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ABSTRACT

The purpose of this symposium was to provide a forum for the interchange of state of the art mathematics and science education teaching in two Southeast South Dakota National Science Foundation Statewide Systemic Initiative projects. Presentations include: (1) "To Get This Car Moving, We Will Have to Put It in Gear" (Delmar Janke); (2) "Math Change: More Than Pennies, Nickels, and Dimes" (William Tomhave); (3) "When the Night has a Fever, It Cries in the Morning: Weather Folklore in the Science Classroom" (Lana Danielson); (4) "Tablecloth Mathematics: Create, Conjecture, Cost" (Roger Parsons); (5) "Labs: They Aren't Just for Science Anymore" (Deana Daum); (6) "Having Families Involved in Student's Learning Imperative: A Plan for Implementation" (Delmar Janke); (7) "Spatial Reasoning Activities Using Squares and Cubes" (William Tomhave); (8) "Weather Wizards" (Dean Albertson); (9) "The Web for Science Ed" (Robert Wood, Michael Hoadley, and Dale Farland); (10) "The Effect of the Interaction of Lactic Acid and Carbon Dioxide in Post Exercise Skeletal Muscle Cellular Respiration" (James Richardson); (11) "Invitations to Learn Which Are Difficult to Not Accept" (Delmar Janke); (12) "Science, Society, and America's Nuclear Waste" (Gail Westmoreland); (13) "Creek Quest Expedition Organization Plan with Equipment/Supply List" (David Broadwell); (14) "The Effects of Instruction in Heuristics on the Use of Problem Solving Strategies and Problem Solving Performance of Preservice Elementary Education Majors" (Janel Fiksdal); (15) "Teaching Math in an Integrated Environment" (Sheila McQuade); (16) "Plant Tissue Culture-African Violet" (Mark Buechler); (17) "Project-Based Learning-Integrating Science, Communications, Technology, and Social Studies" (Ron Newell); (18) "Eating Your Way Through Mathematics: Integrating Children's Literature and Cooking" (Maurine Richardson, Constance Hoag, and Margaret Miller). (JRH)

The Second University of South Dakota Mathematics and Science Symposium

Proceedings

Second Eisenhower Focused Initiative
K-12 Mathematics & Science Symposium
University of South Dakota
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Paul B. Otto, Ph.D., Editor

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Symposium Preface

The University of South Dakota Began early in the evening with opening remarks from Dr. Delmar Janke, science education, from Texas A and M University. His presentation entitled "To Get This Car Moving, We Will Have To Put It In Gear!" was quite timely in respect to the present emphasis on student-oriented, hands-on, project-based learning in science education. Dr. Janke urged members of the audience to continually improve their professional status through dialog, reading, and attending and presenting at professional meetings. He launched into a suggested teaching model by referencing a personal childhood experience with Christmas tree lights connected in series. A sequence of eliminating bulbs in the circuit led to normal processes easily integrate into today's teaching of science based on student interests and experiences. A very workable model for assessment (based on teaching practice) was introduced with several excellent examples for modeling in the classroom.

On Saturday morning, the principal speaker was Dr. William Tomhave, mathematics education/mathematics, Concordia College, Moorhead, Minnesota. The title of his presentation was "Math Change: More Than Nickels, and Dimes. A review of some of the national studies and board recommendations criticizing mathematics education was followed by an overview of the four goals of the 1989 National Council of Teachers of Mathematics (NCTM) recommendations. The goals covered mathematically literate workers, lifelong learners, opportunity for all, and an informed electorate. Dr. Tomhave gave an enlightening discourse on the 1989 NCTM Curriculum Standards as well as the 1991 NCTM Professional Standards. He shared some intriguing ideas in respect to the concept of change in mathematics teaching. Perhaps the problems in bringing about change was best focused on a quotation from James Whitney of Honeywell; "It is easy to change if you have been a failure. It is difficult to change if you have been successful. And the corollary of Ross Taylor, a former mathematics consultant to the Minneapolis Public Schools; "It is impossible to change if you are a failure but you believe you are successful!"

Small-group presentations filled the Friday evening and Saturday schedule. The purpose of the symposium was to provide a forum for the interchange of the state of the art mathematics and science education teaching in two Southeast South Dakota National Science Foundation Statewide Systemic Initiative projects. The project director wishes to thank Ms. Deana Daum from the Lake Andes, South Dakota and associated schools NSF-SSI project as well as Mr. Robert Vanderlinde, and Mr. Randy Gibbons from the Southeast Area Cooperative NSF-SSI project for their guidance in planning the symposium.

The project director also recognizes the assistance in planing of the symposium and making small-group presentations by Dr. Gail Westmoreland, science education and Dr. Roger Parsons, mathematics education, University of South Dakota. Their editorial activities in respect to the Proceedings is also appreciated.

Paul B. Otto, Ph. D.
Project Director
Proceedings Editor

Science Opening Address
To Get This Car Moving, We Will Have To Put It In Gear!"

Delmar Janke
Texas A & M University

John Denver once said in addressing the topic, "On Becoming Human", that he wished to be appreciated as an intuitive person - one who has recognized directions in which we should move, but that it is acknowledged that not many of his thoughts to be shared were going to be new ones. They were good ideas that had been around for some time and that they were recognized as good ideas, but that they were not being implemented to any great degree.

It is being suggested here that the same truth holds for the reform of the enterprise of education. We have many of the answers, but it seems that they are not being implemented to anywhere near the degree that they should be implemented.

Institutionalizing Change

So, what can be done to implement more of the ideas and practices which have merit? One thing which must be done is to identify some potent ideas/practices which we as a profession can agree are worthy of pursuing and then agree to together implement those ideas/practices even though they just possibly may not be our personal "favorite" ones. Surely, a goal implementing such ideas as "less is more" into our practices will be acceptable to a majority in our profession. So, let's do it and continue to do it for at least the next 20 years! (More about that number later!)

Many of what should become recognized as those "potent ideas/practices" are being identified in recommendations as those found in the "Professional Standards for Teaching Mathematics" developed by the National Council of Teachers of Mathematics for the field of mathematics and by Project 2061 in their Benchmarks for Science Literacy and the National Research Council in their National Science Education Standards for the fields of science.

Timeframes For Change

Many educators have claimed that changes being recommended for the teaching of mathematics and science have been coming to us too frequently in too short of times between different sets of recommendation packages which seem very different from each other. In a recent AAAS Science Forum on the topic of Reform in Science Education Iris Weiss and Mark St. John agreed that in order to make systemic change, whatever is proposed must remain an unchanged proposal for a relatively long period of time. In fact, twenty years, for a number of reasons, is what might be viewed as that relatively long period of time. Many educators would respond, "Amen! Let's set the goal for some major changes and not change our minds in 3-5 years. We are sick and tired of expending a great deal of time and other resources in implementing good ideas/practices only to be told in a short period of time that those ideas/practices are no longer valuable ones and we must now implement a new set."

Surely, we can agree upon some set of important changes which we will make and then focus on them for a sufficiently long enough period of time to have those changes significantly implemented. That is not to say that there might not be some intelligent tinkering with those or other goals, but that significant energy will be directed toward the identified important changes and that those changes will be institutionalized.

So, What Can Each of Us Do About Making Important Changes?

Basically, do not stay the same as you presently are, professionally! Become willing to change and not only make changes based upon suggestions from such goal-making endeavors as outlined by Project 2061 in their publication, Benchmarks for Science Literacy, but beyond that, select some area or a few areas in which changes are being recommended in which you have some expertise and help other educators by strengthening their skills in those areas by your sharing.

We are often inclined to ask, "Why me? I do not have the time and I doubt that I have the expertise to make a significant impact in achieving major changes in the way mathematics and/or science is taught in the United States." To which my reply can only be, "If not me, who? If not you, who?" It is our profession and only if you and I make changes will anything ever be accomplished.

Review the recommendations for change which have been made and make a decision on which one or ones you can aid in implementing. Talk with others in the profession and then make the effort to cause the change. Enlist others in your effort. Go to a professional meeting and share your ideas while receiving additional ones. While doing this, share your ideas/practices with colleagues in your school or nearby schools. And implement the changes, revising ideas and practices as indicated by feedback from the local teachers with whom you are working.

An Example From Assessment

One of three areas in which I am working is that of assessment. Many of us realize that pencil and paper evaluations have their place and, in fact, can be very worthwhile, but we also know that as presently practiced something is left to be desired using only such evaluations.

I use a technique which I refer to as "deep digging" assessment.
An Example of "Deep-Digging" Assessment: Electrical Circuits

Description

Important Background Information:

I came from a poor family. My father was an automobile mechanic and I enjoyed helping him in the garage and was especially fascinated by the process of stripping electrical wires and re-connecting them to make a usable circuit.

What Happened

One of my favorite holidays is and always has been Christmas. Among other things, I have always enjoyed decorating the Christmas tree.

As a child of about 6 or 7, I "commandeered" the job of getting the three strings of Christmas tree lights which we had ready to be installed on the tree. Our bulbs were the kind where if one bulb was burned out, the whole string of eight bulbs would not operate. What Kind of an Electrical circuit was that? (series). Why wouldn't the bulbs other than the burned out one light? (In a series circuit if the path is interrupted in any place, no electricity flows). Up in the warm attic during the summer, some of the bulbs were loosened and I soon learned to make sure all of them were screwed in before attempting to light the string of bulbs.

Sometimes after making sure that all of the bulbs were screwed in, a string of lights still would not light. What was probably the problem? (A bulb was burned out). I would then take one of the spare replacement bulbs and in turn screw each bulb from that set out until I located the burned out bulb. But sometimes I still could not get the string to light - What was the problem? (More than one bulb was burned out.) Being a fairly intelligent boy, I soon recognized that I could test each of the bulbs in a receptacle of a set which was successfully lighting.

One year when the strings of lights were brought down, one of the bulb holders was smashed beyond repair. This was a significant problem since we really did not have money to purchase another set. But then, my experiences of helping Dad in the shop made me think of cutting that receptacle out, stripping the wires, and reconnecting and taping the wire to make a usable set of bulbs. I did this and now plugged in the set of seven bulbs. And, indeed, it lighted, But something was different -What was that? (Since the resistance was lowered, the electrical flow was greater and the bulbs were brighter than previously).

Now my ten-year old (or thereabouts) mind said to me, if another bulb were removed, the bulbs would burn still brighter (10 year olds frequently do not think ahead that mom and pop will notice that the wires have been cut and retaped in several places!!). So, I removed another bulb and socket - What was the result? (Indeed, in the remaining six bulb series each bulb burned brighter yet).

And then, taking the ultimate leap, my mind said, "Wow, if there were only one bulb in the circuit, it should be really bright." So, I cut and repaired the circuit such that there was only one bulb in it. What Happened? (The bulb, indeed, was very bright - and burned for a very short period of time - and then "blew"!!). Why? (Little resistance, lot of electrical flow, filament heated to melting point). So, at that time I repaired the set of bulbs to be a seven bulb circuit.

At this point for reasons of time and space, I will leave the circuits example which would continue on to parallel Christmas bulb circuits and the circuits which are now present in the strings of miniature bulbs which are presently in wide-spread use.

So, Now What?

I have accomplished generating one assessment item and perhaps setting a model for other such items in other science topic areas may be meaningful, but what must happen to develop this into a significant part of institutionalizing reform in science education? Generating assessment items of the nature of the one presented for many science topics and for many grade levels could be significant. Feedback from educators with whom these ideas have been shared lead me to judge that this assessment technique is potent.

So, now what can I do to make it available to others for use in changing assessment to become more meaningful and powerful? First, I share it with other teachers in sessions of any kind which I can get invited to make a presentation of it. Next, I write about the practice. And, then, the assistance of other educators who have science background strength in areas where I have less, will be needed to design similar assessment items for the many science topic areas and over the grade levels.

Do I need to focus on this particular assessment technique for the next twenty years? Perhaps! Or, perhaps, some other educator may move into this area and I can move to another of the reform recommendations for implementation.

A Challenge To You

1. You generate and send to me a description in a format similar to the electrical circuits example which I have described some similar type of an evaluation item for a different science topic (could be concept, process and/or attitude). REWARD: Some outstanding specimens of petrified wood (4-6 pieces). GREATER REWARD: Twice as much petrified wood if you e-mail me the description. (NOTE: For those reading this manuscript, I will have to limit the offer to the first 100 who respond!) (my e-mail address: dlj1757@acs.tamu.edu)

2. You help me establish an e-mail system through which educators can contribute and extract evaluation items of the type described in this workshop. REWARD: That good feeling one gets knowing he/she has made an important contribution to bettering education - also collaboration with me in writing a manuscript for publication - further, valuable teaching materials which you can use in teaching whatever you teach.

