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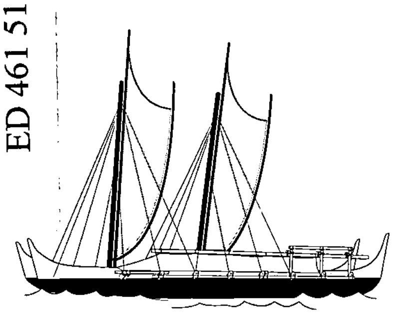
ABSTRACT

The feature article of this newsletter issue describes a course designed for the professional development of math teachers that uses inquiry-based classroom learning and presents articles on inquiry-based science and mathematics teaching. Other articles include: (1) "An Inquiry-Based Mathematics Classroom" (Lesley Lee); (2) "Teaching Science as Inquiry" (Donald B. Young); (3) "Learning about the Environment in American Samoa" (Donna L. Tiapula); (4) "More Teachers in American Samoa Join the GLOBE Program" (Elise Leroux); (5) "Project DELTA Holds Third Regional Institute" (A.J. Sandy Dawson); (6) "PREL/ENC Pacific Access Centers for Mathematics and Science Educators" (Alice Borja); (7) "The Pacific Consortium Welcomes the New PEIRS"; (8) "Mathematical Challenges" (A.J. Sandy Dawson); and (9) "PRISM Science: An Inquiry-Based Institute for Science Educators" (Elise Leroux). Solutions/Answers for "Mathematical Challenges" are included. (YDS)



Voyages in Mathematics and Science

PACIFIC RESOURCES FOR EDUCATION AND LEARNING

Pacific Mathematics and Science Regional Consortium:
An Eisenhower Consortium

Project DELTA: A National Science Foundation Program

Inquiry-Based Professional Development: Letting Questions Direct Teachers' Learning

By Norma Evans

The words in the journal entry below were written in November 1995, two months after the writer, a fifth grade teacher named Maria, and I had embarked upon a joint journey of discovery. I had been asked to teach a summer course for elementary teachers interested in understanding the new standards for mathematics learning and teaching. The idea was to have teachers spend one week engaged in math activities that modeled these new standards. After each activity, we would examine the mathematics involved, as well as the learners' and teachers' role(s) in building key understandings. By the end of the five days, we would hopefully arrive at a shared awareness of what "standards-based" mathematics learning and teaching looks and feels like.

The five days didn't really present a challenge. I had taught similar courses and felt very comfortable with the format. What was different with this experience was the final assignment. Rather than ask teachers to complete a task that would let me know how well they had understood the ideas I had presented, I was to give them permission to decide for themselves what they wanted to learn more about and how they wanted to go about learning it. They would be invited to identify an important question

> *My goal this semester has been to try out some of the ideas in the new textbooks, the ones that I haven't wanted to use. I remember looking at them last year and thinking "Where's the math? Not enough exercises, too many word problems! On top of that, the book is all mixed up. The word problems come at the beginning of the chapter, rather than at the end!" I now understand why the book looks the way it does. It uses problems as a way of introducing mathematical ideas, rather than as a way of checking whether students can apply ideas they have been presented. The authors feel that the search for solutions will lead students to discover mathematical ideas and relationships. As they work together, students are encouraged to talk about what they are observing, to share their insights and theories, and to debate the merits of the ideas presented by other students.*
>
> *I recently came across the statement: "I hear and I forget. I see and I remember. I do and I understand." This is very powerful, and it stands out loud and clear for me. It's what my students are beginning to experience in my math class. It's also what I am beginning to experience. As I experiment with new ways of doing things and talk or write about what is happening in my math class, new understandings seem to be emerging—about learners, about me as a teacher, and about what it means to "learn" mathematics.*
>
> *Maria, Grade 5 Teacher*

Note. This material was taken from the teacher's unpublished journal. It is printed with her permission.

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Inquiry-Based Professional Development

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about mathematics teaching they wanted to explore in their classrooms. They would develop an action plan for the next three months that would answer this question. The plan would include the relevant research they wanted to review, the new practices they wanted to incorporate, and the evidence they would collect to assess the impact of these new practices on students' learning. The teachers and I would meet on a regular basis over the semester to look at the evidence collected and make sense of what was happening in their classrooms. The meetings would offer a venue for them to share their successes, frustrations, and uncertainties, and provide them with the support and encouragement to persist along their learning pathways. The three months would end with the teachers presenting portfolios documenting their learning journeys. This would be an occasion to "talk story" about what they had learned about themselves and about the art of teaching mathematics.

The course was an attempt to introduce a new model for teacher professional development, one that incorporated many of the elements of the new mathematics standards (see the table at right for a comparison between inquiry-based mathematics and science classroom instruction and inquiry-based professional development). Just as students can learn important mathematics by engaging in problem-solving experiences, teachers can construct deep understandings of the learning and teaching process by engaging in authentic problem solving—identifying a problem important to them as teachers of mathematics and tracing out a way to solve or investigate the problem. The search for a solution would require them to imagine, explore, test, and verify all processes central to standards-based mathematics instruction.

This new approach to professional development was very unfamiliar to me. As a course instructor or workshop leader, I had been expected to be an authority on learning and teaching mathematics. My role had been to set directions, dispense knowledge, and present solutions. In this new course, I would be a guide or a coach. My role would be to ask questions rather than to give answers and to help teachers clarify what they wanted to do in their classrooms and why. I would have to allow the teachers to direct their own learning. This would mean disregarding my own sense of where I thought teachers should go and allowing them to choose for themselves directions for their own learning.

