utahweather.org/

Organizations

Agriculture in the Classroom has many lessons that correlate with the core. They send a seasonal newsletter that includes new lessons to anyone who registers., www.agclassroom.org/ut

Family Connections

- Students create a chart in which they draw their own glyphs for the day's weather over a week. Then record how the weather affected their choices for after school activities and how it may have affected their family in any way. Students can find weather information on the television news, computer, or newspaper.

Name _____

Rubric for Glyphs and Graphs

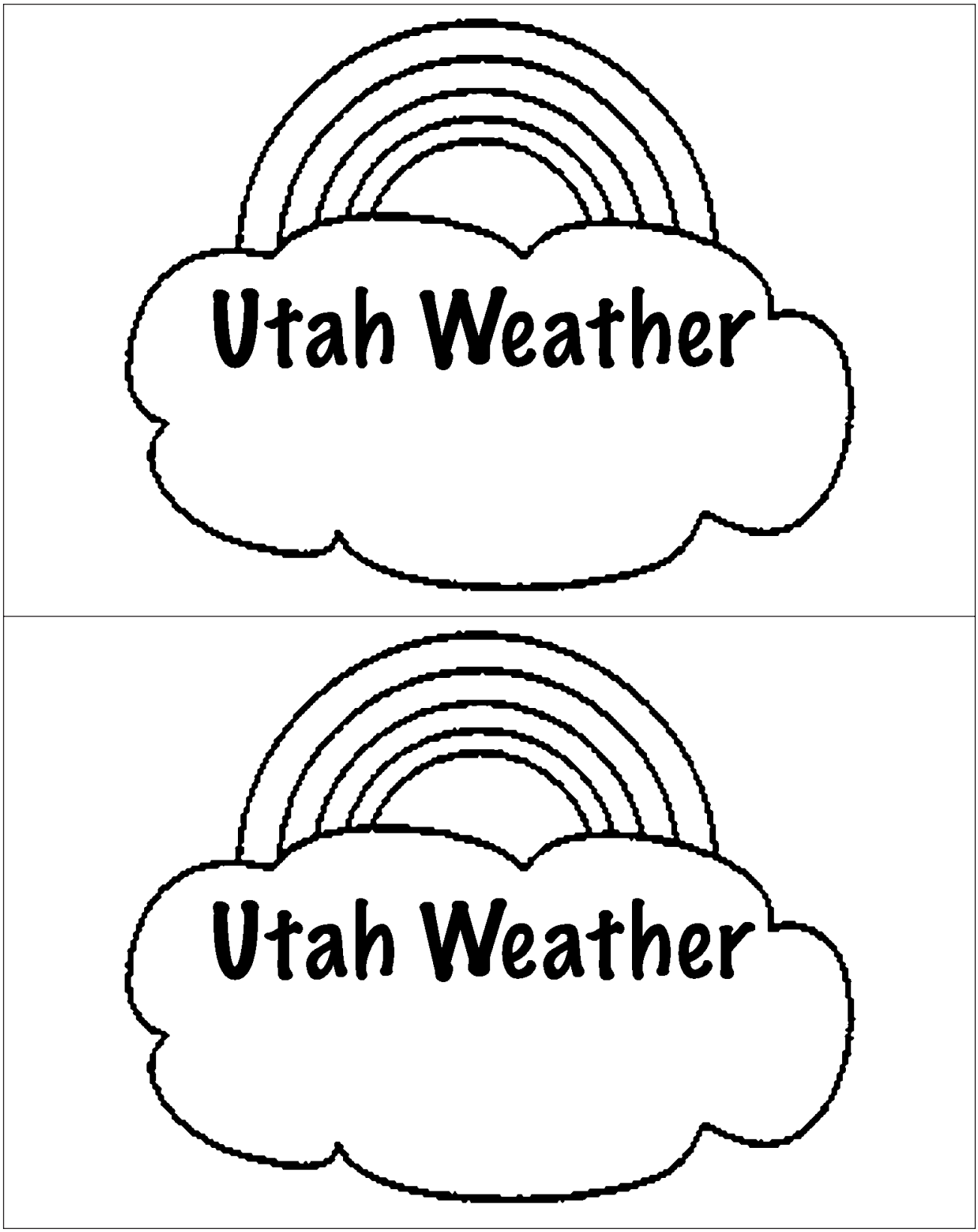
Score	3—My Best Work	2—Average	1—Poor
My glyph is neatly cut.			
My glyph is neatly colored.			
My glyph has the right information.			
My partner and I created a graph of the data.			
I worked well with my partner			
Total score			

Name _____

Rubric for Glyphs and Graphs

Score	3—My Best Work	2—Average	1—Poor
My glyph is neatly cut.			
My glyph is neatly colored.			
My glyph has the right information.			
My partner and I created a graph of the data.			
I worked well with my partner			
Total score			

Utah Weather Glyph



Weather Glyph Questions

Directions: Answer each of the following questions by completing the request on your weather glyph.

① What was the location's average July temperature?

	Below 69° F	69° to 78° F	79° to 88° F	89° to 99° F	100° F or above
Cut out the sun on this line	1st line; smallest sun 	2nd line; a little larger 	3rd line; even larger 	4th line; still larger 	5th line; largest sun 

② What was the location's average January temperature?

	Below 0° F	0° to 9° F	10° to 19° F	20° to 29° F	30° F or above
Draw this number of birds on the cloud	0	1 	2 	3 	4 

③ What was the difference between the July and January temperatures?

	59° to 60°	61° to 70°	71° or more
Color of the sun	Red	Orange	Yellow

④ What was the amount of average annual precipitation?

	10 inches or less	11 inches or more
Draw a lightening bolt on the cloud	No lightening bolt	Draw a lightening bolt

⑤ Write the elevation of your location in the center of the cloud.

⑥ Write the name of your location directly above the elevation number.

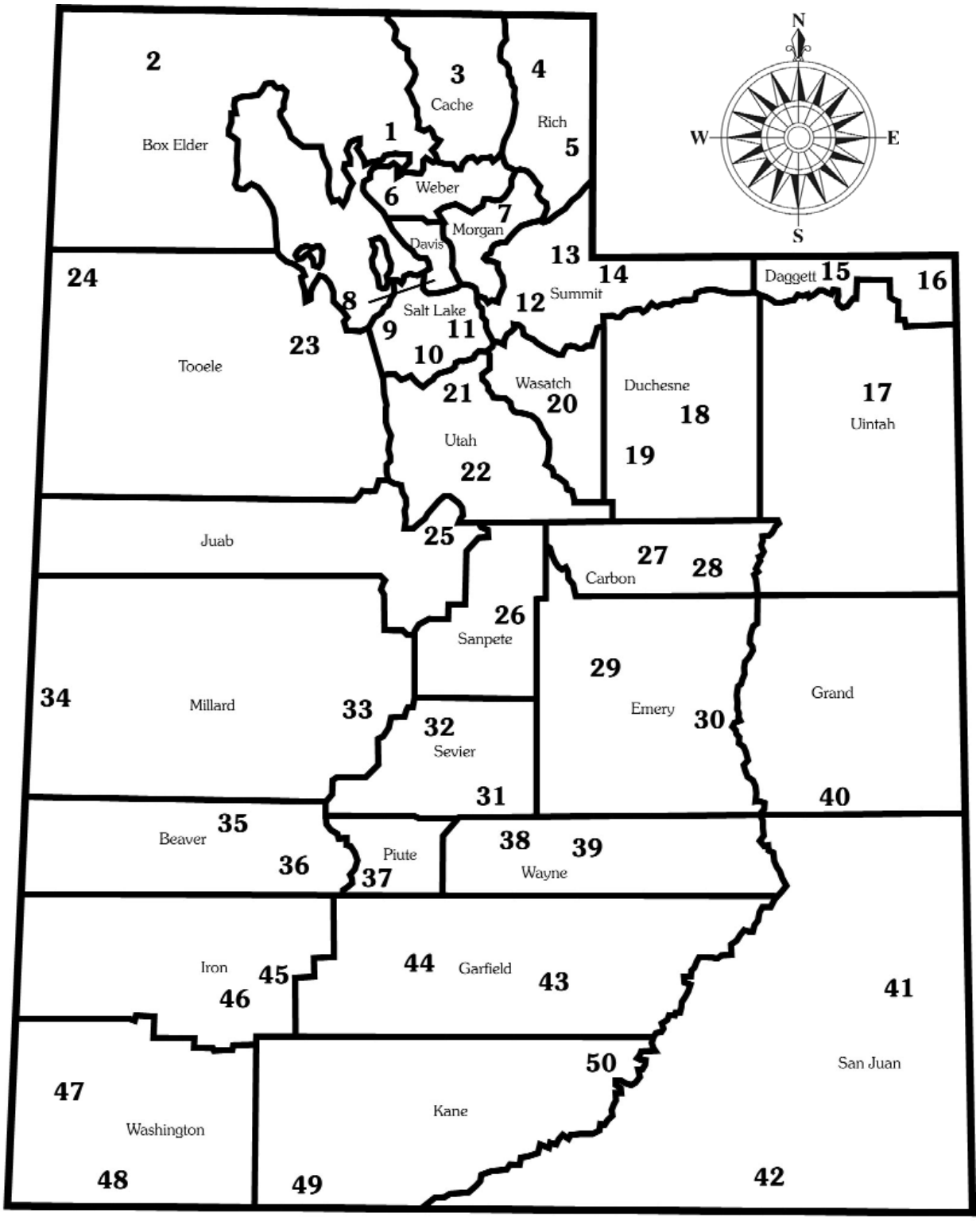
Name _____

Utah Weather Map Cities

KEY		
	☼ July Average Maximum Temperature (°F)	♦ Total Average Precipitation (inches)
	❄ January Average Minimum Temperature (°F)	△ Elevation (feet)

