



Project 2061
American Association for the Advancement of Science

Heavy Texts Light on Learning

On September 28 at Washington, D.C.'s National Press Club, Project 2061 director Dr. George Nelson announced that not one of the middle grades science texts evaluated by Project 2061 rated satisfactory.

"Our students are lugging home heavy texts full of disconnected facts that neither educate nor motivate them," said Nelson. "It's a credit to science teachers that their students are learning anything at all. No matter how 'scientifically accurate' a text may be, if it doesn't provide teachers and students with the right kinds of help in understanding and applying important concepts, then it's not doing its job."

The evaluation, headed by Project 2061 curriculum director Dr. Jo Ellen Roseman, examined how well textbooks for the middle grades help students learn key ideas in earth science, life science, and physical science, drawn from AAAS's *Benchmarks for Science Literacy* and the National Research Council's *National Science Education Standards*. The study probed beyond the usual superficial alignment by topic heading and examined the text's quality of instruc-

tion aimed specifically at the key ideas, using criteria drawn from the best available research about how students learn. The evaluation procedure was developed and tested over a period of three years in collaboration with more than 100 scientists, mathematicians, educators, and curriculum developers, with funding from the National Science Foundation.

The analysts—middle school teachers, curriculum specialists, and professors of science education—found that the textbooks covered too many topics and didn't develop any of them well. The texts, which included widely used books and those just entering the market, included many classroom activities that either were irrelevant to learning key science ideas or didn't help students relate what they were doing to the underlying ideas.

GUIDING IMPROVEMENT

"Although Project 2061 does not write textbooks," Nelson explained, "our goal is to provide guidance for those who do. Project 2061 hopes the reviews not only will guide textbook development in the future but also will be valuable for middle school teachers today. We

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Above: Project 2061 director Dr. George Nelson and curriculum director Dr. Jo Ellen Roseman.

2061 *today*

Christy Bowe

Science Literacy
for a
Changing Future

Mathematics

Natural Sciences

Social Sciences

Technology

FALL 1999

VOLUME 9, NUMBER 2

AAAS PROJECT 2061 MIDDLE GRADES SCIENCE TEXTBOOKS EVALUATION

Criteria for Evaluating the Quality of Instructional Support

CATEGORY I

Providing a Sense of Purpose

- I.1 Conveying unit purpose
- I.2 Conveying lesson purpose
- I.3 Justifying activity sequence

CATEGORY II

Taking Account of Student Ideas

- II.1 Attending to prerequisite knowledge and skills
- II.2 Alerting teacher to commonly held student ideas
- II.3 Assisting teacher in identifying own students' ideas
- II.4 Addressing commonly held ideas

CATEGORY III

Engaging Students with Relevant Phenomena

- III.1 Providing variety of phenomena
- III.2 Providing vivid experiences

CATEGORY IV

Developing and Using Scientific Ideas

- IV.1 Introducing terms meaningfully
- IV.2 Representing ideas effectively
- IV.3 Demonstrating use of knowledge
- IV.4 Providing practice

CATEGORY V

Promoting Student Thinking about Phenomena, Experiences, and Knowledge

- V.1 Encouraging students to examine their ideas
- V.2 Guiding student interpretation and reasoning
- V.3 Encouraging students to think about what they've learned

CATEGORY VI

Assessing Progress

- VI.1 Aligning assessment to goals
- VI.2 Testing for understanding
- VI.3 Using assessment to inform instruction