This new approach was also unfamiliar to Maria. Like the students in her mathematics class, she took comfort in the notion that there were "right"

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The parallels between inquiry-based classroom learning and inquiry-based professional development

Inquiry-based mathematics and science classroom instruction	Inquiry-based professional development
In inquiry-based mathematics and science classrooms, students construct meaning by engaging in inquiry. Student inquiry takes a variety of forms and occurs at different levels of depth and complexity... In such classrooms, students:	In inquiry-based professional development experiences, teachers construct new understandings about learning and teaching by engaging in inquiry. Teacher inquiry takes a variety of forms and occurs at different levels of depth and complexity... In inquiry-based professional development, teachers:
• Participate fully in and quite often initiate activities related to their own learning →	• Participate fully in and quite often initiate activities related to their own learning
• Collaborate with their teachers and other students in the pursuit of ideas →	• Collaborate with teacher colleagues in the pursuit of ideas
• Formulate questions that can be answered through planned investigation →	• Formulate questions about their teaching that can be answered through planned investigation
• Devise ways of answering questions, collect data, decide how to represent it, decide how to explain and justify their work to one another →	• Devise ways of answering these questions, collecting data, deciding how to represent it, deciding how to explain and justify their work to one another
• Learn to cope with shortcomings of equipment and consider the challenges of others →	• Learn to cope with the ambiguities and challenges of the inquiry process
• Assess the effectiveness of their efforts and make generalizations of their findings. →	• Assess the effectiveness of their efforts and make generalizations of their findings.

Note. Adapted from *Pacific Standards for Excellence in Teaching, Assessment and Professional Development*, by the Pacific Mathematics and Science Leadership Team, Pacific Region Educational Laboratory, 1995, p. 16.

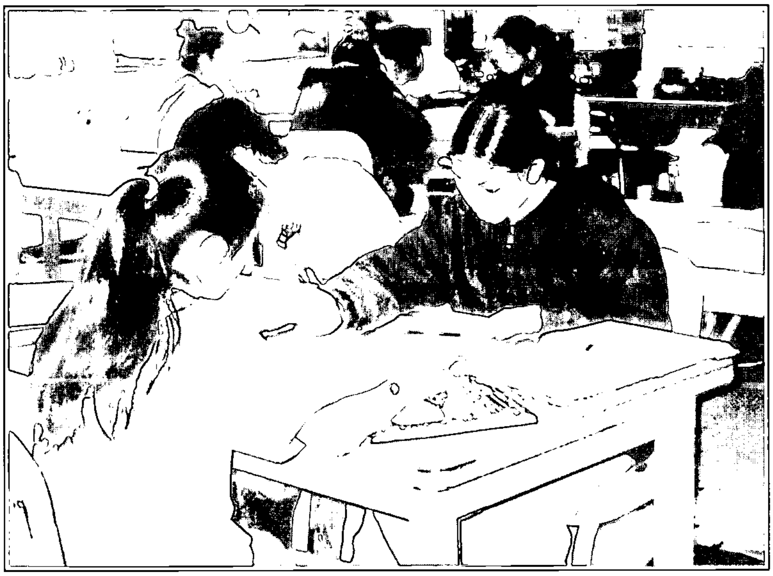
An Inquiry-Based Mathematics Classroom

By Lesley Lee

One of the most delightful characteristics of young children is their uncensored and wide-ranging curiosity about the world around them—from how a light switch works to why some things break when thrown and others bounce. From their first months of life, they are engaged in inquiry learning about their own bodies and the world around them. When they learn to speak sufficiently, they exhaust us with their "why," "when," "where," and "how" questions. Inquiry-based classrooms encourage children to continue asking these questions and help them to structure ways of finding answers to their questions through working and communicating with others.

An inquiry-based science classroom is fairly easy to imagine. We have all experienced laboratory-type science classes, and from that we can move to a picture of students engaged in a genuine inquiry—perhaps grouped around some apparatus, pouring and measuring, making conjectures and testing them. There are a number of resources available through the Internet and in print that help us think further about the characteristics of an "inquiry-based" science classroom, for example, the site of the Northwest Regional Educational Laboratory (www.nwrel.org/msec/science_inq/) or the article "Teaching Science as Inquiry" in this issue of *Voyages*. Perhaps because it is a little less obvious and less related to our own school experience, an inquiry-based mathematics classroom is a little more difficult to imagine and has inspired the creation of fewer resources. Yet the National Council of Teachers of Mathematics (*Professional Standards for Teaching Mathematics*, 1991) has identified the inquiry-based mathematics class as one of the most important contexts in which students learn mathematics. What does such a classroom look and sound like? How can we build on children's natural curiosity about comparing quantities, shapes, numbers, and so on? How can we introduce them to mathematical ways of seeing the world and answer their questions about it?

In an inquiry-based classroom, everything begins with a problem or a question. While the students in the classroom do not have an answer to the problem or question, they have some tools to begin the work of finding the answer. So let us begin with the question posed above: What does an inquiry-based mathematics classroom look and sound like? To make the question more specific, imagine a primary class where children have recently learned to identify odd and even (natural) numbers. One student notices that the sum of any two even numbers always gives her an even number as an answer. How the teacher responds to this student's contribution is critical. If the teacher does not draw attention to the child's discovery, it falls on the floor and the class moves on to the next lesson. But imagine that the teacher asks the child to share her discovery with the class and then asks the class if this is always true.