1	Brigham City:	☼93	❄19	♦19	△4439
2	Park Valley:	☼86	❄14	♦11	△5543
3	Logan:	☼87	❄16	♦18	△4535
4	Bear Lake State Park:	☼85	❄15	♦14	△5950
5	Randolph:	☼81	❄1	♦14	△6289
6	Ogden:	☼92	❄18	♦17	△4299
7	Morgan:	☼90	❄12	♦18	△5064
8	Bountiful:	☼89	❄22	♦23	△4408
9	Salt Lake City:	☼91	❄22	♦15	△4267
10	Draper:	☼94	❄23	♦16	△4698
11	Alta:	☼72	❄13	♦54	△8530
12	Park City:	☼82	❄12	♦21	△6980
13	Coalville:	☼87	❄12	♦16	△5586
14	Uintalands:	☼74	❄7	♦23	△8410
15	Manila:	☼85	❄12	♦9	△6375
16	Flaming Gorge:	☼86	❄9	♦12	△6270
17	Vernal:	☼90	❄5	♦8	△5322
18	Roosevelt:	☼92	❄4	♦7	△5100
19	Duchesne:	☼87	❄4	♦10	△5517
20	Heber:	☼87	❄9	♦16	△5595
21	Alpine:	☼91	❄19	♦17	△4957
22	Spanish Fork:	☼93	❄20	♦19	△4549
23	Tooele:	☼88	❄20	♦18	△4923
24	Wendover:	☼92	❄19	♦5	△4246
25	Nephi:	☼93	❄17	♦15	△5133
26	Manti:	☼87	❄15	♦13	△5530
27	Price:	☼91	❄11	♦10	△5566
28	Sunnyside:	☼84	❄14	♦14	△6710
29	Castle Dale:	☼89	❄8	♦8	△5771
30	Green River:	☼98	❄10	♦6	△4079
31	Koosharem:	☼85	❄10	♦9	△6914
32	Richfield:	☼90	❄14	♦8	△5308
33	Fillmore:	☼92	❄18	♦15	△5135
34	Garrison:	☼93	❄15	♦8	△5273
35	Milford:	☼92	❄13	♦9	△4957
36	Beaver:	☼87	❄13	♦11	△5898
37	Circleville:	☼89	❄13	♦9	△6063
38	Loa:	☼83	❄7	♦7	△7000
39	Capital Reef:	☼92	❄19	♦8	△5499
40	Moab:	☼98	❄18	♦9	△4025
41	Monticello:	☼84	❄14	♦15	△7066
42	Monument Valley:	☼92	❄24	♦7	△5192
43	Escalante:	☼89	❄14	♦11	△5812
44	Panguitch:	☼85	❄8	♦10	△6624
45	Brian Head:	☼70	❄10	♦33	△9800
46	Cedar City:	☼85	❄19	♦15	△5834
47	Enterprise:	☼90	❄13	♦10	△5500
48	St. George:	☼102	❄26	♦8	△2761
49	Kanab:	☼93	❄22	♦14	△4909
50	Bull Frog Basin:	☼100	❄25	♦6	△3690

Utah Weather Map



Weather Data Analysis

	Monday	Tuesday	Wednesday	Thursday	Friday
Temperature	75˚ F	65˚ F	70˚ F	68˚ F	72˚ F
Air Pressure	31	28	29	30	30
Wind	15 mph	29 mph	24 mph	23 mph	15 mph
Clouds	Partly Cloudy	Cloudy	Partly Cloudy	Clear	Clear

What day will it rain? What season is this? What activity could you do each day?

	Monday	Tuesday	Wednesday	Thursday	Friday
Temperature	32˚ F	30˚ F	22˚ F	21˚ F	28˚ F
Air Pressure	29	27	25	22	27
Wind	10 mph	15 mph	25 mph	34 mph	30 mph
Clouds	Partly Cloudy	Partly Cloudy	Cloudy	Cloudy	Partly Cloudy

What day will it precipitate? What kind of precipitation? What season is this? What activity could you do each day?

	Monday	Tuesday	Wednesday	Thursday	Friday
Temperature	50˚ F	49˚ F	59˚ F	59˚ F	59˚ F
Air Pressure	27	26	28	29	30
Wind	10 mph	20 mph	20 mph	12 mph	12 mph
Clouds	Clear	Cloudy	Partly Cloudy	Partly Cloudy	Clear

What day will it rain? What season is this? What activity could you do each day?

	Monday	Tuesday	Wednesday	Thursday	Friday
Temperature	90˚ F	92˚ F	95˚ F	96˚ F	95˚ F
Air Pressure	30	30	30	30	31
Wind	5 mph	7 mph	2 mph	5 mph	6 mph
Clouds	Clear	Clear	Clear	Clear	Clear

Will it precipitate? What season is this? What activity could you do each day?

Name________________________________

Data Charts for Weather Forecasting

Week of					
	Monday	Tuesday	Wednesday	Thursday	Friday
Temperature					
Air Pressure					
Wind					
Clouds					

Week of					
	Monday	Tuesday	Wednesday	Thursday	Friday
Temperature					
Air Pressure					
Wind					
Clouds					

Week of					
	Monday	Tuesday	Wednesday	Thursday	Friday
Temperature					
Air Pressure					
Wind					
Clouds					

Week of					
	Monday	Tuesday	Wednesday	Thursday	Friday
Temperature					
Air Pressure					
Wind					
Clouds					

Picnic Possibilities

Math Standard V

Objective 1

Connections

Standard V:
Students will collect and organize data to make predictions and use basic concepts of probability.

Objective 1:
Collect, organize, and display data to make predictions and answer questions.

Intended Learning Outcomes:
5. Make mathematical connections.
6. Represent mathematical situations.

Content Connections:
Science II-1

Background Information

Utah's weather is never boring! Our state has just experienced a six year drought, and recently several weather disasters, including severe flooding in the St. George region. While the whole state is temperate in nature, we have eight different USDA plant hardiness zones. There are technically four climatic regions; Desert, Steppe (Semiarid), Humid Continental-Hot Summer, and Undifferentiated Highlands. This indicates great variation in annual high and low temperatures across the state. Because weather mainly moves from west to east in the United States, the presence of the Sierra Nevada Mountains on the border of California and Nevada helps to create the desert environments of the Great Basin.

Planning outdoor activities can be a challenge in Utah. While precipitation may not be a problem in many months, the potential for high summer temperatures and freezing winters in many Utah regions makes "comfortable" outdoor days limited. We do not experience the frigid, wet cold of the central United States, or constant extreme heat of more southern states.

Weather is just one subject area where it is important to use data charts and graphs. Being able to interpret data from graphic organizers can be crucial to everyday life, like planning outdoor recreation. Data appears frequently in newspapers, magazines, brochures, and on Web pages as charts and graphs. The following activity allows students to use data for real-life purposes.

Research Basis

Heidorn, P.B. (1999). Image Retrieval as Linguistic and Nonlinguistic Visual Model Matching. *Library Trends, 48*(2), 303-325.

The article reviews the research on how people use models of images in an information retrieval environment. It describes the human use of images (nonverbal representations) as predating human language and explains that language evolved out of a need to communicate about the world. Verbal language is limited in that it is dependant on a shared experience or shared vocabulary. Some aspects of our mental models are not easily described using words. For example, our brains perceive millions of color indexes and we only have relatively few color names. Some iconic representations are simple and some can be more complex. Our mental models have many aspects including color and shape. Some images are content-based, while others are concept-based.

The Institute for the Advancement of Research in Education. (2003). *Graphic Organizers: A Review of Scientifically Based Research*. URL: http://research@inspiration.com

The report is a complete review of 29 research studies about the effectiveness of graphic organizers. Studies were carefully selected by meeting the institute's criteria for scientifically-based research as defined by the *No Child Left Behind Act*. In the section about the use of graphic organizers for thinking and learning skill, researchers found that students scored higher on tests, retained and transferred learning, and improved critical thinking skills, with the use of graphic organizers. In a section about other classroom work, researches concluded that problem solving, performance, comprehension and retention of learning were all enhanced by the use of graphic organizers.

Assessment Suggestions

- *Rubric for Picnic Possibilities*
- Teacher observation

Invitation to Learn

Show the overhead of *The Man in the Bathtub*. Ask the students if they can tell a story about the water level in the bathtub by reading the graph. Have them share ideas with the class or as partners. Encourage them to use the XY coordinate plane.

Materials

- ❑ *Man in the Bathtub* handout

Instructional Procedures

Materials

- ❑ *Utah Weather Data* handout
- ❑ *Utah Weather Map* (from previous activity)
- ❑ Crayons/colored pencils and scissors for each student
- ❑ Tape or "wall tack"
- ❑ Graph paper

This activity requires advanced preparation. Teacher will need to copy the *Waterdrop Glyphs* and *Temperature Glyphs* onto cardstock, cut out individual squares, and laminate.

1. Provide each student with a copy of the *Utah Weather Data* handout. A copy of a simple Utah map would also be helpful. Place students in pairs.
2. Ask students to look at the data and share anything they notice. Responses may include: It looks like there is more precipitation in the Wasatch Mountains. It's hotter in St. George. Tell the students that they will be helping to organize the data in a way that is easier to read.
3. Review the background information with the students. You may wish to emphasize that this activity will allow them to see the differences in temperature and precipitation in the northern and southern parts of the state. You may also wish to discuss comfortable temperatures for being outside to picnic.
4. Students create a graph for a given table on the data sheet with their partner. Review the kinds of graphs that they have used or worked with and discuss possible formats for the weather graphs. Let them know that at the end of the lesson they will be making a decision about what month would be the best month to plan a picnic in both regions of Utah. They will need to write why these months are ideal.
5. Give students graph paper to make their graphs on.
6. Once the graphs are complete, display them in a central location. Ask them to describe how these graphs might be sorted. You may choose to write these suggestions on a chalk or white board. Ask the students if looking at an individual graph gives them all the information they need to decide which month is best for picnicking in the north and in the south. Tell them that they will be creating another graph in a future lesson that puts all the information together.