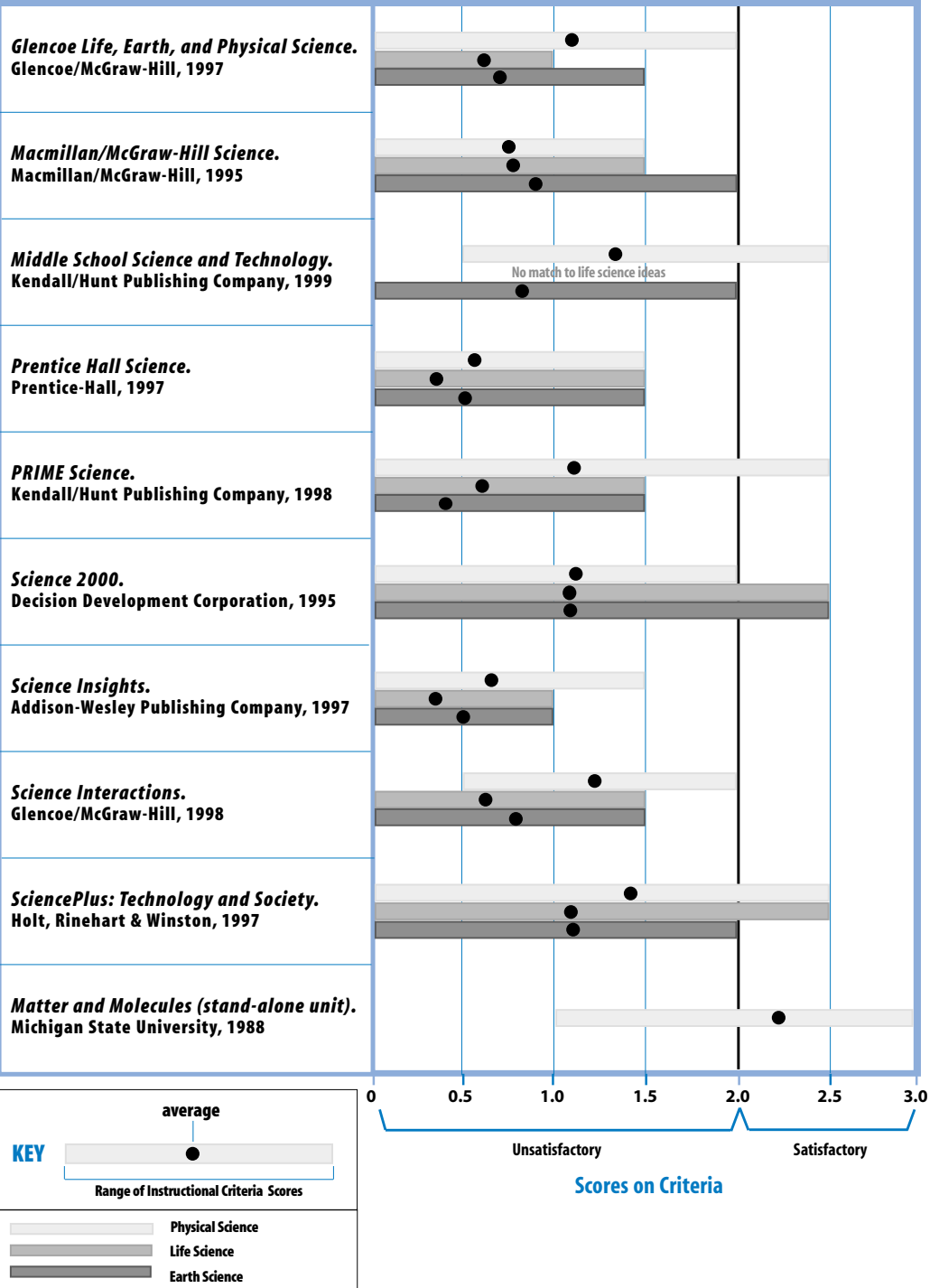
CATEGORY VII

Enhancing the Science Learning Environment

- VII.1 Providing teacher content support
- VII.2 Encouraging curiosity and questioning
- VII.3 Supporting all students

Textbooks in Alphabetical Order

Rating of Instructional Quality in Student and Teacher Editions



Science Textbooks *from page 1*

understand that these negative evaluations will be disturbing for schools using these texts, but teachers should be able to use the explanations in the full reports to start looking for ways to compensate for the texts' shortcomings."

Until better texts are developed, Project 2061 recommends that schools keep their current texts and spend their money on professional development to help teachers to supplement the books.

The study looked at three stand-alone units that are not part of any textbooks—*Matter and Molecules*, *Food, Energy, and Growth*, and *Chemistry That Applies*. Developed at Michigan State University and the Michigan Department of Education through research aimed at how students learn, the units rated much higher than the textbooks. "These encouraging results show that good science materials can indeed be developed," Roseman reported.