The children may be asked to work in small groups to find two even numbers that do not give an even number when they are added together. A few teams may think they have found two and then discover that they have made a mistake adding. They may not be able to produce a formal proof as to why this is true, but because of the large number of examples they have tried, the class will likely become convinced that "an even plus an even gives an even number." But do an odd and an odd give an odd number? What about even and odd numbers? What about the reverse question: Is any even number the sum of two even numbers? What about the difference of two evens, two odds, and so on? Someone might suggest a question concerning the product of evens and odds that others would want to explore. If children are used to using materials such as counters or base 10 blocks to explore number questions, then these would very likely come into play both in their group explorations and in presenting their results to the class. With counters, children might express evenness by the ability to form two equal columns or rows, and a general proof might use this feature by putting together columns and showing how they do or don't remain equal.

Let us stand back from this inquiry and try to tease out the features that make this class different from a more traditional one. First, what does it look like? Where is the teacher? In a traditional class, the teacher is usually up front, but here the teacher may be found

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Teaching Science as Inquiry

By Donald B. Young

Science and technology are powerful forces that shape human life on earth. They have made our societies productive, and they continue to have enormous potential to make our lives better and richer and to keep our world safe and livable. Science education is important because the study of science enriches people's lives. It opens the human mind to a new appreciation of the beauty and precision that surround us. An understanding of science enables people to take greater control of their lives and to face problems with courage and understanding. It liberates them to imagine new questions and to set about finding new answers. In the face of rapid scientific and technological development across the Pacific and throughout the world, all citizens need to be scientifically literate in order to function effectively and to help create and sustain a decent, just, and vigorous society.

We now know that learners need a large amount of experience and information to understand new concepts and apply them to new situations. Thus, if true learning is to occur, concepts must be pursued in depth. Lectures are often not the most effective way to teach and too often result in the ability to say the right words without any real understanding of what they mean or how to use and apply that knowledge. Teaching science as inquiry is a multifaceted activity that involves observing, posing questions, reading accounts of others to see what is already known, designing and conducting investigations, collecting and analyzing data, interpreting findings, posing solutions to problems, and using critical, logical, and creative thinking. Engaging students in inquiry enhances learning. Join me for a visit to an elementary science classroom where inquiry is a way of life.

> The principal welcomed me with a rush of words: "I can't wait for you to visit Mrs. C, she's now soaring like an eagle instead of hopping around like a robin. [Inquiry science] has opened the door to lifelong learning for our staff and students! Honest to goodness, you can't separate language, math, art, or social studies from science. It has enabled this school district to integrate its curriculum!"
>
> Moving down the hallway, the flow of student activity was overwhelming. An entire wall was covered by a graph of sunrise and sunset. The sine curve produced by the seasonal daylight and darkness pattern was emerging beautifully.
>
> Entering the room, students Lindsey and Mary Ann grabbed me by the arm and dragged me to the classroom chicken coop. Carefully cradling the full-grown chickens, they introduced me to Mellow-Yellow, Snowball, and Cuddles. "Would you like to hold Cuddles? He's the gentlest." Mike described the life history of their chickens. This was recorded in the Class Chicken Book, a collection of shadow drawings, height and weight charts, photographs, and so on.
>
> Later, I was instructed by Kiley on the art of growing crystals. "You know," she giggled, "You have to use a super-duper-saturated solution or you'll dissolve the baby seed crystals like we did." Eventual success was obvious from the quarter-inch salt crystals displayed.
>
> Kelly proudly displayed her desktop pencil and supply organizer made from a recycled plastic milk jug. A glance out the window revealed garden spaces for each classroom, a bird feeder, a giant thermometer, and several wind-measuring inventions the class had made.
>
> Where was the teacher during all this activity? She was quietly moving from group to group as they worked on their propeller-driven boats, facilitating the creative thinking of her students with a gentle, "What do you think? Perhaps a look in the Inventor's Box would help" (Young et. al., 1993).

The new standards provide a common focus on what can be achieved. There is a high degree of agreement on what students should know and be able to do and that science should be taught as inquiry. We must ensure that the standards-based movement deals with both what students should know and *how* they should be taught.

Eisner (1995) points out that one of the negative consequences of our preoccupation with standards is that "it detracts from paying attention to the importance of building a culture of schooling that is genuinely intellectual in character, that values questions and ideas at least as much as getting right answers . . . . One of the important aims of education is to free the mind from the confines of certainty . . . . Genuine education reform . . . is about vision, conversation, and action designed to create a genuine and evolving educational culture." Teaching science as inquiry contributes to the vision making, the conversation, and the actions of reform.

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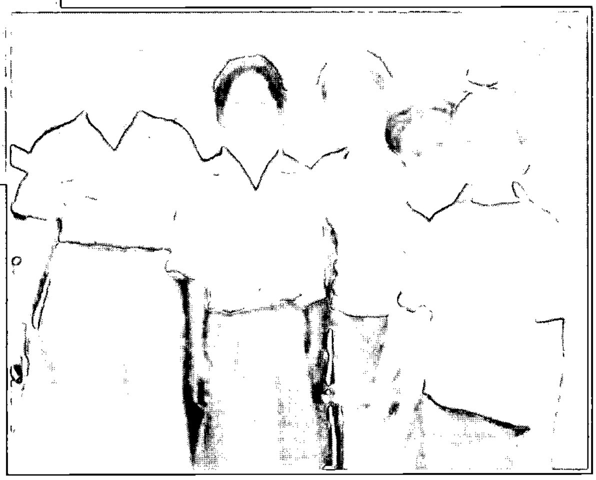
Learning About the Environment in American Samoa

By Donna L. Tiapula



In the small village of Aoa on Tutuila in American Samoa, lunch is a busy time for fifth and sixth graders. As soon as my students finish eating, they pick up the scientific tools provided by PREL and GLOBE. In groups of five, they are off to their assigned stations to collect data about the environment.

