



**Enhancing Professional Development for Teachers:  
Potential Uses of Information Technology, Report of  
a Workshop**

Committee on Enhancing Professional Development for  
Teachers, National Academies Teacher Advisory  
Council, National Research Council

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# **Enhancing Professional Development for Teachers Potential Uses of Information Technology**

## **REPORT OF A WORKSHOP**

Committee on Enhancing Professional Development for Teachers

National Academies Teacher Advisory Council

Center for Education

Division of Behavioral and Social Sciences and Education

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## Preface

This report is a comprehensive overview of a unique workshop, held to explore a vision of the potential of online teacher professional development, its challenges, and the research needed to understand and advance this rapidly emerging area. In the workshop presentations and discussions, master classroom teachers joined with researchers, curriculum and information technology developers, professional development experts, state-level policy makers, principals, and foundation representatives. It is to all of the audiences represented by these participants that this report is addressed.

The journey to this workshop began in November 2002 when Bruce Alberts, then president of the National Academies, convened the first Teacher Advisory Council. This council was formed to enable classroom teachers to bring the wisdom of their practice into the Academies' work in education. That opportunity brought outstanding teachers together, empowering them as a community to "make a difference." The current members of the Teacher Advisory Council include teachers of science, mathematics, technology, reading, and English as a second language across the elementary, middle, and secondary grades. They teach in inner-city, rural, and suburban schools. Many are recipients of the Presidential Award for Mathematics or Science Teaching. At least one member from each educational level (elementary, middle, secondary) is certified by the National Board for Professional Teaching Standards. A primary criterion for serving on the council is that each member must spend at least 50 percent of her or his time in the classroom working directly with students.

Over the past five years, the members of the council have spent substantial time in meetings providing advice to staff from across the National Academies who work on many aspects of education. The council was initially established for three years, after which an evaluation of its efficacy was undertaken. The Governing Board of the National Research Council (NRC) deemed the work of the council important enough to the education mission of the Academies that in 2005 it designated the Teacher Advisory Council as a standing board in the Center for Education of the NRC's Division of Behavioral and Social Sciences and Education.<sup>1</sup>

The teachers on the council also have sought to make a difference through designing and hosting two workshops, each on a different aspect of professional development, a topic that has direct relevance and impact, both positive and negative, on all teachers' professional growth, their willingness to remain in classrooms, and ultimately their ability to improve student learning. Teachers too often have experienced a "one-size-fits-all" professional development model, in which someone else decides what they need to learn. And too often experiences with professional development focus primarily on improvement (i.e., remediation) rather than professional growth and exploration of new ideas, cutting-edge developments in a teacher's field of expertise, or promising new pedagogies. This conventional model seldom meets the particular needs of teachers in specific fields and disciplines, such as mathematics, science, and technology. Recognizing ineffective professional development as a critical issue, the Teacher Advisory Council convened a workshop in October 2004 and issued a report called *Linking Mandatory Professional Development with High-Quality Teaching and Learning* (National Research Council, 2006).

At the same time, the council members sought to find organizations that might be willing to develop and sponsor state-level councils for teachers that would be modeled after the council at the National Academies. The first state council was established in California<sup>2</sup> under the sponsorship of the California Council on Science and Technology.<sup>3</sup> Javier Gonzalez, a founding member of the Teacher Advisory Council, worked with leaders at the California Council on Science and Technology to establish the California Teacher Advisory Council, becoming one of its charter members.

In an effort to build on the knowledge gained at the first workshop on linking mandatory professional development, the Teacher Advisory Council began to explore emerging opportunities in professional develop-

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<sup>1</sup>Additional information about the council is available at <http://www7.nationalacademies.org/tac>.

<sup>2</sup>For more information see <http://www.ccst.us/ccstinfo/caltac.php>.

<sup>3</sup>For more information see <http://ccst.us>.

ment. Council members saw the potential for online learning technologies to provide professional development that could be far more tailored to the needs of science, mathematics, and technology teachers, to all teachers at different stages of their professional careers, and to teachers who are located in places where access to high-quality face-to-face professional development experiences to their schools is difficult.

Because so much of the information technology economy is centered in California, the Teacher Advisory Council began discussions with the California Teacher Advisory Council to organize the February 2007 workshop that serves as the basis for this report. According to the rules of the NRC, workshop planning committees must be comprised of experts in the areas on which the workshop will focus. Thus, a planning committee consisting of teachers from both councils and other outside experts was appointed by the chair of the NRC (biographical sketches of the planning committee members are found in Appendix D).

Flexibility is of primary concern for teacher professional development. Workshop participant Leah O'Donnell provided a clear statement about the potential of online learning technologies to transform professional development for teachers: "Different teachers have different needs, depending on such factors as the schools in which they teach, the students in their classes, their career stage, their previous experiences, and their individual preferences and learning styles." Information technology through online courses can deliver what teachers need, when they need it, and where they need it. This flexibility can make the same opportunities available to teachers everywhere, from the rural schools of Iowa, to the inner city of Boston, to the suburban schools of California—and beyond. At the same time, unless careful planning and budgeting are taken into account, these new technologies also could exacerbate inequities in hardware, speed, and dependability of connections to the Internet and technological training for teachers. It will be a challenge to provide equal access to all and not expand the "technology divide."

The workshop participants made clear that online professional development has the potential to alleviate many professional development concerns through flexibility, versatility, and leveling the playing field for teachers. For example, many workshop participants emphasized the versatility of information technology in teacher professional development. Online courses can be developed to address individual teachers' needs to increase their content knowledge, learn new pedagogies, and in the process build a common professional language. Online professional development also has the ability to expand learning communities beyond the boundaries of individual districts, states, and even nations, tying teachers together worldwide in their desire for personal improvement. The ability of information technology to expand the boundaries of professional learn-

ing communities brings the world to the fingertips and minds of teachers, improving the experience for all.

One of the challenges of online professional development is a general dearth of research on its effectiveness, combined with the facts that many teachers are unaware of these new technologies and are not included in discussions about their future uses. Bruce Alberts addressed both of these issues during the workshop:

More broadly, the role of teachers in shaping online professional development needs to be a focus of research. . . . One thing we badly need research on, which I don't think has been directly addressed here, is exactly how to give teachers a voice, an appropriate voice, at school district levels, in what professional development they get. I would like to encourage a variety of different approaches in different school districts, associated with some evaluation of how those work. . . . If we can't give teachers a voice in their professional development, I don't think we are going to solve this problem.

It is our hope that, through this report, readers will discover the potential for expanded opportunities in professional development for all teachers that can be enhanced by information technology, as well as learn about the challenges that teachers face when expanding their own learning and the learning of students in their classrooms. Above all, we hope everyone who reads this report will better understand the benefits of empowering teachers to express their "wisdom of practice" and consider that wisdom to be an integral component of decisions about future research, products, and implementation strategies in what could be a new era for teacher professional development.

Lyn Le Countryman and Chris Dede  
Cochairs, Committee on Enhancing  
Professional Development for Teachers

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This report has been formally reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the Report Review Committee of the National Research Council. The purpose of this independent review was to provide candid and critical comments to assist the institution in making its published report as sound as possible. The review comments and draft manuscript remain confidential to protect the integrity of the process.

We thank the following individuals for their review of this report: Martha A. Darling, Consultant, Ann Arbor, MI; Robert G. Dean, Department of Coastal and Oceanographic Engineering, University of Florida; Jerry P. Gollub, Department of Physics, Haverford College; Joellen Killion, Office of Special Projects, National Staff Development Council, Arvada, CO; Michael Koehler, Department of Mathematics, Blue Valley North High School, Overland Park, KS; and Michelle Williams, Department of Science Education, Michigan State University.

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the content of the report nor did they see the final draft of the report before its release.

The review of this report was overseen by Melvin D. George, president emeritus, University of Missouri, Columbia. He was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authors and the institution.

Model programs described in this report are those that were presented by workshop participants. Their inclusion in this report does not necessarily imply endorsement of any kind by the National Research Council. All web addresses listed in this report were operational as of April 2, 2007.

## Introduction

Education researcher Gary Sykes has written that the professional development of K-12 teachers is “the most serious unsolved problem for policy and practice in American education today” (Sykes, 1996, p. 465). Teachers, like other professionals, need to stay informed about new knowledge and technologies. Yet many express dissatisfaction with the professional development opportunities made available to them in schools and insist that the most effective development programs they have experienced have been self-initiated (e.g., see National Research Council, 2006).

On February 8-9, 2007, a National Research Council planning committee hosted a 1.5-day workshop to explore a particular approach to the improvement of teacher professional development: the use of online learning technologies. The Committee on Enhancing Professional Development for Teachers operates under the aegis of the National Academies Teacher Advisory Council (TAC),<sup>1</sup> a standing board in the National Research Council’s Center for Education,<sup>2</sup> and the California TAC,<sup>3</sup> which is part

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<sup>1</sup>Additional information about the National Academies Teacher Advisory Council is available at <http://www7.nationalacademies.org/tac>.

<sup>2</sup>Additional information about the Center for Education is available at <http://www7.nationalacademies.org/cfe/>.

<sup>3</sup>Additional information about the California Teacher Advisory Council is available at <http://www.ccst.us/ccstinfo/caltac.php>.



of the California Council on Science and Technology.<sup>4</sup> The provision of professional development through online media has had a significant influence on the professional lives of a growing number of teachers. Growing numbers of educators contend that online teacher professional development (OTPD) has the potential to enhance and even transform teachers' effectiveness in their classrooms and over the course of their careers. They also acknowledge that it raises many challenging questions regarding costs, equity, access to technology, quality of materials, and other issues (e.g., Dede et al., 2006).

The workshop had several major goals. It sought to define the boundaries of OTPD, in part by examining online programs that are already in place. (Appendix C contains brief descriptions of several such programs and provides links to other programs that were described or referenced during the workshop.) It explored how online professional development could meet the varied needs of teachers throughout their careers and in a range of settings. The workshop also investigated the drawbacks and barriers to online approaches that have limited them to date and could continue to do so in the future.

Perhaps most important, the workshop was specifically designed to provide significant participation by and input from classroom teachers. Too often the "wisdom of practice" is largely missing from discussions of education research, policy making, and decision making. As Bruce Alberts of the University of California, San Francisco, said, "if you want to know how to make something work better, you go to the people who are doing it, as you do in the automobile industry. We learned from the Japanese that you have to go to the people on the shop floor to figure out how to make a better car. Why we continue not to do that as we should in the field of education is beyond me." Both the National Academies and the California TACs were founded and operate on the premise that teachers must have a voice in shaping what they do in their classrooms, the resources that are available to them, the policies that enhance student learning, and the future of the teaching profession itself.

Presenters at the workshop reviewed the relevant research undertaken to date and outlined future research that needs to be pursued. Participants also discussed what teachers, administrators, and policy makers at the local, state, and federal levels need to do to make much more widespread and effective use of these approaches. Although the programs and examples cited in the workshop focused primarily on professional development for teachers of mathematics, science, and technology, it should be

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<sup>4</sup>Additional information about the California Council on Science and Technology is available at <http://www.ccst.us>.

noted that the general principles that were articulated at the workshop apply to any subject area of teaching and professional development.

This report is written as a narrative rather than chronologically to highlight the major themes that emerged from the presentations and from the rich discussions that occurred in both plenary and breakout sessions throughout the 1.5 days. The agenda, which lists the plenary, breakout, and discussion sessions in the order in which they occurred, appears in Appendix A. The diversity of interests and expertise of workshop presenters and participants is evident from the list of participants and their institutional affiliations, which also appears in Appendix A. Readings, case studies, and other materials that were distributed to participants prior to and during the workshop appear in Appendix B. Model programs of OTPD that were highlighted during the workshop are summarized in Appendix C, along with a list of helpful websites that were mentioned. Biographical sketches of the planning committee members and the workshop presenters appear in Appendix D. Readers are encouraged to contact speakers if they wish to obtain additional information about any of the points in this report. Access to all PowerPoint presentations is available on the website of the National Academies Teacher Advisory Council at [http://www7.nationalacademies.org/tac/Potential\\_Uses\\_Presentations.html](http://www7.nationalacademies.org/tac/Potential_Uses_Presentations.html).

Quotations are from a transcript of the speakers' comments, and the report draws on PowerPoint presentations and other materials distributed prior to and during the event.

The planning committee and the two TACs that oversaw the committee's work viewed the workshop as an initial step into largely unexplored territory. By exploring the potential benefits and barriers to OTPD, the National Academies and California TACs hope to initiate more thorough investigations of the potential of online technologies to dramatically improve the professional development of K-12 teachers. They also intend to ensure that the voices and perspectives of teachers are fully reflected in future discussions and uses of online learning.

## WHAT IS ONLINE TEACHER PROFESSIONAL DEVELOPMENT?

Just as new technologies have the potential to transform teaching, they also have the potential to transform teacher professional development. "Teachers used to teach in a one-room classroom," said workshop participant Barbara Thalacker of the California Department of Education. "Now they teach in a no-room classroom."

Ten to fifteen years ago, discussions of teacher professional development using advanced communications technologies would have focused on videoconferencing, satellite-based lessons, electronic bulletin boards, and other distance learning techniques. The use of these technologies

remains important today. For example, in settings such as isolated rural communities, electronic conferencing can be an important way for K-12 teachers to remain in contact with colleagues and other professionals elsewhere. At the same time, new interactive media are replacing older, more expensive means of distance learning. For example, Internet-based videoconferencing is less expensive than telephone or satellite-based videoconferences.

Today professional development based on electronic technologies increasingly refers to web-based, interactive experiences combining text, video, and sound. It is often asynchronous, in that all participants do not have to be engaging in an experience at the same time (as is the case with e-mail). Yet OTPD also can be richly interactive, in that it can give participants multiple opportunities to reflect on issues, questions, or answers before responding online. With courses taken in person, said National Academies TAC member Valdine McLean, who teaches science at Pershing County High School in Lovelock, Nevada, "often you are just a name or a number, with very little interaction with the professor or classmates. Only the loud extroverts are heard in any discussion-type settings. . . . That's not who I am. I am the quiet person who you will never hear. By the time I think and feel that I have something valuable to contribute, your conversation has already passed me, so you never hear my voice. How many students are like that?"

Online, said McLean, "my voice can be heard. I am a reflective thinker. I can contribute quality responses to my peers. It's very intense and specific. I improved my knowledge, my skills in content, and my ability to deliver better as a teacher with each course." (For a description of McLean's experiences with OTPD, see Box 1, "One Teacher's Experience—Pursuing a Master's Degree Online.") McLean indicated that research documents that many students who are mute in face-to-face settings find their voices in some form of "mediated" interaction.

The movement of teacher professional development to the web reflects important trends in the broader society, according to Chris Dede of the Harvard Graduate School of Education, cochair of the workshop planning committee. Today, thinking is distributed in ways that it has not been in the past. For one thing, thinking is distributed among groups of people. "A lot of work has moved to teamwork," he said in his keynote address. "In the 21st century, that is going to be even more true. It may not be true in schools, but it is very much true in society."

Thinking also is distributed across space and time, Dede observed. "Not only do you have to be able to collaborate with whoever is sitting across the table from you, but you may have to collaborate with somebody halfway across the world from you."

K-12 education has been slow to recognize and react to this seismic

### BOX 1

#### One Teacher's Experience—Pursuing a Master's Degree Online

Valdine McLean had been teaching science for 15 years at Pershing County High School in Lovelock, Nevada, when she decided that she wanted to get a master's degree in science education. McLean has two children, and Lovelock is too far away from a college to attend in person, so she searched the web for an online program, and in 2003 she enrolled in the online master's program at Montana State University.

"I really struggled with my first two courses, because I never had to do this on campus," McLean recalled. "You had to reflect on the readings. You had to illustrate an application of the science and pose a thought-provoking question. If you didn't do that, you scored low. I had never done that before. It was a whole new level of participation."