This is the second in a series of Project 2061 textbook evaluations funded by the Carnegie Corporation of New York. The findings from Project 2061's analysis of middle grades mathematics textbooks, released in January 1999, are influencing textbook adoptions across the nation. For more information on the evaluations, visit www.project2061.org. Full reports on each science textbook will be available next year.

Key Ideas Used for the Analysis

PHYSICAL SCIENCE TOPIC: Kinetic Molecular Theory

Ideas that served as the basis for the analysis were drawn from Chapter 4, Section D of *Benchmarks for Science Literacy* and from Physical Science Content Standard B of the *National Science Education Standards*.

- All matter is made up of particles called atoms and molecules (as opposed to being continuous or just *including* particles).
- These particles are extremely small—far too small to see directly through a microscope.
- Atoms and molecules are perpetually in motion.
- Increased temperature means greater molecular motion, so most materials expand when heated.
- Differences in arrangement and motion of atoms/molecules in solids, liquids, and gases:
 - In solids, particles (i) are closely packed,

- (ii) are [often] regularly arranged,
 - (iii) vibrate in all directions, (iv) attract and "stick to" one another.
- In liquids, particles (i) are closely packed, (ii) are not arranged regularly, (iii) can slide past one another, (iv) attract and are loosely connected to one another.
- In gases, particles (i) are far apart, (ii) are randomly arranged, (iii) spread evenly through the spaces they occupy, (iv) move in all directions, (v) are free of one another, except during collisions.
- Explanation of changes of state—melting, freezing, evaporation, condensation, and perhaps dissolving—in terms of changes in arrangement, interaction, and motion of atoms/molecules.
- Connection between increased temperature and increased energy: Increased temperature means greater average energy of motion, so most substances expand when heated.

LIFE SCIENCE TOPIC: Transformation and Transfer of Matter and Energy

Ideas that served as the basis for the analysis were drawn from Chapter 5, Section E of *Benchmarks for Science Literacy* and from Life Science Content Standard C of the *National Science Education Standards*.

- Food (for example, sugars) serves as (molecules that provide) fuel and building material for all organisms.
- Plants make their own food, whereas animals obtain food by eating other organisms.
- Matter is transformed in living systems:
 - Plants make sugars from carbon dioxide in the air and water.
 - Plants break down some of the sugars they have synthesized back into simpler substances—carbon dioxide and water—and assemble some of the sugars into the plants' body structures (including some energy stores).
 - Other organisms break down the stored sugars or the body structures of the plants they eat (or in the animals they eat) into simpler substances and reassemble them into their own body structures (including some energy stores).
 - Decomposers transform dead organisms into simpler substances, which other organisms can reuse.

"Teachers should be able to use the explanations in the full reports to start looking for ways to compensate for the texts' shortcomings."

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ABOUT PROJECT 2061

Project 2061 of the American Association for the Advancement of Science is a long-term initiative to reform K-12 education nationwide so that all high-school graduates are science literate. Project 2061 is developing a coherent set of reform tools to help educators meet science literacy goals in their own districts.

Science for All Americans (OUP, \$14.95) describes what every citizen needs to know in science, mathematics, and technology.

Benchmarks for Science Literacy (OUP, \$23.95) presents specific learning goals in science, mathematics, and technology for the ends of grades 2, 5, 8, and 12. Both of these books are also available in Spanish (OUP-Mexico). **Resources for Science Literacy: Professional Development** (OUP, \$49.95) provides educators with valuable background materials to improve their own knowledge and skills. **Blueprints for Reform** (OUP, \$17.95) outlines changes needed in a dozen areas of the education system to improve learning in science, mathematics, and technology. **Dialogue on Early Childhood Science, Mathematics, and Technology Education** (AAAS, \$12.95) discusses the latest findings on teaching these subjects to preschool children. **Middle Grades Mathematics Textbooks: A Benchmarks-Based Evaluation** (AAAS, \$89) presents the results of Project 2061's analysis of both widely used and newly developed middle grades mathematics texts.

In addition, **Project 2061 Professional Development Programs** provide custom-tailored workshops on understanding benchmarks and standards and aligning curriculum and assessment to them.

