

The Annenberg/CPB Channel
Professional Development Workshop Guide



Part 2

An Eight-Part Workshop Series for K-12
Teachers of Mathematics and Science

produced by Harvard University



and the Smithsonian Institution



CREDITS

Executive Director

Dr. Matthew H. Schneps

Executive Producers

Ara Sahiner
Nancy Finkelstein

Project Manager

Nancy Finkelstein

Series Producer

Veda Reilley

Producer

Clive Grainger

Associate Producer

Karen McMillen

Content Advisors/Writers

Rebecca Corwin, Ed.D.
Anita Greenwood, Ed.D.

Writer

Alexander D. Ulloa

Director of Outreach

Nicole Stark

Outreach/Scheduling Consultant

Dana Rouse

Web Designer

Melissa Cheung

Print Designer

Alicia Staples

Looking at Learning...Again, Part 2

is produced by the Science Media Group
of the Harvard-Smithsonian Center for Astrophysics

©2000 Smithsonian Institution Astrophysical Observatory

All rights reserved.

ISBN: 1-57680-197-7

Funding for *Looking at Learning...Again, Part 2*

is provided by Annenberg/CPB.

Annenberg/CPB, a partnership between the Annenberg Foundation and the Corporation for Public Broadcasting, uses media and telecommunications to advance excellent teaching in American schools. Annenberg/CPB funds educational series and teacher professional development workshops for the Annenberg/CPB Channel. The Channel is distributed free by satellite to schools and other educational and community organizations nationwide.

The notable series, workshops, and activities of Annenberg/CPB include *A Biography of America*, *Destinos*, *French in Action*, *In Search of the Novel*, *Journey North*, *The Mechanical Universe*, *The Private Universe Project*, *Signature*, the *Teaching Math Libraries*, *Voices & Visions*, and *The Western Tradition*.

To purchase copies of our videos and guides, or to learn more about our other professional development materials and the Annenberg/CPB Channel, contact us by phone, by mail, or on the Web.



1-800-LEARNER

P.O. Box 2345

S. Burlington, VT 05407-2345

info@learner.org

www.learner.org

Table of Contents

About the Workshops	5
Workshop Components	11
About the Contributors	13
Helpful Hints	16
Ongoing Activity	17
Materials Needed	18
Workshop 1. Behind the Design	19
Workshop 2. Mathematics: A Community Focus	25
Workshop 3. Learning to Share Perspectives	29
Workshop 4. Conceptual Change	37
Workshop 5. Infusing Critical and Creative Thinking	41
Workshop 6. Algebra and Calculus: The Challenge	47
Workshop 7. Children’s Ways of Knowing	51
Workshop 8. Learning to Listen	55
Bibliography	59
Other Resources.....	59
Video Production Credits	61
Appendix	63
Index of Readings	63
1. About Project DESIGNS: Project DESIGNS Goals That Cross All Modules, by Philip M. Sadler	
2. Bridging In-School Mathematics and Out-of-School Mathematics: A Reflection, by Marta Civil	
3. Fostering Critical Analysis and Reflection Through Mathematics Case Discussions, by Carne Barnett and Alma Ramirez	
4. Conceptual Change in Science Teaching and Teacher Education, by Peter Hewson	
5. Critical and Creative Thinking in Science, by Robert Swartz	
6. Transforming Algebra From an Engine of Inequity to an Engine of Mathematical Power by ‘Algebrafying’ the K-12 Curriculum, by James Kaput	
7. Young Children Doing Mathematics, by Herbert Ginsburg	
8. Handling Children’s Questions and Assessment in the Inquiry Classroom, by Wynne Harlen	

About the Workshops

Series Overview

How many times have you wished you could just erase your students' "wrong" ideas and help them relearn a topic? It's tempting to think that a teacher's job is simply to push those ideas aside and teach "right" ideas as replacements, but contemporary learning theories indicate that students are best able to rethink and exchange their ideas when they have tested them experimentally and shared their thinking with others. To assist children in this process, teachers must be armed with knowledge of how children construct their ideas and how they can help children make sense of their world. Children's prior knowledge, like our own, is powerful and often persistent, and we have much to learn about it!