McLean took a course on science education and one or two science courses each semester, putting in 40 to 50 hours in addition to her normal teaching responsibilities. But "my classroom students were my partners in research," she said. She did special projects with them in such areas as hydrology and astronomy, applying what she was learning online in the classroom even as she used her school experiences to satisfy the requirements of her online courses.

She found herself bonding with a far greater range of people online than she ever had in a face-to-face course. "The experience was shared from a worldwide audience—professors from UCLA, Arizona, Alberta, Canada, and the Montana State staff. We had student colleagues from Colombia, Japan, Afghanistan, Sarajevo, Pakistan, and all across the U.S." At the capstone event, at which the online students finally met each other in person, "it was like trying to find your lost brother or sister."

Since receiving her degree in 2005, McLean has been a steadfast proponent of online professional development in her work in Nevada and as a member of the National Academies Teacher Advisory Council. "This can be a valid and rigorous form of learning," she said. "I am very passionate about sharing that, because this experience changed me."

shift in the broader society, Dede said. "If teachers are going to prepare students for 21st-century work, they have to understand 21st-century work. In schools, there is no opportunity to do that. . . . Thinking, working, and learning are now richly distributed in just about every sector of society except education. Why don't teachers deserve the best? . . . If we believe all these reports on global competitiveness and the centrality of the U.S. education system for economic development, why don't we think about online professional development from a sophisticated perspective?"

Most teachers are eager to learn and change, workshop participants said. But they need to be engaged in the same way that students are

engaged. Teachers “are like anyone else,” said California TAC member Janet English, a former middle school teacher currently working for KOCE-TV in Huntington Beach, California. “They want things that engage their learning, but they are not going to do something that is boring, that takes their time, or is another requirement, because teachers’ schedules are so filled with requirements now that it is harder to teach.”

Because of their immersion in an online world outside school for entertainment, communication, and personal expression, many students have skills and perspectives that previous students did not, Dede pointed out. Today’s students are accustomed to acquiring information when and where they want. Using search engines and instant messaging, they often look for small bits of information to support a position. Most high schoolers have grown up with the World Wide Web.

Most teachers, in contrast, have to undergo a cultural change to become thoroughly fluent with current technologies. Yet such a change can have a dramatic impact on individual teachers and on their students. “We need to inspire teachers to look beyond their classroom model, to inspire deeper thinking, to think about things in new ways, to communicate with people around the world, to act like scientists,” said English.

Teachers also need to be familiar with new ways of learning to take advantage of them in schools. “If we are not increasing the effectiveness and efficiency of teachers in the classroom, managing curriculum and managing information, I think we are missing the point,” said Thalacker. As Dede said, “Maybe the real thing about online professional development is not whatever content we put into it, but the process of experiencing it, and experiencing something that is like what kids experience.”

Unless teachers can experience this world themselves, they may be unaware of the influence and power these technologies have on students’ lives. “And if I have learned one thing in my own 35 years of teaching, it is that you have to start where the learner is,” said Dede. “If you don’t do that, you’re dead, no matter what else you do.”

In that respect, experiencing the online world through professional development opportunities may be as important for teachers as the content conveyed. “We know as teachers that the process of communication is as important as the content of communication,” said Dede. “Anyone who has sat through a professional development lecture on the importance of doing has resonated to the impact of that.”

Online technologies have slowly begun to have an impact on K-12 education, and considerable discussion at the workshop centered on how much more forceful that impact could be. Maybe some math lessons will become immersive collaborative electronic simulations. Or maybe students will someday use their cell phones as an augmented technology to guide their interactions with each other or with the learning environment.

Rather than telling students to turn off their electronic devices when they enter a classroom, teachers could put those sophisticated artifacts to work for learning. "In this way," said Dede, "learning could be deeply embedded within the social context in which many students live."

These approaches could be applied to online professional development as well as to classroom teaching. In this way, online experiences for teachers could be tailored for their individual learning styles. "People learn in different ways," said Dede. The comparison he often makes is with sleeping, eating, and bonding. Sleeping is fundamentally the same for all people, Dede observed. That's why it is not difficult to design hotel rooms, because they are all designed to help people sleep.

Eating is more diverse. "People like to eat really different things, and they like to have the process of eating take place in different ways." That's why restaurants are so diverse, because they are trying to serve these many different needs and preferences.

Bonding is even more complex. "People bond to pets, to sports teams, to groups. They bond sexually, platonically, with the same sex, with the opposite sex, with people who are opposite, and with people who are similar."

"The punch line is that we treat learning like it is sleeping," said Dede. "But from everything we know, learning is like bonding, or at least like eating. Yet the very best of our academic environments at every level of education have less variety than a bad fast food restaurant. . . . And even more narrow than the bad fast food restaurant is the range of learning styles our professional development accommodates now."

The flexibility of OTPD can enable schools, districts, and states to tailor material to meet their individual needs. For example, William Thomas of the Southern Regional Education Board (SREB),<sup>5</sup> a policy organization that works with 16 state governments to improve student performance, noted that "every one of the SREB states is doing some level of online professional development." But departments, schools, and districts "are picking and choosing where it makes sense for them."

One of the ways in which OTPD is flexible is that it occurs on different scales, according to Raymond Rose of the consulting group Rose & Smith Associates. Some professional development experiences can be very brief. "If you want to get help to do a specific application, you can go online and get a tutorial. Short [i.e., brief sessions] works online," said Rose. Other online experiences can extend over the course of a year or longer. "As with face-to-face professional development, there is a range of things online," Rose said.

In addition, online professional development can be geared toward

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<sup>5</sup>Additional information is available at <http://www.sreb.org/indexPage2.asp>.

teachers at different stages of their careers, observed Louis Gomez of Northwestern University. "The goal of new technologies, rather than trying to find the best of the best, is to find things that people at all stages of their careers can talk about and improve."

Peter Bruns of the Howard Hughes Medical Institute expressed interest in the "power and strength" of online professional development. He asked about the importance of the "human connection." Do proper facilities for promoting professional development and a support structure of experts and teacher colleagues need to be in place first or are finely tuned and exciting programs sufficient in and of themselves? Bruns ventured that "I'm sure there is utility in both, but is there some way we need to worry about that?" Dede agreed, "I do think that it is both. I think which is more important first depends on who you are and where you sit and what your needs happen to be. If we took a survey in this room, we might end up with a pretty diverse set of needs that would be answered by different parts of this complex professional development design space."

OTPD is often combined with other kinds of professional development experiences, observed Rose and others (e.g., Marcia Linn, of the University of California, Berkeley) at the workshop. These blended or hybrid models provide an additional dimension along which online programs can vary. "There are a lot of pieces that you can pull together from some of the face-to-face channels and some of the online channels to craft professional development that meets the needs of individual teachers," said Leah O'Donnell of the consulting firm Eduventures.<sup>6</sup>

This flexibility has led many schools to take at least some initial steps to provide their teachers with online professional development. In one survey reported by O'Donnell, a third of school districts reported that they provide some form of online professional development for teachers (Wiley, in press).

Yet more traditional forms of professional development remain prevalent. In another survey of 300 teachers across the country (Wiley, in press), more than six in seven teachers reported participating in one-day workshops, face-to-face training, and other conventional professional development experiences. Participation in online programs was markedly lower. "I don't think this is particularly surprising," said O'Donnell. "The online channel is a new kind of technology, a new way of thinking, a new way of doing things. . . . The more traditional forms of professional development still dominate what we are seeing today."

The same survey showed that administrators expect to be investing new money for professional development into traditional rather than

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<sup>6</sup>Additional information is available at <http://www.eduventures.com/index.cfm?pubnav=home>.

online channels. “Despite the fact that you are getting more and more feedback from teachers and from administrators that one-shot workshops are not very effective, that they want things that are more tailored to their experiences and more interactive—all these wonderful things that online professional development can bring to the table—it’s a slow tide that is changing,” O’Donnell said.

## **MODELS OF ONLINE TEACHER PROFESSIONAL DEVELOPMENT**

At various points during the workshop, participants described online programs of professional development with which they have been involved. The workshop planning committee decided to include both for-profit and not-for-profit programs so long as the organization offering a program had an ongoing research program to evaluate its efficiency and planned to share those data with the research community.

The programs described at the workshop are presented in Appendix C. They represent just a fraction of the programs currently being offered. Nevertheless, they demonstrate the diversity of approaches being taken and the opportunities offered. Appendix C also lists several additional programs reviewed by workshop participants but not discussed at the 1.5-day event.



## Advantages of Online Professional Development

Online teacher professional development (OTPD) has many potential benefits for teachers, schools, districts, and states. According to statements and discussions by a number of workshop participants, its greatest potential benefit should be the improvement of student learning, as is the case for all forms of high-quality professional development. "Online professional development, when it is done well, has the opportunity to change teachers' practice," said National Academies Teacher Advisory Council (TAC) member and planning committee cochair Lyn Le Countryman of the Malcolm Price Laboratory School in Iowa, "and we know that teachers' practice is the most important factor impacting student achievement." Rose concurred, saying "Experience is the encapsulation of practice. I believe that those data, collected by a whole bunch of folks, suggest that teacher practice is probably the most important thing that we can improve to improve kids' lives."

Other potential benefits of online professional development were discussed by workshop participants:

- *flexibility and versatility,*
- *potential to build community among teachers and across groups,*
- *new possibilities for accountability, and*
- *improvement of teacher retention by enabling teachers to become more directly involved in their own learning and professional growth.*

### FLEXIBILITY AND VERSATILITY

Compared with the one-time workshops and face-to-face sessions that are characteristic of most current professional development, online programs can take a very wide variety of forms, with concomitant advantages of convenience, scalability, and adaptability. "You can't compete with the anytime/anywhere [capabilities] that online professional development can provide," said O'Donnell.

Different teachers have different needs, depending on such factors as the schools in which they teach, the students in their classes, their career stage, their previous experiences, and their individual preferences and learning styles. If properly structured, online programs can be customized and tailored to meet these varying needs. For example, modern information technologies make it possible to store and tag huge amounts of data so that people can access them in different forms, edit them, comment on them, share them, interact with them, and acquire pieces to create their own lesson plans or resources. "There is a real ability to share vast amounts of content, keeping it up to date and relevant to what teachers are looking for," said O'Donnell.

Furthermore, although it may be labor intensive, once a flexible and versatile online system has been developed, the number of people who can make use of it is essentially unlimited. OTPD is therefore eminently scalable, in that the same system that can be used by the teachers in a single school can potentially be used by teachers around the world. As Thomas put it, "Once you have a course developed, multiple people can use it."

### COMMUNITY OF PROFESSIONALS

Teaching, which is one of the most social of activities, can also be very isolating. According to TAC member Deborah Smith, a second grade teacher at the Woodcreek Magnet School for Math, Science and Engineering in Lansing, Michigan, "Sometimes schools are deserts for teachers, if there is really not anybody there you feel you can talk to about your passions in teaching and about kids in the way that you would like to talk about kids."

Online technologies in general and some kinds of online professional teacher development programs in particular can help build the community that is so often missing from the daily lives of teachers. Teachers can interact with each other online in real time or asynchronously, offering them time to reflect on an ongoing exchange. Online interactions "capitalize on the collaborative nature of learning to create an expansive synergy between people and connections," said Le Countryman. Or, as Bruns put it, "We can maybe think of it as 'no teacher left alone.'"

One great benefit of online professional development is that it can provide teachers with a common language to communicate about teaching and learning. “We don’t have good language to talk about instruction,” said Gomez. Online technologies “can go a long way to deepening the professional language of instruction that we can share.” For example, such technologies can help generate “shared beliefs about what instruction looks like,” according to Gomez. When an educator refers to “ambitious instruction,” online technologies can show what that term implies. In this way, Gomez said, online exchanges can make instruction less idiosyncratic or ambiguous and thereby create a stronger professional community.

Online technologies also can build community between teachers and other groups. “Teachers work in a number of different contexts,” said Hilda Borko of the University of Colorado’s School of Education. “We work in our classrooms, in school communities, in the community, and in professional development courses. One feature of effective professional development is [that it] bridges these multiple settings.”

For example, online communications can establish connections between teachers and the administrators in their schools, as several workshop participants pointed out. Such experiences can build the skills and knowledge of each group about the other’s areas of expertise, which makes it easier to achieve consensus within a school. In turn, online communications can link teachers and administrators to education researchers. “[They can] make the practice of teaching and administration and doing research to help improve schools be a part of one shared community of language, beliefs, and values,” said Gomez.

Professional development that uses online technologies can also connect schools to schools, schools to districts, districts to other districts, and states to states. It can seek out the commonalities among schools serving different groups of students, with benefits to all partners. In addition, it can tap into expertise no matter where it is located, so that teachers with a specialty or an expertise can serve as resources for teachers elsewhere. With online professional development, said Planning committee member Tad Johnston of the Maine Department of Education, “you can leverage, consolidate, and share promising practices in your district, so that pockets of excellence don’t have to remain pockets.” According to O’Donnell, teachers “can get what they need from people around the country, around the world, that they might not be able to access within their own district.”

Many teachers enjoy the opportunity to become leaders for other teachers (additional discussion about teachers serving as leaders can be found below). They can act as coaches, instructors of online courses, and leaders in their schools and districts. “Teachers truly are effective

leaders and really enjoy being involved in online professional development," said Planning committee member Barbara Treacy of the Education Development Center in Newton, Massachusetts. "Their colleagues like learning from a colleague. [This] peer-to-peer relationship is very powerful. It's good face to face, and it works extremely well online."

According to David Zarowin of the Harvard Graduate School of Education, another benefit is that, "in sharp contrast to the typical workshop, where you sit for three hours and you get a whole bunch of really good ideas, but you are left to your own devices as to how to integrate this into your practice, [courses taken online] are courses where you learn something, you get a little bit, you try it out in the classroom, you reflect on it, and then you develop your practice."

### ACCOUNTABILITY

Perhaps, counterintuitively, OTPD offers more opportunity and scope for assessment and accountability of participants than does face-to-face professional development. "There is no hiding under the chair in the back row," said Andee Rubin of TERC in Cambridge, Massachusetts. "It is easy for a facilitator to note whether someone is present, and also the quality of their learning from the very beginning." Similarly, facilitators have more opportunity to bring a person into a discussion who isn't participating.

Usually, a failure to participate is not a major concern, according to workshop participants who have taken online courses. Teachers "are in there posting and posting, and coming back and seeing what the other teachers are saying, and learning from that sharing in the online community," said O'Donnell. "It's very reflective and involving." Because the participants have time to think about an activity or issue and post comments or responses, they have ways to communicate that are not possible face to face.

OTPD also offers opportunities for assessment that go beyond what can be done with face-to-face programs. When someone is working at a computer, the software being used can capture all of the information exchanged through a keyboard, mouse, video camera, or microphone. "There are lots and lots of data that are automatically collected in an online workshop because of the technology," said Treacy. "We have to learn how to capture it and how to take the time to look at it. There are incredible opportunities for more assessment and more accountability, as long as we take advantage of it."

"You can see what teachers are doing, where they are going on the web, the amount of time they are spending on something," said O'Donnell. "You can track some of the accountability and outcomes that go along with these forms of professional development."

Remarkably, instructors typically claim to know their online students better than their face-to-face students. “We have heard that over and over again,” said Thomas. “It’s something that we don’t want to lose sight of as we move down the road.”

## RETENTION

The turnover of K-12 teachers in many parts of the country is a severe challenge both to educational stability and to developing quality programs for professional development. Though virtually no data have been collected on the topic, some workshop participants suggested that online technologies may offer a way to attract new teachers into the profession and retain current teachers—especially in areas of science and mathematics, in which teacher shortages are most severe. “We might have the best staff development program going, but a year or two later, a third or 50 percent of the teachers that have experienced that training are gone,” said Thomas. “Online learning would allow us to go back and pick up those new teachers coming in and work with them.”