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Mathematics Opening Address

MATH CHANGE: MORE THAN PENNIES, NICKELS, AND DIMES

William K. Tomhave
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Criticism of Mathematics Education

The level of mathematics achievement of students in the United States came under intense criticism as the decade of the 80s progressed. In reaction to international studies and A Nation at Risk several organizations, including the Mathematical Sciences Education Board and the National Council of Teachers of Mathematics, began a series of activities which produced several key documents. Two of these documents, Everybody Counts, and Curriculum and Evaluation Standards for School Mathematics are among the most visible of the efforts. The momentum for reform which began in the late 1980s carries through to today, and their commendations of the reform documents will serve as the basis for the talk today.

Goals

In 1989 the National Council of Teachers of Mathematics asserted that society at large had four primary goals for mathematics education: Mathematically literate workers, lifelong learning, opportunity for all, and an informed electorate. These goals reflected changes taking place as complex technical and scientific issues need to be faced in order to set public policy and judge its effectiveness. Mathematics instructional practices of previous years had left students with serious misunderstandings of what mathematics is and what it means to do mathematics. Many otherwise capable and educated individuals openly comment about their inability to do anything mathematical. Yet the cost of this lack of mathematical literacy is substantial as it has negative impact on economic competitiveness and research capabilities in American businesses and industries.

International comparisons from this time showed that United States students lagged far behind their contemporaries in mathematics achievement. Studies showed that countries with high academic mathematics and science performance had a longer school year, a longer school day, more hours per day devoted to mathematics, a greater emphasis on effort over ability, and greater expectations of students from parents and teachers. These studies raised several critical questions. Are we teaching the mathematics that our students will need in the future? Do school programs reflect the realities of a technological world? Are we teaching mathematics in a way that allows students to use mathematics productively?

The general consensus of the mathematics education community was that mathematics is more than a collection of concepts and skills to be drilled and memorized. Problem solving needed to become the focus of mathematics instruction, with a strong emphasis on using mathematics in open problem situations using a variety of techniques including working with others on solutions. In addition it was clear that mathematics could no longer be used as an academic filter which eliminated students, closing access to important career paths. Rather it needed to become a pump where everyone is provided with a mathematics preparation sufficient for a wide range of future career options.

The Standards

The Curriculum and Evaluation Standards for School Mathematics was officially released by the National Council of Teachers of Mathematics in the spring of 1989. It had been widely shared in draft form and its pages reflected the input from hundreds of mathematics teachers and other stakeholders from across the nation. The Standards was never intended to be a curriculum. Rather, a standard is defined to be a statement about what is valued, and as such the Standards serve as a stepping off place for a major revision in how mathematics is taught.

The Standards identify several important issues. First, the purpose of mathematics instruction should be to provide mathematical power for all in a technological society. Second, mathematics must be seen as something one does, not a subject to be passively received. Third, the curriculum should include a broad range of content in a variety of contexts which make deliberate connections between mathematics and the rest of the world. Fourth, the learning of mathematics must be an active, constructive process. Fifth, instruction should be based on problem situations. And sixth, evaluations should provide a means for improving instructional practices, student learning, and mathematics programs.

The Standards lists a series of general goals for students across grades K- 12. The document then discusses content standards for grade level sub-groups: K-4, 5-8, and 9-12. While there are many specific content standards for each sub-group, across all the content areas are four common threads: problem solving, mathematical reasoning, communication, and mathematical connections. All mathematics content is to be developed using these four standards. The Standards certainly contains new concepts and approaches, but it also differs from other curricular reform efforts in one major way. In the past more and more topics were added to school programs until the academic closet was bursting at the seams. The Standards, in addition to suggesting topics which need increased emphasis, also clearly identifies areas that need decreased emphasis.

Professional Standards for Teaching Mathematics

In 1991 the NCTM released the second volume in the Standards series: Professional Standards for Teaching Mathematics. This work picked up the instructional themes of the Curriculum and Evaluation Standards. The goal of mathematics teaching should be to help all students develop mathematical power. To accomplish this it must be recognized that what students learn is fundamentally connected with how they learn it. "Math Power for All" requires a belief that all students can learn to think mathematically and that teaching mathematics is a complex practice not reducible to prescriptions. Perhaps the key acknowledgement made in this document is that the teaching envisioned differs significantly from what many practicing teachers themselves experienced as students.

Teaching Standards calls for major shifts in the mathematics classroom environment, making the classroom a place of conjecturing, inventing, reasoning, and problem solving while connecting mathematics, its ideas, and its applications. Discourse replaces lecture as the predominant instructional practice.

Change

All of this discussion of what mathematics teaching can and should be is contained in documents which are more than six years old. Much of what I have shared calls for significant changes to be made in what we do and how we think about mathematics teaching. In 1989 the call was for a decade of change. Now in 1995 we still have a long way to go before the vision of the Standards becomes a reality.

Change is the only constant on the instructional horizon for the foreseeable future. Yet change is never easy. Change is threatening to some which being challenging to others. Change requires planning, patience, and persistence. It requires commitment and collaboration. Change happens slowly, and it also happens personally. It is easier together than alone. Change happens painfully sometimes, and it can happen top-down or bottom-up. As Jim Whitney of Honeywell noted some time ago:

> It is easy to change if you have been a failure. It is difficult to change if you have been successful.

Ross Taylor, formerly a mathematics consultant to the Minneapolis Public Schools added a corollary:

> It is impossible to change if you are a failure but you believe you are successful!

Systemic change can happen in big ways in small venues, and it is often small, single school ventures which pave the way for larger statewide efforts. Through it all, two key assumptions need to be kept in mind. First, teachers are the key figures in changing the ways in which mathematics is taught and learned in schools. Second, these changes will require that teachers have long-term support and adequate resources to carry out the tasks.

What can you do? You can read the Standards and other relevant publications. You can reflect on what you read and on your own classroom practices. You can discuss ideas with peers. You can try new strategies. You can become a promoter of the Standards in your school and community. Remember, the finest plans will not work without the finest people implementing them. It is through the individual efforts of teachers that reform of school mathematics will become a reality. And one final exhortation: Don't ever give up!

Acknowledgements

I would like to acknowledge the National Council of Teachers of Mathematics and SCIMATHMN for creating and providing many of the transparency masters used in this presentation.

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SMALL GROUP PRESENTATIONS

"When the Night Has a Fever, it Cries in the Morning": Weather Folklore in the Science Classroom

Lana M. Danielson
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This article and the earlier presentation of it are based on a seventh grade language arts unit designed by Lynn Danielson, Beatrice (Nebraska) Middle School.

Theoretical Framework

While elementary teachers have recognized the value of combining two or more subjects in a lesson when a logical connection will enhance their students' learning, departmentalization of content in junior and senior high schools has historically preserved the boundaries of individual disciplines. However, there has been growing support for the practice of integrating the curriculum in classrooms at the secondary level. Researchers (Armstrong, 1994; Fogarty, 1991; Jacobs, 1989; Lounsbury, 1992; and Tchudi, 1993) have studied the learning potential of students when teachers incorporate appropriate connections across different subject areas in their lessons and capitalize on their students' diverse ways of processing and using information.

Research confirms the importance of activating prior knowledge (Alvermann, Smith, and Readence, 1985; Anderson, 1984; Rumelhart and Norman, 1977). Students may have insufficient schema or relevant background knowledge to understand new concepts or they might employ schema selectively, unaware that what they already know often makes a significant contribution to what they are learning. Interdisciplinary integration can help build schema or capitalize on that knowledge base which the student has already developed because it can enrich the teaching of subject matter content, make connections between the focus subject concepts and other content areas, promote growth in knowledge by linking rather than fragmenting curriculum, increase motivation for learning by presenting new ideas in a variety of ways, and foster collaboration among teachers.

Theory into Practice

Weather folklore is an effective vehicle for integrating language arts and science. Most of our students have heard predictions about the weather based on long-standing experience and have likely accepted these observations as fact. Examining some of this traditional wisdom gives students an opportunity to study language, consider possible interpretations, and generate hypotheses about their factualness. Although the unit described here has been implemented with seventh grade students, with minor modifications it would be appropriate for younger or older students as well.

Phase One of the unit is introduced by asking students if they are familiar with any sayings related to the weather. For example, the teacher might ask if they have ever heard that "Flies bite more before a rain." Students can generate a list of statements they have heard. A discussion on the reliability of the sayings might follow. How do they know if the statement is true?

After an introductory discussion, students are given a list of weather folklore statements and are asked to indicate on their individual papers whether they believe each statement to be true, false, or possible. The following statements serve as examples:

- Swallows fly close to the ground before a rain.
- If the sun sets clear on Friday, it will storm on Sunday.
- Sun or moon haloes indicate coming rain (or snow); the larger the halo, the nearer the precipitation.
- Lightning in the south brings little else but drought.
- Migrating birds fly higher in fair weather than in foul.
- The higher the clouds, the better the weather.
- Cobwebs on the grass are a sign of frost.
- Crickets are accurate thermometers; they chirp faster when warm and slower when cold.
- Moonlit nights have the heaviest frost.
- When the buffalo band together, the storm god is herding them.
- When the night has a fever, it cries in the morning.

After the students have read the sayings, ask them to interpret what they mean. Why do people come to believe these notions? How might they find out? Such questions lead easily into Phase Two of the unit. Each student must interview an adult, preferably someone who has had to anticipate the weather in day to day work. This is a wonderful opportunity for them to talk with elderly relatives or neighbors, to develop interview and social skills, and to begin the process of collecting data. The interview phase is a positive intergenerational activity that fosters a reciprocal appreciation by students who learn information that is new to them; by parents who are sometimes invited into the activity as facilitators and thus have an authentic conversation with their children about what is happening in school; and by grandparents or other participants who may have limited opportunities to interact with young people. The elderly are also the population who most likely can provide the reasoning behind some of these traditional beliefs about weather.

The students begin their interview by sharing the sayings on the sheet and asking their interviewees whether they have heard of any of them, if they believe them to be true, and if so why. All of this information is documented so it can be used as class data. Students also inquire about other weather folklore with which their interviewees are familiar, noting these for class discussion later.

Phase Three of the project is the sharing of individual data with the class. Students might initially explore the meaning of new sayings they discovered and how they relate to the those on the interview sheet. They might compare individual data sets, leading to a discussion on what the collapsing of individual data might tell them about a larger population. This discussion sets the stage for how hypotheses are generated, tested, and evaluated.

Designing a research project to test one of the sayings is the Fourth Phase. Individual or small groups of students select a saying on which they believe they can design an experiment. They write a hypothesis to predict that the selected folklore statement is true, false, or possible; determine one or more methods by which it might be tested; gather and then analyze data; accept or reject the hypothesis; formulate and then evaluate conclusions. Written and oral presentations of the findings would follow. Class discussion would consider the validity of the study, reliability of the data, and reasonableness of the conclusions drawn.

This unit integrates language arts and science, but it is obvious that other disciplines such as mathematics, social studies, and art would provide meaningful connections as well. In addition to the interdisciplinary focus, students are encouraged to integrate the knowledge and skills they have as well as to develop new expertise. They are actively involved in the communication skills of speaking, listening, and writing; they have the opportunity to develop both interpersonal and intrapersonal skills through the varied tasks they are asked to complete; they are required to interpret figurative language and to comprehend the scientific process as well as the data generated by it; and they must engage in problem-posing and problem-solving.