During another session, tell the students that they will be working as a class to display all the data on one big graph—a bar graph using pictographs.

1. Display the "picnic cloth" on the board. Explain that graphs are used to make data "pop-out" in a more usable way. After the data has been displayed, partners will work together to choose the best month for a picnic in both regions.

2. Show the students the *Waterdrop* and *Temperature Glyphs* and explain that each waterdrop represents 2" of rain, and each thermometer represents 5˚ Fahrenheit. (You may choose to use different ratios.) Draw a key on the board. Across the X-axis (horizontal line), write the months of the year so that a red strip is for the rain and a white and red strip are for the high and low temperature averages. Using the information on the *Utah Weather Data* handout, choose either the Wasatch or desert data to begin with.
3. Working together as a class, determine how many of each picture will be needed to complete the first bars for January. Assign cooperative groups to take two months and complete the graphs as they determine the number of pictures they will need.

11. When the graph is complete, have groups determine which month is the best picnic month and why. Each individual should record their response in a journal. Answers will vary. Look for logical connections to the weather graph. For instance, "July is the best month in the Wasatch because there won't be a big chance of rain and the temperature is warm, but not too hot." Have groups share their possibilities. Encourage students to question each other for clarification.
12. Repeat steps 10 and 11 for the other region.
13. At the lesson conclusion, use the *Rubric for Picnic Possibilities* to have students score themselves on the activity. You may wish to add your own scores in another color.

Materials

- ❏ Checkered table cloth
- ❏ *Waterdrop Glyphs*
- ❏ *Temperature Glyphs*
- ❏ *Utah Weather Data* handout
- ❏ *Utah Weather Map*
- ❏ Crayons/colored pencils and scissors for each student
- ❏ Tape or "wall tack"

Curriculum Extensions/Adaptations/Integration

- Have students decide the "worst" month to plan an outdoor picnic.
- Using the Utah maps, have students locate counties, cities or national/state parks that are located either in the southern or northern regions of Utah.
- Ask students to gather data about the daily high and/or low temperatures in a particular Utah city for a one-week period of time and to create a line graph to show their data.
- Invite students to research average monthly precipitation and temperatures for your city or area. Have them create graphs and list what types of advantages and disadvantages that area may have if they were trying to ski, hike, or travel.

Materials

- ❑ *Ant Attack Game Instructions*
- ❑ *Ant Attack Game Board*
- ❑ *Ant Attack Food*

- Students create displays about Utah weather using their own ideas about graphing and charting.
- Students may research other weather phenomena (e.g., lightning or high winds) about a given Utah area and create graphs about this data.
- Students can play the *Ant Attack* game to practice coordinate graphing. Remember to have students call the x axis number first.

Resources

Web sites

Utah Drought Conditions
www.water.utah.gov/droughtconditions/default.asp

Utah Climate Summaries (specific state locations)
www.wrcc.dri.edu/summary/climsmut.html

Utah Current Weather Conditions
http://web.ksl.com/TV/weather/index.php

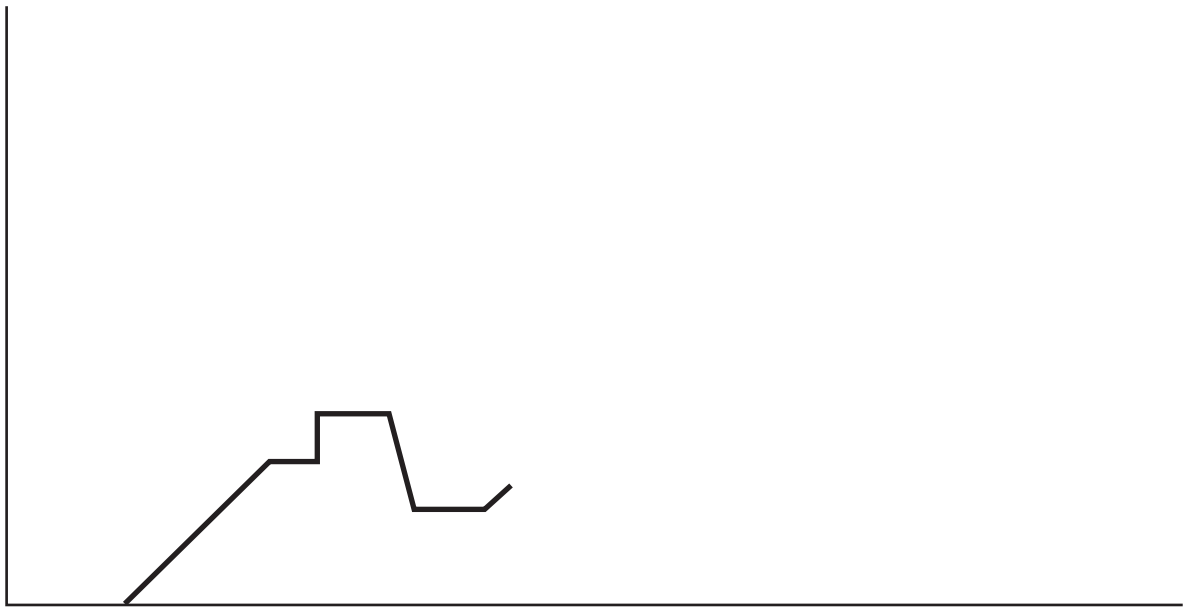
Utah's premier site for state wide current and forecast
weatherhttp://www.utahweather.org/

Family Connections

- Students can plan an indoor/outdoor picnic with their family and predict whether the weather will be best for the indoor or the outdoor version of their picnic.
- Take home the *Ant Attack* game and play with a family member.