Increasing numbers of young people who are considering becoming teachers are likely already to have experience with new information and communication technologies. If they see teaching as a profession that employs these devices productively, they may be more likely to make a commitment to teaching. “This can be a great tool for getting those younger teachers engaged and feeling that they have support in a lengthier context,” said O’Donnell. Or, as Dede pointed out, the lack of modern technologies in the classroom is sure to have a discouraging effect on newer, younger teachers. “We throw away a tremendous amount of talent in young teachers, just as we throw away a tremendous amount of talent in young kids.”

Online technologies are not just for new teachers. Teachers at any stage of their careers can benefit from the new ideas and new connections made possible through them. “What I am looking for as a teacher is professional development that is refreshing to my mind, my spirit, my teaching, and my community,” said Smith, a teacher with many years in the profession. “I think all of us get to a place in our careers where we feel kind of dull and jaded. We need connections to opportunities to learn and people to learn with that help us feel, ‘I’m ready to go. I have something to tell or teach or make available to kids.’”

Because teachers at different points of their careers have different needs and interests, some may see current professional development offerings as a waste of their time. “I notice that many of my colleagues do not take advantage of professional development opportunities because they see it as something that they really don’t need or it’s not interesting

to them," said National Academies TAC member Robert Willis of Frank W. Ballou High School in Washington, DC. "The benefit of an online program would be that teachers can tailor a program of professional development according to where they are and what they need."

Even teachers nearing the end of their careers can benefit greatly, said California TAC member Sandie Gilliam, who serves on the California Mathematics Council.<sup>1</sup> More experienced teachers need help with new approaches to pedagogy and with content that is more suited to today's students, and even experienced teachers can be novices in some areas. Keeping these teachers engaged and working makes it possible to take advantage of their years of experience. "I could retire if I wanted to now," said Gilliam. "I don't want to. . . . So even though you want to work with the younger teachers and the ones who are in the first five years to keep them teaching, think about us, too."

Another group of teachers who can benefit are those who serve as mentors to less experienced teachers in online networks. Workshop participant Barbara Shannon of Westridge School in Pasadena, California, served as an online mentor through a program known as E-Mentoring for Student Success.<sup>2</sup> "It gave me a group of young people, whom I didn't even know, who looked up to me as a mentor and asked me for knowledge," said Shannon. "I went back and told my colleagues about the program, and other people I met. I told my students about the program. They told their parents about the program, . . . and they went back and told the administrators about the program. So now we are looking into online professional development at our school because of what it has done for me."

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<sup>1</sup>Additional information is available at <http://www.urbanedpartnership.org/catalog/providers/133.html>.

<sup>2</sup>Additional information is available at [http://hub.mspnet.org/index.cfm/showcase\\_project/project\\_id-53](http://hub.mspnet.org/index.cfm/showcase_project/project_id-53).

## Obstacles to Online Teacher Professional Development

**A**long with its potential benefits, online teacher professional development (OTPD) has many potential barriers to its implementation and effective use. Workshop participants discussed possible problems posed by inadequacies in a number of areas:

- knowledge about online technologies and programs;
- support from administrators;
- access to technologies;
- time, financial support, and parental support;
- materials;
- support from higher education; and
- teachers' beliefs and practices.

### LACK OF KNOWLEDGE

Although most teachers have heard of OTPD, relatively few have experienced it. For example, despite their presence at a workshop on OTPD, fewer than half of the very experienced teachers and teacher leaders in attendance had actually taken an online course or engaged in other forms of online professional development. Many knew that such courses were available, but they did not know where to go online to find them.

According to Lyn Le Countryman and other workshop participants, part of the problem is that they are unaware of any central listing or clearinghouse of online professional development opportunities for teachers.

Websites set up by organizations typically do not link to others with similar offerings. And research findings or assessments of online programs by independent evaluators are rare.

Also, educators rely heavily on peer recommendations and scientific research when making decisions about professional development, surveys have shown. A lack of experience with OTPD therefore limits the likelihood of personal recommendations. And a lack of good scientific research on the quality and impact of online programs may be holding back their adoption. (Scientific research on OTPD is the subject of the next major section.)

Finally, surveys show that educators desire face-to-face interactions in professional development (Wiley, in press). If they are unaware that online approaches often incorporate such interactions as part of blended or hybrid programs, they may be biased against online opportunities and fail to seek them out.

### LACK OF SUPPORT FROM ADMINISTRATORS

As important as it is for teachers to know about the potential of online opportunities for professional development, it can be even more important for principals, curriculum supervisors, and other administrators to know about their potential, since they are the ones who usually make the decisions about professional development options and control the funding for them.

However, surveys have shown that many administrators remain skeptical about the merits of OTPD. According to one survey, “administrators typically thought that online channels were very low in terms of effectiveness, and teachers ranked them relatively high. That was the biggest gap in perception,” said Leah O’Donnell (Wiley, in press).

Districts also have a tendency to create and retain their own professional development programs. These programs could still employ online technologies, but “if you have a district or administrator who isn’t particularly familiar with online channels and is keeping a lot of professional development in-house, it’s going to tend to create some of the more traditional face-to-face or workshop situations,” O’Donnell said.

One of the best ways of making administrators aware of the potential of online professional development is to have them participate in an online course. Administrators also need evidence of the effectiveness of current offerings if they are to make good decisions.



## LACK OF ACCESS TO TECHNOLOGIES

Advocates of OTPD often depict students as fully immersed in a wide range of communications technologies—but that is true of only some students, not all. “My kids are not like those kids,” said Deborah Smith of her students in Lansing, Michigan. “They have video and TV at home, and they may have some games and things. But they don’t have computers, they don’t have cell phones, and they are not engaged in the kinds of things that [some other] kids are.”

The same can be said of teachers. While some have access to technologies at school or in their homes, others do not. As Smith said, “We may have cell phones, and we may have a computer at home that is a laptop that the state gave us ten years ago that couldn’t do anything like that. But we really need to think hard about the equity issues.” Martha Valencia of the Los Angeles Unified School District’s Instructional Technology Branch said, “There is really only a 10 to 20 percent access level across the different campuses, from elementary all the way to high school.”

Even if teachers have access to computers, those computers don’t necessarily work well. Without a technology support person who can provide a quick response to a problem, the frustrations of getting computers and software to function may negate the value of OTPD. “Over the three years that we have been working in schools, there have been fewer and fewer tech support people available, and if they were available, they were no longer very close to the school site,” said Linn.

## LACK OF TIME, FINANCIAL, AND PARENTAL SUPPORT

On one hand, OTPD has certain economies of scale, in that the same online system can be used by an indefinitely large number of teachers. On the other hand, Chris Dede said, “Most online professional development involves facilitators, the availability of whom may constrain scale.”

OTPD is not free. Materials cost money to develop. Schools and districts often need to enter into licensing agreements to use an OTPD program. Licensing agreements have their own set of constraints, thereby limiting teachers’ ability to make any changes for classroom use. Hybrid programs, consisting of both online and face-to-face programs, add costs to the online expenses. In general, effective professional development approaches do not fit the profile of a passive online system composed largely of readings and videos. Program developers, online facilitator and mentor training, and custom-designed programs are all costly. Administrators often have to make difficult trade-offs regarding the resources that they decide to devote to traditional and online professional development, according to Barbara Treacy, Leah O’Donnell, and others.

Then again, as several workshop speakers pointed out, schools already

spend substantial amounts on professional development. "A district could spend \$7,000 on a single speaker," said Valdine McLean. "Or the district can apply the same amount of money to 21 to 49 people, depending on how they divide it up, providing intense specific content and skills for improved instruction, and then rotate the next set of people, so that each year some of your staff is getting improved."

OTPD also requires that time be made available in teachers' schedules. Administrators sometimes assume that online professional development can be done on teachers' own time away from school, but like any other work-related expectation to be completed outside of contractual time, this expectation is unfair and counterproductive. "Teachers need to be given the same number of opportunities to participate [in online professional development] as they would if it were a face-to-face workshop. Time needs to be devoted to that," said Liz Pape of VHS, Inc., in Maynard, Massachusetts.

A lack of knowledge among parents is another potential barrier. Despite the growing presence of technology in their own lives, many parents continue to believe that education in schools should be delivered entirely by teachers—an attitude that they often extend to teachers' professional development as well. "[Parents] say, 'We want our children to be educated the way we were. We are successful. We want the same thing for our children,'" said William Thomas. "Somehow they don't connect the dots, that a new world is there available to their students" (as well as to their teachers for professional development).

### LACK OF MATERIALS

Although the amount of professional development material available online is large and growing, this material does not necessarily cover all needs for all teachers. Some areas of the curriculum, some age groups, and some teacher backgrounds are still not addressed. For example, "there are different needs at the beginning and at the end [of teachers' careers]," said Janet English. "We need to make products that will make them want to use them. If they don't want to use them, it's not a successful product. [And] if it's too complicated to use, it's a poor design."

Developing materials for professional development in science and mathematics also presents challenges, noted Andee Rubin. "If we value the creation of online communities for scientific inquiry, then . . . you must provide students with the ability to create representations that they can think with and use as evidence as part of their scientific community involvement," Rubin said. She noted that many of the tools needed for high-quality, effective online professional development in math and science are not yet widely available.

Materials for online programs also need to be engaging if teachers are to make wide use of them. As English said, "What teachers really want to do at the end of the day is go home, relax a bit, be with their family, get through dinner, get through homework, and try to do something creative to fulfill themselves and have enough energy to go back the next day." One way to ensure the necessary level of engagement, noted participants, is to involve teachers in the development of materials, so that online tools reflect what teachers want and need. An additional way, said workshop participant Cornelius Sullivan of the University of Southern California, is to draw on "some of the basic principles of the entertainment industry." When lessons can be structured in such a way that they are emotionally engaging, Sullivan pointed out, "the audience doesn't forget the lesson or the excitement."

However, Dede also reminded workshop participants that one potential drawback of the content and use of online technologies as they are currently configured is that they can isolate some users just as easily as they can build community among others. Today, for some students, online technologies more often act as a distraction from learning than as a tool for learning. "We have this wonderful engine for learning . . . that typically has junk inside it," said Dede. "We can't control that from within the academic setting. But we can put up a fight by coming up with things ourselves that are engaging and interesting and powerful."

### LACK OF SUPPORT FROM HIGHER EDUCATION

The instruction that future teachers receive during their undergraduate and graduate years can have a powerful influence on how they teach. Yet colleges and universities have been very slow to adopt the approaches that have so much potential for OTPD.

That's a contradiction, Dede pointed out, since faculty members "are part of a very wide-ranging virtual community of practice that is actively engaged in richly interpreting data. Yet some of the same people who have gone through that transformation in their research lives will blithely march into a lecture with 10-year-old notes, feeling proud of themselves if they have put their syllabus up in PDF form and are using PowerPoint instead of chalk. They don't get it."

The education that future teachers receive in college comes up short in other ways, Smith noted. Even though future science teachers often take many of the same courses as future scientists, "many teachers have felt alienated from science and don't see themselves as valid participants in the scientific community," she said. "The opportunity to engage in the actions, talk, and tools of science is a really important thing to offer teach-

ers. We need to have teachers feel that they are part of the scientific community and see themselves as scientists. How will they model science for children if they aren't?" Many workshop participants agreed that online technologies may provide a means to overcome this gap in experience from higher education by making it possible for teachers to work more closely and directly with scientists and engineers in a number of venues, including research projects and mentoring relationships.

### CHANGING TEACHERS' BELIEFS AND PRACTICES

To be effective, online professional development has to change the knowledge, beliefs, and values of teachers. Simply moving ineffective forms of professional development onto the web will do little to effect this transformation. "Simple structural characteristics are not going to change anything," said Louis Gomez. "We need to understand, first, what we want schools to do. Second, we need to understand specifically what sorts of tools might support that."

Changing teachers' practices often requires unlearning past practices as well as learning new practices, said Dede. "It is unlearning fluencies and skills that we have built up over a lifetime, first being a student within a conventional system and then teaching within conventional systems. Unlearning is really hard, because it is not primarily an intellectual activity. It is an emotional activity and a social activity. When you look at unlearning in other parts of life, like unlearning bad eating habits or sedentary exercise habits, where it tends to be effective is putting cohorts of people face to face and having them unlearn together, sharing their success and failures, providing moral support for one another. Can that really happen online? Some of it can happen online for some people. How much of it can happen for teachers is an interesting question."

Also, using online technologies to learn new teaching practices can be difficult, Dede acknowledged. "I have looked at video case studies of teaching—I have actually helped to design some video case studies of teaching. I have watched people wrestle with watching and interpreting and defining video case studies of teaching, and it is hard. It is hard to watch somebody else's practice richly captured and then transfer it into your own strengths, your own material, your own students, and your own context. I do think that it is a good idea, but it is not simple in any sense. It is a very demanding, labor-intensive, and expensive form of pedagogy that has a big grain size associated with it. It's not the kind of thing where you can say, 'I've got a half hour. I'm going to sit down, watch a video, study math teaching, and see if I can pick up some hints on how to manage the discussion between boys and girls.' It is a lot more complicated than that."

“At the end of the day,” said Gomez, “[teaching and learning] are about being interpersonally and emotionally connected with the things that you do.” Online technologies can foster that connection, but they cannot create a connection all by themselves. “If online is the frosting,” said Dede, “how much have you really changed the cake?”

## Teacher Leadership

Opportunities for teachers to play leadership roles are strong in online professional development. For example, as Barbara Treacy explained, the EdTech Leaders Online program offered by the Education Development Center is “a teacher leadership model. It’s a capacity-building model where we work with any educational organization to help them figure out how to use online learning to meet their goals.” An organization’s leadership selects staff to be trained to become online professional development instructors, thereby creating a long-term relationship and capacity building in a school district.

For example, in Mississippi, a cohort of 24 online facilitators were trained by EdTech Leaders Online and now are offering online summer courses to teachers who hold emergency certification; 90 percent of these teachers complete the course that also matches their content areas and assigned grade levels.

In the Los Angeles Unified School District, there is a growing opportunity for teachers to receive online professional development. According to Martha Valencia, many of the district’s teachers prefer to take the required professional development online; surveys of teachers indicate that this mode is popular because it allows them greater flexibility in their schedules to complete the program and also to avoid long commutes to professional development sites.

Teachers who want leadership opportunities have doors open to them through training to become online trainers, online course developers, and part of an online program development both in their own school districts and in some of the many online programs now available nationally. This could become a new step in a teacher career pathway.

## The Need for Research on Online Teacher Professional Development

Very little research has been done on the effects of online professional development on teachers or their students. For that matter, not much is known about the impact on teachers of professional development in general. “The reality is that we know very little about what characterizes effective teacher professional development,” said Hilda Borko. “If we want to be able to gather the information necessary to guide professional development, we have a big task ahead of us.”

Many additional questions remain to be addressed by research on online teacher professional development (OTPD), workshop participants pointed out. Most broadly, “What is the benefit?” asked Raymond Rose. “Is it only [for] the teachers who are techies? Is it only the teachers who have been doing things for a long time? And what are the benefits . . . to teachers’ students? Is it all kids? Is it one kid? Is it only the white kids? You need to be asking those questions and requiring answers,” Rose stated.

Another interesting set of questions revolves around how OTPD is structured. For instance, Dede observed, “What is the grain size of meaningful professional development for teachers? Is it ten minutes? . . . Is it two hours? Is it a day, a month?”

Similarly, can all of teacher professional development occur online? Dede said that he thought not, but “Do we know what the proportion is, the blend? No. There are a lot of unanswered questions.”