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"How Coyote Was the Moon" (Kalispel)
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"Spring Defeats Winter" (Seneca)

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"Why the North Star Stands Still" (Paiute)
"At Rainbow's End" (Navajo)
"The Origins of Summer and Winter" (Acoma)
"Sun Dance Mountain" (Dakota Sioux)
"Warm Wind Brothers/Cold Wind Brothers" (Columbia River)

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Tablecloth Mathematics: Create, Conjecture, Coat

Roger Ray Parsons
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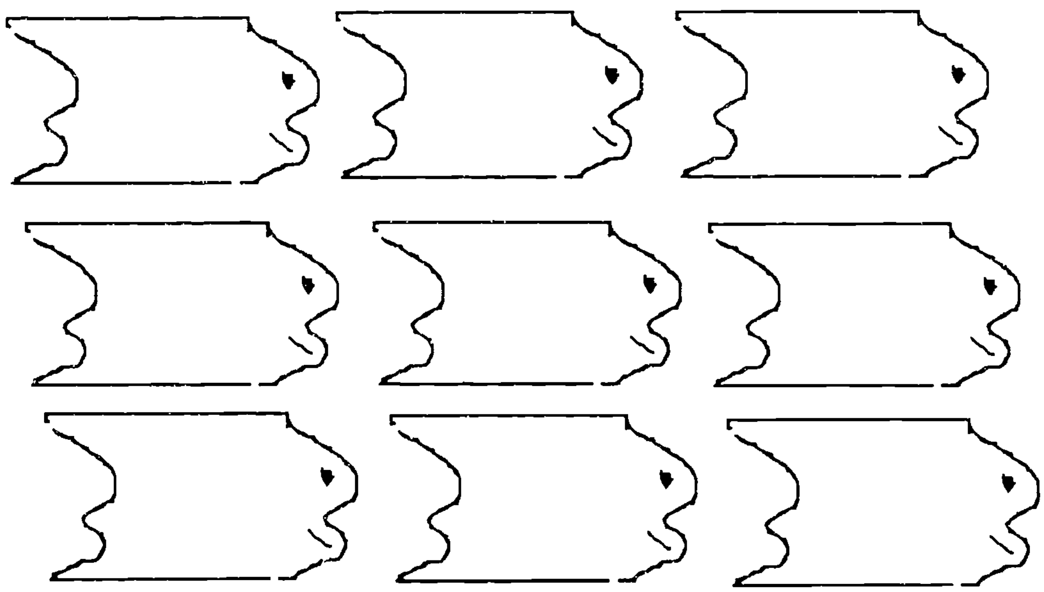
Introduction

A goal established by the National Council of Teachers of Mathematics for the teaching of mathematics in K-12 classrooms is that "students of all ages will be able to make connections between school mathematics and the real world" (NCTM Standards,1989,1991). Teachers of all grade levels search for simple ideas that will bring real-world applications of mathematics to their classrooms. Tablecloth designs contain and display many interesting mathematics concepts to which students of all ages can relate. Tablecloth designs help young children with their counting skills, help middle school students with an introduction to statistics, and help high school pupils with a mathematics lesson on transformations. What other mathematical concepts can be taught using this tablecloth?



The basic design of a tablecloth is the result of a particular portion of the pattern being translated over the plane. This specific portion of the plane is made to move and cover the plane completely; that is, it is tessellated over the plane. A tessellation is an arrangement of polygonal regions which have only sides in common and which completely coat the plane (Musser & Burger, 1991). A polygonal region is a polygon together with its interior. Tessellating patterns can be found in many places and can be made quite easily using a square as the basic building block.

Building Tessellations

Giganti and Cittadino (1990) suggest that the best way to build irregularly shaped tessellations is to us the "nibble" technique. That is, any polygon that tessellates can be altered by taking a nibble from one side of a tessellating polygonal region and then using a slide transformation on the nibble to the opposite side. This will form a new closed figure that also will tessellate (see figure 1).

Once students have the "nibble" technique mastered, each student can then proceed in producing her/his own tablecloth design. These tablecloth designs can be made with the aid of a computer by students familiar with this technology. Eastman and Parsons (1995), were able to take the paint program that existed on their Macintosh computer and build irregularly shaped closed figures by use of the "nibble" technique. Furthermore, Eastman and Parsons were able to take the "tablecloth" designs made by the students and relate them to Indian-American culture.

Conclusion

By using the "nibble" technique suggested by Giganti and Cittadino (1990) and a paint program, students can begin to make their own closed figures that tessellate. Furthermore, teachers as well as their students can relate these tessellation to designs that they find on tablecloths.

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Labs: They Aren't Just for Science Anymore

Deana Daum
Andes Central School District

Attempting to teach a classroom full of tree squirrels might be much the same as teaching in a classroom full of junior high students. Teaching math to junior high students can be frustrating. They chatter. They stuff their mouths with food. They are very active and noisy animals. In such a situation, a teacher has three choices: adapt, cope, or collapse.

One method of adaptation is the implementation of alternative learning situations. Hence came the advent of math labs. Adapting science learning techniques to math is logical. Math is considered to be the language of science. Experience in either subject creates a student more capable of problem solving and success in both subjects.

Many aspects of teaching math can be changed to a lab setting. Math is one of the most practical and applicable subjects that a student encounters. It is truly one of the subjects they learn in school that they will continue to use throughout their lives.

Some ideas for math labs include the topics of measurement of linear space, capacity, mass and growth, ratios, proportions and scale models, percentages and decimals, the economy, geometry as it applies to construction, and data collection and application.

Math teaching can also be enhanced with things such as alternative assessments, rubrics, and self evaluation. A student who builds a scale model of a building can be given a rubric which correlates quality and specifications to a letter grade. The student, when finished with the project, can assess himself with a self-evaluation form.

This form can be a simple checklist of which requirements have been met and his own interpretation of how well he met them. From this point a teacher needs to determine whether the learning goals were met and what level of achievement the student reached.

Students can expand their exposure to math in everyday life by meeting architects, construction experts, bankers, accountants, retailers, salesmen, engineers, seamstresses, computer programmers and technicians, as well as a host of other people from jobs which require practical applications of math.

Needed job skills can lead to math labs. Students can determine and present a construction bid on replacement of the wooden portion of gym bleachers. Students can work with a local expert on the creation of a star quilt using their geometry knowledge. They can collect weather data and present valuable information in the form of charts and graphs. They also can have mock checking accounts or begin a business.

Math is everywhere. Students are more likely to use it well if they practice using it in real situations. The main idea behind math labs is, "Learn by doing."

"Having Families Involved in Students' Learning Imperative A Plan for Implementation"

Delmar Janke
Texas A & M University

Varieties of Family Science

Family science comes in several varieties. One variety brings families together at their student's school for an evening of learning -- that variety is an excellent one, but not the variety that will be addressed in this workshop. The variety with which we will be dealing is the one in which students take something home which can be participated in by the students and their families.

Purposes For Doing Family Science Activities

The following are some reasons for doing family science:

> Getting parents involved in the education of their child
>Informing parents about what their child is studying
>Satisfying parents interest and need to learn
> Communicating that science relates to our every day lives
> Generating good public relations for our schools
> Getting families involved in doing things together

Considerations In Developing Family Science Activities

It hardly seems necessary to be reminded that parents have limited amounts of time and that they will not do uninteresting and boring things. But if one looks at some of what goes home with children, it becomes obvious that those factors are not always considered. Perhaps a rule of thumb to begin with is, "Would you be positively interested and excited about what is being sent home if it were coming to you?"

Using a Letter Format to Send Activities Home

One useful format in which to send family science activities home is to do so by way of a letter to the students' parents. Samples of such letters are found at the end of this article. The letter must be short and it is suggested that it include some sort of graphics - that combination would make the letter inviting to read. The letter could contain the following parts: a short informational section, a description of 1-3 activities, an unusual bit of information, and a very short list of children's books on the topic of the activities.

How Can the Letter's Contents Be Constructed?

Of course, the teacher can create such a letter entirely from their own knowledge and creativity, but many aids in developing such letters exist. The portion of the informational section which provides background on the topic can be developed from such information in a teacher's edition of a book or from a popular journal article on the topic (e.g., from National Geographic). The activities included can be taken from additional activities presented in the teachers editions of textbooks or from special science activity books. Unusual bits of information may be obtained from such sources 3-2-1 Contact and games such as Trivial Pursuit. Appropriate children's books for the topic can be identified from the March issue of Science and Children, from reviewing the card catalog in a library, or viewing the books at a local book store which has a good selection of children's books.

Now, Let's All Share Our Successes!

It would be very helpful to be able to obtain copies of family science letters which have proven to be successful for other teachers. Let's become part of a system which can do that sharing. The author will become the temporary "clearinghouse" for such letters until an electronic and hardcopy clearinghouse can be established either with the Council for Elementary Science International (CESI) at the National Science Teachers Association (NSTA), through some commercial network (such as Prodigy, America on Line, CompuServe, etc.), or through internet. If you wish to contribute to and receive from such a source, send copies of family science letters to the author via mail or through internet.

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Prize! For the first 100 who send usable family science letters in a format similar to the one illustrated in the examples, the author will send a box or 4-6 pieces of really great petrified wood from the Brazos Valley of Texas!

Letter Example #1

Dear Parents,

Our science class is currently studying rocks and minerals. The students are learning about the different types of rocks, how they are formed, and what they look like. Unfortunately, we do not have access to many different types of rocks here at school. Therefore, I am requesting that students, as a extra activity with their parents, make an effort to "explore their yard," in search of various types of rocks and minerals.

We have done this activity in the past, and the students really get involved with their parents. We are not looking for diamonds and the such, just have your child find a few different types that might be found in their yard. This means you do not have to take your child to rock mines or to buy rocks for your child if they cannot find any. They will not be rewarded on the type of rocks they discover.

Now, in saying that, there is one piece of rock that we are interested in seeing if any of the children can find. It is the state rock of Texas, the petrified palm tree. This rock is typically found in abundance in East Texas, and I would not be surprised then if one of the students found this type. You **will not** be penalized if this rock can not be found. This is only a challenge activity and should be utilized as a discovery time.

For more information on rocks and rock collecting, check out some of these books available at local libraries.

The How and Why Wonderbook of Rocks and Minerals by Nelson Hyler

Rocks and Minerals by Robin Kerrod
The Young Rockhound's Handbook by W.R.C. Shendenhelm
Be a Rockhound by Martin Keen

I hope you enjoy the activity!
Sincerely,

_______________________ _______________________
Teacher Child

Letter Example #2

Dear Parents,

Did you know...
...that bats fly with their hands?
...the largest bat in the world has a wing span of six feet?
...the smallest bat weighs less than a penny and is the size of a bumble bee?
...that bats can see quite well-even on the darkest of nights?
...that bats are actually very clean animals, they spend a considerable amount of time grooming themselves?

Howdy! For the next three weeks we will be coming into your child's classroom to contribute to their current unit on bats. As part of their unit, we will be teaching them how bats find their young, what different types of bats eat and about bat conservation .

Attached to this letter are three activities that you and your children might enjoy doing. The activities are enjoyable invitations to learn together, not homework. This information pertaining to bats can be utilized by you and your children to enhance their comprehension of the classroom learning.

Activities:

Echo, Echo, Echo - is an echolocation simulation. Ask your child to tell you what echo location is.

Refrigerator Bats - is a recipe on how to make refrigerator magnets.

A Bat House - Assembly instructions for Bat Conservation Internationals bat house.

Some suggested reading materials are:

Stellaluna, by Janell Cannon The Bat in My Pocket, by Amanda Lollar and Tree of Life by Barbara Bash.

We hope you enjoy sharing in your children's learning experience about bats.

Gig 'Em,

Brian, Lanette, Jennifer, and Kimberly

Letter Example #3

Dear parents

This letter is to inform you that your child will be study the days to c~me. In order to make this learning experience as fulfilling as possible, your cooperation is desired. Below you will find a few activities that you and your child can do together. These activities will not only enhance your child's learning, but hopefully, it will enhance your learning as well. This is also an excellent opportunity for you and your child to spend quality time with each other and have fun doing it. I have included some fun facts and a list of books that you and your child can read together. Thank you for your time and cooperation.

Sincerely,

Suggested Activities:

1. Go outside around dusk with your child. You can either go to a remote area (such as Research Park on University Dr.) or you can go to your own back yard, and take a pencil and some paper with you. Look mat the sky for an extended period of time (about an hour) and look for bats. If you look around a la~mp post, you might have better luck. Mosquitoes are attracted to the light and bats in this area eat mosquitoes. If you think you see a bird, you probably see a bat! Record what you see. What does the bat look like? How does it fly? Is it swooping? If it is, it might be trying to catch an insect. Bats are quite prevalent in this part of Texas so be patient, and you will probably spot one!

2. Build a bat house. m e directions are enclosed. If you prefer, you can buy a bat house at The Brazos Valley Museum of Natural History. Just take the Briarcrest exit off of Highway 6 and turn right at the light. The museum will be about a block down on the right. Bat houses are not only fun to put up, but you will have a lot less mosquitoes in your yard!