This series provides elementary and secondary teachers of mathematics and science the opportunity to hear from science and mathematics educators and some of the teachers, students, and parents who work with them. Each of the eight featured educators has studied some aspect of teaching and learning and has proposed modifications of classroom practices as a result of that research. *Looking at Learning Again...Part 2* encourages teachers to examine how theory and research into learning may inform their own classroom work. The series provides opportunities for teachers to discuss, critique, and apply the presented ideas with their colleagues. Finding ways to share ideas and to learn more about knowledge that is being newly generated is the core of this workshop series. In order to make teaching more effective, many different perspectives are brought together through videotapes, readings, discussions, and the Internet.

Series Structure

This exploration into learning theory will be carried out in a series of eight weekly workshops. Participants will be invited to reflect on their own beliefs about learning and discover the importance of looking at learning again and again throughout their teaching careers. Each workshop will feature a different educator and the theory that guides his or her practice. In addition to interviews with the featured educator, programs will include video clips of classrooms in which the theories are being practiced and discussions about the impact and the outcomes of such practices.

Each of the eight workshops will be two hours in length—a one-hour broadcast sandwiched between two 30-minute Site Investigations. These discussion/activity sessions will introduce and extend the featured learning theories and provide a forum for participants to discuss their application in the classroom. Weekly homework assignments will promote continued thinking between workshops and help participants document their progress throughout the series.

Workshop participants are encouraged to communicate and share ideas with teachers across the country on the *Looking at Learning Again...Part 2* interactive Web site (www.learner.org/channel/workshops/lala2). The collective information exchanged via cyberspace will enrich and extend the weekly workshops, and the opportunity to engage in discourse with a national community of teachers will greatly enhance the overall value of the series for all participants.

About the Workshops

Workshop Descriptions

Workshop 1. Dr. Philip Sadler—Behind the Design

Examine prototypical engineering designs and see how students modify these and learn physical science principles as they do so.

Workshop 2. Dr. Marta Civil—Mathematics: A Community Focus

Find out more about the “funds of knowledge” that children’s homes provide, and reflect on ways to connect children’s mathematics experiences at home and at school.

Workshop 3. Dr. Carne Barnett—Learning to Share Perspectives

Learn ways case discussion formats help teacher professional development groups understand children’s mathematical thinking. See teacher groups at work as well as children’s classroom use of mathematics cases.

Workshop 4. Dr. Peter Hewson—Conceptual Change

Discuss how students can be assisted in exchanging less powerful scientific conceptions for generally accepted science ideas.

Workshop 5. Dr. Robert Swartz—Infusing Critical and Creative Thinking

Consider how critical and creative thinking can be infused throughout the curriculum to help students better understand science concepts.

Workshop 6. Professor James Kaput—Algebra and Calculus: The Challenge

Find ways to embed algebra and calculus concepts into the curriculum much earlier in children’s school experience.

Workshop 7. Professor Herbert Ginsburg—Children’s Ways of Knowing

Explore the mathematics that children invent before they come to school and reflect on what this understanding could mean for mathematics curricula...even in high school.

Workshop 8. Dr. Wynne Harlen—Learning to Listen

Study students’ learning-in-progress and discuss ways to assess the development of their science content and process skills. Learn to provide students with the feedback needed to help them refine their ideas, and develop and test their science questions.

About the Workshops

Video Clip Descriptions

Workshop 1

Middle School, Everett, Massachusetts

Nancy Cianchetta challenges her students to design paper bridge trusses in order to look carefully at the concepts of tension and load.

Sharon Middle School, Sharon, Massachusetts

Jim Kaiser's students build understanding by experimenting with electromagnets that they construct.