The effect of online professional development on teachers at different points in their careers remains an open issue. “We need to know from

teachers at all levels in the professional continuum what helps if you are a first-year teacher, what helps if you are an accomplished science teacher, what helps if you are a master teacher, and what are the different ways that people can use these resources to enhance their teaching and student learning," said Smith.

Research is also needed on specifically what teachers learn through online professional development. Do they learn mainly content knowledge, values, new perspectives on teaching, or gaining a better understanding of how their students are learning and where they are in the learning continuum? An especially valuable way to address this question (and many others) is to ensure that teachers are full partners in ongoing research programs. "If there was some way . . . to include teachers online as part of scholarly work, it would be a . . . way to keep us experienced teachers feeling like we can still make a difference," said Sandie Gilliam.

One reason why relatively little research has focused on professional development is that such research is "time-consuming and labor intensive," according to Borko. She described a study in which she and her colleagues reviewed videos of teachers who were watching videos of themselves teaching a lesson. The researchers sought to answer several questions: How could teachers become comfortable sharing video? What was the nature of the discussions? How did this discourse change over time? What role did the facilitators play? As reported in an article scheduled to appear in *Teaching and Teacher Education*,<sup>1</sup> it was only after extensive study that the researchers concluded that the teachers were able to engage in highly reflective conversations about the videos and that these conversations became richer and more extensive over time. They also found that the direction provided by a facilitator had an important influence on the conversation. "When a facilitator provides handouts with questions to both guide the watching of a video and also guide the discussions, it was very helpful," Borko said.

However, most studies have not probed deeply into what teachers learn from professional development, whether online or face to face. As Andee Rubin pointed out, "I don't think we have much of the research that we need. Most of the research I have seen is about process, retention, facilitators' roles, schedules, and support from different stakeholders. One difficulty is that standardized tests based on multiple choice and other short-answer problems typically are not sensitive enough to measure changes in content knowledge among either teachers or their students. "It is challenging," noted Marcia Linn, "because the standardized measures

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<sup>1</sup>The manuscript for this paper is currently available at <http://www.colorado.edu/education/staar/>.



that are commonly used in No Child Left Behind and other programs are so insensitive to anything other than socioeconomic status.”

Also, in many cases, the measures of interest range beyond content knowledge into beliefs and goals. “I would benefit from knowing [how] professional development itself caused or enabled or encouraged changes in teachers’ knowledge and dispositions and beliefs and values,” said Deborah Smith, “and how that then worked in their classrooms to bring about a different kind of understanding for children.” Such measures would be especially valuable at the state level, since they could help meet the demands of accountability with assessments of core objectives in education.

The development of more sophisticated forms of assessment can address some of these challenges, workshop participants noted. For example, Linn stated that measures of such skills as knowledge integration can reveal differences in student performance caused by the professional development their teachers receive. Open-ended inquiry assessment instruments also can measure the ability of teachers to teach inquiry more effectively.

Teachers can provide invaluable input on the development of new forms of assessment. “I think we are learning as we go along what are reasonable assessments both of teacher practice change and student learning change,” said Rubin. “Maybe as a community we have some leverage in being able to come up with newer measures that are more sensitive to the kinds of issues that we care about.”

The nature of OTPD itself poses unique assessment challenges. For example, as Peter Bruns asked, how much of it should be staged, using actors and scripts, and how much should be based on the experiences and struggles of real teachers?

However, online technologies also offer radically new approaches to evaluation. “Advances in technology and assessment are opening up a completely different way of thinking about this issue,” said Chris Dede. “In my work, we have developed a virtual world in which students learn scientific inquiry. As a by-product of that, we have log files to capture second by second everything the student is doing, where they go, what they access, what they say, what people say to them, what data they collect, and what they post in their online notebooks. We are now using some of the very powerful data mining tools that people have developed in other sectors of society to do two things. One is to give teachers real-time diagnostic feedback on what students are up to. So the next morning, the teacher gets an e-mail that says, ‘I know that you have only ten minutes in this class period to work with students individually, so here are four students to work with today, and here is the topic for each of them that is coming out of the data mining where you should focus.’ The other thing

. . . is that we don't have to do the summative assessment anymore. If you are able in a sophisticated way to chart what students are learning formatively, that is summative, in the same way that supermarkets don't close any more for three days a year to do inventory. They always know what the inventory is. People are gathering data at the checkout counter about what is disappearing and what is appearing." Online technologies do not solve the problem of assessment for either classroom learning or professional development, Dede said. But they offer creative ways of gathering both formative and summative information that can inform the design of educational programs.

Despite the limitations of previous research on teacher professional development, several important conclusions have emerged that can be applied to both online and more traditional approaches to professional development for teachers, said Borko. First, "teachers can increase their knowledge and change their practice through intensive professional development. Second, . . . strong professional development communities can foster teacher learning. And third, . . . records of practice are powerful tools for teacher learning."

Regarding the first of these conclusions, Borko observed that teacher knowledge can be divided into three broad domains: subject-matter knowledge, knowledge of instructional practices, and understanding of student reasoning. Teachers need to know a subject differently than do other professionals, Borko said, "because their practice of it is different." Teachers also need to understand how to use their knowledge of content in teaching—"things like now that we understand the content, how do we sequence the content." Finally, teachers need to know how students learn—"things like being able to anticipate their efforts and being able to anticipate their alternative conceptions and misconceptions."

The development of strong professional communities can be a critical element in changing the practices of teachers, Borko noted. But community building can be "difficult and time-consuming work," she said. "What some of the research shows is that we have to establish trust. We have to reach a balance between providing a comfortable environment, so that people are comfortable sharing, and also keeping on pushing people—and pushing ourselves—to look critically at our own teaching, to look critically at our own subject-matter knowledge, and to work together to improve practice. And improving practice, as we all know, is not easy."

Finally, research has clearly pointed toward the importance of records of practice as teachers strive to improve. What happens in the classroom must be part of professional development, Borko said. "That does not mean that you have to do professional development in teachers' class-

rooms. What it means is that it's important to bring the classroom into the professional development setting."

A few initial steps have been taken to begin establishing a base of research information on OTPD, often by the organizations that offer materials online today. For example, the Education Development Center is doing a two-year study that will track the impact of professional development on teachers' content knowledge and practices, as well as students' content knowledge. Eduventures is planning to release a research report on professional development in general in fall 2007.

More broadly, the role of teachers in shaping online professional development needs to be a focus of research, according to Bruce Alberts. "One thing we badly need research on, which I don't think has been directly addressed here, is exactly how to give teachers a voice, an appropriate voice, at school district levels, in what professional development they get. I would like to encourage a variety of different approaches in different school districts, associated with some evaluation of how those work. . . . If we can't give teachers a voice in their professional development, I don't think we are going to solve this problem."

In the recent paper *A Research Agenda for Online Teacher Professional Development* (Dede et al., 2006), Dede and his colleagues present a clear vision for the kinds of research questions that need to be addressed. They suggest research strategies, plans, models, and designs that may offer guidelines to funding agencies about where the needs are strongest.

Research is not going to answer all of these questions, workshop participants acknowledged. On the contrary, it is likely to raise as many questions as it answers. But identifying the most pressing questions also should be seen as a major objective of the research community in this realm, particularly if those questions encourage foundations, governments, and other organizations to support and expand research on OTPD.

## Next Steps

**E**ven without the results of more comprehensive research on teacher professional development, workshop participants suggested that plenty of steps can be taken to enhance the use and effectiveness of online teacher professional development (OTPD).

### **PROVIDING TEACHERS, ADMINISTRATORS, AND POLICY MAKERS WITH INFORMATION**

According to workshop participants, perhaps the most straightforward step would be to make teachers, administrators, and policy makers aware of what is currently available. If an online listing were available of existing programs, individuals and organizations could easily find and compare options. Even more useful, suggested David Vannier of the National Institutes of Health, would be a Consumer Reports type of guide that describes the features of programs and offers evaluations. Such a guide could include costs, the experiences of previous users, any available research results, and perhaps independent evaluations. An online guide would have many potential users, said Vannier. "It's important for everyone involved to know what [an online professional development] program is, whether that's the teacher taking the course, the administrator who approves the course, the parents whose district is adopting the course, or the students who might be affected." Such a guide would also make it easier to identify gaps in content areas, grades, or ranges of teacher experience.

## **BUILDING SUPPORT AMONG ADMINISTRATORS AND POLICY MAKERS**

Administrators and policy makers especially need to be convinced of the value or potential of online professional development. Involving administrators in online communities was suggested by Deborah Smith, who asked, "How can we get principals and administrators into an online professional development program that would help them build a vision that would be shared and collaborative?" "If you can't get past the building principal and the downtown administrator, this is not going to happen. . . . You absolutely need someone who not only values but understands what you are doing."

Beyond administrators, policy makers need to be aware of the potential for online professional development to make a difference in the professional lives of teachers. Barnett Berry asked, "How can teachers, especially our very best teachers across the country, provide a huge important bridge to the policy world to bring their expertise and voice to the deliberations about their profession?"

"We would like policy makers to set up mechanisms to more effectively listen to teachers' voices and choices about online professional development," said California Teacher Advisory Council (TAC) member Juliana Jones, a middle school teacher in Berkeley, California. In particular, if policy makers were able to experience an engaging online course, they would be more likely to provide teachers with the time and resources needed for online learning.

Embracing OTPD means that policy makers and administrators must give up some measure of control over professional development decisions, said Sherri Andrews of the North Carolina School of the Arts in Thomasville. "Administrators have to be able to give up the fact that they want to tell us what we need to do and when we need to do it." Also, the technology is changing so quickly that administrators and policy makers will need to involve teachers in making strategic decisions about the best possible uses of what is available. For example, although the Internet is the source of most online courses today, new technologies, such as immersive learning environments that are now part of online video gaming technologies, may someday supersede today's offerings.

## **PROVIDING TEACHERS WITH ACCESS TO ONLINE TECHNOLOGIES**

Teachers need appropriate, modern tools to take advantage of online programs. Administrators cannot assume that teachers will have the necessary computer equipment and Internet connections at their homes, nor should teachers be expected to engage in online professional development

entirely on their own time and away from school. Technology policies and purchases of computers and networking equipment in schools should take into account the use of that equipment for learning by teachers as well as students.

Federal and state policy makers have an important responsibility to promote equal access to technology. "There is a disparity in those who have technology and those who don't," said National Academies TAC member Ford Morishita of Clackamas High School in Portland, Oregon. "This is going to be absolutely critical, not just for online professional development, but for all use of technology."

Access implies that *all* teachers should be able to use online technologies, not just those with special expertise or training. As noted above, workshop participants agreed that OTPD cannot be just for "techies." In addition, access for all users often must involve captioning or translation of text, which can benefit many teachers and is essential for some. Captioning is also required if federal funds are being spent to develop products. "Captioning helps everybody," said Raymond Rose.

### FOSTERING DEVELOPMENT OF GOOD MATERIALS

Teachers need the ability to become more involved and proactive in customizing online learning for their own schools. "I really like trying to keep teachers in the loop as designers, evaluators, and intellectual participants," said Smith. "[But] we have seen a movement away from that in a lot of schools in districts and states, where teachers are told what to teach, what time to teach it, and how much to teach." Even little things can make a difference, Smith noted. On the websites for professional development, there ought to be a suggestion box in which teachers could say, "We really need some professional development on this."

It's important not to let discussions of OTPD get sidetracked into either/or dichotomies, said workshop participant Ellen Hershey of the Stuart Foundation in San Francisco.<sup>1</sup> "It is very important to talk about more high-quality professional development for all teachers," she said. According to Liz Pape, "The purpose of any type of professional development is to try to move teachers and administrators forward as a community of practice to impact the learning of the entire student body." Online programs should be part of a continuum of learning opportunities in schools for students and teachers. "It's not the online program here and the other stuff over there," added Barbara Treacy.

The federal government and foundations have an important role to play by supporting the development, evaluation, and revision of OTPD,

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<sup>1</sup>Additional information is available at <http://www.stuartfoundation.org/>.

said workshop participant Jean Treiman of the California Subject Matter Projects.<sup>2</sup> Online materials and technologies are changing quickly, and a mix of public and private support can help the developers create better materials and stronger markets. "The tools that are available are paltry by comparison to the visions that exist," said Louis Gomez.

### CHANGING TEACHERS' BELIEFS AND PRACTICES

Much more could be done to make teachers aware of the many potential benefits of online professional development. Some teachers may have had poor early experiences with computers, and their skepticism will need to be addressed. Teachers need to learn how to use new technologies both for their own teaching and for professional development, in part to acquaint them with the world in which their students now live. As new people continually enter the profession, online professional development needs to be marketed and promoted.

Standards for OTPD could establish expectations for teachers, schools, districts, and state governments, and to help change attitudes. The Southern Regional Education Board has published "Standards for Online Professional Development" that encompass "E-Learning Context Standards," "E-Learning Process Standards," and "E-Learning Content Standards."<sup>3</sup> For example, the context standard for resources states that "schools and states provide adequate and ongoing funding for the online program as part of the overall professional development plan" and "schools and states provide adequate resources of time, personnel and support systems for online professional development."

### INVOLVING TEACHERS AS ACTIVE PARTICIPANTS IN PLANNING AND IMPLEMENTATION

The theme that emerged most strongly from the workshop was the need to have teachers involved in all stages of online professional development, from its design and development to its implementation, assessment, and ongoing revision. According to Bruce Alberts, "we will never have a better education system than we have now unless we change the dynamics of how teachers' voices are heard, at the national level, at the state level, and at the district level."

Teachers have a strong incentive to be involved in this process. Many

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<sup>2</sup>Additional information is available at <http://csmc.ucop.edu/>.

<sup>3</sup>Southern Regional Education Board, "Standards for Online Professional Development: Guidelines for Planning and Evaluating Online Professional Development Courses and Programs" <http://www.sreb.org/programs/EdTech/toolkit/Standards>).

are dissatisfied with current forms of professional development and would welcome an opportunity to shape new approaches. Many are using information technologies more intensively in their classrooms and recognize the potential of online approaches for learning. "If you give teachers a tool that makes their job better, they will do everything to knock down the door and get it," said Janet English. "If you try to take it away, you had better watch out. They want to learn. They want to be the best teachers possible. They want their kids to learn."

Teachers currently have a unique opportunity to gain a new role in decisions about professional development, said California TAC chair Stan Hitomi of the San Ramon Valley Unified School District in Danville. "Looking at the latest reports that have been coming out, this is a very special time. The country's attention has turned to science and math and what needs to be done. It is the work of groups like this one today that will inform policy makers on the type of data that will be important. . . . Teachers are engaged in a dialogue with people who can make a difference." As Valdine McLean put it, "professional development needs to make science teachers exciting, so that they can make their students very excited about science, so that they can come and fill our shoes, so that our nation won't be left behind."

Traditional approaches to professional development need to change. The advent of online learning has presented teachers with a chance to gain a direct voice in the planning and organization of professional development. "In too many districts, it's someone in the central office who decides what it's going to be," said National Academies TAC member Elizabeth Carvellas of Essex High School in Essex Junction, Vermont. "If you involve the teachers, you are going to get the buy-in, and you are going to get what you need for professional development, whether it's online or face-to-face. Please involve the teachers."