AAAS gratefully acknowledges the following for their support of Project 2061: Carnegie Corporation of New York, Hewlett-Packard Company, John D. and Catherine T. MacArthur Foundation, Andrew W. Mellon Foundation, National Science Foundation, and The Pew Charitable Trusts.

For more information contact: Project 2061/AAAS, 1333 H Street, NW, P.O. Box 34446, Washington, D.C. 20005; Phone: 202-326-6666; Fax: 202-842-5196; E-mail: project2061@aaas.org; Web site: www.project2061.org.

To order Project 2061 products call: Oxford University Press (OUP)-1-800-451-7556; OUP-Mexico-011-52-5-592-5600, ext. 166; AAAS Distribution Center-1-800-222-7809.

- Energy is transformed in living systems:
 - Plants use the energy from light to make “energy rich” sugars.
 - Plants get energy by breaking down the sugars, releasing some of the energy as heat.
 - Other organisms get energy to grow and function by breaking down the consumed body structures to sugars and then breaking down the sugars, releasing some of the energy into the environment as heat.
- Matter and energy are transferred from one organism to another repeatedly and between organisms and their physical environment.

EARTH SCIENCE TOPIC: Processes that Shape the Earth

Ideas that served as the basis for the analysis were drawn from Chapter 4, Section C of *Benchmarks for Science Literacy* and from Earth and Space Science Content Standard D of the *National Science Education Standards*.

- The (seemingly solid) earth is continually changing (not only has it changed in the past but it is still changing).

- Several processes contribute to building up and wearing down the earth's surface.
- The processes that shape the earth today are similar to the processes that shaped the earth in the past (not comparing rates).
- Some of the processes are abrupt, such as earthquakes and volcanoes, while some are slow, such as continental drift and erosion.
- Slow but continuous processes can, over very long times, cause significant changes on Earth's surface (e.g., wearing down of mountains and building up of sediment by the motion of water).
- Matching coastlines and similarities in rocks and fossils suggest that today's continents are separated parts of what was long ago a single vast continent.
- The solid crust of the earth consists of separate plates that move very slowly, pressing against one another in some places, pulling apart in other places.
- Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.

High School Evaluations are Underway

Project 2061 will release its findings for high school algebra and biology textbooks next year. The following books are being evaluated:

Algebra 1: Explorations and Applications – McDougal Littell

Algebra 1: Integration, Applications, Connections – Glencoe/McGraw-Hill

Algebra: Tools for a Changing World – Prentice Hall

Concepts in Algebra – Everyday Learning

Contemporary Mathematics in Context (CORE-Plus Mathematics Project) – Everyday Learning

Cord Algebra 1: Mathematics in Context – South-Western Educational Publishing

Focus on Algebra – ScottForesman/Addison Wesley

Interactive Mathematics Program (IMP) – Key Curriculum Press

MATH Connections: A Secondary Mathematics Core Curriculum – It's About Time, Inc.

Mathematics: Modeling Our World, COMAP – South-Western Educational Publishing

SIMMS Integrated Mathematics: A Modeling Approach Using Technology – Simon & Schuster

UCSMP Algebra – ScottForesman/Addison Wesley

Biology, 4th Ed. (Miller and Levine) – Prentice Hall

Biology: A Community Context – South-Western Educational Publishing

Biology: Principles and Explorations – Holt, Rinehart, and Winston

Biology: Visualizing Life – Holt, Rinehart, and Winston

BSCS Biology: A Human Approach – Kendall Hunt

BSCS Biology: An Ecological Approach – Kendall Hunt

Heath Biology – D.C. Heath and Company

Insights in Biology – Kendall Hunt

Modern Biology – Holt, Rinehart, and Winston

What Can a Teacher Do?

During her 34-year teaching career, Susie Hix has taught both science and math. For the past 25 years she has worked at Oakland Mills Middle School in Columbia, Maryland, where she currently teaches eighth grade physical science. Since 1995, she has helped Project 2061 to test and refine its curriculum-materials analysis procedure. Recently, she analyzed physical science textbooks as part of the middle grades science textbooks evaluation. She spoke with staff member Susan Shuttlesworth about what she learned from doing this analysis.

SS: What was most challenging about using Project 2061's procedure to analyze middle grades science texts?