Heights Elementary School, Sharon, Massachusetts

Diana Stiefbold's sixth-grade class works with chemical interactions by combining baking soda and vinegar and recording the results.

Workshop 2

Mary Louise Robins Elementary School, Tucson, Arizona

Leslie Kahn works with fourth- and fifth-grade students to develop their awareness of the mathematics in the games they play.

Liberty Elementary School, Tucson, Arizona

Juanita Diggins and her fifth-grade class are studying area. She has invited parents to observe the teaching and learning that are happening in the math class. Dr. Civil meets with the parents after the class to debrief and explore the math concepts.

Wakefield Middle School, Tucson, Arizona

This mothers' group has been meeting for more than a year to deepen their own understanding of mathematics, literacy, and school.

Sunnyside High School, Tucson, Arizona

Parents from around the city come together to learn more about the new methods of mathematics teaching and learning so that they can support their children's work at home.

Workshop 3

Maricopa Community College District Office, Tempe, Arizona

Alma Ramirez leads a discussion with a group of teachers as they analyze a case of teaching. They examine some of the pitfalls children fall into when manipulating fractions with different denominators.

Whittier Elementary School, Phoenix, Arizona

Maria Hernandez's sixth-grade class begins to use math cases by starting with familiar material.

About the Workshops

Video Clip Descriptions, cont'd.

V. H. Lassen Elementary School, Phoenix, Arizona

Jodi Griff's fifth-grade class uses a math case to discuss whether they would rather have $\frac{6}{10}$ or $\frac{4}{5}$ of a dollar.

Park Elementary School, Hayward, California

Janna Winkowski's second-grade students deepen their understanding of the equal sign by examining other children's mathematical reasoning.

Treeview Bidwell Elementary School, Hayward, California

The first-graders in Leanna Baker's class are constructing their understanding of the meaning of the equal sign.

Workshop 4

Day Middle School, Newton, Massachusetts

Robert Tai's students share their ideas about what might happen in a frictionless universe and compare them with the science ideas they have been taught about friction and gravity.

Johnston Elementary School, Appleton, Wisconsin

Sara Bayer, a student teacher, interviews second-grade students to find out their ideas about the heart. She then goes on to plan class work.

Monona Grove High School, Madison, Wisconsin

Sue Johnson's eleventh- and twelfth-grade genetics class test their ideas about genetic variation as they predict the wing shape and color of fruit flies.

Workshop 5

Brookfield Elementary School, Brookfield, Massachusetts

The children in Virginia Williams' fourth-grade class are about to study the states of matter: solid, liquid, and gas. Virginia infuses creative thinking skills into the lesson by asking her students to brainstorm ways to melt an ice cube.

Millville Senior High School, Millville, New Jersey

Stephen Fischer uses graphic organizers with his tenth-grade students as they learn to categorize and identify organic molecules.

Freetown-Lakeville School District, Freetown, Massachusetts

Dr. Swartz works with teachers from the Freetown-Lakeville School District to explore how to incorporate creative and critical-thinking skills into their lessons.

About the Workshops

Video Clip Descriptions, cont'd.

Workshop 6

Doran Elementary School, Fall River, Massachusetts
June Soares encourages her third-grade class to record data and analyze patterns in many ways.

Doran Elementary School, Fall River, Massachusetts
June Soares presents mathematics problems that draw out algebraic reasoning with her third-grade students.

Central High School, Newark, New Jersey
Dr. Roberta Schorr from Rutgers University works with Ken Herskovits' eleventh- and twelfth-grade students who are developing some sophisticated calculus ideas using computer simulations.

Fall River Teachers Workshop, Fall River, Massachusetts
Professor Kaput and his colleague Dr. Maria Blanton work with teachers who are introducing algebra concepts in their elementary mathematics lessons. The teachers discuss their students' work and share ideas about ways to teach these concepts.