Name _____

Man in the Bathtub



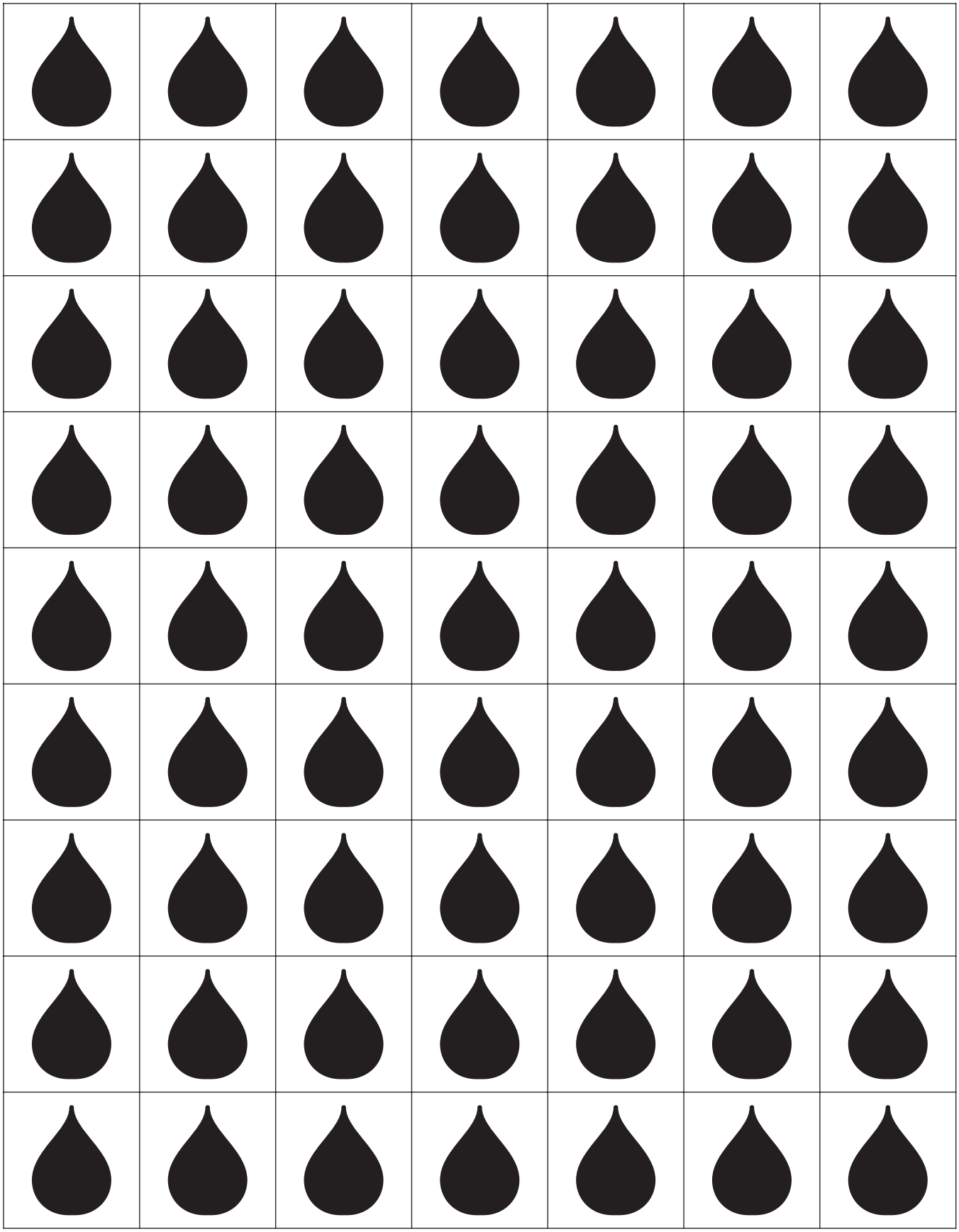
Name _____

Utah Weather Data

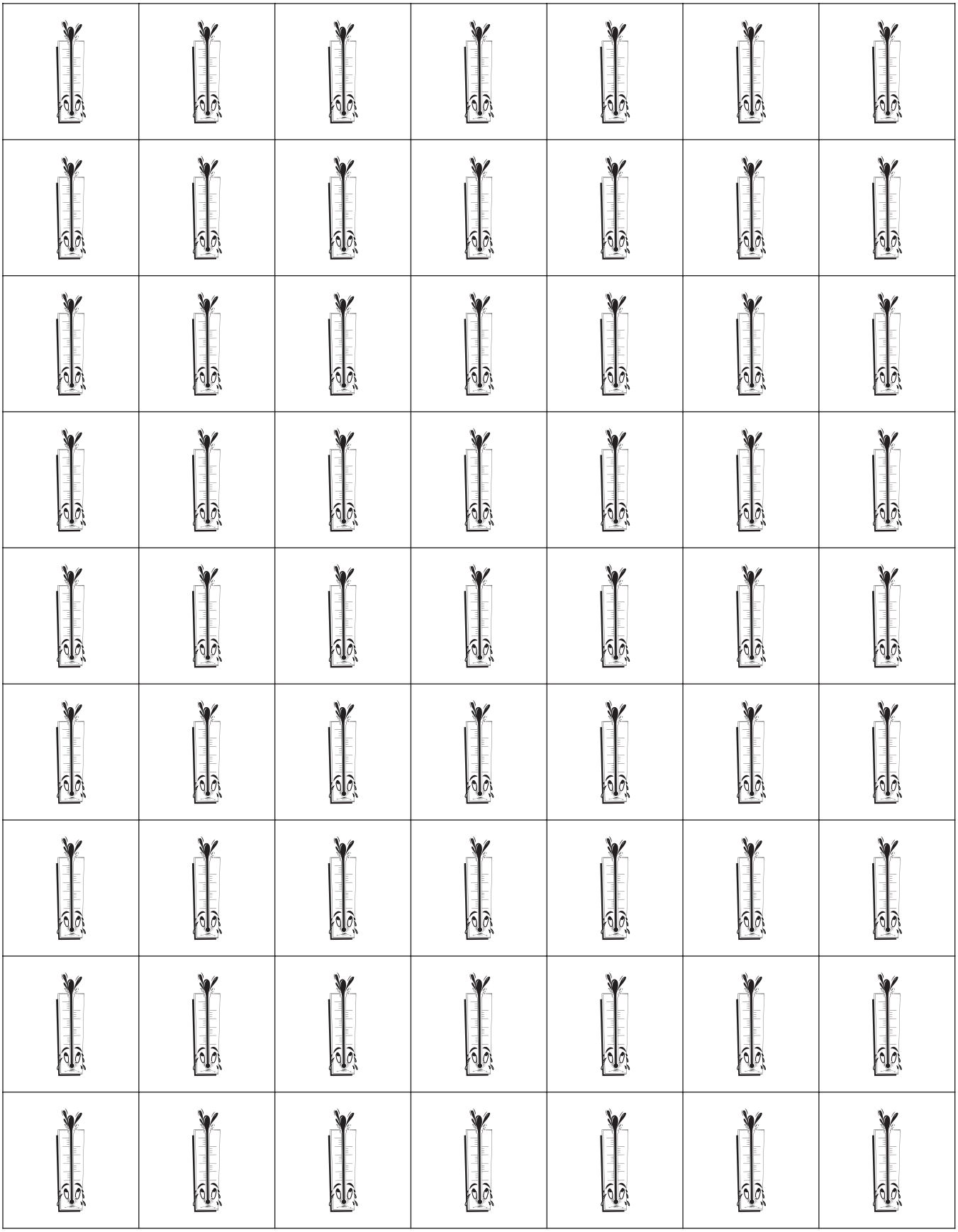
Average Precipitation	Wasatch Front Salt Lake City	Desert St. George
Month	**Inches**	**Inches**
January	1.37	1.07
February	1.33	.84
March	1.91	1.11
April	1.11	.51
May	2.09	.39
June	.77	.17
July	.72	.60
August	.76	.76
September	1.33	.54
October	1.57	.84
November	1.40	.71
December	1.60	.88
Annual	16.50	8.06

Average Precipitation	Wasatch Front Salt Lake City		Desert St. George	
Month	**High**	**Low**	**High**	**Low**
January	37	21	54	27
February	43	26	61	32
March	53	33	68	38
April	61	39	77	44
May	71	47	87	53
June	82	56	97	62
July	91	63	102	69
August	89	62	100	67
September	78	52	93	58
October	64	41	81	46
November	49	30	65	35
December	38	22	54	28

Waterdrop Glyphs



Temperature Glyphs



Name _____

Rubric for Picnic Possibilities

Score	3—My Best Work	2—Average	1—Poor
Our graphs are neatly drawn.			
We graphed the precipitation and temperatures in both regions.			
Our graph has the right information.			
I worked well with my cooperative group.			
I worked well with my partner.			
Total score			

Name _____

Rubric for Picnic Possibilities

Score	3—My Best Work	2—Average	1—Poor
Our graphs are neatly drawn.			
We graphed the precipitation and temperatures in both regions.			
Our graph has the right information.			
I worked well with my cooperative group.			
I worked well with my partner.			
Total score			

Ant Attack Game Instructions

This game is played like Battleship. Students will need to be placed in pairs.

1. Give each student two copies of the game board, plastic ants to mark hits, and five different picnic food pictures. They will also need a pencil and a book or folder to create a barrier between the game boards.
2. Students place their five food items on one of their game boards reserving the other to mark hits and misses.
3. Have students determine who starts the game.
4. The first player calls a coordinate starting with the x axis and then the y axis (i.e. 2,H). They mark their game board with an x for a hit or an O for a miss.
5. The other player places an ant on the coordinate if it is hit. Play continues back and forth until one player "hits" all the other players' foods.

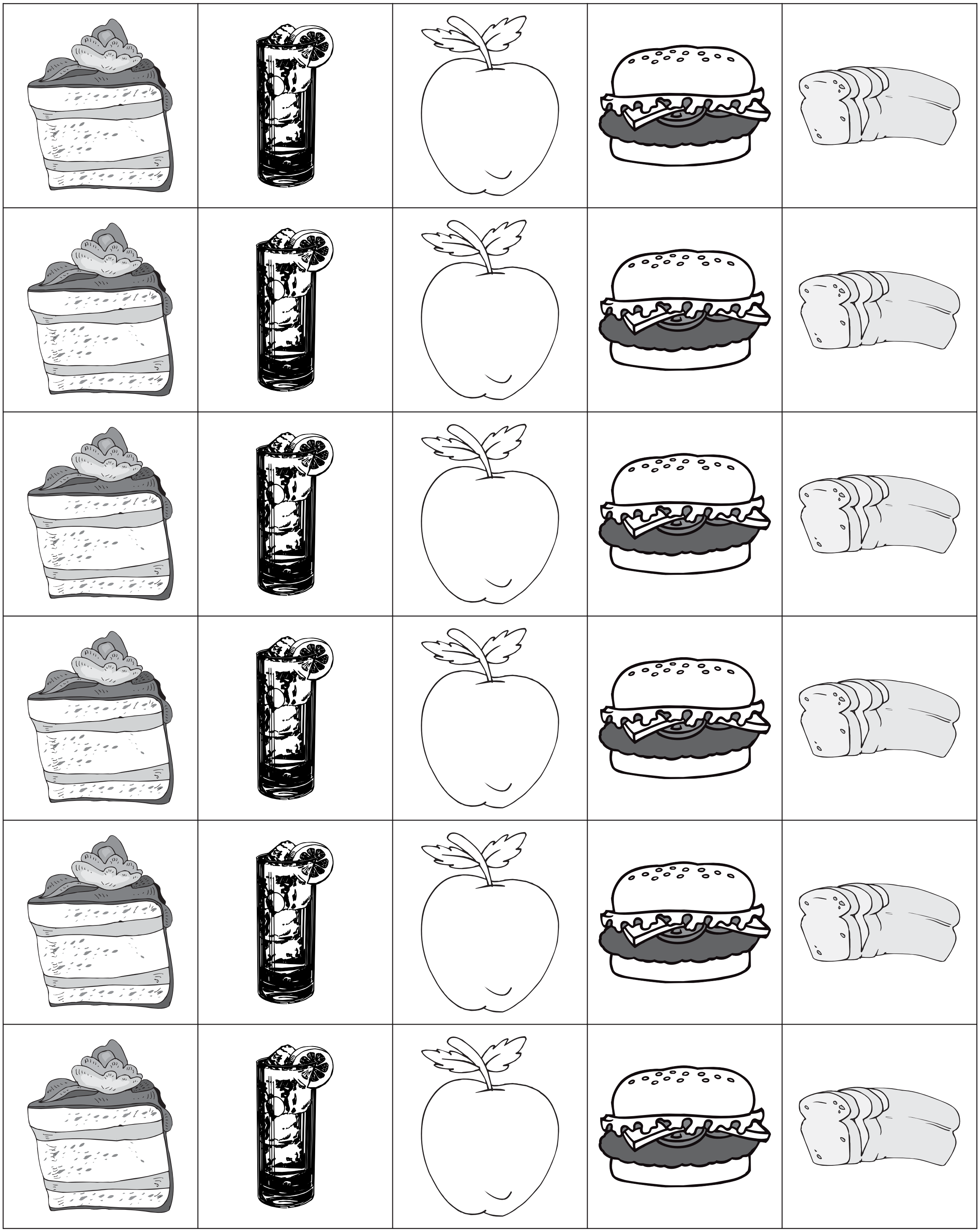
Name _____

Ant Attack Game Board

L									
K									
J									
I									
H									
G									
F									
E									
D									
C									
B									
A	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Name ________________________________

Ant Attack Food



Science Standard III-2 Activities

Plop! Plop! Fizz! Fizz!