SH: The time it took to become familiar with the textbook and the way it presented information. I felt I was completely immersed in the book when I was doing the evaluation.

SS: How does Project 2061's procedure differ from other analysis procedures you have used?

SH: In the past, I did a lot of textbook evaluation in Ohio and Maryland. We would discuss things like: Was the book attractive and appealing? Was the binding well done and would it last? Were there questions at the end of the chapter and an index? It was very superficial. And I never received any training. It was definitely once over lightly compared to what Project 2061 does.

SS: What did you learn from doing the Project 2061 analysis?

SH: It's true you can't judge a book by its cover. Some of the prettiest books and the ones you would think were really great when leafing through showed how poor they were during the careful evaluation. Some of the stand-alone units that were black and white and drab were excellent and showed they could really help students learn. There were a lot of shortcomings and misleading statements in the books, and I was very shocked that they contained so few hands-on experiences. I was also surprised that the books didn't rate higher than they did. The best books that we had to analyze were poor to medium. That was somewhat surprising.

I learned that a lot of students have trouble with application and need a lot of help in

using the information they have learned to explain the phenomena they see in their real life. I also didn't realize that teachers have to be told some of the misconceptions that students have and how to get the students to change these. There are things that the procedure deems necessary as part of the teacher help in textbooks that I always assumed were part and parcel of the education of a teacher in a particular subject area.

I can say that being aware of some of these things has improved my teaching. I am focusing more on requiring students to apply their knowledge to the phenomena they see. Encouraging students to use the knowledge they have just learned and the knowledge they previously learned to explain things that happen in their environment develops thinking processes that will serve them well throughout their lives. I'm not implying that I didn't do this before, because I did, but now I'm doing more of it.

SS: How else have you applied Project 2061's criteria in your classroom?

SH: I've spent more of my time finding out where kids are and helping them modify the misconceptions they hold. I've also focused more on building a case, developing evidence-based arguments for benchmark ideas. The students not only need to recognize this when it is modeled in textbooks but they also need to learn how to develop an evidence-based argument to support their answers or proposals.

SS: Have you found that focusing on these criteria have made a difference in your classroom?

SH: I think improvement in the classroom comes in small steps. I wish I could say I have a magic wand, and all of a sudden the performance of my students increased by 50 percent, but I haven't found that. As I implement more and more of the concepts and ideas from the procedure and learn a little bit more myself as I go through the process, I have achieved better results, but the progress is slow.

I think that the procedure can definitely help all teachers. My concern is that it is not something you can take two or three hours and read and then implement. Most teachers are

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Susie Hix

Until publishers present a material that does a better job, I'll still continue to pick and choose from texts and then implement as many of Project 2061's guidelines as possible.

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EXHIBIT SCHEDULE

Look for Project 2061's exhibit booth and presentations at the following conferences in 1999 and 2000:

National Science Teachers Association Western Area Convention

December 2-4, 1999, Reno, NV
Contact: (703) 243-7100 or
<http://www.nsta.org>

National Association of Secondary School Principals

February 4-8, 2000, San Antonio, TX
Contact: (703) 860-0200 or
<http://www.nassp.org>

American Association for the Advancement of Science

February 17-22, 2000, Washington, DC
Contact: (202) 326-6450 or
<http://www.aaas.org>

American Association of Colleges for Teacher Education

February 26-29, 2000, Chicago, IL
Contact: (202) 293-2450 or
<http://www.aacte.org>

American Association of School Administrators

March 3-6, 2000, San Francisco, CA
Contact: (703) 528-0700 or
<http://www.aasa.org>

Association for Supervision and Curriculum Development

March 25-27, 2000, New Orleans, LA
Contact: (800) 933-ASCD or
<http://www.ascd.org>

National School Boards Association

April 1-4, 2000, Orlando, FL
Contact: (703) 838-6722 or
<http://www.nsba.org>

International Technology Education Association

April 6-8, 2000, Salt Lake City, UT
Contact: (703) 631-6220 or
<http://www.iteawww.org>

National Science Teachers Association-National Meeting

April 6-9, 2000, Orlando, FL
Contact: (703) 243-7100 or
<http://www.nsta.org>

National Council of Teachers of Mathematics

April 12-15, 2000, Chicago, IL
Contact: (703) 620-9840 or
<http://www.nctm.org>

Interview *from page 5*

not going to be able to do that. It's going to take some in-depth study and discussion and inservicing for teachers to make this procedure a part of how they evaluate and use materials. Teachers who are using the procedure need to get together and talk about how they've implemented it and what results they've had.