3. Make a bat bumper sticker. The directions are also enclosed for this activity. This activity is not only fun, but educational as well.

Bat Fun Facts:

1. Bats are not blind.
2. The smallest bat is only the size of a bee.
3. A bat can catch 600 mosquitoes in one hour.
4. There are nearly 1,000 different kinds or species of bats. Almost 1 in every 4 mammal species is a bat!
5. Out of the nearly 1,000 species of bats, only about three species are vampire bats.

Books:

Stellaluna by Janell Cannon
Shadows of the Night: The Hidden World of the Little Brown Bat by Barbara Bash
Batman: Exploring the World of Bats by Laurence Pringle
Extremely Weird Bats by Sarah Lovett

October 23, 1995

Dear Family:

We are currently studying oceans and ocean life. Topics that are being covered in class range from what makes up an ocean to animals found in the ocean such as whales, sharks, and octopuses. This week we are studying waves and the effects they have on ocean life. The students are very excited when it comes to this topic. As part of this unit, the students and I have decided to include some activities to do at home that will help the students learn more about the ocean. However, these activities are not homework activities, they are only activities to enhance learning.

Listed below is an activity entitled "The Wave Machine". In order to do this activity you will need a clear two-liter soda bottle, blue food coloring, baby oil, and water. Remove the label and the base of the bottle. Fill the bottle about 1/2 full of water and add a few drops of blue food coloring. Then add baby oil until the bottle is filled. Screw the cap on tightly. When the bottle is turned sideways and rocked gently, the wave motion of the ocean is created! The activity is completed.

Please encourage your child to tell you what he/she has learned about waves and the ocean. Together, both you and your child can have a great learning experience. Have fun and let me know how your wave machine turns out. Each week I will be sending a fun activity you and your child can do at home. Below, I have included a list of hooks about the ocean you and your child may enjoy reading together. Also, please do not hesitate to call if you have any questions.

Teacher's Name

*The Magic School Bus On The Ocean Floor written by Joanna Cole and illustrated by Bruce Degan
*Ibis: A True Whale Story written and illustrated by John Himmelmann
*Sam the Sea Cow written by Francine Jacobs and illustrated by Laura Kelly
*Ocean Animals written by Michael Chinery and illustrated by Eric Robson

Spatial Reasoning Activities Using Squares and cubes

William K. Tomhave
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Over the past several years critics of American mathematics education have written that one area where students, particularly females students, have shown insufficient growth is spatial reasoning. Spatial abilities include several aspects: making drawings, forming mental images, and visualization of changes in these images. The physical world is generally understood in terms of its geometry, so improvement in spatial reasoning is a worthwhile educational goal.

The purpose of this talk is to provide participants with experiences in two and three dimensions which incorporate problem solving, geometric concepts such as perimeter, area and volume, and some challenging amusements.

Tile Activities - Two dimensions

The session began with consideration of a standard 8x8 checkerboard. Participants were asked to determine how many squares with whole number dimensions that they could find on the checkerboard. This problem generates the series $1^2 + 2^2 + ... + 8^2$. As a follow-up we then consider the number of rectangles of whole number dimension that are contained on the checkerboard.

We next consider the interaction of perimeter and area. After discussing definitions of the two terms, regions are constructed with square tiles where adding a tile produces perimeter changes of 2, O, or -2 units while always adding one unit to the area. We also consider arrangements with a fixed perimeter and various areas.

The two dimensional activities conclude by finding all unique arrangements of from 1 to 5 tiles ending with the twelve pentomino pieces and a brief discussion of some common puzzles involving these pieces.

Cube activities - three dimensions

Three dimensional activities are introduced by looking at the twelve pentomino pieces and determining which can be folded to make an open topped cube. This process can also be reversed by attempting to slice a milk carton to form pentomino pieces.

To stimulate visual thinking we build a cube from twenty-seven unit cubes. We use what we discover to solve a puzzle involving a cube of cake.

Building cubes into various arrangements participants generate all arrangements of one, two, three, and four cubes. Combining their regular arrangements of three and four cubes participants discover the six pieces which are the Soma Cube puzzle.

If time permits, for the final activity participants work with arrangements of five cubes in order to generate the pieces of the PentaCube puzzles.

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Weather Wizards

Dean Albertsen
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Canton, SD

Editor's note: In this presentation, Dean Albertsen, a middle school teacher, describes how he teaches a lesson on weather maps and how he integrates it with mathematics. The general format that he follows is based on the Robert Karplus Learning Cycle. The Learning Cycle sequentially begins with an "exploration phase," followed by a "concept introduction phase." and concluded with a "concept application phase." He uses non-threatening "assessment" processes to find out what the students really know.

The lesson begins with a review of weather instruments. Weather instruments:

Anemometer--measures wind speed
Wind vane--measures wind direction
Thermometer--measures temperature
Thermometer and anemometer measurements combined for wind chill
Barometer--measures air pressure
Rain gauge--measures precipitation

Next ,weather terms and symbols used by weather forecasters on weather maps are introduced.
Meteorologist--weather scientist
High pressure--heavy air mass
Low pressure--light air mass
Cold front--leading edge of a cold air mass
Warm front--leading edge of a warm air mass
Stationary front--boundary between a cold and warm air mass (stalled)
Wind--air movement
Lightning--light emitted from heated air molecules
Thunder--sound waves from heated air molecules
Precipitation--condensed water vapor falling to the earth's surface (hail, rain, snow, sleet)
Troposphere--layer of the atmosphere closest to the earth where most weather occurs
Weather radio--a listening device for up-to-date weather watches and warnings
Storms--violent weather (hurricanes, thunderstorms, tornadoes)

At this point weather related pamphlets are distributed and discussed.

What follows is an explanation of the use of weather maps in the classroom setting.

Students demonstrate and verbalize their knowledge of weather maps.

I. Exploration phase: Students work in cooperative learning groups. They place the symbols on their maps and discuss with each other the kinds of weather across the country. When they have documented the activity, the group leader will share their findings with the class.

2. Concept introduction phase: Discuss the students' explanations of their weather maps. Introduce the terms: lows, highs, fronts (warm, cold, stationary), precipitation. Students incorporate these words into their weather maps and use them to make a forecast of the

weather for the next day. They will use a weather map that has been made from the current newspaper which will be revealed on a bulletin board.

3. Concept application phase: Each day during this unit on weather, two students are responsible for putting up the weather symbols on the U.S. map on the bulletin board. Also keep a daily record chart of temperature, precipitation, wind direction and speed, using instruments available. The students can challenge the weather man on TV with their own weather forecasts and long range predictions.

4. Integration with math: Have the students average the data for a week and a month.

5. Assessment: Assessments are made by listening to the presentations and asking questions of the two presenters.

Following the presentation of the students' activities, a video of the students in action is viewed as well as a video of the students on a commercial TV station KDLT TV Weather Kids.

Weather instruments available from:

Davis Instruments
3465 Diablo Ave.
Hayward, CA 94545

Peet Bros. Company
601-410 Q Woodland Rd.
W. Allenhurst, NJ 07711
1 800-872-7338

Pamphlets available from:

National Weather Service
26 Weather Lane
Sioux Falls, SD 57104-0198
605-330-4247

Browse the Web for Science Ed

Robert W. Wood
Michael Hoadley
Dale S. Farland
University of South Dakota

Practically every magazine and paper you look at has some reference to the Internet and especially to the World Wide Web (WWW). The Web is one of the most dynamic and exciting things to happen to the world of computer technology since the invention of the microprocessor and the computer spreadsheet. Fortunately education is not being left behind on this frontier. Much of the activity in the development of the Web occurred in higher education and especially science fields. As a result, there are tremendous science education resources available on the Web for teachers and students. This paper introduces the World Wide Web, suggests some of those resources, and suggests Web-based activities that science educators may use in their teaching.

The materials that follow are organized in the form of a lesson plan.

Time Required: Multiple Class Periods

Instructional Objectives:

Students will:

- Demonstrate proficiency in connecting to the Internet.
- Demonstrate proficiency in using a browser to connect to the World Wide Web (WWW).
- Browse the World Wide Web to locate science Home Pages.
- Use selected science Home Pages to locate information about science.
- Complete assignments using the World Wide Web as a source of information on science topics.

Background Information:

- The World Wide Web (WWW) is a collection of information found on the Internet which includes multimedia and is linked in a hypermedia fashion. The WWW can use color, text, graphics, and sound in delivering information to the learner.
- In order to access Internet, educators will need to locate a service provider. Service providers could be a local university/college; commercial on-line services such as America Online, Compuserve, Delphi Internet, Genie, and Prodigy; or regional Internet service providers.
- Appropriate Internet access tools will be needed to start browsing the World Wide Web. The tools you need depend on what you want to do with the Internet. If you are located at a school connecting through a modem and telephone line to your server, you may wish to consider the integrated packages that include a web browser, e-mail, newsreader, and other tools. A dial-in connection to the WWW requires a SLIP or PPP

connection (this must be supported by your provider). The programs to support this are usually included in the software provided by the commercial Internet service provider or for a commercial product like Internet in a Box, etc. Selected integrated software Internet tools are Internet Chameleon, Netscape Navigator; Internet In A Box; etc. (Visit your local computer store for more information).

- Once you are on the Internet, use a Web browser (Netscape, Mosaic, etc.) to navigate the World Wide Web. It is absolutely essential that time be spent learning how to browse the Web and to learn how to locate Home Pages appropriate for the type of information that is needed by teachers and students alike.

- Plan ahead carefully. Web addresses change and disappear. They can also be too busy to be reached when you want to connect; plan alternatives. One other caution is that your students may find material on the Web that is not deemed appropriate for them. Many schools have parents sign a use contract acknowledging awareness of the risks and approving their child's access to the Internet.

- It is essential to learn how to independently access Internet resources by understanding a Uniform Resource Locator (URL). This will allow you to type in a Home Page address without going through a lengthy browse. URLs must be EXACT including case after the third "/". The following URL Home Page addresses dealing with selected science topics will get you going on the World Wide Web.

Web Page Addresses (URLs):

http://www.usd.edu/intec/science.html (This page in the School of Education at the University of South Dakota contains links to almost all of the addresses below plus many others.)
http://www.yahoo.com/ (Search index for anything and everything)
http://webcrawler.com/ (At the space to "enter some words and start your search" area, type science topics to get science information)
http://www.cris.com/felixg/OE/OEWELCOME.html (ONLINEEDUCATOR Web Page)
http://www.odci.gov (A good source for government information).
http://faldo.atmos.uiuc.edu/WEATHER/weather.html (Hurricanes, snowstorms, tornadoes)
http://www.ncl.ac.UK/~nantig/menu.html (Stone Age, flints/stones)
http://www.cs.uidaho.edu/~connie/interests.html (An excellent selection of science/math information)
http://quest.arc.nasa.gov/livefrom/livefrom.html (Live from Antarctica)
http://www.pbs.org (A lot of great educational resources, especially for science teachers)
http://www.duq.edu/facultyhome/fredbortz/KidSciBooks/main.html (A WWW site for children's science books)
http://scitech.lm.com/ (Science brain teasers)
http://www.gene.com/ae/ (Organized access to sources of scientific information)
http://www.covis.nwu.edu/Classroom/ClassroomHome.html (Thousands of students, over one hundred teachers, and dozens of researchers all working together to find new ways to think about and practice science)
http://www.enc.org (Eisenhower National Clearinghouse for Mathematics and Science)
http://curry.edschool.virginia.edu/kpj5e/Project.html (Whales)
http://www.npac.syr.edu/textbook/kidsweb/chemistry.html (Kid's web for chemistry)
http://www.npac.syr.edu/textbook/kidsweb/geology.html (Kid's web for geology)
http://volcano.und.nodak.edu/ (VolcanoWorld Home Page)
http://www.kobe-cufs.ac.jp:80s/kobe-city/ (City of Kobe Home Page)

http://ww\ ~nos.uiuc.edu/wxworld/html/top.html (Welcome to Weather World)
http://hea-\ .. w.harvard.edu/QEDT/jcm/jsr.html (The Space Report is issued about once a week. It describes all space launches)
http://128.174.173.205/ (A page of earth science resources. Links to all Web paleontology museums)
http://www.gsfc.nasa.gov/ (You can get the latest space shuttle information and take tours of NASA sites around the country)

- To enhance your science teaching, you may want to subscribe to ONLINE EDUCATOR, PO Box 251141, West Bloomfield, MI 48325. The cost is $25.00 per year and is published monthly during the school year. Get on their Home Page at: (http://www.cris.com/~felixg/OE/OEWELCOME.html). Other educational magazines are also devoted partially or entirely to using the World Wide Web for education.