What is the tide like today? What is the air pressure? Are there white caps on the ocean? How fast is the wind blowing? What is the temperature of the air today? What is the temperature of the water in our stream? How much rainfall did we have last night? What is the humidity? Are the clouds stratus or cumulus?

Each group is assigned only two questions to answer, and then the students record the data on their daily weather sheets. At the end of the month, the five members of each group (leader, recorder, and three data collectors) write a summary of the weather data, look for patterns, and calculate the averages.

From these published summaries, our classes can discuss the environment of Aoa. Because GLOBE is an international organization, the students can also access the same data from other schools around the world to compare and contrast other students' environments.

When asked why they like GLOBE, my students give many different answers. "It is nice because I am using science," says Opetaia Sitafine. "Measuring the rainfall is fun. I will be glad when I get to do soil and water next month. That looks like fun too," says Maluai Liulevaega. And, "I like putting the data into the computer and using the turbidity tube to find how clear the river water is," Setu Fuimaono says.

As a teacher, I have found that this is a great way to teach my students science and math. After using GLOBE for two years, I have found that the students are motivated to measure correctly. This is real integrated learning, and the students love using the computer to complete their assignments.

"It is an all-around subject," says Maraia Leiato, Principal of Olomoana. "The students become aware of their environment and learn scientific knowledge and measurement. They work cooperatively to complete student-centered assignments."

Note. Donna L. Tiapula is a teacher at Olomoana Elementary School in Aoa, American Samoa.

A New Look for *Voyages*

Near the end of each year we all tend to reflect on our lives and consider "resolutions" to improve. Like many people and organizations, the Pacific Consortium continually looks for avenues of improvement. In an effort to better serve our readers, *Voyages* and several other PREL newsletters will be produced as a joint publication beginning in early 2002. The new publication will continue to contain information related to mathematics and science education with additional articles related to school improvement, literacy, and educational technology. We are excited about the change and hope that you will find the new publication informative and useful.

Once you have a chance to review the new format in February, we would appreciate your feedback. Let us know what you think by messaging the Consortium at askmathsci@prel.org.

More Teachers in American Samoa Join the GLOBE Program

By Elise Leroux

Fourteen science teachers from all over Tutuila, American Samoa, participated in a Global Learning and Observations to Benefit the Environment (GLOBE) workshop August 14-17. GLOBE is an international program that combines hands-on science activities with data reporting via the Internet. Teachers practiced learning activities and collected data in the areas of atmosphere, water, and soil studies.

Atmospheric data included rainfall amounts, pH of rain water, daily high and low temperatures, and cloud cover and cloud type. The teachers collected water samples at different points along Pago Stream and compared water temperature, clarity, pH, and conductivity. The teachers also laid out soil study sites and measured soil temperature and moisture. They connected the activities to local and global weather and climate patterns, made connections with other subject areas, and discussed how the activities fit into the curriculum.

Back in the computer lab, teachers practiced entering their data on the GLOBE website. When students enter data they have collected, scientists synthesize it into charts and graphs. They use the information to get a better picture of local, regional, and global weather and climate patterns. Students can look at their data as well as those of students at other participating schools around the world. They can also use GLOBEMail to communicate with students at other GLOBE schools.

There were several guest speakers during the workshop. Ms. Malelega Tuiolosega of the American Samoa Environmental Protection Agency led an activity that involved exploring water properties. She also talked about water quality and water purification systems in American Samoa. Mr. Anwar Karim of the American Samoa Soil Conservation State Office and Mr. Manu Tuionoula of the Department of Agriculture Soil Extension Program in American Samoa spoke about soil properties and their relationship to the rest of the environment.

The teachers will continue to receive support as they bring GLOBE to life in their classrooms. Further training will take place throughout the school year.

For more information about the GLOBE program visit www.globe.gov or contact the Pacific Consortium.

An Inquiry-Based Mathematics Classroom

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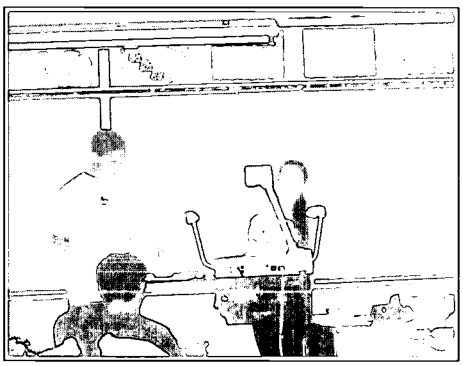

perched on a desk at the back of the classroom, sitting with a group, or circulating from group to group. The children are normally working in small groups around tables or in front of the class presenting their ideas. A variety of materials are often in use as tools for thinking and for communicating ideas with others.

Secondly, what does this inquiry-based class sound like? In this case, the class started with the conjecture of one pupil about the sum of even numbers. It could have been the teacher who asked the question or the question could have been a homework item to prepare students' thinking for more investigation. The original conjecture led to a cascade of questions and conjectures, and quite probably the class closed with a problem to think about in preparation for the next class. Thus problem solving and problem posing weave through the class from beginning to end. In a traditional class, the teacher poses the problem, but in an inquiry-based class, the children pose and solve their own questions with the occasional, and often generic, question raised by the teacher, like "Do you think that's always true?" or "Did anyone do it another way?" The teacher models inquiry behavior and the children soon begin to ask the same questions of each other. This makes an inquiry-based class somewhat noisy. Six to eight groups of four students arguing, challenging, and explaining their ideas can be noisy. Yet two to four children presenting to the class can be surprisingly hard to hear. Children have to learn the art of public speaking fairly quickly. One child said, "In my math class, they don't let you be shy." It is amazing how quickly children learn to function in this way. Children in their third week of grade 1 are already initiated into inquiry-based mathematics learning in a new program at the University Laboratory School at the University of Hawai'i.