SS: How much do you think teachers rely on textbooks in the classroom?

SH: It depends a lot on the teacher. There are teachers who start on the first page and teach through that textbook. Four years ago in our county, they introduced an integrated curriculum, and they used one of two integrated textbooks. The teachers taught through those books. There are processes in place that encourage teachers to teach through the textbook. I've always been one to teach the curriculum. That's been my guide. I would pick and choose among textbooks and activities and sort of put together my own course of study.

SS: Now that you've seen that so many of the science textbooks are unsatisfactory, how are you going to deal with that in your classroom?

SH: Until publishers present a material that does a better job, I'll still continue to pick and choose from texts and then implement as many of Project 2061's guidelines as possible. I'm using *Matter and Molecules*, one of the units out of Michigan State that Project 2061 recommends, in my classroom this year.

SS: What advice can you give other teachers who are trying to teach to standards and trying to supplement their texts?

SH: They should take advantage of all opportunities for training—even if it's on their own time. Also, they need to have an open mind and be willing to try new things. But they shouldn't blindly accept the idea that new or different is necessarily better.

Peer coaching, working with other teachers who are also committed to improving the science education of our youth, can produce benefits for both the students and the teachers. Peer coaching can provide feedback, support, and shared ideas as well as a sounding board and encouragement. Truly, two or more heads and hearts are better and can achieve more than one.

Project 2061 to Produce New Assessment Guide

Project 2061 has received \$2.4 million from the National Science Foundation for a research project to develop strategies and tools for judging the alignment of K-12 science and mathematics assessments with benchmarks and standards.

Project 2061's research will address the current lack of useful guidelines and proven techniques for aligning assessment with the national and local learning goals used in the classroom. Drawing on its experience in evaluating textbooks, Project 2061's three-year project proposes to: (1) develop criteria and an analysis procedure for judging alignment of assessment tasks to specific learning goals, and (2) produce case studies to illustrate how the criteria may be used to revise existing tasks and create new ones. The assessment analysis procedure will focus primarily on individual tasks—from large-scale, standardized tests to classroom-based quizzes.

Some 21 states are currently engaged in developing statewide assessments, and Project 2061 expects the results of its research to have a major impact on the development of these tests. The research data should also be extremely helpful to classroom teachers, according to Project 2061 associate director Andrew Ahlgren.

"Data from this research will provide guidance for classroom teachers who are required to assemble their own tests, interpret students' responses, and make instructional decisions accordingly," said Dr. Ahlgren.

The main product of this research project will be a book and Web-connected CD-ROM that will include the alignment-analysis procedure, analyses of existing tests for their alignment to standards, illustrative case studies, and guidelines for creating and improving standards-based assessment tasks.

DIRECTOR'S NOTES

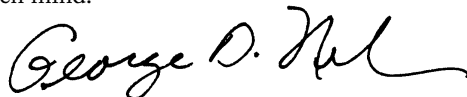
Slow Motion

Sometimes, to gain fresh perspective when mired in the politics and problems surrounding our work to improve science education, we need to step back and take a longer view. George Bradley is a wonderful poet who often uses science in his work. This poem comes from *Terms to Be Met*, 1986.*