Workshop 7

Carillo Elementary School, Tucson, Arizona
Maria Lily Olivas' fourth-grade students work on a valentine exchange problem. During the lesson, Ms. Olivas employs many strategies to learn about the children's methods for solving the problem.

Corpus Christi School, New York, New York
Professor Herbert Ginsburg observes children in a Pre-K class during their free play with blocks and play dough and at the water table.

Corpus Christi School, New York, New York
Professor Ginsburg conducts clinical interviews with young children to discover their natural mathematics ideas.

Chatsworth Elementary School, Mamaroneck, New York
This research footage of Kay Kobe's third-grade class shows how the students naturally develop their own methods for solving the multiplication problem 23×4 .

Workshop 8

Clarendon School, San Francisco, California
Denise Ebisuzaki uses inquiry skills to assess her students' comprehension of what materials conduct electricity. She uses the information she gathers during the lesson to plan her next steps.

Exploratorium Institute of Inquiry, San Francisco, California
Dr. Wynne Harlen conducts a professional development workshop with teachers and curriculum developers from around the country to assist them in the process of formative assessment.

Workshop Components

Day of Each Workshop

Site Investigation: Getting Ready

30 minutes of discussion and activity to prepare you for the workshop video

Workshop Video

60 minutes of video with guest interviews, classroom footage, teacher panels, and more

Site Investigation: Going Further

30 minutes of discussion and activity to wrap up the workshop video

Between Workshops

Homework Assignment

an exercise or activity that ties into the previous workshop or prepares you for the next one

Reading Assignment

an introduction to the theories of the guest featured in the next workshop; reading assignments can be found in the Appendix

Ongoing Activity

a reflective journal for keeping track of reactions to readings and videotapes, collecting and reflecting on data, and recording teaching ideas for yourself

Web site: <http://www.learner.org/channel/workshops/lala2>

a place to go for additional activities, resources, and discussion

Web Buddies: <http://www.learner.org/channel/workshops/lala2/buddies>

We encourage you to register to be matched with a Web Buddy, a colleague from another site who teaches at your grade level. Web Buddies will work together throughout the series on Ongoing Activities and other assignments and activities.

Channel-Talk

an opportunity to communicate with other workshop participants via email

To subscribe to Channel-Talk (the workshop email discussion list), send an email message to: channel-talk-request@learner.org.

The message should read: subscribe channel-talk <Your Name>

For example: subscribe channel-talk <Amanda Cho>

Be sure to remove any signature files before sending your message.

About the Contributors

Featured Educators

Dr. Carne Barnett

Carne Barnett is a senior research associate at WestEd in Oakland, California, where she directs the Mathematics Case Methods Project. Teachers in this professional development project discuss cases about mathematics teaching dilemmas. Dr. Barnett's own teaching experiences led to her interest in this pioneering work, which is patterned after methods used in other professions such as business and health. She has written numerous books for teachers and students and has been published in research journals. She was formerly a teacher educator at the University of California, Berkeley, and has conducted professional development across the United States and in Malaysia, Australia, and Saipan.

Dr. Marta Civil

Associate professor of mathematics at The University of Arizona, Marta Civil specializes in mathematics education, and in particular, in mathematics teacher education for grades K-8 and in cultural and social aspects in the teaching and learning of mathematics. She has presented her work at national and international meetings and has several published papers and articles. Currently, she leads three funded projects—one on bridging in-school and out-of-school mathematics, another on parental involvement in mathematics, and a third on gender equity in science, technology, engineering, and mathematics. Most of her work has focused on working-class Latino communities.