If we view mathematics as a culture, then the inquiry-based classroom simply brings that culture into the classroom. This is how mathematicians work. Group inquiry, observing patterns, testing conjectures, estimating results, and communicating is central to mathematical activity. Children in inquiry-based classrooms are learning mathematics in the same way mathematicians do.

Project DELTA Holds Third Regional Institute

By A. J. Sandy Dawson

The Third Regional DELTA Institute, held in Kona, Hawai'i, June 20-30, brought together the DELTA Cadre teams from American Samoa, Hawai'i, Kosrae, Pohnpei, Chuuk, Yap, Guam, the Commonwealth of the Northern Mariana Islands (CNMI), the Republic of the Marshall Islands (RMI), and Palau, along with resource staff from Honolulu, Guam, and Iowa—46 people in all. This was the third and final regional meeting of the DELTA Cadre and the culmination of two years of intensive work across the region focused on the improvement of the teaching of mathematics in the middle grades. The DELTA teams meet once more subregionally and then offer a set of local institutes in the summer prior to the formal culmination of the Project in August 2002.

The Kona institute opened with a Hawaiian blessing, mele, and chant by Mikahala Roy of the Hawaiian Cultural Center in Kona. Ten days later, it closed with a communal lunch at which each entity shared aspects of their cultures through songs, stories, and skits. In between these two events, all participants were actively and enthusiastically engaged in activities focused on improving their knowledge, skills, and attitudes regarding the teaching and learning of mathematics in the middle grades.

The content focus of the meeting was on the mathematics of rational numbers. Led primarily by Barbara Dougherty from the University of Hawai'i, participants engaged in activities and challenges that forced them to examine their understanding of fractions, ratios, and proportion. Each activity was tied to specific Pacific Standards. Extensions of each activity were identified, and ways of creatively reinforcing conceptual understanding through practice were explored.

The leadership aspect of the meeting, led primarily by Norma Evans, focused on inquiry-based professional development. Participants were guided through a series of activities that culminated in the development of individual action plans by each team member. Team members selected a focus of inquiry for their own work as mathematics educators. For example, some team members from different entities chose to examine aspects of good questioning, one in her work with pre-service teachers, one in her work with students in a college mathematics course, and a third with children in her grade 5 classroom. Two mathematics specialists decided to co-teach with some middle grade teachers as a means of exploring these specialists' role as teacher mentors. A college mathematics instructor will examine the use of writing in his freshman college algebra course. In all cases, these DELTA team members developed a plan for investigating the issue or question in the context of their daily practice. This provides team members with the lived experience of inquiry-based professional development. It also provides Project DELTA staff, as they travel across the region, with a meaningful context in which to examine with team members both the process of educational change and the role of mentors in fostering an inquiry stance to teaching and learning.

The DELTA Institute opened and closed the day with a Circle. Each morning in Circle, one entity reported on the DELTA activities undertaken by the local team since the last regional institute. At the end of the day, the entity posed a question or raised an issue that was then discussed around the Circle. As in past institutes, Sandy Dawson's sacred eagle feather was used as the "talking stick." This feather was passed hand-to-hand

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Free NASA Program Available to Science Educators

The NASA "Why?" Files is a series of instructional programs consisting of video, print, and online components. Emphasizing standards-based instruction, problem-based learning, and science as inquiry, the series seeks to engage students in grades 3-5 in critical thinking and active problem solving activities. Each program supports the national mathematics, science, and technology standards and includes:

- a 60-minute video broadcast,
- a companion educator's guide,
- Web-based activities and materials.

The story line is based on the exploits of six school children ages 8-12 known as the "tree house detectives." The students and a retired science teacher, "Dr. D," use scientific inquiry to investigate a variety of issues and problems such as the "Case of the Unknown Stink," the "Case of the Barking Dogs," the "Case of the Electrical Mystery," and the "Case of the Challenging Flight."

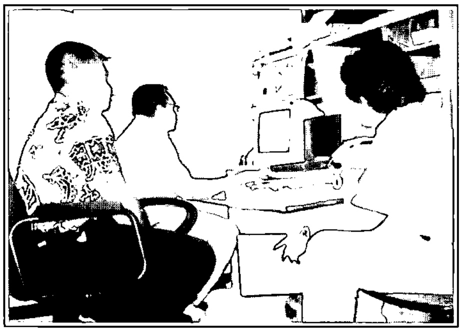
To register or to obtain more information, visit http://whyfiles.larc.nasa.gov.

An annual series of integrated mathematics, science, and technology distance learning programs for students in grades 6-8 is available free to educators through **NASA CONNECT.** To register or to obtain more information, visit http://connect.larc.nasa.gov.

PREL/ENC Pacific Access Centers for Mathematics and Science Educators

By Alice Borja

The Pacific Eisenhower Mathematics and Science Consortium at Pacific Resources for Education and Learning (PREL) has a collaborative partnership with the Eisenhower National Clearinghouse (ENC) at the Ohio State University in Columbus. ENC's mission is to identify effective curriculum resources, create high-quality professional development materials, and disseminate useful information and products to improve K-12 mathematics and science teaching and learning. For more information about ENC, visit the website at www.enc.org.



Left to right: Tulensru Waguk (science specialist), Winton Clarence (PREL program specialist), and Tulen Peter (mathematics specialist).