Standard III:
Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 2:
Explain how the processes of weathering and erosion change and move materials that become soil.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
3. Understand Science Concepts and Principles

Content Connections:

Science Standard III

Objective 2

Connections

Background Information

Earth's surface is constantly changing. Over time, rocks can be broken down and moved by the processes of weathering and erosion. Weathering breaks rocks into smaller and smaller pieces. There are two types of weathering—*physical* and *chemical*.

Physical weathering is the process that breaks rocks into smaller pieces that have the same composition as the rock they came from. Rocks can be affected by changing temperature. During the day the sun's energy heats Earth, and during the night the rock surface cools. This process can go on, causing the rock surface to peel or flake. Rocks can be affected by water through frost, freezing, and thawing. Water can find its way into a small crack or hole in the rock. When the water freezes, it expands and then, as it melts, it may move deeper into the rock and refreeze. Eventually the rock may break into pieces. Utah has wide temperature swings during seasons, so there is evidence of this physical weathering not only on rocks, but also on our highways. Tree and plant roots may push into a rock and, as roots grow bigger, rock material is pried loose. Gravity can also pull rocks down a hillside where they collide and break into pieces. Abrasion wears away rocks by solid particles carried by wind or water. All of these forms of physical weathering can be seen in Utah.

Chemical weathering may also alter the size of the rock, but it changes the mineral composition or chemical makeup of the rock as well. This can occur through the dissolving action of water. Water mixes with carbon dioxide to form carbonic acid, which can dissolve some minerals over time. Limestone is especially susceptible to rain/carbonic acid. Oxygen can also mix with iron to form rust, which can change the

internal composition of some rock. Mosses and lichens produce acids that weaken the surface of rocks. By altering the minerals of rocks, they break over time. Chemical and physical weathering work together to break rocks apart.

Research Basis

The Institute for the Advancement of Research in Education. (2003). *Graphic Organizers: A Review of Scientifically Based Research*. URL: http://research@inspiration.com

This compilation of 29 research studies about the use and effectiveness of graphic organizers. In using graphic organizers, researchers found that students improved critical thinking skills, retained learning, and had higher test scores when taught to use graphic organizers. These studies were carefully selected by meeting the institute's criteria for scientifically based research as defined by the *No Child Left Behind Act*.

Gibson, Helen L. (1998) Cases Studies of an Inquiry-Based Science Programs Impact on Students' Attitude towards Science and Interest in Science Careers. Paper presented at Annual Meeting of the National Association for Research in Science Teaching. (San Diego, CA)

This presentation explores the relationship between inquiry-based science programs on students' attitudes toward science. The article states that inquiry teaching approach in science helps students to connect classroom activities with personal experiences. Inquiry requires students to work with others while asking questions, searching for and selecting information to answer their own questions. The importance of connecting a problem to a student's own background can empower students to become independent learners.

Lee, O., & Fradd, S.H. (1998). Science for All, Including Students from Non-English-Language Backgrounds. *Educational Researcher*, *27*(4), 12-21.

This article addresses the issue of second-language students needing to have ways of making academic content accessible, meaningful, and relevant. Science learning process through inquiry can benefit second-language students learning through the language of science, such as describing, hypothesizing, reasoning, explaining, predicting, and reflecting. It helps preliterate students understanding through hands-on experiences to provide a foundation for academic learning. Second-language students can manipulate materials, make observations, and connect evidences to help them acquire science vocabulary.

Assessment Suggestions

- *Plop, Plop, Fizz! Fizz!* worksheet
- Depth of journal entries.
- Check student's ability to explain his/her understanding on the *Group Observation* worksheet.
- Group presentation to the class about five new things they learned about weathering.

Invitation to Learn

Give everyone a lifesaver and ask them to put it in their mouth.

Take a small clear container with a lid. Open the container and put about 8-10 sugar cubes in the container. Begin to shake the container.

What do you think will happen? Over what length of time will you see change? What kind of weathering is this? Open your mouth—what size do you think the lifesaver is in your mouth? If this was like weathering, what might we call it?

Instructional Procedures

1. Divide students into small learning groups (four to five students) and distribute the materials.
2. Give each group 10 small graduated cylinders. Each group member is responsible for observing chalk, limestone, sandstone, granite, or marble. Students may work with partners if necessary.
3. Students use the *Plop, plop, Fizz! Fizz!* worksheet and draw their rock. Write a prediction for what will happen if dropped in water and in vinegar.
4. When predictions are finished, have the students measure 35 milliliters of water in one cylinder, and 35 milliliters of vinegar in another. Place their rocks in each container. Cover the lip of the cylinder with a balloon and shake the cylinder 10 times.
5. Wait five minutes and observe the reaction in the cylinder with a hand lens and draw it.
6. When finished, students shake the cylinders again 10 times and watch the reaction.
7. After 10 minutes, have the students observe with a hand lens—drawing the reaction in the cylinder on their *Plop! Plop! Fizz! Fizz!* worksheet.

Materials

For each group:

- ❑ 10 graduated cylinders (small)
- ❑ 5 plastic petri dishes with lids
- ❑ 10 balloons
- ❑ Water
- ❑ Vinegar
- ❑ Chalk
- ❑ Limestone chips
- ❑ Marble chips
- ❑ Sandstone chips
- ❑ Granite
- ❑ Paper towels
- ❑ Pocket hand lenses
- ❑ Tweezers
- ❑ *Group Observation* worksheet

For each student:

- ❑ *Plop! Plop! Fizz! Fizz!* worksheet

8. Students take each cylinder and shake it 50 times, then 75 times, waiting as indicated on the worksheet.
9. Students write a description of the experiment they conducted in their journal. Answer the questions, "What did I predict? What did I observe? Was I right? How did the rock change? Why did the rock stay the same? Was there a difference between the rocks in the vinegar and the rocks in the water? What were the bubbles in the water? Was there change in the rock? What surprised you?"
10. Slip off the balloons and take pieces of rock out of the cylinders with tweezers. Place them in the lid of the Petri dish to see what changes have taken place. Fill in the "After" comments and draw the rock on the worksheet.
11. Students share in their group the reactions and changes that their rocks made. Have them fill in the *Group Observation* worksheet.
12. Discuss as a class what was observed. Which reaction was chemical weathering and which was physical weathering? Why were there differences? What do you think could happen over time with water? With acid? Where might we see this type of weathering in Utah?
13. Students write their reactions and observations of all the rocks in their group in their journals. Describe what kind of weathering they observed and draw a picture of the rocks with the largest reactions. Which rocks did not react?
14. Complete a graphic organizer about weathering.

Curriculum Extensions/Adaptations/Integration

- Leave the balloons that have filled with gas on the graduated cylinders and watch to see how long before the balloon returns to flaccid state.
- Make a Venn Diagram of two different areas of Utah, e.g., Bryce Canyon and Wasatch Mountains. What is the same, what is different? How would what we did relate to these areas in terms of weathering.
- Have students research the Internet Sites on State/National Parks in Utah to determine what kinds of weathering caused the landforms in the area.
- Ask students if they have been to a cemetery. What happens to the headstones?

- Have students create a K-W-L chart to show what they know and list what else they would like to learn about weathering.

Resources

Books

Grand Canyon, A Trail Through Time, by Linda Vierira; ISBN 0802775691

Everybody Needs a Rock, by Byrd Baylor; ISBN 0689710518

Earth, All About Earthquakes, Volcanoes, Glaciers, Oceans and More, by Carol Allen; ISBN 1895688061

Earth, by Science Photo Library; ISBN 0671686291

Mountains, by Seymour Simon; ISBN 0688154778

Web sites

Weathering in the Utah National Parks: http://www.nps.gov/brca/geology

U.S. Geological Survey Site: http.www.usgs.gov/

Geologist's Lifetime Field List of Things to see: www.uc.edu/geology/geologylist/

Family Connections

- Take your family to a cemetery and talk about the weathering of headstones.
- Do the class experiment at home with a family member.

Name _____

Plop! Plop! Fizz! Fizz!

Type of Rock:			
Water		Vinegar	
Before Illustration	Prediction	Before Illustration	Prediction
Shake 10 times and wait 5 minutes			
Illustration	Observation	Illustration	Observation
Shake 10 times and wait 10 minutes			
Illustration	Observation	Illustration	Observation
Shake 50 times and wait 10 minutes			
Illustration	Observation	Illustration	Observation
Shake 75 times			
After Illustration	Observation	After Illustration	Observation
Comments		Comments	

Name _____

Group Observation

Rock	Water	Vinegar
Chalk		
Limestone		
Sandstone		
Granite		
Marble		
Observations		

Slip Sliding Away...

Science Standard III

Objective 2

Connections

Standard III:
Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 2:
Explain how the processes of weathering and erosion change and move materials that become soil.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests

Content Connections:

Background Information

How does erosion move and change the shape of Earth?

All along mountains and hillsides, weathering is breaking down rock into small pieces. These pieces can be sand, gravel, or small bits of clay. As this material is broken up, it is moved by erosion from place to place. The agents of erosion include gravity, moving water, ice, waves, and wind. Deposition is the process of laying the weathered material, called sediments, in a new location.