Professor Herbert Ginsburg

Professor Herbert Ginsburg holds the Jacob H. Schiff Chair at Teachers College, Columbia University, where he is professor of psychology and education. For the past 30 years, he has conducted research on cognitive development—particularly the development of children's mathematical thinking—both within the U.S. and in various cultures around the world. He has used the knowledge gained from research to develop several kinds of educational applications and has created video workshops to enhance teachers' understanding of their children's learning of mathematics. He has also contributed to the Silver Burdett & Ginn mathematics textbook series, developed tests of mathematical thinking, and explored how the "clinical interview" method for assessing children's mathematical knowledge can be used by teachers in their classrooms. Currently, he is engaged in research on young children's mathematical competence and is developing a new mathematics curriculum for 4- and 5-year-old children.

Dr. Wynne Harlen

Wynne Harlen worked as a professor of education at universities in Reading, London, and Liverpool before being appointed as the director of the Scottish Council for Research in Education. She has spent her working life in research, development, and evaluation of children's learning in science. Her particular concerns are to help teachers help children learn with understanding and, through the use of scientific process skills, to develop concepts, attitudes, and values that promote scientific literacy, lifelong learning, and respect for the environment. Her 16 books include *Taking the Plunge*, *The Teaching of Science in Primary Schools*, and the recently published third edition of *Teaching, Learning and Assessing Science*.

About the Contributors

Featured Educators, cont'd.

Dr. Peter Hewson

Professor of science education at the University of Wisconsin-Madison, Peter Hewson studies how students learn science, how teachers teach science, and how people become teachers of science. In doing so, he uses ideas about conceptual change as a common theme in understanding the complexity of practice in classrooms with diverse human beings. He is a co-author of *Designing Professional Development for Teachers of Science and Mathematics*, published in 1998, and is currently working on teacher professional development in a joint collaboration between the U.S. and South Africa.

Professor James J. Kaput

Chancellor professor in the Department of Mathematics at the University of Massachusetts, Dartmouth, James Kaput specializes in elementary students' development of algebraic reasoning and the development of affordable technologies for mathematics education. Dr. Kaput has recently turned his attention to the massive implementation of technology-based innovations to democratize access to powerful mathematics, especially among disadvantaged populations. He is on the editorial board of six mathematics education journals and is a founding co-editor of a new series of volumes sponsored by the Conference Board of the Mathematical Sciences on Research in Collegiate Mathematics Education.

Dr. Philip M. Sadler

Philip Sadler is an assistant professor of education at the Harvard Graduate School of Education, F. W. Wright Lecturer on Navigation in the Department of Astronomy, and director of the Science Education Department at the Harvard-Smithsonian Center for Astrophysics (CfA). He joined the CfA in 1985 as director of Project STAR and is largely responsible for building the organization that is in place today. He received his B.S. in physics from Massachusetts Institute of Technology in 1973 and, from Harvard University, received both an M.A. in education in 1974 and an Ed.D. in 1992.

Dr. Robert J. Swartz

Robert Swartz received his Ph.D. in philosophy from Harvard University. He is a faculty member at the University of Massachusetts at Boston and the director of the National Center for Teaching Thinking. Through the Center, he provides staff development to educators across the country on infusing critical and creative thinking into content instruction. He has authored numerous articles and books on critical thinking and has acted as a thinking-skills testing consultant for the National Assessment of Educational Progress.

About the Contributors

Content Advisors

Anita Greenwood, Ed.D.

Anita Greenwood has worked in science education for 23 years, first as a teacher in the United Kingdom and now at the Graduate School of Education, University of Massachusetts Lowell. She conducts numerous science workshops for K-12 teachers and works with preservice science teachers and doctoral students. Her background is in the biological sciences. She can be seen in *Shedding Light on Science*, a science content workshop series for elementary teachers.

Rebecca Corwin, Ed.D.

Rebecca Corwin taught fifth grade for 10 years. She is currently professor of education at Lesley College in Cambridge, Massachusetts, and works with her graduate students in an elementary school in Boston, bringing their practical and theoretical knowledge together as they learn to be teachers. She has written a number of books for teachers, including the *Used Numbers* series about statistics and data analysis, and has produced a series of mathematics professional development videotapes and an accompanying book, entitled *Talking Mathematics*.