E Pur Si Muove

Of course it had been madness even to bring it up,
 Sheer madness, like the sighting of sea serpents
 Or the discovery of strange lights in the sky;
 And plainly it had been worse than madness to insist,
 To devote entire treatises and a lifetime to the subject,
 To a thing of great implication but no immediate use,
 A thing that could not be conceived without study,
 Without years of training and the aid of instruments,
 And especially the delicate instrument of an open mind;
 It had been stubbornness, foolishness, you see that now,
 And so when the time comes you are ready to acquiesce,
 When you have had your say, told the truth one last time,
 You are ready to give the matter over and say no more.
 When the time comes, you will take back your words,
 But not because you fear the consequences of refusal
 (Who looks into the night sky and imagines a new order
 Has already seen the instruments of torture many times),
 Though this is the conclusion your inquisitors will draw
 And it is true you are not what is called a brave man;
 And not because you are made indifferent in your contempt
 (You take their point, agree with it even, that there is
 Nothing so dangerous as a new way of seeing the world);
 Rather, you accept the conditions lightly, the recantation,
 Lightly you accept their offer of a villa with a view,
 Because you have grown old and contention makes you weary,
 Because you like the idea of raising vines and tomatoes,
 And because, whatever you might have said or suffered,
 It is in motion still, cutting a great arc through nothingness,
 Sweeping through space according to a design so grand
 It remains, just as they would have it, a matter of faith,
 Because, whether you say yea, whether you say nay,
 Nevertheless it moves.

The idea of science—that the natural world can be understood through application of human creativity, careful observation, and intellectual honesty—is still a radical one. As is the hard won freedom to be always unsure, to change our minds when convincing evidence is at hand—but only then. When new evidence challenges our old ideas, we carefully re-examine both. Objectivity is not easy. It requires “the delicate instrument of an open mind.”



George D. Nelson, Director, Project 2061

*The idea of
 science—that the
 natural world can be
 understood through
 application of human
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 observation, and
 intellectual honesty—
 is still a radical one.*

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New Products on the Horizon!

Project 2061 will release two new products in early 2000. Designs for Science Literacy will help educators take a systematic design approach to planning a K-12 curriculum. A new Web-connected version of the Resources for Science Literacy: Professional Development CD-ROM will contain enhanced search, print, and zoom capabilities and pointers to related resources on the Web. Both will be available through Oxford University Press, 1-800-451-7556.

Technology Conference

Project 2061 will sponsor a conference to explore the current state of research in technology education. Scheduled for December 1999, the two-day meeting of current and future technology education researchers will seek to determine what kind of research needs to occur in order to improve K-12 technology education. For more information contact Fernando Cajas at (202) 326-6209 or fcajas@aaas.org.

AAAS Forum Will Review Progress in Urban Schools

What progress has been made in efforts to improve science and mathematics achievement in America's urban schools? A distinguished panel of educators and researchers will gather to address this question at the Forum for School Science on February 20-21 at the AAAS Annual Meeting 2000 in Washington, D.C. Invited panelists for Reforming Science and Mathematics in Urban Schools: Finding the Road to Success include Charles W. Anderson, Michigan State University; Deborah Ball, University of Michigan; Meir Ben-Hur, SkyLight Training Institute; David Hornbeck, School District of Philadelphia; Madeleine Long, The Implementation Group; Robert W. Ridky, University of Maryland; Maria Santos, San Francisco Unified

School District; and Clara Tolbert, School District of Philadelphia. Travel grants are available for school-district teams to attend the Forum and AAAS Annual Meeting. Contact Betty Calinger at 202-326-6629 or bcalinge@aaas.org. For more information about the Forum visit www.aaas.org/meetings/2000 in the months ahead.

Professional Development News

Project 2061 has been giving workshops to educators from SciMathMN in Minneapolis and the SMART consortium in Cleveland, OH. Visit www.pdp2061.org to learn more about the workshops offered by Project 2061 Professional Development Programs!

Introducing ...

Project 2061 is pleased to announce the following new staff members. Technology specialist Vikas Arya, a graduate of George Mason University, is working on the development of Project 2061 databases. David Peery, previously a network technician for the University of Virginia's Global Environmental Change Program, has also joined Project 2061 as a technology specialist. Brian Sweeney is Project 2061's new Web master. He previously worked at the National Association for the Education of Young Children. Thelxi Proimaki, a former radio announcer and fashion photographer in Greece, comes to the technology department with a specialty in interactive multimedia production. Linda Hackett is the new math workshop leader for Project 2061 Professional Development Programs. She is the former director of educational services at American University. Regina Oglesby, a graduate of South Carolina State University, is the new project assistant for Project 2061 Professional Development Programs.

START THE YEAR 2000 AS A AAAS MEMBER. VISIT www.aaas.org and join today!

2061 *today*

American Association for the Advancement of Science
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