Running water is a major cause of erosion. Stones carried with a river's current scour and abrade the banks and beds. Ocean waves can erode banks and beaches, especially during storms. When an area receives more water than the ground can absorb, the excess flows to the lowest level, carrying loose soil with it. The world viewed the effects of erosion in December 2004—the tsunami in the Indian Ocean, landslides on rain-soaked California hills, and flash flooding in St. George that ravaged homes and property. These are graphic reminders of erosion that causes constant changes in land. In Utah we have many examples of erosion around us through our varied landscapes from northern to southern Utah.

Research Basis

Haury, D. L. (1993) *Teaching Science through Inquiry*. ERIC/CSMEE Digest. www.eric.ed.gov.

This article addresses the benefits of teaching science through inquiry. Inquiry based programs have generally been found to enhance students performance especially in laboratory skills, understanding graphing and interpreting data. Inquiry related teaching is also helpful in helping students understand the scientific process and build vocabulary knowledge.

Ryan, P., & Walking-Woman, L. (2000). Linking Writing to the Process of Scientific Inquiry: Strategies from Writing Teachers in the Disciplines. Paper presented at Annual Meeting of Conference on College Composition and Communication.

This paper encourages teachers to help students use writing as a tool of inquiry. In the disciplines of science, there is benefit for students when completing "hands-on" activities to use writing as a tool of thinking. Rather that just giving answers, students should use writing to show evidences, synthesize data and make conclusions. Writing, when associated with inquiry, can require students to find data and develop skills for dealing with methods of reporting.

Wolf, D. P. (1987). The Art of Questioning. *Academic Connections*, 1-7.

This article attends to the issue that teachers need to develop positive questioning strategies in the classroom. Teachers have the ability, through their range of questioning, to guide students to discover new information. Some of these methods of questioning include inference, (going beyond the available information), interpretation (filling in missing information), hypothesis (predictions & testing), and reflective (what do I know?). If teachers use questions to provoke an atmosphere of inquiry and personally process "when to ask," "who to ask," and "how to ask and respond," then classrooms will provide students with more learning possibilities.

Assessment Suggestions

- Encourage students to draw a mountain that would have the least amount of erosion. Have them include the materials that would resist erosion longest.
- Students predict what would happen if the bottle used to simulate rain had one hole, 8 holes.
- Check Journal entries and *Canyon Building Model* for understanding.

Invitation to Learn

Put a box of sugar cubes on a tray, pouring warm water through the center of them. What will happen? What is that called? How is that different from weathering? Show a pile of sand with coins on the top. Gently drip water over the top of the sand and coins. What do you predict will happen? Do we have places in Utah that might have been formed this way? Show calendar pictures from various places in Utah and discuss what the forces of erosion are evidenced. Question if anyone has seen the effects of erosion on the news or in the newspapers this year in the world, the United States, or Utah.

Instructional Procedures

Materials

- ❑ Potting tray (without holes) 21" x 8"
- ❑ 3 20 oz. bottles of water
- ❑ 10 2-liter bottles
- ❑ Rocks
- ❑ Potting soil
- ❑ Gravel
- ❑ Sand
- ❑ Paper cups
- ❑ Small plastic toys
- ❑ Artificial turf (cut in 3" x 5" pieces)
- ❑ Toothpicks
- ❑ 5 plastic baggies
- ❑ Ruler
- ❑ String
- ❑ Measuring tapes
- ❑ Stop watch
- ❑ Paper towels

1. Students are placed in five groups. Explain to the class that their task will be to build a mountain that will withstand the effects of having water poured over it.
2. Each group will receive different materials.
   Group 1: sand/gravel
   Group 2: sand/rocks
   Group 3: gravel/rocks
   Group 4: soil/gravel
   Group 5: soil/rocks
3. Students are instructed to observe their materials and record their observations on their plan sheets. Each group devises a building plan which they label and draw on their building sheet.
4. Have the students construct their mountain using only the materials they were given.
5. Tell the students they are going to observe erosion rates on their mountain with rain simulated from the 2-liter bottles. They must decide how they will measure the "run-off." Have rulers, string, and measuring tapes available. (Help guide them through what possible ways of measurement. Sometimes it is hard to measure some things because of their shape and size. How might you do it?) Have each student draw the mountain and label it's content materials in their journal. Then write a prediction about what will happen to the mountain when the water is poured over it.
6. Have one student in each group be the "Rainmaker," watering the mountain while standing next to the desk holding Bottle #1 (bottle with 3 holes) at arm's length.
7. One group member will time how long it took to empty the bottle.

8. When the bottle is empty, have the students decide how to measure the amount of eroded material coming out from the bottom of the mountain.
9. Have them measure and record the eroded material.
10. Going back to their journals, students predict what will happen to the mountain when water from Bottle #2 (bottle with 6 holes) rains.
11. Bottle #2 will be poured over the mountain by another member of the group. When the bottle is empty, a group member will note the time. Each group measures the amount of eroded material and adds that to their collected data. When finished, have the students go to their journals and answer:
    - I predicted _____
    - My prediction was _____
    - What surprised me_____
12. As a group, report the group findings. Use an overhead transparency to record each group's materials and rates of erosion.

    Have a group discussion: What materials eroded the most? Why? Whose materials did not erode? Why? What would you use to build a mountain that would erode the least? What is a sediment? Will sediments erode quickly?
13. Ask each group to rebuild their mountains and see if there are some things that might stop erosion. Hand them a plastic bag containing toothpicks, artificial turf, monopoly house, toy people, etc.

    Ask students to answer these questions:
    - Do you think there will be change in water flow the way the hill is rebuilt?
    - Will there be as much erosion?
14. Refill Bottle #2 with water and "rain" on the mountain. What happens?
15. What did you see this time? Ask the students to share:
    - What ways did the mountain change? Why? What forces are working?
    - What ways did they stay the same? What was different?

16. Discuss with the students what factors affect erosion. Can these be changed? What is the difference between weathering and erosion? Have students write their own definition of erosion in their journal and draw an example.
17. Show the *Canyon Building Model* transparency and review erosion.

Curriculum Extensions/Adaptations/Integration

- Build a mountain at home. What would you build it of that would be different from the one at school?
- Identify areas in Utah that have erosion. Collect pictures of them and put them on a map of Utah.
- Make a coordinate grid map where weathering and erosion have occurred in Utah.
- Make a collage of weathering and erosion landforms throughout Utah.

Resources

Books

Mountain Dance, by Thomas Locker; ISBN 152026223

The Unfolding River, by Michael March; ISBN 1561381160

The Mountain that Loved a Bird, by Alice McLerran; ISBN 0887080006

The Mud Family, by Betsy James; ISBN 0195124790

Web sites

Investigating earth systems: www.agiweb.org/ies

The National Park Service Site has good explanations of how the National Parks in Utah were formed by weathering and erosion. Click on individual Utah parks.

The Discovery Channel site: http://school.discovery.com/lesson

Ideas from Wondernet: http://www.chemistry.org

Dirtmeister's Science Reporters: Erosion: http://teacher.scholastic.com/dirtrep/erosion/index.htm

Family Connections

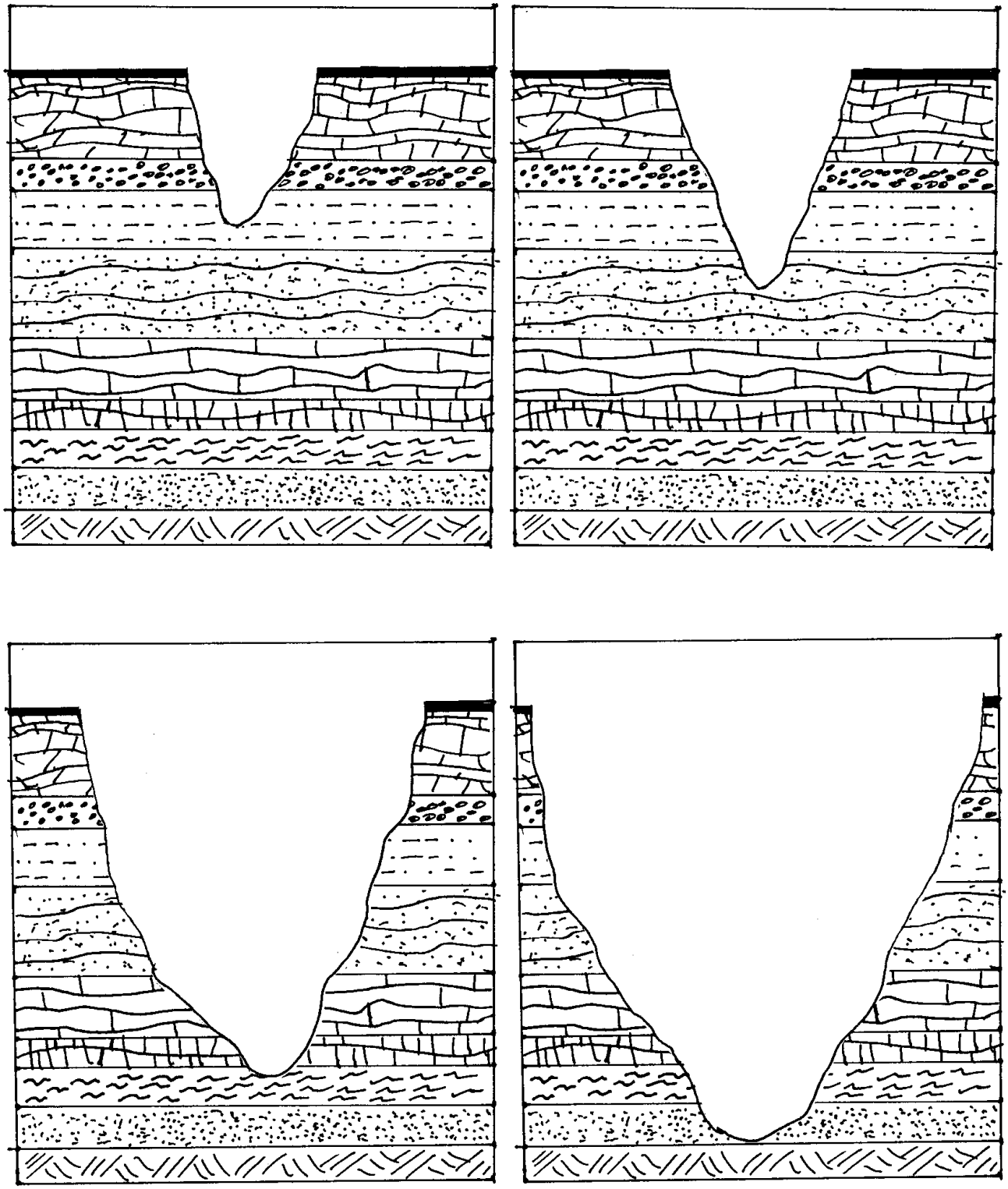
- Listen to the news to see where there are erosion disasters in the world.
- Ask your family if you have been on a trip where there has been erosion.