One of the collaborative projects between ENC and the Pacific Mathematics & Science Consortium is the establishment of the Pacific Technology Demonstration Site, which is currently located at the PREL Guam Service Center. The Pacific Demo Site is one of 12 Demo Sites nationwide and is the only site located outside the continental U.S. The writer of this article is the Demo Site coordinator and represents PREL at the semi-annual meetings.

Another collaborative project is the establishment of PREL/ENC Access Centers in the Pacific. There are currently Pacific Access Centers at the University of Hawai'i Curriculum Research & Development Group, Mathematics Section, and at the PREL Service Centers in the Commonwealth of the Northern Mariana Islands, Yap, and the Republic of the Marshall Islands. Additional access centers will open within the next few months at the PREL Service Centers in Kosrae, the Republic of Palau, and Pohnpei and Chuuk in the Federated States of Micronesia.

The purposes of the Pacific Access

Tulen Peter (math specialist), PREL Kosrae Service Center.

Centers include providing a network to reach math and science educators at the local level; providing online access for math and science educators to "navigate" through the math/science and DELTA resources on PREL's website and ENC websites; disseminating ENC publications and products to math and science educators; and providing training on how to use the Internet effectively, primarily the Math/Science Consortium/DELTA and ENC websites.

For additional information about the access centers, please contact the local PREL Service Center.

Inquiry-Based Professional Development

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answers and felt that the role of the instructor or workshop leader was to reveal those right answers. She was uncomfortable with the degree of freedom and independence she was being given and with the uncertainty that comes with being asked to choose your own learning path. Would it really be okay for her to decide what she wanted to learn? And what was it that she wanted to learn about herself as a teacher of mathematics? In the end, she decided to try out inquiry-based mathematics in her classroom. This would mean shifting her role from "teller" to "questioner." It would also mean that students would have to take more responsibility for their learning in the classroom.

The first few weeks were the most difficult. Maria felt that she was floundering. She was no longer sure what she was doing in the classroom or where she wanted to go. She was trying out the new ideas in the textbook and was uncomfortable with both the level of independent work she was now expecting from her students and about the new roles she and her students were playing in the classroom. Her role as an orchestrator of learning rather than a math expert was far more difficult than she had ever imagined. It would be so much easier to just tell them the answers! What made it even harder was that her students wanted her to tell them the answers! She had serious doubts about her effectiveness as a teacher and about whether her students were learning any mathematics at all!

Just as Maria had doubts about her role in the classroom, I had doubts about my role as a facilitator. As I listened to Maria talk about her struggles, it was dif-

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The Pacific Consortium Welcomes Its New PEIRS

Two Pacific Educators in Residence (PEIRs) have just begun their 2001-02 residency with the Pacific Mathematics & Science Consortium at PREL. Mr. Peter James, a mathematics specialist from Chuuk, Federated States of Micronesia, and Ms. Dilmai Saiske, an elementary teacher from the Republic of Palau, began in September.

Ms. Dilmai Saiske has an associate's degree from Kauai Community College and a bachelor's degree from the University of Hawai'i at Hilo. For the last 11 years, she has taught at Ibobang Elementary School in Palau. One of Ms. Saiske's goals as a PEIR is to learn more about teaching math effectively at the elementary and junior high school levels. She will be working to adapt mathematics learning activities within the existing Palau instructional program—making them more relevant to the cultural and educational context in Palau.

Mr. Peter James is a mathematics specialist in the Curriculum and Instruction Unit of the Chuuk Department of Education. He received his B.A. from Spalding University in 1980 and has worked with PREL as a member of the Math/Science Leadership Team and the Regional Educational Laboratory's Research & Development Cadre. He has also participated in the PAN project and is a member of the Chuuk Project DELTA Cadre. Mr. James hopes to learn more about standards-based mathematics instruction and to develop engaging activities for use in Chuuk's elementary mathematics classrooms.

"We welcome Dilmai and Peter, who will contribute to the implementation of mathematics standards and increased student learning in their respective entities and across the region," said Pacific Mathematics and Science Consortium Program Director Paul Dumas. "They will participate in personal professional development activities, carry out a project of importance at home, and contribute to the Consortium's overall mission of improved teaching and learning across the Pacific."

The PEIR program is a one-year residency for educators from the Pacific entities served by PREL, in collaboration with the departments of education and institutions of higher learning. Selection is based on the nominees' background and content-area knowledge in one or more areas (research, teaching, curriculum/program development, educational administration, educational technology, or other field) applicable to PREL's mission and programs. The program is intended to both enhance education within the region and contribute to the work of PREL. For more information about the PEIR program, contact Jamie Mitte at (808) 441-1395 or mittej@prel.org.

Mathematical Challenges

By A. J. (Sandy) Dawson

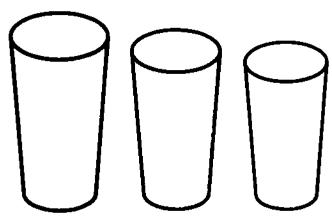
During the Third Regional DELTA Institute in Kona, Hawai'i in June, entity teams were invited to share mathematical challenges with their colleagues. One or two of these will be included in the next few issues of *Voyages*. Readers are invited to attempt the challenge and to send their solutions to Sandy Dawson, Director of Project DELTA. There will be a prize for the first entry we receive that gives a mathematically appropriate response to the challenge. Direct your responses to Sandy at dawsons@prel.org.