Materials:

- Computers
- Access to a World Wide Web service provider and appropriate software
- Questions to be answered via the World Wide Web
- Assignments that can be completed by using the World Wide Web

Procedures:

1. Training of students and teachers in Internet and World Wide Web procedures.
2. Conduct a science search in Yahoo and other search programs.
3. Practice entering URL science addresses provided with this lesson.
4. Present questions to students and review for clarity. (These questions can be from a commercial source or created by the teacher).
5. Determine which science home pages might provide the answers to the questions. It should be noted that a variety of home pages will need to be used to answer the questions.
6. Use the selected science home pages to answer the questions.
7. Review answers and discuss in class.
8. Discuss the students' use of the World Wide Web in answering questions related to science.

Making Connections:

- Have students prepare science project/lessons that utilize the World Wide Web.
- Have students browse the World Wide Web for science topics which can be shared with the class.
- Have the students teach other students and teachers in their school how to use the World Wide Web.

Summarization

In summary, the WWW can help students gain access to information located literally any place in the world. That information can then be used in their reports, in their projects, and even in their personal lives. In the process, students also begin to develop decision-making skills which will help them in evaluating the value, credibility, importance of that information. Teachers also benefit from using this available technology because it helps them keep current and to develop professional skills essential in our rapidly changing environment. When the WWW is properly used and lessons are properly orchestrated to go beyond remedial tasks, participants become "engaged learners" who are actively involved in the learning process, rather than passive on-lookers. In the end, the level of learning becomes elevated as students become involved in more authentic, realistic, and challenging tasks.

The Effect of the Interaction of Lactic Acid and CO_2 in Post Exercise Skeletal Muscle Cellular Respiration.

J. A. Richardson, HPER
University of South Dakota

One of the primary concerns of individuals who want to go from couch potato to relatively fit is the initial startup, the beginning, the first step, all of these can cause pain. The purpose of this commentary is to offer an alternative method to circumvent pain caused by the biochemistry of exercise in the build up of post contraction waste products in the cell, specifically -- carbon dioxide (CO_2) and lactic acid (La^-). As the American culture has changed it's focus from physical to mental labor, it has become apparent that individuals must consciously spend time increasing his/her physical condition so that they may compete mentally in the modern world. Good physical condition allows people to handle stress of all kinds.

Therefore, the individual realizing his/her need to exercise may begin after a long couch potato non-exercise period. In order for this sortie into this long forgotten world of exercise or activity to be successful, it is important that they don't go at it as someone killing mice. Many post collegiate exercisers fail to remember that high speed/low drag will only cause sore muscles, deceased enthusiasm, and non-restart. All of these are counter productive to achieve their goal - improved physical condition.

The individual that is communicating with his/her body will know when to say - enough is enough, and stop to comeback the next day. There are some people that can determine when to go and when to stop, but there are others who have not achieved this nirvonian level of communication and attack exercise full speed ahead, damn the torpedo. The latter will, after a short time, have sore muscles and decreased enthusiasm for activity.

As the muscles contract to produce motions of any kind, the chemistry of function and chemicals produced by this contraction -- adenosinetriphospate (ATP), adenosinediphosphate (ADP), carbon dioxide (CO_2), and lactic acid - decrease and increase respectively. The ADP re-synthesized, either aerobically or anaerobically, into ATP ($ADP + Pi + CO_2 + La^- + O_2 \rightarrow ATP$), also produces by products. Here the primary concern is the control of CO2 and La- since theses are the chemical that cause the pain receptors to react to chemical buildups in skeletal muscles. These by-products are stored in the proximal end of the skeletal muscle until they are exhaled in cellular respiration. The waste products, La- and CO_2, appear in the blood stream as the continual reaction: $Na^+ + HCO_3^- + H^+ + La^- \leftrightarrow Na^+ + La^- + H_2CO_3(\leftrightarrow H_2O + CO_2)$ a weak acid. The levels of La- and CO2 can be controlled and pain, in most cases, can be avoided.

The controlling of CO_2 and La- involves controlling the exercise heart rate. This can be achieved by determining the age adjusted exercise heart rate (AAEHR) of the person. The equation for AAEHR is: 200 minus age minus resting heart rate times .5, or .6, or .7 plus resting heart rate. This will give the person a range of heart rate ± 10 on the AAEHR. This can be applied during the workout through a radial artery or a carotid artery pulse count.

The activity chosen to cause the EHR to increase to the desired level should include activities that will allow the control of the EHR. Some of these activities could include: walking, riding a bike, swimming etc. These activities will cause the heart rate to go up and still allow a participant to stop and take an accurate heart rate.

In conclusion, if exercise is allowed to be controlled by heart rate, the body will be allowed to achieve biochemical equilibrium. This stability will be achieved in a short time. It is critical to have a grasp of this balance, in that this will allow exercisers to experience advancements without the accompanying pain.

Invitations to Learn Which Are Difficult to Not Accept

Delmar Janke
Texas A & M University

Challenge Activities: What Are They?

Challenge activities arise from what is being taught. For example, if one has been studying electrical circuits, students might ask questions such as, "We have a light switch both at the top and bottom of a stairway, how does that work?", "How do three-way lamps work?", or "How do those lamps which turn on when one touches them work?". If you, the teacher, knew the answer (And I bet that for some of those questions, you do not!) you could give the answer, but a better tactic might be to make answering the question a challenge activity. Issue a challenge to the students that whoever is the first to provide an answer with evidence that will make you believe the answer is correct, will be awarded a prize (more about those prizes later).

Other challenge activities can be developed ahead of time by the teacher. For example, if the class has just completed examining owl pellets, a challenge could be offered to students to locate and collect for you (for a modest price!) owl pellets for your use in the future. (See example enclosed.) Or, of course, any of the above challenges related to electrical circuits described above could be pre-designed. But, a caution here, do not pre-design all possible challenges - those arising from student suggestions and inquiries may be more motivating for the students to pursue.

Challenge activities are to be pursued only by students choosing to do so - they are not assignments. They relate to topics being covered in class and may carry interested students to very great depths, indeed, of learning in the selected topic.

Challenges Which I Use In My Classes

In my science education classes, I offer many challenge activities - some relating to science and others relating to the teaching of science. For example, the electrical circuits ones mentioned above were all challenges which were generated by my students' questions. The solutions may be pursued in any manner possible. I did not know the answer to the touch lamp question and offered a "big" prize - the teachers edition of an elementary school science textbook - for the first person who got the answer for me. One student telephoned (long distance!) her father and her brother-in-law, who both worked in the field of electronics, received from them a verbal explanation, and was faxed a printed explanation. All of this given to me the same day the challenge was issued.

Challenges have been given to locate or develop learning activities related to selected topics, find resource materials on selected science topics, collect teaching materials from the local environment, and to get teaching curriculum materials from internet sources.

Rewards For Completing The Challenge

Rewards for completing challenges, this teacher believes, should be the opportunity for more learning. For example, "big" prizes might include hand lenses, magnets, and similar scientific items. Prizes could include more time at the (learning) computer, a chance to talk with a scientist, or helping the teacher set up future lab activities.

Most rewards can be what one might judge to be "small" by some persons' judgments, but which are "big" to students. For example, items which were gathered (at no cost for the items) at a

NSTA convention, rock samples which you gathered on last summers trip (or which were gathered by former students for you!), or special favors like sitting in a special place in the classroom, caring for the aquarium, being a teaching assistant and helping other students complete their learning tasks.

Have Students Develop Challenge Activities

One way to get a nice set of challenge activities is to have your students develop them. Not only will you have a good selection of activities, but the ones generated by the students will reflect challenges which are appealing to them (and probably their fellow students). And, to top it off, demanding that the students produce "quality" challenge activities will almost certainly cause them to learn more about the topic which you wanted them to be studying at the time - sneaky German trick to improve learning! (Yes, my ancestry is German.)

A Challenge To You

1. You generate and send to me a description in a format similar to the examples which have been included, some similar type of challenge activities. Please include the identification of the major science topic area for which the challenge is intended and the range of grades for which you judge it to be usable.

Reward: Some outstanding specimens of petrified wood (4-6 pieces). **Greater Reward:** Twice as much petrified wood if you e-mail me the description. (NOTE: For those reading this manuscript, I will have to limit the offer to the first 100 who respond!) (my e-mail address: dlj1757@acs.tamu.edu)

2. You help me establish an e-mail system through which educators can contribute and extract evaluation items of the type described in this workshop.

Reward: That good feeling one gets knowing he/she has made an important contribution to bettering education - also collaboration with me in writing a manuscript for publication - further, valuable teaching materials which you can use in teaching whatever you teach.

Challenge Activity

College Hills Elementary School

Owl Pellets = $$$?

Do This: Locate some place where you can find owl pellets. This could be in a forest, but in that location weather would help to quickly decompose the pellets. The pellets which you used in class were from Barn Owls. They live in structures such as barns, hunting stands, etc. In such places, the pellets would take a longer time to decompose, and, thus, you might find more at a time. It would be a real "find" to locate a building in which an owl lived (and then be careful to not frighten the owl so that it would move). You might find many pellets.

When teachers use pellets, they usually order them from a science supply store and must pay for them. If you were to find a reliable source of owl pellets, perhaps you could sell them to Texas teachers.

Of course, you would have to learn how to properly collect the pellets so you would not expose yourself to diseases, etc. and so they could be stored and be ready for teachers to use. It seems to me that you could get at least $.25 per pellet - perhaps more. If you find them, I will help you find a way to sell them!

Reward: The fun of finding the pellets and learning about the owl from which they come. Also, $$. (I will be happy to buy several for use with my students.)
Teacher: This is for the students on their own initiative. Just put them in touch with me if they find a good supply and want to sell them.

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Challenge Activity

Grade 3
College Hills Elementary School

Bird Count

Do This: Make a sketch of the 12-20 most common birds which might be found at a bird feeder (feeding chiefly seeds) at College Hills Elementary School.

Whenever you have time to do so, observe birds which come to the feeder and record what birds come to your feeder and how many of each kind which do come. What are the most common kinds of birds which visit your feeder?

Extensions: Do the same kinds of birds visit in the morning as in the afternoon?
Could you put something in the feeder which would attract woodpeckers? What would that be? Add that food and see if woodpeckers actually do come. If any come, what kinds of woodpeckers are they?

Do some birds prefer different kinds of seeds than others? How could you find out?

Reward: Not sure, but probably something for each of the students involved in the activity. Maybe do a class reward if a large number of your students are involved.

Teacher: I will be giving you photographs of 14 of the most likely visitors - students can make sketches viewing these photographs or they could make a sketch of birds which they see at the feeder and then identify them from the photographs or from a field guide. Your students could also use pictures from field guides in making their sketches.

Something which could delay the whole process is having a bird feeder to observe. Second grade students at College Hills are constructing "experimental" bird feeders - perhaps they will be able to do some observing of those feeders. I am also going to contact the local Audubon Society to investigate the possibility of their assistance in installing a permanent bird feeder at College Hills.

Keep this activity up only until Christmas. Let me know if your students are doing this. Thanks.

Encourage students to look for artists who concentrate on birds. Share with them some about John Audubon. Perhaps one of your students will become a modern day Audubon!

Challenge Activity

Grade 3
College Hills Elementary School

How Many in a Hill?

Do This: (This is a really tough challenge!!)

Find some way to determine the number of ants that live in an ant hill. People who study wildlife have ways of telling how many of a kind of animal live in an area - these ways are referred to as "sampling techniques". To find out how to do this you will probably either have to talk with a scientist (wildlife scientist or entomologist or others) or do research at the library - perhaps your mother or father could help you with this.

Find some ant hills (you probably will want to avoid fire ant hills) and using the sampling technique which you have learned, determine the number of ants that live in that hill. Also, determine what kind of ant it is that you are studying.

Make a display (e.g., on a piece of tag board) that explains what you have done to your classmates.

Reward: Because this challenge activity really is a lot of work, the reward will also be great. The reward will be something of the nature of a book or some science equipment which you can use.

Teacher: This is an activity for your students which can involve her/his help from any source which they can find (but NOT including you).