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# Appendix A

## Workshop Agenda and Participants

NATIONAL RESEARCH COUNCIL  
CENTER FOR EDUCATION  
TEACHER ADVISORY COUNCIL  
CALIFORNIA TEACHER ADVISORY COUNCIL  
Enhancing Professional Development for Teachers:  
Potential Uses of Information Technology  
February 8-9, 2007

The Arnold and Mabel Beckman Center  
Huntington Room  
100 Academy Dr.  
Irvine, CA

### AGENDA

**Thursday, February 8**

- 12:45 pm**    **Welcome and Opening Remarks**  
**Lyn Le Countryman**, cochair, Workshop Planning Committee  
**Bruce Alberts**, former president, National Academy of Sciences  
**Wanda Bussey**, chair, National Academies Teacher Advisory Council  
**Stan Hitomi**, chair, California Teacher Advisory Council
- 1:00**        **Keynote Speakers—Online Professional Development for Teachers—Where Are We Today and What Does the Future Hold?**  
**Chris Dede**, Harvard Graduate School of Education  
**Louis Gomez**, Northwestern University School of Education

Questions from participants.

**2:15 Case Study—An Example of Interactive Online Work**  
Examine issues of Online Teacher Professional Development (OTPD) from a systemic perspective using an actual example of a project to promote this kind of professional development. This session is a continuation of the online discussion among participants prior to the workshop.  
**Chris Dede, facilitator**

**3:15 Break**

**3:45 Panel—What Does Research Say About OTPD?**  
**Roxie Ahlbrecht, Moderator**, second grade teacher, math teacher leader, Robert Frost Elementary, Sioux Falls, South Dakota

**Marcia Linn**, Professor of cognition and education, Graduate School of Education, University of California, Berkeley, science perspective

**Andee Rubin**, senior scientist, TERC, mathematics perspective

Examination of issues in OTPD from a systemic perspective. What are the challenges when studying teacher professional development? How can OTPD exploit this knowledge through the unique characteristics of the online environment?

**How Can Teachers Make Use of What Research Says About OTPD?**

**Deb Smith, teacher responder**, second grade teacher, Woodcreek Magnet School for Math, Science and Engineering, Lansing, Michigan

**5:00 A Brief View of Three Research-Based OTPD Programs**  
**Barbara Schulz, moderator**, teacher leader, National Academies Teacher Advisory Council

**David Zarowin, Wide World**, <http://wideworld.pz.harvard.edu/>

**James Pence, Teachers' Domain**, <http://www.teachersdomain.org/>

**Liz Pape, Virtual High School**, <http://www.govhs.org/>

- 5:30**            **Questions for the Day's Speakers**  
**Stan Hitomi, facilitator**, chair, California Teacher Advisory Council and science and math coordinator, San Ramón Valley Unified School District

**February 9, Friday**

- 8:30 am**        **Brief Recap of Ideas from Thursday and Overview for the Day**  
**Lyn Le Countryman**, cochair, Workshop Planning Committee, and biology teacher and science education professor, University of Northern Iowa

- 8:45**            **Panel—Current State of OTPD**  
**Juliana Jones, moderator**, mathematics teacher, Montera Middle School

**What Is the Evidentiary Base for Understanding and Evaluating Professional Development?**  
**Hilda Borko**, School of Education, University of Colorado, Boulder

**Models of OTPD**  
**Barbara Treacy**, Education Development Center, Cambridge, MA  
Explore a capacity building, learning community model where teachers are trained to deliver and/or design online professional development workshops for other teachers in their district, state, consortia or other educational organization.

**Online Teacher Professional Development from a School District Perspective**  
**Martha Valencia**, Master teacher, Los Angeles Unified School District, and trained online facilitator who has been delivering workshops to elementary math teachers, teacher responder

- 10:00**        **View from Ground Level—Small Group Discussions**  
**Lyn Le Countryman, moderator**  
From your perspective, what does the future hold for OTPD in your work?

What might be some roadblocks to a more systemic use of OTPD?

To what extent is OTPD available and used in your professional life?

Facilitators—members of the planning committee

**Barbara Treacy**, Education Development Center, yellow

**Sue Doubler**, TERC, green

**Tad Johnston**, Maine Department of Education, blue

**Stacey Kyle**, Center for the Future of Teaching and Learning, red

**Groups will share ideas at the end of the day.**

**11:15 Refreshments and Move to Breakout Rooms**

**11:30 Panel—What Are the Issues Around Standards, Access and Equity for OTPD?**

**Ford Morishita**, moderator, science teacher, Clackamas High School, Oregon, and Member, National Academies Teacher Advisory Council

**What Standards Should Be in Place for OTPD?**

How should online PD be evaluated?

What should teachers and school administrators look for in OTPD?

**William Thomas**, Southern Regional Education Board

**What Are the Access and Equity Issues in OTPD?**

What technologies are needed for access to quality OTPD?

What are the constraints of access for OTPD?

Does OTPD level the playing field?

**Raymond M. Rose**, President, Rose and Smith Consulting, Texas

**Quality Perspectives on OTPD: Changing the Paradigm?**

**Valdine McLean**, teacher, Pershing County High School, Lovelock, Nevada, and member, National Academies Teacher Advisory Council

**12:30 pm Lunch on the Terrace**

**1:30 Panel and Breakout Groups—Descriptive Synthesis and Visions for the Future**

**Sandie Gilliam, moderator**, California Mathematics Council

**What Are the Economics and Benefits?**

How do we balance a state of the art small innovative program with scalability and effectiveness?

**Leah O'Donnell**, Senior Consultant, Eduventures

**Possibilities for the Future—Cost, Benefit, and Equity Issues**

**Linda Chaput**, chief executive, Agile Mind, Inc.

**Janet English, teacher responder**, middle school science teacher, on leave to serve as Director of Educational Services at KOCE-TV, Orange County, California, and Member, California Teacher Advisory Council

**Breakout Group Discussions**

- Where are the gaps in the offerings for OTPD?
- What is currently missing in OTPD for teachers that can be improved to better focus on teachers' needs for professional development?
- Can quality OTPD be delivered at costs that are sustainable for most school districts?
- How can policy makers help with cost and equity issues?

**3:30 Concluding Discussion—Facilitators:**

**Betty Carvellas**, science teacher, Essex High School, and member, National Academies Teacher Advisory Council

**Javier Gonzalez**, mathematics teacher, Pioneer High School, and Member, California Teacher Advisory Council

**Reports from Breakout Groups**

**Comments from Members of the Planning Committee, National Academies Teacher Advisory Council, California Teacher Advisory Council, and the General Audience**

How can teachers influence the future development of use of OTPD?

What is the intrinsic value of OTPD from teachers' perspectives?

What policies are needed locally, statewide, and nationally to develop coherent strategies for the development, implementation, and use of OTPD?

5:00

**Adjourn**

## WORKSHOP PARTICIPANTS

### Invited Guests

- Dayo Akinsheye**, Principal, Marie H. Reed Elementary School,  
Washington, DC
- Deidre Alves**, National TE Accreditation Associate, National Council  
for Accreditation of Teacher Education, Washington, DC
- Maya Bassford**, Program Officer, American Psychological Association,  
Washington, DC
- Barnett Berry**, Founder and President, Center for Teaching Quality,  
Hillsborough, NC
- Nadine Bezuk**, Executive Director, Association of Mathematics Teacher  
Educators, San Diego, CA
- Peter Bruns**, Vice President, Howard Hughes Medical Institute,  
Chevy Chase, MD
- Daniel Carchidi**, Senior Publication Manager, MIT OpenCourseWare,  
Cambridge, MA
- Brenda Crouch**, Consultant, Panhandle Area Educational Consortium,  
Chipley, FL
- Margaret Crutchfield**, Associate Vice President, National Council for  
Accreditation of Teacher Education, Washington, DC
- M. Daniel DeCillis**, Research Associate, California Council on Science  
and Technology, Riverside
- Carolee Dodge-Francis**, Executive Director, American Indian Research  
& Education Center, University of Nevada, Las Vegas
- Beverly A. Echols**, Executive Director, Workforce and Professional  
Development, District of Columbia Public Schools, Washington, DC
- Myrna Estrada**, Secondary Science Expert, Los Angeles Unified School  
District, Los Angeles
- Belva Free**, FloridaLearns Academy Director, Panhandle Area  
Educational Consortium, Chipley, FL
- Susan Hackwood**, Executive Director, California Council on Science  
and Technology, Riverside
- Susan Harvey**, Program Officer, S.D. Bechtel, Jr., Foundation,  
San Francisco
- Claire Hemingway**, Education Director, Botanical Society of America,  
Long Beach, CA
- Ellen Hershey**, Senior Program Officer, Stuart Foundation,  
San Francisco
- Roberta Jaffe**, Project Director eMSS, NSTA, and New Teacher Center,  
Santa Cruz, CA
- Elaine Keeley**, Administrator, Curriculum & Standards, Orange County  
Department of Education, Costa Mesa, CA



- Lynn Kepp**, Science Outreach Coordinator, New Teacher Center,  
University of California, Santa Cruz
- Joellen Killion**, Director, Special Projects, National Staff Development  
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- George Miller**, Senior Lecturer/Faculty Science Advisor, Department of  
Chemistry, University of California, Irvine
- Barbara Shannon**, Director, Multicultural Affairs, Westridge School,  
Pasadena, CA
- Harris Shultz**, Professor, Mathematics, California Mathematics Project,  
Irvine
- Sam Spiegel**, Science Educator, BSCS, Colorado Springs, CO
- Cornelius Sullivan**, Professor, University of Southern California,  
Los Angeles
- Barbara Thalacker**, State Education Technology Director, California  
Department of Education, Sacramento
- Jean Treiman**, Executive Director, California Subject Matter Project,  
Sacramento
- Mariam True**, Executive Director, San Diego Unified School District,  
San Diego
- Dave Vannier**, Professional Development Coordinator, National  
Institutes of Health, Bethesda, MD
- Anne Westbrook**, Center for Curriculum Development, BSCS, Colorado  
Springs, CO
- Michelle Williams**, Assistant Professor, Science Education, Michigan  
State University, East Lansing, MI
- Dan Wolfson**, Program Manager, Educational Technology, San Diego  
Unified School District, San Diego

### Presenters

- Hilda Borko**, Professor, School of Education, University of Colorado,  
Boulder
- Linda Chaput**, Chief Executive, Agile Mind, Inc., San Francisco
- Louis Gomez**, School of Education & Social Policy, Northwestern  
University, Evanston, IL
- Marcia Linn**, Professor, Graduate School of Education, University of  
California, Berkeley
- Leah O'Donnell**, Senior Consultant, Eduventures, Boston
- Liz R. Pape**, CEO, VHS, Inc, Maynard, MA
- James Pence**, Education Productions, Teachers' Domain, WGBH Boston
- Raymond Rose**, President, Rose and Smith Associates, Cedar Park, TX
- Andee Rubin**, Senior Scientist, TERC, Cambridge, MA
- William Thomas**, Director, Southern Regional Education Board, Atlanta

**Martha Valencia**, Specialist, Instructional Technology, Los Angeles Unified School District, Los Angeles

**David Zarowin**, Executive Director, WIDE World, Harvard Graduate School of Education, Cambridge, MA

### Workshop Steering Committee

**Lyn Le Countryman (Cochair)**, Associate Professor, Malcolm Price Lab School, University of Northern Iowa, Cedar Falls, IA

**Chris Dede (Cochair)**, Wirth Professor in Learning Technologies, Harvard Graduate School of Education, Cambridge, MA

**Susan Doubler**, Center Co-Leader, TERC, Cambridge, MA

**Janet English**, Teacher, Director of Education Services, SVUSD, KOCE-TV, Huntington Beach, CA

**Javier Gonzalez (CalTAC Member)**, Chair, Department of Mathematics, Pioneer High School, Whittier, CA

**Tad Johnston**, Mathematics Specialist, Maine Department of Education, Augusta

**Valdine McLean**, TAC Member, Science Teacher, Pershing County High School, Lovelock, NV

**Barbara Treacy**, Managing Director, Education Development Center, Newton, MA

### National Academies Teacher Advisory Council

**Roxie Ahlbrecht**, Second Grade Teacher, Robert Frost Elementary School, Sioux Falls, SD

**Bruce Alberts**, Ex Officio, Department of Biochemistry and Biophysics, University of California, San Francisco

**Wanda Bussey (Chair)**, Mathematics Teacher, Rufus King High School, Milwaukee, WI

**Elizabeth A. Carvellas**, Science Teacher, Essex High School, Essex Junction, VT

**Mario A. Godoy-Gonzalez**, ESL/Bilingual Teacher, Royal High School, Royal City, WA

**Michael Koehler**, Mathematics Teacher, Blue Valley North High School, Overland Park, KS

**C. Ford Morishita**, Science Teacher, Clackamas High School, Portland, OR

**Deborah Smith**, Second Grade Teacher, Woodcreek Magnet School for Math, Science and Engineering, Lansing, MI

**Robert Willis**, Science Teacher, Frank W. Ballou High School, Washington, DC

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- Peter Arvedson**, La Puente High School, La Puente, CA  
**Anne Marie Bergen**, District Science-Oakdale, Oakdale, CA  
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**Juliana Jones**, NBCT, Mathematics, Montera Middle School,  
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**Suzanne Nakashima**, Teacher, Yuba City, CA  
**Mark Stefanski**, Science Teacher, Marin Academy, San Rafael, CA

### National Academies TAC Associate Members

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**Peggy Carlisle**, Science Teacher, Pecan Park Elementary School,  
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## Appendix B

### Workshop Materials

Prior to the workshop, a web portal was established to enable workshop participants to access a case study. This case provides background information and describes the multiple complexities involved with establishing a comprehensive distance learning program throughout the state of Alabama. Workshop participants were asked to read the case and come to the workshop prepared to discuss it. The assignment and the case study are provided below.

#### ASSIGNMENT

Alabama is developing and implementing a comprehensive distance learning program called ACCESS. This program has the ambitious aim of raising student achievement levels across all student demographic groups by providing courses for advanced diploma requirements, elective courses, AP courses, remedial courses, professional development, and multimedia resources.

The purpose of the Alabama case discussion is to analyze the complexities of this work in progress. The discussion we begin here online and then continue when we meet in a few weeks is a platform for considering the “macro issues.” We are not looking for consensus, but rather, are trying to convene conversation on the multiple dimensions of/perspectives on the issues. Please contribute your ideas and respond to the ideas of your online colleagues in ways that take the discussion of issues deeper.

### **Launching the Debate—Questions for Online Discussion**

1. In its efforts to raise student achievement, Alabama lacks qualified teachers and required course offerings. How well is ACCESS as a solution-in-progress speaking to these aspects of this problem?

2. School reforms such as ACCESS often experience tensions between being seen as a top-down or bottom-up reform. How would you characterize ACCESS?

3. What does the context have to do with the design of ACCESS? If this case were set in a more populous and wealthy state (e.g., Connecticut), how, if at all, would you modify the design?

#### **CASE STUDY:**

#### **ALABAMA CONNECTING CLASSROOMS, EDUCATORS, AND STUDENTS STATEWIDE (ACCESS)**

##### **Context**

The state of Alabama has a challenging environment in which to educate and meet the needs of its 730,000 public school students. School systems must work in a context where more than 51 percent of the public school population is eligible to receive free and reduced lunch. Further, the state has many rural districts, where schools and school districts stand miles and miles apart from one another—literally spreading thin state resources for education to these many remote sites. Because of these issues, like many states throughout the country, Alabama has struggled to raise student achievement levels across all student demographic groups. All of these factors combine to create a situation where many schools and school districts—which have few students and thus small budgets, but must educate students according to state standards—have lacked sufficient resources (including qualified teachers, required course offerings) for adequately meeting the needs of all students.

This is especially problematic given that Alabama has a two-tiered high school diploma system. According to state policy, students can earn a regular diploma, taking one set of curricular offerings; or an “Advanced Diploma” by taking advanced level courses in the areas of language arts, math, science, and social studies. Historically, many Alabama high schools have not had the resources to offer students the requisite courses to obtain the Advanced Degree. In sum, students in Alabama have not had access to all the educational opportunities and resources necessary to successfully complete a high school curriculum. This has tremendous ramifications for these students’ ability to go onto higher education, earn adequate wages, and ultimately, compete in local, national, and global economies.