Math Challenge 1

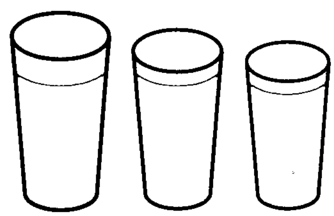
A Pacific Island woman decides to give her three daughters 17 of her precious shell necklaces. She gives one half of the necklaces to her eldest daughter, two thirds of the remaining necklaces to her second daughter, and two necklaces to her youngest daughter. Give an explanation as to how the woman could distribute the necklaces in this fashion.

Math Challenge 2

You have three glasses: an 8-oz, a 5-oz, and a 3-oz glass. The 8-oz glass is full of water.



Pour water into the glasses so that you end up with 4 oz of water in each of the two *bigger* glasses.



Rule: Every time you pour water from one glass to the other, you *must* fill the glass you are pouring into or you must empty the glass you are pouring out.

Provide an explanation as to how this can be done.

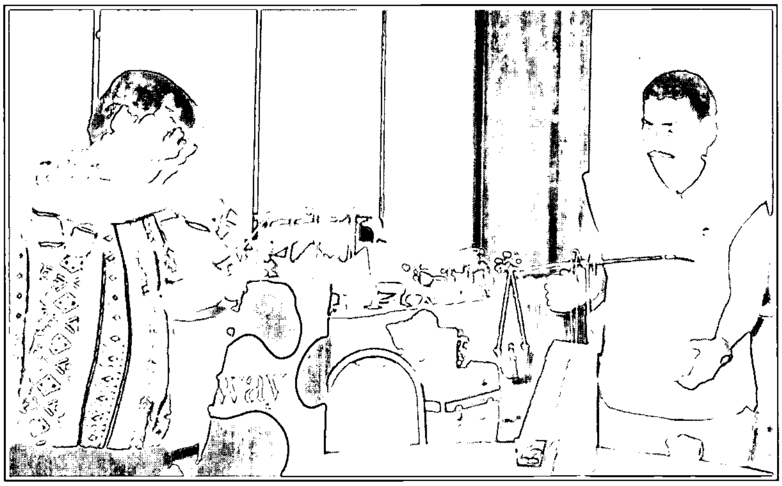
Good luck. Send your solutions to Sandy Dawson right away in order to win that prize.

Note. These mathematical challenges were presented to participants at the Third Regional DELTA Institute held June 20-30 in Kona, Hawai'i.

PRISM Science: An Inquiry-Based Institute for Science Educators

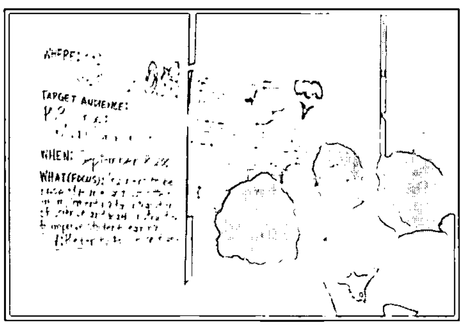
By Elise Leroux

Many people have asked, "What about a science version of Project DELTA?" To explore the possibility of a science project similar to math's Project DELTA, PREL's Pacific Mathematics and Science Consortium brought together a group of 25 science educators. The group met in conjunction with the Third Regional DELTA Institute, which was held in Kona, Hawai'i, June 20-30. The joint institute was called PRISM, short for Pacific Regional Institute for Science and Mathematics.



The science educators, representing all 10 Pacific entities served by PREL, are classroom teachers, curriculum specialists, college educators, and professional scientists involved in informal education. They spent several days immersed in standards-based, hands-on, inquiry-based physical science activities led by Don Young and Frank Pottenger of the Curriculum Research & Development Group at the University of Hawai'i.

The science group spent time learning from the experiences of the DELTA entity teams, who deliver professional development to math teachers. Each member of the science group developed a plan for putting into action some of what they learned during the institute. Many of these action plans are entity team plans, and some of the teams have already begun their proposed work. At least two of the groups have teamed with their local DELTA cadres to work at the current Pacific Schools Partnership (PSP) intensive sites, delivering professional development to science and math teachers.



The science educators were very engaged in all the activities, and despite days packed with professional activities and evening homework assignments, the majority of the group attended an optional evening session on making classroom laboratory equipment out of simple materials. Did you know you could make meter sticks out of adding-machine tape, using a sheet of notebook paper and a ruler? Or that you can create a balance with a stick, a paper clip, a wire coat hanger, and some string?

The inquiry-based science activities included continuous reflection on teaching practices and introduced participants to useful classroom tools. Some of these are described below:

Inventor's box. A box of materials that students can use to create experiments such as constructing a life preserver to study buoyancy. The teacher determines the options the students will have, allowing a range for creativity while providing some hints.

Working dictionary. A continually evolving dictionary created by the students. This can be added to and revised as students gain an understanding of new terms.

Wonder and discover book. A tool for capturing questions that are off-topic. These can be addressed later, perhaps as starting points for new inquiries.

Learning calendar. A method of recording daily observations, discoveries, data, natural events, and activities.

Each of the PRISM Science Teams is now actively involved in work at home to further the improvement of science teaching and learning. These teams are building on the planning that occurred in Kona as they work with schools and teachers across the region. For further information concerning the work of the PRISM Science Team in your entity, contact your science specialist.

Project DELTA Holds Third Regional Institute

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around the Circle, conferring on the holder of the feather the sole right to speak while all others in the Circle listen attentively.

Note. The term *regional* is used when DELTA teams from the 10 Pacific entities served by PREL assemble. The term *subregional* is used to denote four sub-sections of the region. The subregions are Hawai'i and American Samoa; the RMI and Chuuk, Pohnpei, and Kosrae, FSM; Yap, FSM, and Palau; and Guam and the CNMI.