The task is indeed challenging and it is meant to be so. If any of your students choose to do this activity, please try to display and recognize their work. Of course, let me know about it so I can see their work and "pay off" the reward.

Challenge Activity

Grade 3
College Hills Elementary School

Picture That Insect!

Do This: Either take pictures of or make drawings of (being careful to show all important details) five helpful insects. Write a short note on how each of the insects is helpful. You may do this by yourself or in teams of two.

Reward: For doing this challenge, you will receive a prize - probably a magnifying lens (or possibly some other thing of equal value).

Teacher: The students are responsible for doing this (without any help from you) and should turn it in to you in some kind of a storage envelope. Hopefully if they do this activity, you may be able to display their work some place in your school building.

Science, Society, and America's Nuclear Waste

Gail Westmoreland
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Science, Society and America's Nuclear Waste is a secondary curriculum for grades 8-12. It was produced by the US Department of Energy's Office of Civilian Radioactive Waste Management (OCRWM). Emphasis on secondary education is a relatively new interest of the DOE, as traditionally it has focused on the university-level student.

This curriculum has been field-tested via team-teaching in the southern-tier states of Texas, Louisiana, Mississippi, Alabama, Georgia, Florida, and South Carolina. It is intended to teach students about the management and safe disposal of spent nuclear fuel. Teachers who have reviewed the materials claim that it would be appropriate for environmental science, social studies, and STS classes. The curriculum includes units on nuclear waste, ionizing radiation, the nuclear waste policy act, and the waste management system. There is a teacher's guide and a student's booklet for each unit. The teachers' guides contain lesson plans, summaries, enrichment activities, glossary of terms, bibliographies, and transparency masters. The students' booklets contain background readings, enrichment readings, and a glossary of terms. In addition to the written materials, there is a VHS videotape with 90 minutes of footage and an IBM-compatable computer program. The videotape is divided into ten segments, ranging from 2-25 minutes long, that are to accompany lessons throughout the four units, however, the computer program is only used in one activity.

Each unit will be described briefly below, but first it should be noted that actual experiments or activities using radioactive isotopes are, with a few exceptions, not possible. Obviously, due to the potentially harmful nature of nuclear waste, students should not be working with it even if a teacher is able to obtain it. Instead, many of the activities involve reading and mathematics, making this curriculum an excellent one for integrating reading and mathematics with science.

The emphasis in Unit 1 is on nuclear waste. The concepts of fission and isotope chemistry are explained. Students learn where spent fuel, both high-level and low-level, is stored in the United States. Maps and pie charts provide data for students to complete worksheets, solve math problems, and graph data. This unit teaches that the accumulation of nuclear waste is a national problem that does have a solution.

Unit 2 teaches students about ionizing radiation. To start off the unit, radiation exposure pathways are introduced. They are presented in a cycle in much the same way as a biology or an environmental science textbook would present the carbon or water cycles. Readings and activities lead students through a study of how radioactivity enters their bodies in food they eat (among other methods). The structure of DNA is illustrated and the readings describe how base pairs can be damaged by radiation. Radioactive decay is described in this unit and demonstrated through an activity using some radioactive material, dry ice, and a cloud chamber. Students learn how they can indirectly view radioactive particles inside the cloud chamber. The emphasis in this unit is that ionizing radiation is all around us and is naturally occurring. With an understanding of background radiation, it is hoped that students' fears or misperceptions of the risks of radiation from nuclear power and nuclear waste will be put into perspective.

Unit 3 describes the nuclear waste policy act. The readings indicate how national policy may be influenced by public perception of risk. Factors influencing risk perception are discussed, such as whether the potential hazard is considered controllable or voluntary and whether the effects are observable or immediate. Published research on the topic of college students' perception of environmental risks, including nuclear power-related accidents (Westmoreland, 1994, 1995) is forthcoming. The emphasis of this unit is that all human activities involve some risk.

The information in Unit 4 describes different aspects of the waste management system. Concepts such as transportation, monitored retrievable storage, repository site selection, and site control are discussed. There are readings and activities on permeability, porosity, erosion, and contour mapping. This unit emphasizes that with careful planning and monitoring, hazardous nuclear waste can be safely contained until it decomposes.

For more information regarding this curriculum and other educational materials from the DOE, call 1-800-225-6972 (within Washington, D.C., 488-5513) or write to the address below. Second edition materials are expected to be ready by January of 1996.

OCRWM Information Center
Attention: Curriculum Department
PO Box 44375
Washington, DC 20026
[http://www.rw.doe.gov]

References

U. S. Department of Energy. (1992). *Science, society, and America's nuclear waste* (Office of Civilian Radioactive Waste Management Publication No. RW-0361). Washington, DC: U. S. Department of Energy.

Westmoreland, G. (1994). *Perception of Risk from Environmental Hazards: A Comparative Study of Undergraduates in the United States and Costa Rica.* Unpublished empirical research, Emory University, Atlanta, Georgia.

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"Creek Quest" Expedition Organization Plan with Equipment / Supply List

David Broadwell
Alcester Elementary School

Overview

Our Creek Quest "expedition" is a culminating activity for the ecology unit with which I like to begin the school year's sixth grade science study. In addition to requiring students to apply concepts developed during earlier lessons, it requires them to apply some mathematics and language arts skills taught during the first weeks of the school year.

The "Creek Quest Field Journal," prepared for our sixth graders' Creek Quest expeditions, is the best source by which understand what we do. Each student uses the Field Journal as an activity guide and to record observations and measurements. The data recorded is used in classes following the expedition to draw conclusions about the health of the creek. Each teacher interested in developing a similar expedition will want to design his or her own activities according to the grade level, site resources, and curricular expectations of his or her situation.

The trip we take and the activities we conduct are accomplished within a two hour period. Students rotate from one station to the next at twenty minute intervals. Twenty minutes are allowed for transportation to and from our "expedition" site, including loading and unloading time. We leave the school at 1:00 PM and returned at 3:00 PM. This schedule is pretty/ tight, but avoids "slack time" opportunity for students to get into mischief.

I meet with parent volunteers and high school student helpers between our school's 12:15 lunch period and our 1 :00 departure time. During this time I briefly explain the activities, the locations of the stations, the schedule plan, and match the volunteers to a station or group of students.

Site Preparation

For sixth grade/middle school students I looked for a site with a stream or creek not more than waist deep and not more than six or seven feet wide. The Brule Creek, which runs through Union County on its way to the Big Sioux River works well for us. There are accessible points, at bridge crossing, to the Brule Creek within two or three miles of the Alcester Elementary School.

There are still concerns, however. The bank of the channelized Brule tends to be steep. The soil in and around the Brule is mostly a slippery silt. I have had to change sites within the past year to find a stretch of the creek allowing safe access to the students, because the water has continued to be high even into the middle of the fall.

It is important to secure permission to conduct the "expedition" from landowners of the property adjoining the creek. It is also important to secure adequate adult assistance for the trip. Each of the last two years I have had little difficulty finding at least a dozen parent volunteers to join us for the afternoon, with a sixth grade student body of close to forty-five. We have also had several of the high school ecology class students join us, specifically to conduct the activities using the Hach Kits. These are the test for dissolved oxygen and to determine the pH of the water.

To prepare the study area physically, several preliminary visits are necessary. It helps to make station signs and put these in place the day before the expedition (unless it is possible to leave school earlier during the day of the trip). In addition to setting the station signs in place, the twenty meter distance for stream flow velocity determination needs to be laid out and marked.

Station #1 - Observations and Reflections

Thermometer(s) Compass Copy of Beaufort Scale Cloud Chart (optional)

Station #2 - Critters of the Creek

For benthic macroinvertebrate study:

"D" nets and or "kick" nets, an observation basin or tray, pictures of invertebrates with pollution tolerance identification, one or two pairs of waders, and a PFD for each person wearing the waders.

For plaster casting of shoreline footprints:

Strips of posterboard and paperclips
Plaster of Paris
Water jugs
Plastic (disposable) cups
Stirring sticks

Station #3 - How Fast?

How Long?
A 20 meter length of line (or 10 meters used twice) to lay out 20 meter distance.
Two stake markers - lath with colored cloth or plastic stapled to them.
Several oranges.
Stopwatch or watch with second hand.

A 10 meter (long enough to reach across your creek and use to lay out 20 meter distance) line knotted or otherwise marked at 5 dm (half meter) intervals. Two tent stakes and hammer (to anchor the line across the creek). Meter or stick marked to measure depth in dm increments.

Station #4 - How Clear? (Turbidity)
Secchi Disk (white and black sectioned disc on line), a couple of clothes pins, a meter stick or ruler (if the water is pretty murky).

What is there to breathe in the water (Dissolved Oxygen Test)?

Hach Dissolved Oxygen Test Kit Goggles for all individuals running or closely watching test.

Station #5 - Running Hot or Cold? (Water Temperature)

Thermometer (weighted if necessary) on string or line, pole or stick in order to extend thermometer to middle of creek

How Acidic or Alkaline? (pH Testing)
Hach pH testing kit

Nitrates?
"Water Quality Test Strips" from AquaChek kit.

The best overall resource for preparation for these activities is probably the Field

Manual for Water Quality Monitoring. An Environmental Education Program for Schools; Mitchell, Mark and Stapp, William.; Thomson-Shore Printers, Dexter, MI

Order from:
William B. Stapp
2050 Delaware Rd.
Ann Arbor, MI 48103

The Effects of Instruction in Heuristics on the Use of Problem solving Strategies and Problem Solving Performance of Preservice Elementary Education Majors

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Results from research (Schoenfeld, 1979a, 1979b; Schoenfeld & Herrmann, 1982; Lucas, 1972; Hembree, 1992) suggest that problem solving instruction by way of heuristics will enhance students' problem solving performance. Mathematics teachers realize that they need to teach their students to think their way through problems to solutions (Hughes, 1976). T 'nking one's way through problems is thinking heuristically. Thinking heuristically means s ching for a technique or strategy that may lead to the solution of the problem. Heuristics is the science of discovery. In the plural, heuristics signifies a collection of techniques for discovering solutions to problems (Hughes, 1976).

During most of the 2Oth century, the teaching and learning of problem solving has received special time and attention. This attention was formalized when the National Council of Supervisors of Mathematics (NCSM) declared problem solving first among ten essential proficiencies (1977). Three years later, the National Council of Teachers of Mathematics (NCTM) chose problem solving to be the focus of its 1980s yearbook (Krulik & Reys, 1980s). This emphasis on problem solving was extended in the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) and again in the recent Professional Standards for Teaching Mathematics (NCTM, 1991).

It has been noted that for teachers to effectively teach their students to think through problems, that is to think heuristically, they need to learn to think heuristically themselves (Hembree, 1992; Hughes, 1976; LeBlanc, 1982). LeBlanc (1982) feels that of all the issues related to research in mathematical problem solving, the question of how to train teachers to teach problem solving is the one that needs the most urgent attention.

The purpose of this study was to investigate whether or not preservice elementary education majors can be trained in the heuristics of problem solving.

This study was conducted to investigate the effect of five weeks of instruction in heuristics on the use of problem solving strategies and problem solving performance of preservice elementary education majors. Preservice elementary education majors from two Mathematical Concepts for Elementary Teachers Classes participated in the study. The experimental group received instruction in five heuristics. The five heuristics included (1) draw a diagram, (2) make a list, (3) solve a simpler problem, and (4) use a variable (5) look for a pattern.

Research Questions

The study was designed to investigate three questions:

1. Can the problem solving heuristics that expert problem-solvers use be taught to an experimental group of preservice elementary education majors?

2. Following specific instruction in heuristics, do preservice elementary education majors in an experimental group use problem solving strategies with greater frequency when solving problems?
3. Following specific instruction in heuristics, does the problem solving performance of an group of preservice elementary education majors improve?

Method

Preservice elementary education majors from two Mathematical Concepts for Elementary Teachers classes at a small, private, liberal arts university in the upper Midwest participated in the study. Both classes were taught by the investigator. One class of twenty-two students participated as the experimental group. The other class of twenty five students participated as the control group.

The first phase of the study was an observational phase. This phase involved giving a questionnaire to each of the participants. The questionnaire included gender, age, year in college, math background and confidence in solving mathematical problems. Both groups had four male participants. The experimental group had eighteen female participants. The control group had twenty-one female participants. The average age in both groups was 19. The experimental group had 55% freshman. The control group had 56% freshman. All of the participants had completed or tested out of the university's required Intermediate Algebra course. Rarely had a participant completed a math course beyond algebra. The majority were not confident in their ability to solve mathematical problems. In the experimental group, 59% claimed they were not confident in solving mathematical problems. In the control group, 56% claimed they were not confident in solving mathematical problems.