### How to Deal with These Issues?

Given the national spotlight on increasing achievement levels, Governor Bob Riley convened a task force to study and make recommendations on ways to increase access to a full range of educational opportunities to all of Alabama's students. The committee's primary recommendation was to develop and implement a comprehensive distance learning program—appropriately called ACCESS (Alabama Connecting Classrooms, Educators, and Students Statewide)—throughout the state. ACCESS would provide courses necessary to meet the advanced diploma requirements; create additional online course offerings including elective courses, Advanced Placement courses, and remedial and enrichment courses; and provide both online professional development for teachers and access to multimedia resources to be used in their instruction. ACCESS is to accomplish this by building upon the infrastructure capacity the state and some districts had already created by implementing various types of technology systems throughout the state—with the ultimate goal of raising overall student achievement levels generally, and math and science in particular. The state officially began the program in 2005.

The State Department of Education's Office of Educational Technology was named to lead this statewide distance learning effort. The charge to create and implement this program created two fundamental challenges for state leaders: 1. The Task Force gave the state a task that was extremely large in scope and included a broad range of diverse issues that had to be addressed with this single distance learning school (e.g., course levels range from advanced to remedial; content includes core subject areas and electives). 2. A tremendous number of stakeholders are involved in creating such a program. Thus, representatives from all these groups needed to be included in the planning phases, and consensus had to be reached about very difficult issues in order to ensure successful buy-in during the implementation phase. Related to this issue, many Alabama districts prior to ACCESS had already implemented different technology systems within their home districts. The state team was thus left to integrate this balkanized system into one coordinated and comprehensive plan.

#### Seeking the One Best System: Bringing the Stakeholders Together

In recognizing the latter of these issues, the Governor's Task Force—and, by extension, the Office of Educational Technology—actively recognized the need to develop a strong network and infrastructure to support both the initial and ongoing efforts of the distance learning program. To this end, they made a very concerted and deliberate effort to convene a variety of stakeholders (including individuals from school districts, universities, public television, vendor partners, the Southern Regional Education Board,

the Appalachian Regional Commission, and the Alabama Supercomputer Authority), both to gather the wisdom their experience had to offer and to facilitate future buy-in to the program. This group was charged with choosing the most effective method for developing the online programs and the best means of delivery.

This allowed the state to learn lessons from districts that had already implemented some aspects of technology systems (this included interactive videoconferencing and nonsystematic web-based courses) and build on those foundations. In addition to district resources, the state also had two universities (University of Alabama and Troy University) that had previously developed online courses for high schools in each of their respective areas. The state worked with administrators from each of these programs to utilize their resources and knowledge and to integrate them into the development and implementation of the ACCESS program. Crucial to the success of this initiative, though, is that the state remains *the* official, guiding voice—the central point of contact—of the ACCESS program (International Society for Technology in Education). From the very start of the program, the state, as the leader, recognized and encouraged input from these various other program stakeholders.

### **The ACCESS Program: From Pilot to Implementation**

The ACCESS program allows for courses to be delivered in two ways: 1. through online media using a web-based system, and 2. via interactive videoconferencing (IVC) technology. The ACCESS program has integrated resources from an online library and other school-based resources into both of these systems. As it goes forward, the delivery method is morphing into a blended learning model, whereby courses are designed to utilize the advantages (in terms of both content and student participation) of both types of delivery. To spearhead the initiative, the Alabama Legislature appropriated \$10.3 million for the program in October 2005, which allowed for the first phase of pilot implementation. The original emphasis on collaboration among stakeholders continued through this implementation. During this first phase, the school-based implementation team included a teacher, facilitator, school counselor, principal, and education technology coordinator, with a great deal of planning and coordination support from the State Office of Educational Technology.

The State Legislature re-funded the program at the original levels this fall, giving it the support to move into full implementation. As the program expands, moving beyond the pilot phase, the school-based team will remain the same. However, three regional “ACCESS Support Centers” are now functioning to supply a great deal of the support the State Office of Educational Technology provided during the pilot phase. Two of these

centers are housed at universities and one is at a local school system; their role is to assist teachers, schedule courses, and serve as liaisons between Department of Education staff and distance learning teachers.

The state resources and the careful, yet centralized planning effort by the State Office of Educational Technology have empowered a speedy implementation process. This funding has allowed for the courses to be offered free to participating public high schools in the state and has provided incentives for delivery schools to share teachers, as well as for teachers to learn course delivery using technology tools. In the fall of 2005, a total of 425 students were enrolled, with 21 course offerings and fewer than 8 percent of school districts sharing teachers via interactive videoconferencing. This fall, those numbers rose to approximately 4,500 students in more than 42 different courses. Roughly 44 percent of the school districts will be sharing teachers via IVC. To stimulate this growth, "The districts that have certified, highly qualified teachers, extra seats for students, and IVC equipment will receive funds for every student seat they deliver to schools outside their districts," according to Dr. Melinda Maddox, AL State Education Technology Director.

With these subsequent phases of implementation, as part of the program, courses that had previously been offered by individual districts are currently being purchased, rewritten, and aligned to Alabama content standards with the help of the districts and university partners. Further, the Office of Technology is adding a plethora of new courses to the list it offers—including the full Advanced Diploma curriculum and elective courses, such as math, science, and foreign language courses. These offerings generally fall outside the traditional curriculum or the possible scope of courses one single school or district has the resources to offer, but are growing in importance as the nation strives to compete in a global economy where such skills are necessary. With the development of these courses, this online curriculum is allowing for a richness of curriculum that few public schools around the nation can match.

The state has made education and professional development for schools and teachers an integral part of both the implementation process and the ACCESS program itself. In rolling out the program, the state team made concerted efforts to educate the schools and the community "writ large" on the program, the resources it offers to all students in Alabama, and its potential to ultimately raise student achievement. The State Office of Technology used a Bell South Foundation grant to provide a communications consultant who was responsible for getting this message out to the public.

Within the school system, the program also includes a specific online professional development and resource tool that serves to educate teachers and administrators in both their support of students using the



ACCESS program and online tools to be integrated into regular classroom instruction. This resource portal, the Alabama Learning Exchange (ALEX), includes online materials, professional development, resources, and online learning materials. Specifically, easy access is available to rich materials, including full-text access and search of the Alabama content standards, as well as teacher created and reviewed lesson plans. ALEX coexists as an online resource for all teachers—traditional and virtual.

### **The Future of the Program: Expansion and Challenges**

As the program moves into its second year, the partners continue to deal with the initial challenges and new ones that have arisen with the program's implementation and expansion. The state, through very careful planning throughout each step of the process, has very successfully navigated the issue of stakeholder buy-in from such a large group of individuals, representing a broad range of interests. The initial issue of the breadth and depth of the scope of the needs intended to be met by the distance learning school remains. With the program still in its formative years, state officials continue to struggle to determine how to meet all of these needs (e.g., planning, resources, professional development), an issue that will likely remain a constant challenge.

One area of particular concern is the challenge of attracting and retaining highly qualified teachers in districts throughout the state. The virtual learning initiative has in part addressed this issue, as districts that might not have otherwise had access to a French teacher, for example, can now potentially access an instructor via an online course. However, there still simply is not a large enough overall supply of highly qualified teachers from which to choose, so the struggle continues to find and train teachers to take part in the initiative.

One other major challenge for the program has been showing tangible results quickly enough to continue justifying funds. Budget constraints mandate that, when initiatives are funded, proof must be provided that the money was well spent and did in fact advance student access and outcomes. To help facilitate this and to improve the program overall, the state hired the International Society for Technology in Education to provide an evaluation of this past year's implementation. Surveys, interviews, and data analysis are currently taking place in the sites to determine whether the goals of the project are being met and to provide general feedback from observations of the courses in action. A report is expected in early 2007 and will help guide the future direction of the project. State leaders will take lessons learned from these evaluations to improve future iterations of the program.

### Conclusion

At the start of this program, Governor Bob Riley stated that, because of the state's mix of rural challenges and inequitable distribution of educational resources, some districts "aren't able to offer classes in foreign languages or advanced math and science. Through ACCESS, we can use existing technology in our schools to open up a world of new opportunities for our kids." Sustaining the high quality of the program and keeping momentum rolling are difficult as the program expands and time passes. However, Alabama has recognized that meeting this need is integral in providing the type of education necessary to improve student achievement levels and provide necessary skills that allow for individuals, states and the nation to be competitive in this global economy.

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# Appendix C

## Programs Highlighted During the Workshop

Throughout the workshop, a series of online programs for teacher professional development was described and discussed to enable participants, many of whom had not personally partaken of such opportunities, to better appreciate the spectrum of possibilities that online learning technologies offer. A description of these programs is presented below.

The planning committee recruited examples of online technologies for professional development from both the for-profit and nonprofit sectors. The primary criterion for including a particular program or application was that it had been rigorously evaluated for its efficacy. Selection of these programs for inclusion in the workshop does not imply endorsement by the National Research Council.

### ONLINE PROGRAMS

#### EdTech Leaders Online

EdTech Leaders Online (ETLO) is an online resource designed to build the capacity of organizations to use online learning.<sup>1</sup> ETLO works with educational organizations at all levels—including school districts, state departments of education, universities, regional consortia, and professional development providers—to help those organizations “figure out why they want to use online learning, what lessons it will address, and

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<sup>1</sup>Additional information is available at <http://www.edtechleaders.org>.

how they should do it based on their own needs and goals,” said presenter and planning committee member Barbara Treacy of the Education Development Center, Inc.,<sup>2</sup> which supports ETLO through its Center for Online Professional Education.

Since its launch in 2000, the project has trained more than 1,400 online specialists, course developers, and online facilitators in more than 35 states. It offers two main types of capacity-building programs: how to be an online instructor and how to be an online course developer. About 50 online workshops are now offered in different subject areas and grade levels. The project also has created an online community of online instructors in which participants can discuss resources, share answers to questions, and reflect on the work they are doing. Many of these discussions are archived and available to new participants.

Because the emphasis of ETLO is on building capacity, it seeks to enlist participants as long-term partners in professional development. “It’s not just a course. People are getting involved for a long-term relationship,” said Treacy. “We are there both to train people and to make sure they and their participants are successful.” After they finish the course, participants develop a plan with their district or departmental leadership to run a series of workshops within their organizations based on identified goals and needs. These workshops result in projects that teachers can implement in their classrooms. Surveys show that of 2,500 teachers who have received training through ETLO, 98 percent are using the workshop projects in their classrooms.

An example of ETLO’s influence is its work with the Mississippi Department of Education. ETLO trained a cohort of 24 online facilitators who then offered online workshops to teachers across the state who were teaching on emergency certificates. “It became the only way those teachers on emergency certificates could get into the classroom,” Treacy said. The program was so successful that Mississippi made the training mandatory for online facilitators, and the approach has spread to other parts of the Mississippi education department.

*“The course moved rapidly as research articles provided meat for discussions on topics relevant to online learning and facilitation. Attributes of adult learners, different teaching and learning styles, and developing plans to encourage high levels of participation provided content for lengthy discussions. These qualities and strategies not only enable online learners but students in classrooms as well. I cannot think of when I’ve enjoyed a course as much as I have this one, nor can I remember feeling any more comfortable, or gaining more applicable learning than in this course.” — online facilitator participating in ETLO workshop (as presented by workshop presenter Barbara Treacy)*

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<sup>2</sup>Additional information is available at <http://main.edc.org/>.

### Southern Regional Education Board

The Southern Regional Education Board (SREB) has an Educational Technology Cooperative that represents more than 3,300 school districts and nearly 800 colleges and universities in its 16 states.<sup>3</sup> One initiative of the cooperative is the Multi-State Online Professional Development toolkit, which provides resources to promote and support the efforts of states and schools to deliver professional development online. According to SREB's William Thomas, the overall objectives of the program are to improve the quality of teaching and learning and to provide equity of access to teachers regardless of where they are located.

From the cooperative's initial experiences with online professional development, SREB discovered that it needed "to promote this idea with our state legislators and governors," said Thomas. The result was a 6-page document called *Online Professional Development: Why SREB States Should Use It*.<sup>4</sup> The publication emphasizes the advantages of online professional development in reaching all teachers, reducing travel time and expenses, avoiding the "one-time workshop," providing "just-in-time" learning, and building a community of learners. "It was almost a sales pitch to our legislators and policy makers of why they have to start thinking in their states about a different way of going about doing professional development," Thomas said.

Different states are using the resources provided by SREB in different ways. Arkansas, for example, is drawing on those resources as part of its \$2 million Online Professional Development Initiative,<sup>5</sup> whereas West Virginia is using online professional development to provide teachers with 21st-century skills. "Each state will do it its own way, but their ultimate goals are the important things," said Thomas.

### Technology-Enhanced Learning in Science

Technology-Enhanced Learning Science (TELS) is an instructional program for students in grades 6-12 that has a prominent professional development component.<sup>6</sup> The program is organized around 18 instructional modules that help students learn difficult scientific concepts through hands-on, interactive classroom activities that feature scientific visualizations and simulations. "Our project is focused on how to take advantage

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<sup>3</sup>Additional information is available at <http://www.sreb.org/programs/EdTech/edtechindex.asp>.

<sup>4</sup>Available at <http://www.sreb.org/programs/EdTech/pubs/PDF/04T05-OnlineProfDev.pdf>.

<sup>5</sup>Additional information is available at <http://ideas.aetn.org/>.

<sup>6</sup>Additional information is available at <http://telscenter.org>.

of visualizations that make the unseen visible, or that bring to life scientific phenomena that might be difficult for students to understand," said the director of the program, Marcia Linn of the University of California, Berkeley.

TELS works with more than 125 teachers in Arizona, California, Massachusetts, North Carolina, and Virginia. Its approach is to offer a brief orientation to a given module before teachers use that module in their classes. The program then provides an opportunity for teachers to reflect on and discuss their experiences teaching the module with other teachers and with facilitators. Mentors and facilitators associated with TELS work with the teachers to improve and adapt both the module and their teaching of the revised module. In this way, the materials are continually customized to the needs of individual teachers and their students even as teachers gain experience with the modified material.

TELS offers several forms of support for teachers making use of their materials. When the materials are first being used, a technology support person is present at the school to make sure that computer problems are quickly addressed. The module materials are modified to satisfy learning standards in different states. TELS works with the principals at the participating schools, since it has found that more teachers participate in schools in which the principal is involved with the program. And an online community has been established to support the professional development of the teachers using the modules.

Teachers using the modules report that their practices in the classroom have changed, Linn stated. Instead of lecturing and giving out assignments, the teachers who have gone through this professional development experience are more likely to wander among students who are working on the modules. When teachers call for the attention of all the students, the things they say are different than if they were lecturing. Through their online community, then teachers have shared experiences and are creating an online database of ways to use the modules most effectively.

TELS researchers have measured student achievement in classes using the modules and have found significant improvements. And "the more experience the teacher had in inquiry and technology, the more effective the materials were for their students, which I think shows the benefits of professional development," said Linn. "If you get more experience and learning on how to use [the materials] better, you can have a bigger impact on students' learning."

As teachers have engaged in the material more deeply, they have begun to think about integrating ideas across the curriculum. "Teachers want us to help think about the sequence of the curriculum," said Linn. Teachers also want to "apply some of the issues from the modules to

strengthen the connections that students need to remember what they have been taught.”

### Force Equals Mass Times Acceleration

A group at Lesley University has put together an online master’s degree program in science education that incorporates feedback from the teachers taking the courses. The second 13-week course developed by the group focuses entirely on the concept that force equals mass times acceleration ( $F = ma$ ). “The goal we had was [to achieve] a rigorous qualitative understanding of this law,” said presenter Andee Rubin, a senior scientist at TERC.<sup>7</sup> “We wanted teachers to know the shapes of curves, how they displayed characteristics of physics, something about numbers. . . . We wanted them to develop a physicist’s eye and the ability to see  $F = ma$  everywhere, in every instance of motion that they observed or experienced.”