Name _____

Slip Sliding Away

Material	Number of Holes	Time to Empty	Depth of Erosion	What the Mountain Looks Like	
				Before	After
Rebuilt Mountain					

Canyon Building Model



Name _____

Landform Creation

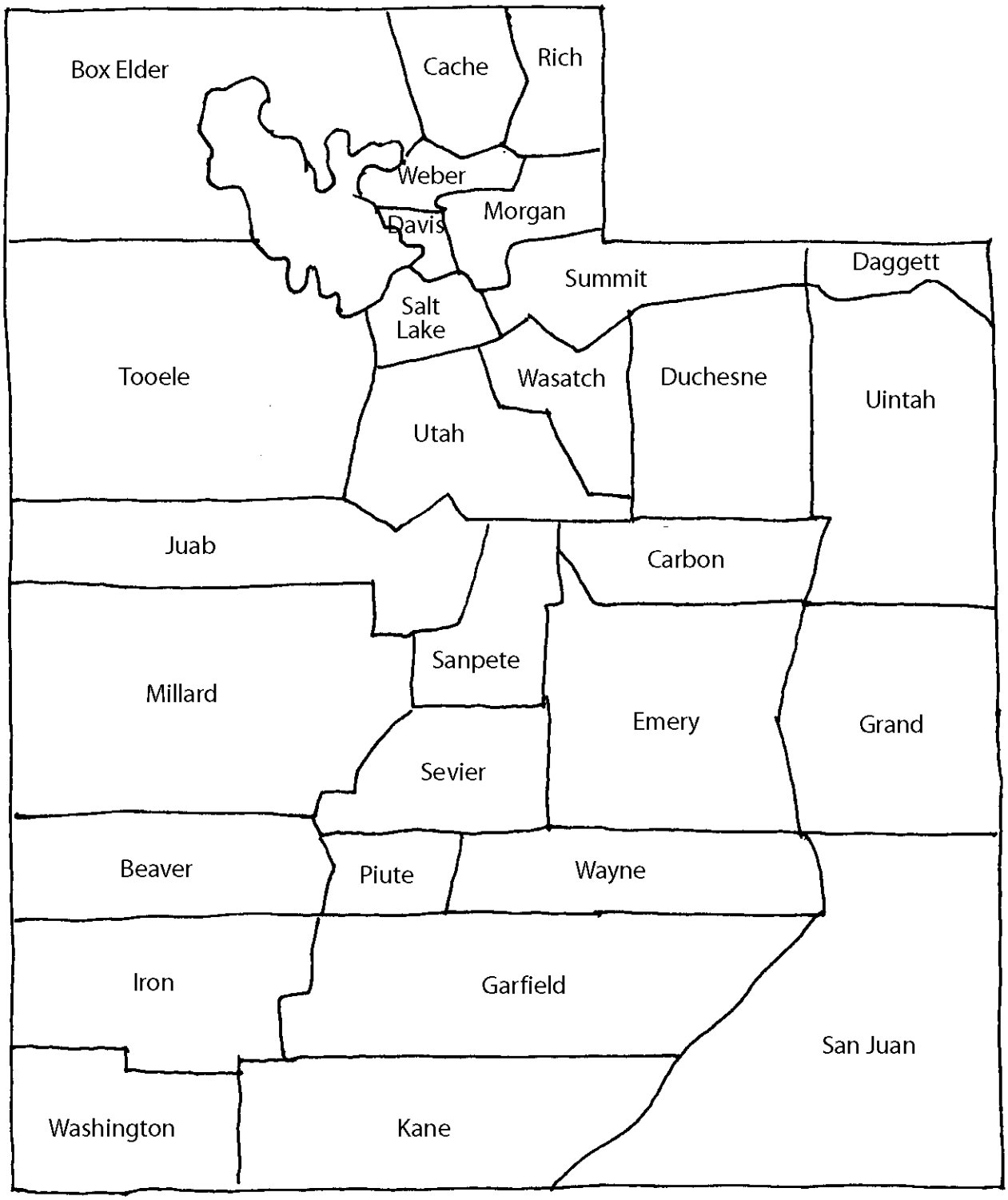
Draw what the land looks like and explain what you think happened to make the land this way.