To complete the observational phase of the study, a pretest was given to each participant. The pretest determined the preinstructional status of the students on heuristic usage and problem solving ability. The pretest contained five problems. Each problem could be solved using one of the five heuristics chosen for the study. The instructions for the test informed the students that the examiners were interested in everything they thought about as they worked on the problems including (a) things they tried that didn't work, (b) approaches to the problems they thought might work but didn't have the time to try, and (c) the reasons why they tried what they did. Participants were told to take the test with a pen. This allowed the examiners to see everything they had written; the participants simply put a large X through anything they decided was wrong.

The second phase of the study was the instructional phase. Students in both the experimental group and the control group were told they would be given some specially chosen problems to solve, designed to improve their problem solving ability. This phase lasted five weeks (fifteen hours). Each class met three times a week for 50 minutes. Virtually all of the class time was devoted to solving problems, in small groups or individually. Out of class the students worked on assigned problems alone, with a partner, or in small groups.

During the instructional phase, the experimental group was given one of the five strategies to use each week. They received an assignment of eight to ten problems that could be solved using that strategy. The strategy was discussed in each of the three class meetings during the week. The majority of class time was devoted to the experimental group students discussing how and why the strategy was useful and on finding solutions to the problems.

The control group received the same problems, but the problems were scrambled so that the control group received the problems in a more natural, random order. There was no mention of strategies. The majority of class time was devoted to the control group finding solutions to the problems. The students in the control group were left to intuit the strategies on their own.

The final phase of the study involved a posttest and questionnaire. The instructions for the posttest were the same as those given for the pretest. The posttest was directly related to the instructional phase in the following sense: each of the five questions could be solved (though not solely) by the application of a particular strategy that was studied in the course. The final questionnaire assessed the students' confidence in solving mathematical problems to detect any change in the students' confidence since the beginning of the study.

The method of data analysis that was used was presented and discussed in Schoenfeld (1982). The measure provided an inexpensive assessment of heuristic usage and problem solving performance. The purposes of the pretest and posttest assessments were to focus on the problem solving process and to examine students' ability to generate, select, and pursue plausible approac ies to mathematical problems. In the scoring, a plausible approach did not yield a solution to a problem, but had be germane. For each student's attempted solution to a problem, the following questions were asked (1) Did the student show any evidence of being aware of the particular strategy (approach) to the problem, (2) Did the student pursue the strategy, and (3) If the student did pursue a strategy, how much progress did he/she make toward the solution: (a) little, (b) some, (c) almost, or (d) solved. Scores in each category were either O or 1; under "progress" a 1 was given for the highest ranking a solution achieved. Thus a student who almost solved a problem by using one or more of the five strategies, received scores of 1 in the categories "evidence," "pursuit," and "almost," and O's elsewhere.

Results

Both the control group and the experimental group showed an increase in their use of problem solving strategies to solve the problems. On the average, the control group students showed evidence of using one of the five strategies on 2.00 of the problems on the pretest. On the posttest, the students in the control group used one of the five strategies to solve the problems on an average of 4.16 of the five problems. On the average, the experimental group students showed evidence of using one of the five strategies on 2.27 of the problems on the pretest. On the posttest, the students in the experimental group used one of the five strategies to solve the problems on an average of 4.27 of the five problems.

Both groups showed an increase in their problem solving ability by demonstrating better progress toward solutions to problems by having completely solved a larger number of problems on the posttest than on the pretest. On the pretest, the control group students completely solved an average of .6 problems. On the posttest, the control group students completely solved an average of1.88 of the five problems. The experimental group, on the pretest, completely solved an average of .6 problems. On the posttest, the experimental group students completely solved an average of 1.5 of the five problems.

The students' confidence in solving mathematical problems also increased for both groups. Twenty-one percent of the control group students reported they were not confident in solving mathematical problems at the end of the study, compared to 56% prior to the study. Eleven percent of the experimental group participants indicated they were not confident in solving mathematical problems at the end of the study, compared to 59% prior to the study. The performance of both the control group and the experimental group indicated that the students learned to be better problem solvers.

Preservice elementary education majors in the study used the problem solving strategies with greater frequency when solving problems following instruction in heuristics. Furthermore, the problem solving performance of these same preservice elementary education majors improved following instruction in heuristic. It appears that the problem solving heuristics used by expert problem solvers can be taught to preservice elementary education majors.

Discussion

Analysis of the data from this study suggests that preservice elementary education majors can learn the problem solving strategies that expert problem solvers use. However, questions remain to be answered concerning the best method for preservice elementary education majors to learn those problem solving strategies.

Cooperative learning may have increased the problem solving ability of both the experimental group and the control group, because both groups engaged in cooperative learning. Therefore, further research is needed to determine if education majors who engage in cooperative groups in problem solving ability exhibit greater gains compared to groups working individually.

The experimental group and the control group may have increased their problem solving ability simply by working problems, because both groups worked problems. Therefore, further research is needed to determine the optimum number of problems necessary to increase problem solving performance.

The number of problems worked by the experimental group and the control group may have led to knowledge of managerial strategies. Therefore, further research is necessary to determine if managerial strategies can be taught and if preservice elementary education majors being taught managerial strategies can improve their problem solving ability versus preservice elementary education majors not being taught managerial strategies.

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Teaching Math in an Integrated Environment

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Prior to teaching in an integrated environment, I had heard and read much of the research supporting integrating math with other academics, especially science. It is important to note that while some schools have the resources to offer team-taught classes in which there are two teachers and approximately twenty to twenty five students, I do not teach in a school where that is possible. I have attended many inservice sessions, seminars, and workshops where the presenters have sung the praises of an integrated curriculum that is team-taught in such a manner. However, believing in it and being able to do it are often two different things. In writing an application for a National Science Foundation grant, the high school science teacher and I became even more determined to do something, anything to integrate the math and science departments.

We became increasingly aware of how our curriculums supported each other. We also became even more aware of content areas that overlapped. Often, I was teaching the very thing she had recently taught to the very same students. If the lesson is taught well the first time, there is no need to teach it again, time is too valuable. We have since been working toward shared responsibility for some topics, or shifting the responsibility entirely to either the math or the science department.

Our first challenge in actual team-taught, integrated units, was to find lessons, activities, or labs that were of educational value to our students and at the same time were something we could handle with 40+ students. Our first activity involved our juniors and seniors and required that we each did a portion of the lab with half of the group in the morning. Both groups were combined for the afternoon portion of the lab. I sometimes marvel that we ever continued to develop labs after the challenge we faced with the first one.

One of the unforeseen benefits of integrated units is the increased involvement of the community. Community members (not necessarily parents) have been invited to participate in as many units/activities as possible. Community involvement has included acting as building inspectors for a toothpick bridge activity, forming a mock city council for the "Garbage Dump Dilemma" activity, and loaning needed equipment. Community involvement is always of a relevant nature and not a token appearance.

The integrated lessons have been developed with the idea that "ALL students can learn". They are not intended as enrichment for "gifted" or "challenged" students, but for ALL students. The Chester Area School mission statement "Cooperatively Preparing ALL students to Succeed" is demonstrated in the way we have made every effort to include all students in all activities. A variety of teaching methods are used to meet the needs of students who have varied learning styles.

We have developed our own philosophy for grouping students, cross age and cross curriculum. Our groups are heterogeneous with an emphasis on working as a team. Students are taught to accept each other as individuals and are gaining a new-found respect for each other. Students are beginning to understand that you do not always get to choose who you work with in the real world. As a result, we have found that students work as well as with their friends as they do with others.

One emphasis of the integrated lessons is student responsibility. Students are responsible for their materials, their work and to meet deadlines without constant reminders. Since students are often from two different classes, two different age groups, and are working with two teachers, the sense of responsibility is increased. They can not rely on a teacher walking them through an activity step-by-step. Scheduling often requires two academic classes be combined for an integrated lesson. As a result, the number of students working on the activity can be as many as 50. It then becomes necessary, in some cases, to meet in places other than the classroom. This adds to the students' expected responsibility. They need to get to the meeting place, with all necessary materials, on time.

As a result of team-teaching integrated lessons, I have changed the way I teach math. When I first started teaching, I taught the way I was taught, very traditionally. I now look for ways to make my lessons discovery lessons where students discover trends, patterns, theorems et cetera. Students learn and understand the many "rules" of mathematics so much better if they discover them. My students ability to reason and communicate mathematically is much stronger than when I lectured and completed examples all hour. A talented teacher and friend once told me that he attempts to ask the question "Why?" at least ten times during each class hour. You have a much better idea of their level of understanding based on their responses.

A benefit of open ended problems is that our students are becoming more creative. Having as many solutions to a problem as there are groups of students is quite common. Students have started taking pride in coming up with a creative, yet reasonable, solution. They are no longer asking other groups for "the" answer or solution. They also display ownership for their finished product, reveling in the differences and not the similarities. I have noticed that this attitude is starting to carry over to other lessons in the traditional classroom. We have a standing rule in my class, "If you can do a problem using a process that "works" mathematically, your process does not have to match mine." I encourage my students to use whatever makes sense to them.

One of my goals was to increase my students' enjoyment of math. In some ways, this was the most important goal and the most difficult to measure or monitor. Student interviews have shown that they do enjoy the integrated activities and also now see a need for math and science skills in "real life". One telling fact of student enjoyment is that they are talking to their parents about the integrated activities. An unexpected benefit has been the increased enjoyment I have in teaching math. As a math teacher, I also have a renewed appreciation of science.

In addition to students becoming more aware of math and science as related disciplines, we have become more aware of how closely related our fields are. I've always known that math and science supported one another, but I was not fully aware of how often I teach the same concepts as the science teacher until we started working together regularly. When we first started looking for units to team-teach, it was difficult to find lessons, units or even activities that were suited to our students and subjects. Now, it seems that we discover new ideas daily.

Plant Tissue Culture - African Violet

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Plant tissue culture is the propagation of plants through "cloning," an asexual method of reproduction. A small piece (explant) of a desired plant is cultured in a sterile, enclosed environment on a defined medium rich in nutrients and sugar which promotes rapid manipulation. The explant should be selected from younger leaves near the center of the plant because their cells are more likely to regenerate. If bacteria or fungi come in contact with the plant tissue or the medium, the culture becomes contaminated. The contaminants (bacteria and fungi) will use nutrients from the medium and the plant and quickly destroy the plant tissue. Our aim is to surface sterilize the plant tissue and put it on a sterile growth medium without any bacteria or fungi getting on the plant or medium. As the new plants develop, they are removed from culture and transferred to a standard potting medium.

Tissue culture is based on the theory of totipotency; that is, the genetically based ability of a non-embryonic organ or cell to develop along a pathway, identical to the original. Currently, tissue culture is being used in both research and commercial applications. Tissue culture not only provides a method of mass propagation, but also allows for the reproduction of disease-free plants, mutants, and secondary plant products. A new and important use is in the genetic engineering of plants. A single plant cell can be genetically modified and grown into a mature plant or plants having new characteristics.

There are five stages of plant tissue culture:

Stage 0 is the condition of the stock plant

Stage 1 takes the plant part from *in vivo* ("life") to in vitro *("glass")*. This means simply that the explant is taken from its normal relationships to the other plant parts and is placed under "test-tube" culture conditions.

Stage 2 is the manipulation stage. The plant undergoes rapid tissue or shoot multiplication. This process can be repeated, depending upon how many plants are ultimately desired. 4-6 weeks.

Stage 3 is the rooting stage. A different growth medium is used to induce root formation from stage 2 plants. 4-6 weeks.

Stage 4 is the transfer of the plants to a potting medium.

Procedure:

1. Clean the room.
2. Prepare media 24 hours prior to use, melt the media and lay the jar on a slant to make a larger surface area.

    a. These media and most other plant tissue culture media are composed of inorganic salts, vitamins, hormones, a carbon source, and agar.
    b. The inorganic salt base will provide all the essential macro- and micro-nutrients.
    c. The vitamins used are thiamine, i-Inositol, and adenine. The adenine enhances shoot production; the pre-transplant medium lacks adenine because roots rather

than shoots are desired.

d. Two types of hormones are contained in these media - auxins (IAA) and cytokins (kinetin). IAA stimulates root production, kinetin promotes shoot production, and both stimulate cell division.

e. Sucrose is used in the media as a carbon or energy source.