A major focus of the course is the representation of scientific knowledge, since representations are important vehicles of understanding in science. These representations can take the form of text, diagrams, or mathematical symbols. They start with concrete representations that students and teachers can see with their own eyes and progress to the more abstract. Students then use these representations to construct models that serve as analogs to systems in the real world.

Because representations can move beyond text to graphs, equations, videos, and animations, they are particularly suited to online learning. For example, at one point in the course, teachers view a video of a ball rising and falling under the force of gravity. The speed of the video can be slowed down so that its movements in equal intervals of time can be measured. In this way, teachers create representations of the ball’s motion and relate those representations to the fundamental concepts of the course.

Another goal of the course, Rubin said, is to encourage the development of teacher communities analogous to those that scientists form when they engage in the practice of science. Like scientists, teachers should ask questions, make observations, generate evidence, search for patterns, and communicate and defend their findings and conclusions to a wider community so as to reach a common, consensual understanding.

Teachers who have taken the course report that “they began to ask very different questions of their students,” said Rubin. “They began to ask students to support their ideas with evidence. There was . . . more

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<sup>7</sup>Additional information about TERC is available at <http://www.terc.edu/>. Additional information about the program  $F = ma$  is available at [http://scienceonline.terc.edu/demo/bb\\_demo/bb\\_frame.htm](http://scienceonline.terc.edu/demo/bb_demo/bb_frame.htm).

time for students to investigate and more time for students to talk about what happens.”

### Wide World School Improvement Process

The Wide World School Improvement Process was developed at the Harvard School of Education to provide online professional development for K-12 teachers. Its goals are to develop more effective teachers, create more effective schools, and prepare students for 21st-century work.<sup>8</sup>

A prominent emphasis of the project is what its executive director, David Zarowin, calls “teaching for understanding.” This approach involves setting goals and undergoing assessments that measure progress toward those goals. “We use that process to help teachers identify what is going to be needed for students and to design lessons in ways that make the students engaged learners,” said Zarowin. “Out of that we expect will come improved classroom performance.”

An instructor leads these online courses and coaches facilitate them. The job of the coaches, said Zarowin, is “to draw out the participants in the study group, make sure they are doing their work, give them feedback on their work, and encourage dialogue among the participants. As the course goes on, the facilitation becomes less extensive, because the participants are talking more to each other. It is the coach’s job to catalyze.” To date, the Wide World project has worked with approximately 6,000 teachers from all over the world in about 190 school systems.

Typically, teachers enroll in the courses in teams of three or four people. They take turns being the person to go online and post the group’s assignment results to the coach, and they receive feedback from the coach on behalf of the team. These teams then become the leaders in their own schools. In this way, the kernel of a learning community is created in each participating school, rather than having an individual maverick who is trying to drive change.

In addition, the program offers a course called Leading for Understanding. This course helps school leaders understand their roles in fostering a community of learners. The intent, said Zarowin, is to “bring all those voices that are involved in the structural enterprise together to promote change.”

Other courses include Data Wise, which covers the use of student data to inform curriculum changes in schools, and a course for people interested in becoming coaches. “The first cohorts that come to our courses are typically the people who could become the online coaches for subsequent cohorts,” Zarowin said. “So they take a course like teaching for under-

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<sup>8</sup>Additional information is available at <http://wideworld.gse.harvard.edu>.



standing, and then they take a coach development course. They serve an apprenticeship, and then they become a coach, at which point they are ready to lead the study groups.”

Surveys done at the end of courses show that 97 percent of course participants report improvements in their teaching practices.<sup>9</sup> As their primary focus, the Education Development Center studied 321 participants’ ability to integrate theoretical concepts learned in their Wide World course into their practical decisions as educators and found that teachers made robust use of ideas in classrooms after taking a single course.<sup>10</sup>

*“[The World Wide project] helped us, not only in improving math instruction, but in proving that team work is a big part of the future for all educators for years to come. I know that we will never go back to ‘go it alone’ education.” — elementary school teacher course participant (as reported by workshop presenter David Zarowin)*

### Teacher’s Domain

As reported by James Pence at WGBH Television, Teachers’ Domain<sup>11</sup> is an online multimedia resource with two related components. One is a library of free digital resources that includes streaming video clips and interactive lessons. It is searchable, aligned with individual state and national standards, and has more than a thousand offerings in science (a smaller collection provides resources on the civil rights movement).

Teachers’ Domain also offers professional development courses that are sold to districts through licensing agreements. Teams of science writers, expert advisers, and web developers develop these courses together. They draw on a set of video libraries and workshops created by WGBH. The professional development component also includes unscripted videos that capture teachers in the process of bringing life to the ideas and content of their courses.

Teachers can apply the multimedia content available through Teachers’ Domain in a wide variety of ways, said Pence. Teachers can use the resources in their classrooms, after which students can call up the same content at home or in a library. Teachers taking the professional development courses can engage in discussion groups or see examples of students’ work. According to Pence, the courses are also now available

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<sup>9</sup>More details on this study are available on the following website: <http://learnweb.harvard.edu/wide/ri/impact/evaluation.cfm>.

<sup>10</sup>More details of this study are at the following web site: <http://learnweb.harvard.edu/wide/ri/impact/oneyear.cfm>.

<sup>11</sup>Additional information is available at <http://www.teachersdomain.org>.

through PBS TeacherLine, a professional development resource that spans the PreK-12 curriculum.<sup>12</sup>

### Virtual High School Global Consortium

The Virtual High School Global Consortium offers full-semester high school courses over the Internet to students at more than 400 high schools located in 30 states and 20 countries.<sup>13</sup> The courses are project-based, collaborative endeavors that rely extensively on online communication and collaboration skills. According to workshop presenter Liz Pape, the chief executive of the consortium, "there is nothing like a student taking an environmental course with 24 others students from all over the world, so that when they start talking about air quality and water quality issues, they are talking about issues in Dubai and Malaysia and South Africa and Massachusetts."

The professional development component of the consortium is directed toward preparing teachers to teach online. For example, online teachers need to know how to manage a class with students distributed around the world working both synchronously and asynchronously. High school teachers have developed all of the courses in the Virtual High School course catalog. Many of these developers have participated in annual teacher learning conferences and in a semester-long course for teachers focusing on methods for teaching online. "High school teachers become students in an online course so they can experience exactly what it is that they will be teaching to their students," said Pape.

Online teachers can adapt the courses to their own students and circumstances. "We don't believe that online courses should be teacher-proofed," said Pape. "We believe it is really important for teachers to be able to review their online course as they need to, rather than licensing content from a provider and not being able to touch that content to modify it for their students' needs or having to wait two years for the content provider to modify that course for you." (For additional discussion of this topic, see also the section "Lack of Time and Financial Support" in the main report.)

To provide online teachers with ongoing support and development, the consortium has developed a program called the Community of Virtual Educators. Some of the teachers have been with the program since its founding in 1996, and it has been one of the means used to keep their skills up to date.

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<sup>12</sup>Additional information is available at <http://teacherline.pbs.org/teacherline/>.

<sup>13</sup>Additional information is available at <http://www.govhs.org/website.nsf>.

Pape reported that a recent evaluation of the consortium and its professional development model found that teachers with online experience were focusing more on higher level skills, engaging everyone in a classroom, bringing more students into discussions, and asking better questions. They relied less on worksheet activities and more on understanding by design. According to the evaluation, three-quarters of the teacher said that the professional development they had received had positively affected their teaching.

Pape believes that the ultimate goal for online teacher professional development is to foster a blended approach in the classroom in which teachers seamlessly add online components to their teaching. "I believe that this is the killer app of what is going on in online education—blended learning and global virtual classrooms for students," said Pape.

### **Los Angeles Unified School District**

Martha Valencia was a language arts teacher who, in her words, "gradually drifted away from the classroom into the computer lab." Now a specialist with the Instructional Technology Branch for the Los Angeles Unified School District, she serves as both an online facilitator for professional development and as a face-to-face facilitator to integrate technology into schools.

The district has been emphasizing online teacher professional development for both professional and practical reasons. Teachers take online courses both to satisfy the district's requirements for professional growth and to take the next step in their career ladder. Valencia reported that they also take courses online to avoid Los Angeles's notorious traffic. "What's bringing people to the online environment is the fact that L.A. freeways are jam-packed right at the time when they need to go to these labs to take training," said Valencia.

The online offerings include courses developed by outside developers and by the district. Participants, who are from a mix of content areas and grades, often coach each other, Valencia reported. The most popular courses involve project-based learning, Web-enhanced lessons, and integrating technology into the curriculum. A big challenge for the online facilitators is the mix of abilities and comfort levels the participants have with technology. "It becomes hard when you have a person who is just learning how to click the mouse and a person who has designed Web pages."

The facilitators have found that teaching adults can be a different experience from teaching students. "Even our most seasoned teachers, coaches, or technology experts can fall apart in front of an adult audience," said Valencia. "They are intimidated or afraid of being challenged."

Surprisingly, good face-to-face presenters don't always make the best online presenters. In addition, there is a constant challenge to recruit enough people for both the face-to-face and online professional development, especially in science and mathematics.

The program has not yet explored the link between online teacher professional development and student performance. But it has an extensive set of tools for gauging the effects of the course on teachers, including an online registration format that provides completion rates, no-show rates, online evaluations, and a report on how teachers liked a particular approach.

Currently, more than 1,000 teachers take online courses through the district each year, with 4,000 having taken at least one online course to date. In response to teacher requests, the district has begun diversifying the range of courses offered. To its traditional 16-hour courses it has added 2-hour courses with 2 hours of follow-up. The district also has been encouraging administrators to take courses, because "even though they are designated for teacher use, [administrators] need to learn and grow in their capacity to offer courses to their staff."

### Agile Mind

Agile Mind is an education company founded in 2001 to support both equity and high achievement in challenging academic courses.<sup>14</sup> In addition to its tools for students, Agile Mind has a prominent professional development component, according to the company's chief executive Linda Chaput. "We try to focus on and shape what happens between teachers and students in the classroom," she said. The company also works with school and district leaders to give them the "stable support that really ensures the improvement of instruction."

In its fifth year of operation, the company is currently serving 290,000 students and 4,400 teachers in nearly 500 schools. Many are from underserved areas of California, Illinois, New York, Maine, and Texas, with incubator sites in New Jersey, Ohio, and Washington state.

A particular focus of Agile Mind, according to Chaput, is the generation of real-time student performance data and the information needed to act on those data. These data permit educators to make decisions based on their experiences, their students, and their teaching preferences. According to surveys of participating teachers, 90 percent wish to continue using the services once they have experience with the program.

Another important component of the program is that it is designed to make use of older computers and slow data transfer rates. With a dial-

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<sup>14</sup>Additional information is available at [http://www.thinkfive.com/index\\_flash.html](http://www.thinkfive.com/index_flash.html).

up speed of 28K, said Chaput, “it is a formidable challenge to optimize visualizations so that they load in less than a second. But we found that if you want a child or a teacher to be able to use this ubiquitously, the T1 line is in the district office, and the learning lab [at the school] does not have the throughput.” Thus, even with technical capacity in a school, access to that capacity often is unavailable to teachers and students.

Agile Mind is designed to support teachers rather than replace them. “We try very hard to design our technologies to make it convenient for the adults to make the right instructional decisions a higher percentage of the time,” said Chaput.

### HELPFUL WEBSITES

<http://www.marcopolo-education.org/home.aspx>

The site offers teacher resources, professional development, and roll-out networks within states. It provides information for teachers as to how to get professional development credit for their participation in these programs.

<http://www.teachersdomain.org/>

Teachers’ Domain offers professional development courses in collaboration with the Public Broadcasting System and WGBH-TV. Teachers have access to NOVA videos and courses are research based, informative, and thought-provoking.

<http://www.teachscape.com/html/ts/public/html/index.htm>

TeachScape is a research-based and data-driven site for teacher professional development. The main goal is to raise student achievement. It enables teachers to deliver differentiated instruction to students. It works with districts to provide systemic and outcome-based professional development to meet the needs of schools and districts.

<http://wideworld.pz.harvard.edu/>

Wide World is an outgrowth of the Harvard program Project Zero and is based on years of classroom-based research incorporating basic elements of professional development, including coaching, developing a shared language and communities of learners, thus building capacity for sustained long-term improvement programs.

<http://www.learner.org/>

Annenberg Media offers free professional development for teachers. The courses contain print, video, and web-based components and are designed for both pre-service and practicing teachers.

<http://www.iearn.org/>

Started in 1988, this site consists of a large nonprofit global network that enables teachers and young people to use the Internet and other new technologies to collaborate on projects that both enhance learning and make a difference in the world.

<http://www.ed.gov/teachers/how/tools/initiative/index.html>

The Teacher-to-Teacher Initiative, a program offered through the U.S. Department of Education, was designed by teachers for teachers in order to provide technical support, professional development opportunities, and recognition for teachers of all content areas and grade levels.

<http://www.learningscience.org/index.htm>

This site is dedicated to sharing the newer and emerging “learning tools” of science education—tools such as real-time data collection, simulations, inquiry based lessons, interactive web lessons, micro-worlds, and imaging, among others, which can help make teaching science an exciting and engaging endeavor.

<http://www.thirteen.org/edonline/concept2class/about.html>

Concept to Classroom features a series self-paced workshops covering a wide variety of hot topics in education. Some of the workshops are based in theory, some are based in methodology, and all of the workshops include tips and strategies for making classrooms work.

<http://teacherline.pbs.org/teacherline/about.cfm>

PBS TeacherLine offers professional development courses to individual PreK-12 teachers and districts. Its specially trained, certified facilitators lead over 100 standards-based courses that include mathematics, reading/language arts, science, instructional technology, and instructional strategies. Coursework can cover a complete sequence of study or address a specific requirement, depending on a teacher’s or a district’s needs.

<http://edtechleaders.org>

EdTech Leaders Online based at Education Development Center provides capacity building online training for states and school districts to establish their own online professional development programs, offering online instructor and course developer training, a catalogue of 50 online workshops in the range of K-12 subject areas and grade levels, and a national forum for trained online specialists.

## Appendix D

### Biographical Sketches of Committee Members and Workshop Presenters

#### COMMITTEE MEMBERS

**Lyn Le Countryman** (*Cochair*) teaches eleventh grade biology and mentors undergraduate education majors at the Malcolm Price Laboratory School and teaches undergraduate biology and graduate-level science classes on the campus of the University of Northern Iowa. In 1994, she was one of the first teachers in the nation to gain national board certification as an early adolescent generalist. She has served as the president of the Iowa Science Teachers Section of the Iowa Academy of Science. She received the 1999 Presidential Award for Excellence in Mathematics and Science Teaching and the 1998 Tandy Award for outstanding teaching. She is a founding member of the National Academies Teacher Advisory Council and also is a member of the Teacher Advisory Council Museum Associates for the Marian Koshland Science Museum. She serves as a liaison from the Teacher Advisory Council to the Center for Education's Committee on Teacher Preparation Programs in the U.S. She has a B.S. in zoology and secondary education and M.A. and PhD. degrees in science education from the University of Iowa.