Jayne Ogata

Jayne Ogata has worked for the past 10 years as a performing artist and educator in the Boston area. She has also toured with Shakespeare & Company's education program, bringing theater performances and workshops to schools throughout New England and in New York City. Ms. Ogata recently earned her Master's of Education in Learning and Teaching from the Harvard Graduate School of Education. She continues to participate in creating quality educational programming for the classroom through workshops and media.

Helpful Hints

Successful Site Investigations

Included in the materials for each workshop, you will find detailed instructions for the content of your Getting Ready and your Going Further Site Investigations. The following hints are intended to help you and your colleagues get the most out of these pre- and post-video discussions.

Designate a facilitator.

Each week, one person should be responsible for facilitating the Site Investigations (or you may select two people—one to facilitate Getting Ready, the other to facilitate Going Further). The facilitator does not need to be the Site Leader, nor does it need to be the same person each week. In fact, we recommend that participants rotate the role of facilitator on a weekly basis.

Review the Site Investigations and bring the necessary materials.

Be sure to read over the Getting Ready and Going Further sections of your materials before arriving at each workshop. The Site Investigations will be more productive if you and your colleagues come to the workshops prepared for the discussions. The weekly readings and homework assignments provide for productive and useful workshop discussions. A few of the Site Investigations require special materials. The facilitator should be responsible for bringing these when necessary.

Note: Special materials and a reading assignment are required for Workshop 1. Prior to Workshop 1, please read the article, “About Project DESIGNS: Project DESIGNS Goals That Cross All Modules,” by Philip Sadler, which can be found in the Appendix. See page 18, Materials Needed, for the special materials required for the Getting Ready activity.

Keep an eye on the time.

Thirty minutes can go by very quickly, and it is easy to lose track of the time. You should keep an eye on the clock so that you are able to get through everything before the workshop video begins. In fact, you may want to set a small alarm clock or kitchen timer before you begin the Getting Ready Site Investigation to ensure that you won't miss the beginning of the video. (Sites that are watching the workshops on videotape will have more flexibility if their Site Investigations run longer than expected.)

Record your discussions.

We recommend that someone take notes during each Site Investigation, or even better, that you make an audiotape recording of the discussions each week. These notes and/or audiotape can serve as “make-up” materials in case anyone misses a workshop.

Share your discussions on the Internet.

The Site Investigations are merely a starting point. We encourage you to continue your discussions with participants from other sites on the discussion area of the Web site and on Channel-Talk, the workshop email discussion list.

Ongoing Activity

Reflective Journal

Overview

A critical part of taking steps toward change is representing learning along the way. This is a deliberate process that calls for reflecting upon your own understandings before, during, and after key experiences, and documenting how these understandings change. While there are numerous ways to represent learning, we suggest using a journal to keep track of your own ideas, reactions, and thoughts. One way to organize the journal would be to keep separate sections for:

- notes on readings;
- data you collect and analyze;
- brainstorming lists or concept maps you prepare for various sessions; and
- your reactions to readings, discussions, and presentations.

You may also organize your journal by session number. Whatever you do, use it to reflect, record, and capture your thoughts about this series.

There will be preparatory readings and/or activities for each session, and having a place to keep those will be extremely helpful. The group meetings will be more productive if you are well prepared for the introductory discussions.

Materials Needed

Workshop Discussions

WORKSHOP 1: Behind the Design

- several single sheets of notebook paper with holes for a standard 3-ring binder
- *if possible*, self-adhesive hole reinforcements for both sides of the paper
- hole punch
- 2 pushpins
- scissors
- large paper clip (bent into an S shape)
- any object weighing about 750g (2 lbs.)

WORKSHOP 3: Learning to Share Perspectives

- 16 beans or other discrete objects (thumbtacks, erasers, small blocks)

WORKSHOP 8: Learning to Listen

- examples of student work