3. Sterilize Work Area --- Use aseptic techniques to insure that the procedure is free of microorganisms. A transfer cabinet provides an enclosed environment that is not sterile but can be surface sterilized. All items going inside the unit should be sterile or sprayed with ethanol. They will remain sterile unless you contaminate them. The culturist is the most likely source of contamination. Hands should be washed with soap and rinsed in 70% ethanol or isopropanol.
   a. Wash work surface with a disinfectant.
   b. Reduce air movement in room.
   c. Spray everything going into sterile area with 70% ethanol or isopropanol.

4. Load transfer cabinet with all needed equipment.

5. Complete all tasks outside of the transfer cabinet.

6. Finish loading transfer cabinet and close. (Cabinet is no longer opened until after sterile techniques are completed).

7. Sterilize all objects and interior sides of the cabinet.

8. Complete the transfer of explant to the proper media.
   In the classroom, success will have to be measured by knowledge gained rather than by the number of sterile cultures.

In the classroom, success will have to be measured by knowledge gained rather than by the number of sterile cultures.

Project-Based Learning - Integrating Science, Communications, Technology and Social Studies

by

Ron Newell
University of South Dakota

The latest trends in education include the following; the use of performance objectives (outcomes), the humane school, total technology infusion, non-grading and self pacing, overcoming ability grouping, increasing motivation, more parent involvement, curriculum integration, more use of problem solving and critical thinking skills, performance assessments, project-based learning, experiential learning, real world experiences, community service components, and more use of community in internships and apprenticeships.

The designers of the Minnesota New Country School began with the philosophy that in order to accomplish an integrated curriculum and the teaching of higher order thinking skills, an individualized project-based system needed to be implemented. In the process of doing so, by creating a system that allowed for individualizing, the teachers at the school discovered the possibility of implementing all of the trends listed in the first paragraph.

The key elements to individualizing, and therefore making available to all students and parents the above mentioned education trends, is to create an individualized learning plan. Individual learning plans are devised from four main sources: the desired outcomes and objectives of the community, state, and business community; from the educational establishment, including state mandates, the views of higher education , and teacher ideals; from the parents desires and wishes for their child; and from the interests, strengths, and weaknesses of the students themselves.

The school is based on the idea that it would be kept small, with a ratio of 1 teacher to 20 students set up in advisor-advisee groups. The teachers would be generalists who would advise the individuals within their group on projects that would meet the criteria established in the overall curriculum as well as the students' own individual plans. Teachers play the role of guides and facilitators, not deliverers of instruction. There are no classrooms, although there are teacher led activities and mini-courses offered. The students choose which opportunities they wish to work into their projects. Students design their own projects to meet certain outcomes. The student is expected to be a reliable worker who is productive and who learns to manage their own time.

There are no text book driven activities. Texts are used only as reference or by individual students who wish to work their way through a certain text to meet certain outcomes.

There is access to computers at almost all times, with individuals making use of powerful desktop computers or laptops with access to internet. Not only information, but other software availability allows for students to create multi-media presentations of their projects.

Projects are developed out of interest and need to meet certain outcomes. There are seven major areas of outcomes in which each student has to show some proficiency: arts, communication, citizenship, mathematics, science, technology, and personal management. Each project may meet outcomes in any area. Once the project is decided upon, the advisor and student look at the possible outcomes that need to be met in the individual plan and the overall curriculum.

The student then is responsible to do the research and create a product which will show learning the outcomes they were trying to meet. The advisor (or other teacher and/or adult) then validates the learning from the product created. Students are encouraged to explain why and how they arrived at the information and the method of presentation, and what learnings actually took place. Reflection is a necessary part of the process.

Knowledge acquisition is not the only thing MNCS is concerned with. We wish to have students show they have applied the knowledge. The projects should show comprehension of information, concept formation and principal formation. In the product, the student should show composing, problem solving, decision making, and research capabilities. These two are wedded through oral discourse.

A list of problem solving reasoning processes is made available to the student, involving comparing, classifying, induction, deduction, error analysis, constructing support, analyzing perspectives and abstracting. These are looked for in the product and process the student went through to produce the product.

Life-long learning skills, such as decision making, investigation, experimental inquiry, and invention are inherent in the process. If a student is to adequately carry out a project, they must do those things. They are responsible for a daily and weekly plan which shows their activities necessary for the completion of their projects. This is what makes the project-based curriculum so different from the traditional school, where projects are rarely carried out; students by necessity have to make judgments, decisions, problem solve, and analyze what they are doing.

The process by which students move along the curriculum is by validating certain outcomes listed in the curriculum guide. Each student moves at his or her own pace, uses their own interests to create project ideas, and makes their own decisions as to use of time. Although this has caused some problems for undisciplined learners, most eventually understand they need to use time wisely to move through the curriculum in an orderly fashion so as to stay on course for graduating to the next level.

The school is organized in two levels: Level I is made up of 7th-9th graders (although those designations are not used at MNCS), and Level II is made up of 10th-12th graders. A student may move through the curriculum faster than the three years, or slower. The number of validated outcomes is what moves a person through. When a student completes the number of validations in each area (see the seven curriculum area mentioned above), then they are ready to move on to the next level or graduate.

Seniors are required to complete a major project in their senior year. This should synthesize much of what they have learned in the area of process and problem solving, life-long learning skills. They have a committee, made up of the advisor, and junior student, and an outside adult. These three assess the final project. Only when a final project is adequately done does a senior graduate. This is in keeping with the philosophy that one graduates by showing competency, not by seat time.

In order to show how the system works, the presentation included showing student work. The project chosen for this demonstration was a Hyper-Card demonstration of the El Nino phenomenon done by Hope Grover, a 15 year old student at MNCS. Hope was unable to be at the presentation, and her El Nino project was too large to be sent to USD other than by SyQuest disk, so the El Nino project was unable to be shown. Consequently, another project by Ms. Grover, which was stored on a laptop hard drive, was shown instead.

The El Nino project, however, is the project explained herein. Ms. Grover needed to attain validations in the area of geography. She has a natural interest and aptitude for science, so we decided to have her integrate the two. The El Nino phenomenon, which had devastating affects in parts of the world, was an area chosen for the project.

In the process of creating her product (the Hyper-Card stack), Ms. Grover had to research using university libraries, internet sources, a graduate student's Master's Thesis, and general textual and magazine sources. She had to use technology in creating the stack, scanning pictures, and in the word processing. She used creative elements in creating the stack.

By doing this large project (the Hyper-Card stack had over 200 cards!), Ms. Grover met the following outcomes:

Communication - Reading to obtain information, reading to interpret, writing to inform, writing to describe, using primary and secondary sources, speaking to obtain information, speaking to inform, listening to obtain information, and viewing to gather information.

Citizenship (Social Studies) - Conduct research on a global problem, gather, analyze, and organize geographic information, apply knowledge of the five themes of geography, use primary and secondary sources to interpret global events.

Earth Systems (Science) - Define and explain scientific problems, explain natural systems, explain natural forces that change the earth.

Technology - Use basic applications, use multi-media by creating a presentation, manage information, and u[illegible] internet.

By doing projects which students enjoy and have an affinity for, the student has great motivation and interest in the outcome. By asking them to put things into a product form, rather than test via paper-pencil, the student is asked to use more problem solving and life-long learning skills.

By individualizing the school, via an advisor-advisee situation, using an integrated project approach, real learning and life skills are gained. Only be restructuring a school can these objectives be met.

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Eating Your Way Through Mathematics: Integrating Children's Literature and Cooking

Maurine V. Richardson
Constance L. Hoag
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The National Council of Teachers Mathematics (NCTM) Standards states what is known about learning mathematics which includes: 1) students should be actively engaged in learning mathematics; 2) learning mathematics is a developmental process; 3) mathematics learning should be built on previous knowledge/learning; 4) communication is an integral part of mathematics learning; 5) good and interesting questions facilitate mathematical learning; 6) multi-embodiment aids learning mathematics; 7) metacognition affects mathematics learning; 8) teachers' attitudes influence mathematics learning; 9) mathematics anxiety is influenced by how mathematics is learned; 10) forgetting is a natural aspect of learning, but retention can be aided by hands on experiences (1989). The position of NCTM includes increased attention on manipulative, active involvement, problem solving, using concrete vs. decreased attention on rote practice, memorization, use of worksheets and teaching by telling.

One way to involve children in learning thematically is by the use of literature and cooking. Children love a good story, and will be excited about one. A way to keep that excitement is to integrate literature into the various subject areas such as mathematics. Combining literature and cooking in the instruction of math concepts will peak curiosity and continue to extend the excitement of learning. Cooking and mathematics class can put the following mathematics concepts to work according to Routledge (1985). When following a recipe children must use problem solving strategies, plan ahead, organize ingredients and mixing in a sequence, be able to handle multi-step tasks and carry through the task to completion. Recipes and cooking also provide many opportunities to involve the students in computation. Operations that call for computation when cooking could be: determining how many cookies, cakes or servings are needed, doubling or increasing recipes, measuring the quantities of different ingredients needed in a recipe, estimating the total cost of materials and deciding if the group can afford them, and if not, how much money would be needed to purchase the needed ingredients, purchasing the materials needed in a recipe and checking for correct change; evenly divide cookies, cupcakes or other food among students, and deciding how best to cut cakes, pies or bread to give each student an equal share (Routledge, 1985).

For younger children computation may involve such concepts as "many" compared to "few," the recognition of numerals and the concept of fractional parts. For kindergarten and first grade students Smith (1974) states that the most easily illustrated mathematical concepts in cooking are: sets; one-to-one correspondence and equivalence; quantity, including as many as, more than, less than; size including ideas of bigness, littleness, larger then, smaller than; measurement of volume, and fractional parts.

Children's literature lends itself to the teaching of mathematics through cooking. There are book series that also have a corresponding cookbook such as The Little House books and the Little House Cookbook or The Winnie the Pooh series has two corresponding cookbooks, The Pooh Cook Book and The Pooh Get Well Cookbook. For example, in the Little House in the Big Woods, Laura Ingalls Wilder wrote about making butter. The Little House Cookbook contains a recipe that replicates how Laura and her mother made butter.

Some authors include a recipe that corresponds with the story line. A book that includes a recipe is Growing Vegetable Soup. By including the recipe, it is easy for teachers and parents to use cooking as a follow-up to reading the story.

Books that mention food in the title could be used. Examples are: Blueberries for Sal, or If You Give a Mouse a Cookie. The teacher or students could find recipes that extend the story. The recipes could be from cookbooks written for children such The Cookie Lovers Cookie Cookbook.

Books that mention food in the story line could be used such as Strega Nona and spaghetti or The Doorbell Rang deals with cookies. The teacher or students could use a recipe from My First Baking Book.

Books about life in another part of the country could be added to the list of literary works used in math class while involved in a cooking unit. Books that could be used are: The Yearling, Spoon Bread; or When I Was Young in the Mountain, Corn Bread.

Another way to integrate mathematics and children's books dealing with cooking is through a learning center in a container: A SHOEBOX Kit. When planning a shoebox kit a teacher should consider these categories: procedures include the topic, a book or theme, NCTM Standards, materials needed, developmental aspects, grade level, or the South Dakota benchmark, six evaluation/s or check off, activities or questions for children to answer, and other ideas or concerns (Richardson, Hoag and Miller, submitted for publication).

After reading a book on the topic of cooking the teacher introduces the Shoebox Kit. Each kit is theme-based and/or can be book-based and prepared in advanced by the teacher. The activities tie directly to cooking theme or book and can be individual or partner-based.

Each activity is self-contained with all directions, materials, equipment, and evaluation or check off found in each plastic zip top baggie. Therefore in the six baggies in the box are six enrichment or extender activities the teacher collected to aid learning and follow-through on any food or cooking concepts.

As a learning experience, cooking employs a broad spectrum of physical and mental skills including eye-hand coordination, math and reading ability. The key to making classroom cooking a successful, satisfying educational time for the teacher and students, is good planning and preparation. The teacher must know every detail of the recipe, and all of the utensils and ingredients should be set out prior to cooking. During the cooking experience, to be certain that ingredients are measured correctly, measure all ingredients separately before mixing them into the recipe. This system prevents errors and ensures time for understanding the math involved in measuring and in doubling recipes (Idea Place, 1993).

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