_____

_____

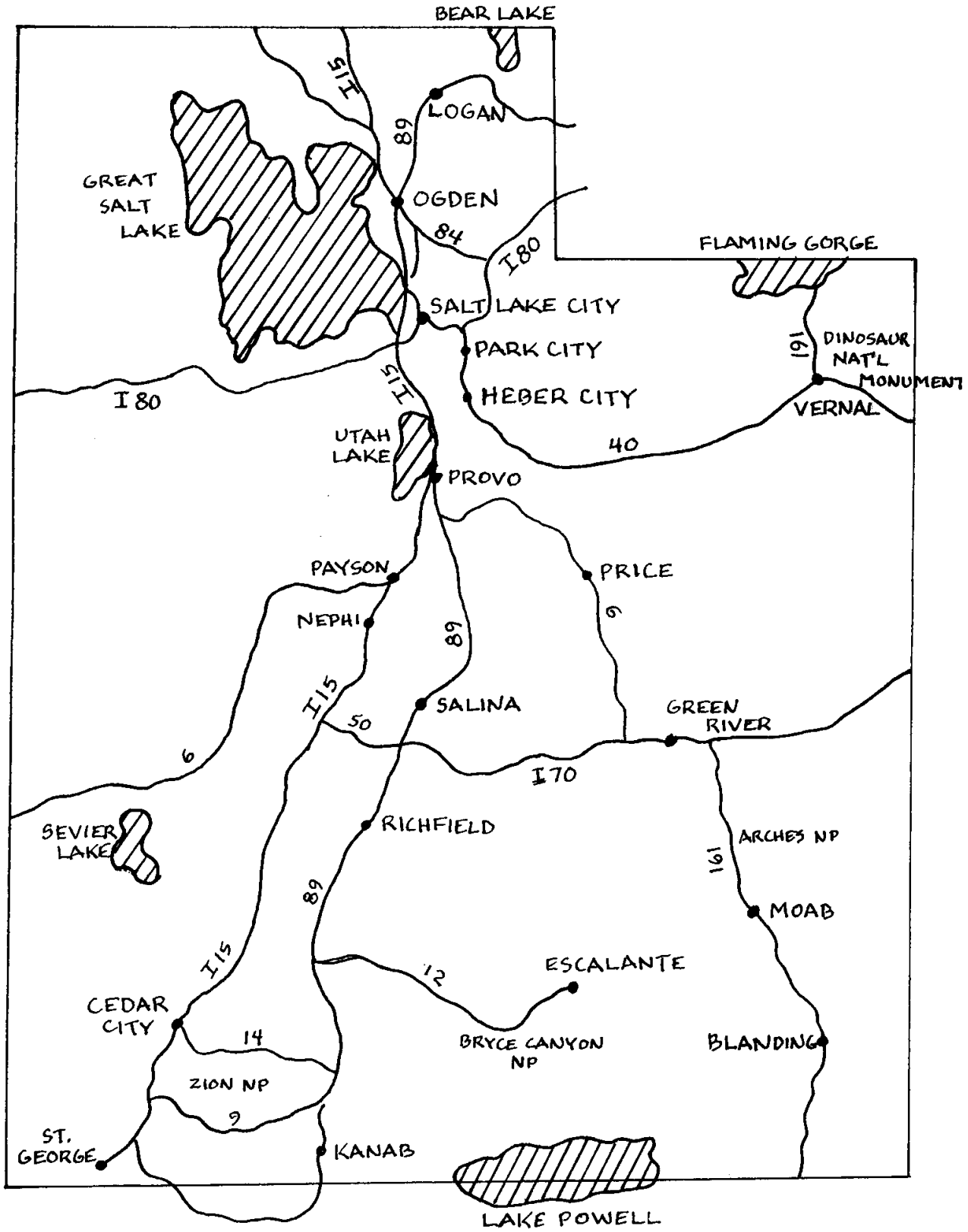
Appendix

Utah Counties Map



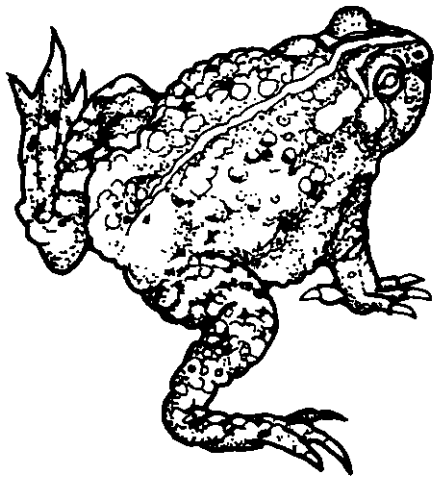
Name _____

Map of Utah

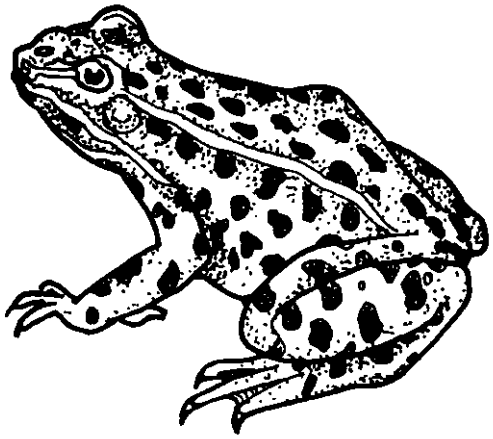


Amphibian Information Cards

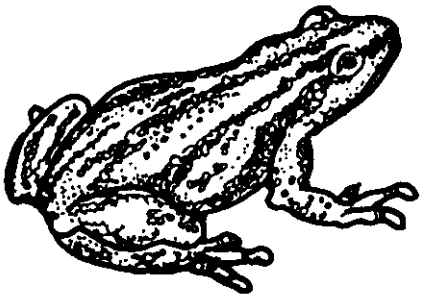
Great Basin Spadefoot Toad
Small, 1 1/2-2 1/2 inches.
Common throughout Utah.
Rough, warty skin. Grayish green.
Wedge-shaped spade on each hind foot. Bump between eyes.
Light stripes on sides.



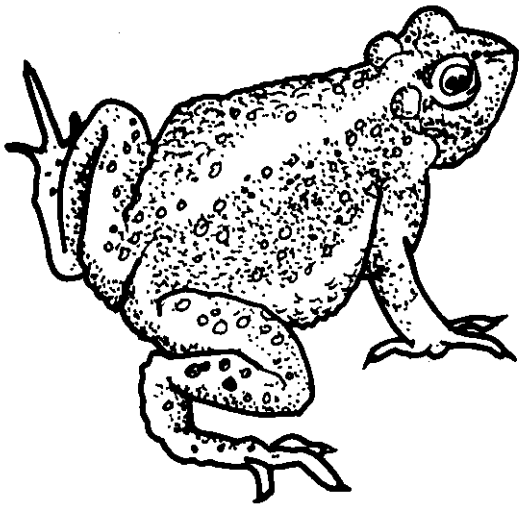
Woodhouse's Toad
2 1/2-4 inches long.
Common throughout Utah. Nocturnal.
Head ridge. Prefers deep soft soil for burrowing. Rough, warty skin.
Color varies, but usually dark with irregular spots.



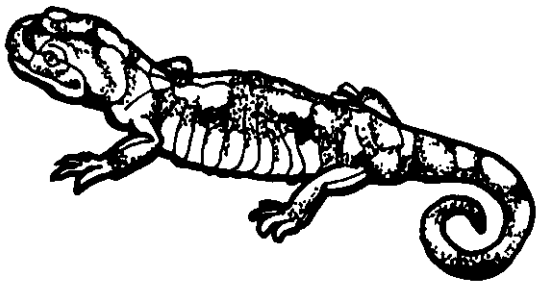
Northern Leopard Frog
Medium-sized, up to 5 inches long.
Lives near cattails and other aquatic vegetation throughout Utah.
Slim, long-legged. Moist skin with green or brownish-colored back with dark spots.



Boreal Chorus Frog
Small, 3/4-1 1/2 inches long.
Lives in grassy areas, damp marshes, woodlands, river swamps. Seldom seen. Moist skin, greenish gray/brown colored. Three stripes on back.
Dark stripe that runs through eye all the way across back.

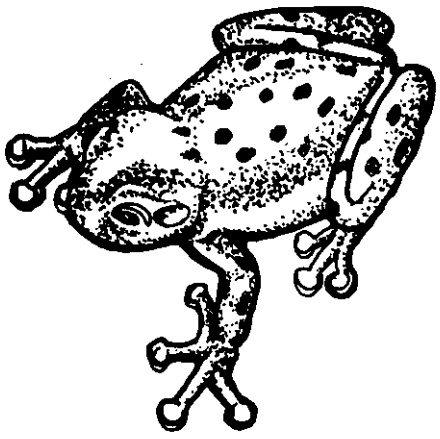


Red Spotted Toad
Small, 1-1/2-2 1/2 inches long.
Found in southern Utah; climb and live among rocks near water. Rough, dry skin with many red or orange warts.
Nocturnal



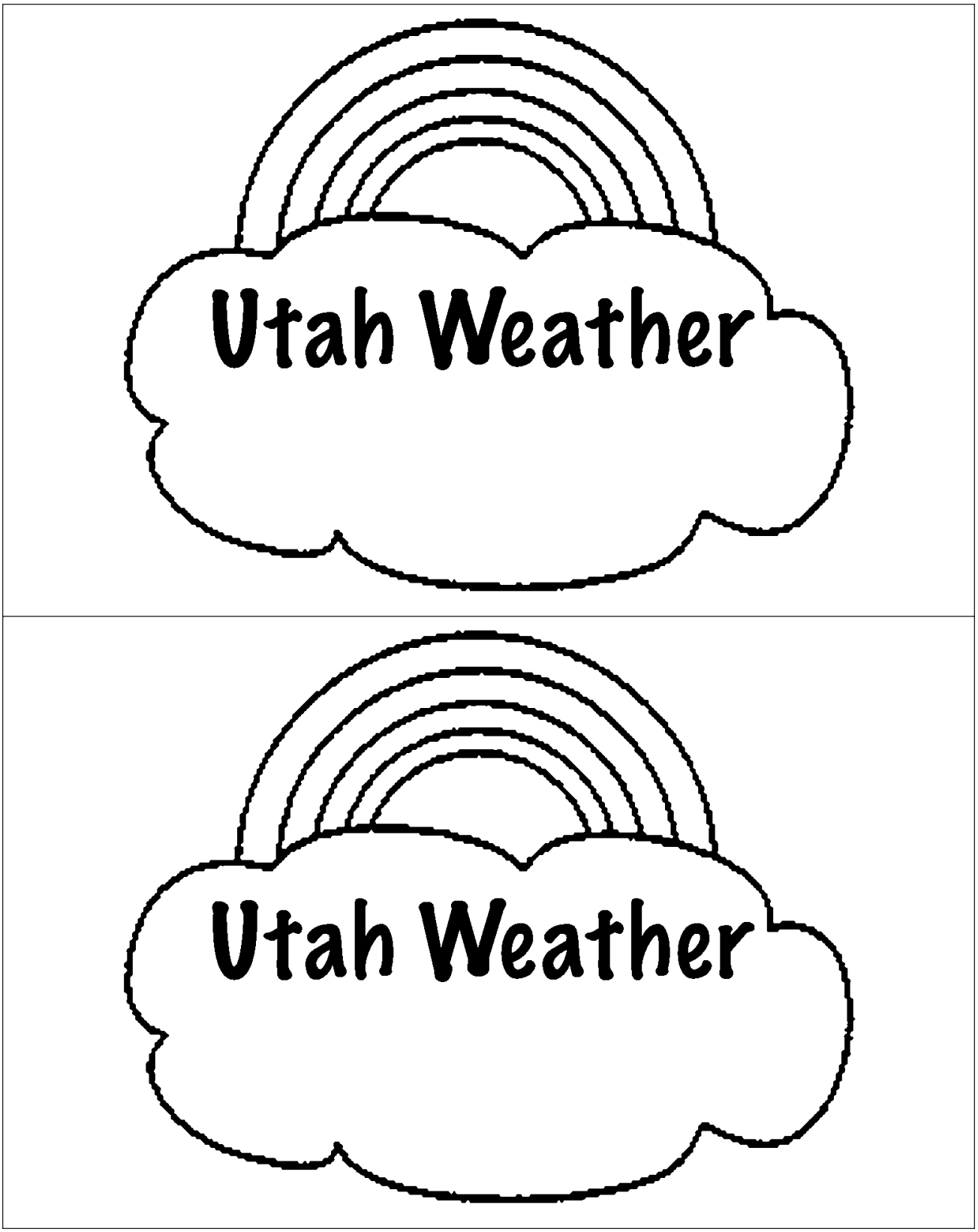
Tiger Salamander
Grows up to 13 inches in length.
Short legs, feet, not webbed feet.
Found in ponds, reservoirs, lakes, rain pools, and streams. Except in West Desert, rarely seen.
Dark with yellow or pale green "tiger-like" markings.

American Bullfrog
Largest frog in Utah.
NOT native, taking over habitats.
Usually green.
Moist and smooth skin.
Distinctive spot/eardrum.



Canyon Tree Frog
Small, less than 2.5 inches.
Found in southern Utah.
Like bottom of rocky canyons.
Does not often climb trees–prefers ground.
Nocturnal.
Moist, smooth skin.

Utah Weather Glyph



Name _____

Ant Attack Game Board

L									
K									
J									
I									
H									
G									
F									
E									
D									
C									
B									
A	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Name _____

Landform Creation

Draw what the land looks like and explain what you think happened to make the land this way.

_____

_____

Name________________________________

Ant Attack Food