Answers to Brain Teasers

Voyages thanks Dr. Kyaw Soe for contributing many of these engaging problems. See *Voyages* issue 25, p. 7 for the complete problems.

1. **To solve the ALPHANUMERIC Problem:**
   In the following layout, each letter represents a digit from 0 to 9. Convert the letters into numbers. The following layout tells us that STAR + REL + MS + PC = PREL.

```
STAR
 REL
  MS
  PC
----
PREL
```

One answer: 1905 + (568) + 71 + 24 = 2568.

Note. (568) can be 568, 586, 538, 583, 536, or 563.

2. **To solve the toothpick problem:**
   Move 1 of the last 2 toothpicks before the equals sign and place it on top of the II. Place it horizontally, so that after the equals sign it now reads: 22/7 = pi (∏).

3. **To solve the paperfold problem:**
   The number of sheets will be 2 raised to the power of 53. The thickness would be more than twice the distance between the earth and the sun (more than 200 million miles).

4. **To calculate the day of the week from the date:**
   For example: What day is July 4, 1993?

Step 1: Divide the last two digits by 12 (remember that 12 months = 1 year). Note the quotient and the remainder. Add them. Record the answer as SUM 1. In our example, if we divide 93 by 12, the quotient = 7 and the remainder = 9. SUM 1 = 7 + 9 = 16. Subtract the nearest multiple of 7.

The answer: SUM 1 = 16 - 14 = 2.

Step 2: Divide the remainder by 4. Record the quotient. Add it to SUM 1. Record this as SUM 2. In our example, if we divide 9 by 4, the quotient = 2. SUM 2 = 2 + 2 = 4.

Step 3: From the following two boxes, pick the number in Box 2 that corresponds to the month in Box 1. Add it to SUM 2. Record the answer as SUM 3.

Box 1

Jan	Feb	Mar
Apr	May	Jun
Jul	Aug	Sep
Oct	Nov	Dec

Box 2

1	4	4
0	2	5
0	3	6
1	4	6

In our example, July in Box 1 is 0 in Box 2. SUM 3 = 4 + 0 = 4.

Step 4: Add the date to SUM 3. Record the answer as SUM 4. In our example, the date is the 4th. Therefore, SUM 4 = 4 + 4 = 8. Since 8 is greater than 7, subtract the multiple of 7. Thus SUM 4 = 8 - 7 = 1.

For years 1900 to 1999: Result = SUM 4.
For years 2000 to 2099: Result = SUM 4 + 6.

The result (for non-leap years) is the day of the week as in the following table.

1 =	Sunday
2 =	Monday
3 =	Tuesday
4 =	Wednesday
5 =	Thursday
6 =	Friday
0 or 7 =	Saturday

Note. For leap years, if the date falls in January or February, add 1 to the result.

5. **To solve the five colored hats problem:**

Although mathematician C could see the two hats on mathematicians A and B in front of him, he said he did not know what color hat he was wearing because they were not both wearing blue hats. If both had been wearing blue hats, he would have known that his hat was red.

Mathematician B, standing in the middle, knew that this left three possibilities:

1. A blue and B red
2. A red and B blue
3. A red and B red.

If she had seen a blue hat on mathematician A (possibility 1), she would have known that her hat was red. However, since she saw a red hat on mathematician A, this left possibilities 2 or 3, which meant that her hat could be either blue or red. Therefore, she said she didn't know the color of her hat.

Mathematician A, who could not see any hats but heard the other mathematician's answers, knew that the only remaining possibilities were 2 or 3. In both cases, his hat was red; that is why he knew the color of his own hat.

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The *Voyages in Mathematics and Science* production team welcomes comments about this publication and suggestions for the next issue. The team is interested in articles about successful mathematics and science programs, practices, activities, games, and puzzles. Please submit them to Paul Dumas, Pacific Mathematics and Science Regional Consortium, Pacific Resources for Education and Learning, 1099 Alakea Street, 25th Floor, Honolulu, Hawai'i 96813.

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Inquiry-Based Professional Development

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ficult not to step in and provide easy solutions to her problems. But honoring her learning would mean listening carefully to what she was saying, asking questions that would allow her to clarify or rethink what she was doing, and respecting her ability to find suitable solutions. While I could suggest things she might read or look at, it would be up to her to decide what to do with this information.

As the weeks went by, Maria and I gradually became more comfortable with "not knowing." Maria began trusting her students to think for themselves, and I began trusting Maria to find the answers to her questions. At the end of the three months, we met one final time to "talk story." Maria proudly presented the work her students had done over the semester and talked about what she had learned about them as mathematics students and about herself as a teacher of mathematics. She talked about the struggles she and her students had gone through to change their roles in the classroom and about what she had learned from each of the struggles. She also talked about the successes she and her students had experienced and about how far they had all come since September. She talked confidently about the new pathways she wanted to explore in the upcoming semester. There would be more struggles, more uncertainty, but the destination would be worth the difficulty of the journey. And it turned out that "not knowing" wasn't so bad after all.

I learned a lot from Maria that semester about the power of inquiry-based professional development. I learned the importance of introducing people to new ideas and then standing back and letting them decide for themselves what they want to do with these ideas. I learned that if you allow teachers to learn what it is they want to learn, rather than what you want them to learn, they will amaze you with their dedication, initiative, and thoughtfulness. I learned that learning is more powerful when students—and teachers—are allowed to struggle or wrestle with new ideas and make sense of them on their own. It's the struggle that makes the learning rich and rewarding. Most importantly, I learned that it's okay to "let go" of the learning agenda, for a thoughtful, attentive question is far more powerful than a "right" answer.

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