**Chris Dede** (*Cochair*) is the Timothy E. Wirth professor in learning technologies at the Harvard Graduate School of Education. His fields of scholarship include emerging technologies, policy, and leadership. His recent research projects include work with middle school students learning science via shared virtual environments and helping high school students

with mathematics and literacy skills using wireless mobile devices to create augmented reality simulations. In 2007, he was honored by Harvard University as an outstanding teacher. At the National Research Council, he was a member of the Committee on Foundations of Educational and Psychological Assessment and a member of the subcommittee on information technology for the Commission on Engineering and Technical Systems. He serves on advisory boards and commissions for Public Broadcasting's TeacherLine, the Partnership for 21st Century Skills, the Pittsburgh Science of Learning Center, and several federal research grants. He is a member of the board of directors of the Boston Tech Academy, an experimental small high school in the Boston public school system. He was the editor of the 1998 Yearbook of the Association for Supervision and Curriculum Development, *Learning with Technology*, and coeditor of *Scaling Up Success: Lessons Learned from Technology-based Educational Innovation* (Jossey-Bass, 2005). In September 2005 he led an invitational research conference on online teacher professional development; the conference volume, *Online Professional Development for Teachers: Emerging Models and Methods*, was published by the Harvard Education Press in 2006. He has an Ed.D. from the University of Massachusetts, Amherst.

**Vinton Cerf** is vice president and "chief Internet evangelist" for Google, Inc. In this role, he is responsible for identifying new enabling technologies to support the development of advanced Internet-based products and services from Google. Previously he was senior vice president of technology strategy for MCI and senior vice president of architecture and technology. He is the codesigner of the TCP/IP protocols and the architecture of the Internet, for which he was awarded the U.S. National Medal of Technology. He received the Alan M. Turing award in 2004. He served as founding president of the Internet Society from 1992 to 1995 and in 1999 served a term as chairman of the board. He was a member of the U.S. Presidential Information Technology Advisory Committee from 1997 to 2001 and serves on several national, state, and industry committees focused on cyber security. He is a fellow of the Institute of Electrical and Electronics Engineers, the Association for Computing Machinery, the American Association for the Advancement of Science, the American Academy of Arts and Sciences, the International Engineering Consortium, the Computer History Museum, and the National Academy of Engineering. He has a B.S. in mathematics from Stanford University and M.S. and Ph.D. degrees in computer science from the University of California, Los Angeles.

**Susan Doubler** is associate professor of science education at Lesley University and codirector of the Center for Science Teaching and Learning



at TERC in Cambridge, Massachusetts. Her work focuses on the interface between science and technology with the aim of bringing together project-based science and technology (microcomputer-based labs, geographic visualizations) to further science learning in the K-12 classroom. This interest has led to work in online learning for teachers of science. She is the coprincipal investigator of the Fulcrum Leadership Institute, a math and science partnership involving Tufts University, TERC, and schools in the Boston area. She is also principal investigator and director of Re-opening the Science Door, a project to develop and implement a fully online master's program in science education for K-8 teachers. Before coming to TERC and Lesley University, she was an instructional specialist and teacher in the Winchester, Massachusetts, public schools. Beginning in 1997, TERC and Lesley University entered into a partnership to develop this fully accredited, online master's degree program in science education. She has a B.S. from Bowling Green State University, an M.Ed. from Boston University, and a Ph.D. from the University of Liverpool.

**Janet English** is currently on leave from her middle school teaching position to serve as director of educational services at KOCE-TV in Huntington Beach, California, and executive director of telecommunications of Orange County. She has taught at the Serrano Intermediate School, Lake Forest, California, for 13 years. She was an instructor for the Middle School Project as part of the California Institute of Technology's Pre-College Science Initiative, the director of the Physics Camp and the Chemistry Camp under the aegis of the University of Northern Colorado's Institute for Chemical Education, and an instructor during summers at the University of California, Los Angeles's Apple Teacher Institute. From 2001 to 2005 she was the teacher trainer and K-12 coordinator for Schoolhouse Video (<http://www.schoolhousevideo.org>) for KOCE-TV. She is a founding member of the California Teacher Advisory Council and received the Presidential Award for Excellence in Mathematics and Science Teaching for Secondary Science in 2003. She has a B.S. in biology from Middlebury College and an M.A. with a focus on middle grades education from California State University, San Bernardino.

**Javier Gonzalez** is a mathematics teacher and department chair at Pioneer High School in Whittier, California. He is the creator of the Pioneer Math Academy, a six-week summer math program that serves over 700 students each year. The academy teaches principles of mathematics by means of students' active participation in math-related projects, which, along with his other enrichment classes, are designed to foster students' mastery and self-confidence in the subject. During the school year he also serves as a mentor teacher and the coordinator of Pioneer's gifted and

talented education program. In addition, he is the adviser to the Pioneer Leo Club, a program affiliated with the Lions Club that provides young people with opportunities for community service. His awards and honors include the 1996 State Teacher of the Year, the Presidential Award for Excellence in Mathematics and Science Education, and the Milken Family Foundation award. He served on the National Commission on Mathematics and Science Teaching for the 21st Century. He is an original member of the National Academies Teacher Advisory Council and now serves as a member of the NRC's Mathematical Sciences Education Board and the California Teacher Advisory Council. He has an M.A. in administrative leadership from Point Loma Nazarene College in San Diego.

**Tad Johnston** is the mathematics specialist and regional representative to Washington County, Maine, for the Maine Department of Education. He works with Maine's mathematics assessment program and numeracy initiative, providing technical assistance to schools, including designing professional development experiences and advising others in the areas of mathematics teaching and assessment. He serves on the boards of several educational organizations as a representative of the commissioner of education, helping them stay abreast of the changing education environment, providing technical advice on mathematics and science education issues, and linking these groups to the Department of Education and to Maine teachers. In his role as a state supervisor of mathematics, he also has been involved with curriculum efforts at the National Aeronautics and Space Administration, especially their Explorer Schools mission. Johnston was a middle and high school teacher for 15 years, *with* an emphasis on mathematics and sciences. He received a Presidential Award for Excellence in Mathematics Teaching in 2000. He is a member of the National Council of Teachers of Mathematics, the Association of State Supervisors of Mathematics, the board of the Association of Teachers of Mathematics in New England, and the Association of Teachers of Mathematics in Maine. He has a B.S. in both mathematics and elementary education from the University of Dallas and an M.Ed. in science education with an emphasis on mathematics-science integration from the University of Maine.

**Valdine McLean** teaches physics, chemistry, and biology to students in grades 9-12 at Pershing County High School in Lovelock, Nevada. She also has been a student via online learning through Montana State University. She holds national board certification in the area of adolescent and young adult science since 2000 and was the National Teacher Training Institute's Teacher of the Year in 1998. Understanding that science is not always easily accessible to students, she frequently develops cooperative projects with colleagues in art, industrial arts, English, and computer sci-

ence. The “pumpkin catapult” activity that she leads every fall involves more than half of the student body at her school, as well as parents, business leaders, and others from throughout the community and the region. She designs hands-on projects to nurture skills in cooperation, teamwork, tolerance, and friendly competition. The first teacher in her school to use computers in her classroom, she has created a technology-rich environment that has proven particularly effective for English language learners and special needs students. Her awards include Pershing County Teacher of the Year, 2000; Nevada Teacher of the Year, 2001; the Horace Mann Teaching Excellence Award, 2001; and the NEA Foundation for Improving Education Teaching Excellence Award, 2001. She is a founding member of the National Academies Teacher Advisory Council. She has a B.S. in biology from Humboldt State University and an M.S. in science education from Montana State University.

**Barbara Treacy** is a managing project director at the Center for Online Professional Education at the Education Development Center (EDC) in Newton, Massachusetts. She directs several online learning projects, including EdTech Leaders Online, a national capacity-building online professional development program for state departments of education, school districts, regional education service providers, and teacher training institutions, with participating organizations in over 35 states. Since the inception of EdTech Leaders Online in fall 2000, she has led teams of online specialists and curriculum developers to provide graduate-level training programs in online learning, a catalogue of over 25 online workshops in specific K-12 subject areas and grade levels, and a national forum for online specialists implementing local online programs. She also directs EDC’s participation in e-Learning for Educators, a large-scale, nine-state collaboration to establish statewide online professional development programs and conduct research on their impact on teachers and students. She has presented at numerous national, regional, and state conferences on online learning and is the coauthor of *EdTech Leaders Online: Building Organizational Capacity to Provide Effective Online Professional Development*. She has an A.B. from Harvard University and an M.Ed. in technology in education from the Harvard Graduate School of Education.

## WORKSHOP PRESENTERS

**Bruce Alberts**, past president of the National Academy of Sciences, is a professor in the Department of Biochemistry and Biophysics at the University of California, San Francisco. A biochemist recognized for his work both in biochemistry and molecular biology, he is noted for his extensive study of the protein complexes that allow chromosomes to be

replicated, as required for a living cell to divide. He is one of the original authors of *The Molecular Biology of the Cell*, used widely in U.S. colleges and universities (5th edition, 2007). Alberts has long been committed to the improvement of science education, dedicating much of his time to such education projects as City Science, a program seeking to improve science teaching in San Francisco elementary schools. He has served on the advisory board of the National Science Resources Center, a joint project of the National Academy of Sciences and the Smithsonian Institution working with teachers, scientists, and school systems to improve teaching of science, as well as on the National Academy of Sciences' National Committee on Science Education Standards and Assessment. He has a B.S. in biochemical sciences from Harvard College and a Ph.D. from Harvard University.

**Hilda Borko** is professor of education and chair of the educational psychology program area at the University of Colorado. Her research explores teacher cognition and the process of learning to teach, with an emphasis on changes in novice and experienced teachers' knowledge and beliefs about teaching, learning, subject matter, and their classroom practices as they participate in reform-based teacher education and professional development programs. Her teaching interests are in the related areas of classroom processes, teaching for understanding, and teacher learning. She is a member of numerous professional organizations in education and psychology and has served as a member and chair of various committees for the American Educational Research Association (AERA) and the Educational Psychology Division of the American Psychological Association. She was president of AERA in 2003-2004, editor of the teaching, learning, and human development section of the *American Educational Research Journal*, and interim editor (with Lorrie Shepard) of *Educational Researcher*. She is currently editor of the *Journal of Teacher Education* (with Dan Liston and Jennie Whitcomb).

**Linda Chaput** is chief executive of Agile Mind, Inc. The company was founded in 2001, and, in collaboration with the Charles A. Dana Center at The University of Texas, and now Biological Sciences Curriculum Study, develops, disseminates, and continuously improves tools and resources designed to help teachers, schools, and districts improve access to—and achievement in—challenging college-preparatory mathematics and science. Linda has more than 20 years of experience in the development and dissemination of educational publications. She was president of Scientific American's education, general, professional and reference publishing, as well as founder and chief executive of Cogito Learning Media, Inc. At Scientific American, she was the president and editorial director of W.H.

Freeman and Company (a wholly owned subsidiary) and later president of Scientific American Medicine. During her tenure, she oversaw the publication of books in biology, psychology, chemistry, astronomy, mathematics, and statistics characterized by innovation, rigor, and commercial success. She oversaw the launch of the Scientific American Library, a series of illustrated books written by leading scientists for general readers. As president of Scientific American Medicine, she oversaw the launch of its multimedia and online professional services, now a part of WebMD. In 1995 Linda founded Cogito, a pioneering provider of top-quality multimedia and Internet-ready learning tools authored by authorities in science, mathematics, economics, and other critical competency subjects deliverable on a variety of platforms, including the Internet, CD-ROM, video, and print.

**Chris Dede** [see the biography under Committee Members]

**Janet English** [see the biography under Committee Members]

**Louis M. Gomez** is professor of learning science and computer science at Northwestern University. He is an expert on technology and curriculum reform that allows students to create products and projects. His interests include curriculum design and systemic school reform; school and classroom organization support through technology; application of computing and networking technology to teaching and learning; applied cognitive science; and human-computer interaction. Over the past several years he has also pursued active research programs investigating techniques that improve the human use of information retrieval systems and techniques that aid in the acquisition of complex computer-based skills. He is chair of the Educational Testing Service's Visiting Panel of Research and a recent recipient of the Spencer Foundation Mentorship Award. He has a Ph.D. in cognitive psychology from the University of California, Berkeley.

**Marcia Linn** is professor in the Graduate School of Education at the University of California, Berkeley, and director of the campuswide Instructional Technology Program. She codirects the Visualization and Modeling theme team, leads the postdoctoral program of the Center for Integrative Learning Technologies (CILT), and coordinates the involvement of Berkeley's Program in Education in Mathematics, Science, and Technology in the research and development and research training components of CILT. She conducts research on the teaching and learning of science and technology, gender equity, and the design of technological learning environments. In 1998 the Council of Scientific Society Presidents selected her for its first award for excellence in educational research. Other

honors include an award for lifelong distinguished contributions to science education from the National Association for Research in Science Teaching in 1994, the Willystine Goodsell Award from the American Educational Research Association, and the Women Educator's Research Award in 1982. She has served on the board of the American Association for the Advancement of Science, the Graduate Record Examination Board of the Educational Testing Service, and the McDonnell Foundation Cognitive Studies in Education Practice Board. She has a B.A. in psychology and statistics and a Ph.D. in educational psychology from Stanford University.

**Valdine McLean** [see the biography under Committee Members]

**Leah K. O'Donnell** is a senior member of Eduventures, an information services company that provides research and analysis to assist organizations in education markets to develop strategies, increase sales, and improve operational performance. Recently, she has identified acquisition opportunities in the postsecondary for-profit market, performed sustainability analyses, developed recommendations for grant-funded education products and services, and assessed the impact of digital media on postsecondary and K-12 markets. Previously, she was a senior consultant at a market research and brand consulting firm, where she managed engagements for clients in the consumer goods sector and focused on developing, executing, and analyzing consumer research, developing channel strategies for new product introductions, and conducting market assessments and competitive landscaping. She has a B.A. from Georgetown University and an M.B.A. from the Tuck School of Business at Dartmouth University.

**Liz Pape** is chief executive of Virtual High School (VHS) in Maynard, Massachusetts, a pioneer in online learning for high school students and online course design for teachers. Under her management, VHS has grown from 28 member schools and 30 classes offered to over 400 member schools and 260 teachers in 29 states and 24 countries. She serves on the board of directors of the North American Council for Online Learning and has served on the U.S. Department of Education's National Online Education Policy Forum and the North Central Regional Educational Laboratory's Blue Ribbon Panel for Online Education.

**James Pence** works at WGBH Educational Productions in Boston. Previously he was product management director at Pearson Achievement Solutions. He has 16 years of experience in the K-12 education sector, including as a high school teacher, a program officer at the National Geographic Education Foundation, an education consultant, and a mar-

keter of professional development services. He has an M.B.A. from the University of California, Davis.

**Raymond Rose** is cofounder and president of Rose & Smith Associates, a consulting group dedicated to sharing the principles of successful online learning and the innovative use of technology in education settings. Previously he was vice president of the Concord Consortium, a nonprofit educational research and development group that guides schools nationally and internationally to realize the educational promise of technology. He works with K-12, college and university programs, policy makers, and leaders of a diverse range of organizations and institutions, helping to shape the nature of e-learning efforts in the country.

**Andee Rubin** is a senior scientist at TERC in Cambridge, Massachusetts, and has worked for over 25 years in the fields of mathematics and language arts education, focusing on the role of technology in both areas, on the evolution of students' mathematical concepts, and on professional development in mathematics and technology for elementary teachers. She designed several pioneering pieces of educational software, including *QUILL* (writing environments for elementary school), *ELASTIC* (statistics software for high school), and *CamMotion* (digitized video tools for teaching advanced mathematical concepts.) Most recently, she was a major author of the K-5 mathematics curriculum *Investigations in Number, Data, and Space*, focusing on data analysis concepts. She developed professional development materials that accompany the curriculum and led national workshops that used these materials. In fall 1997, she was a math content guide for a series of nationally broadcast interactive teacher development workshops entitled *What's the Big Idea?* At TERC, she is currently directing a project that is investigating educational computer games that teach math and are appealing to girls. She has S.M. and E.E. degrees in computer science and artificial intelligence from the Massachusetts Institute of Technology.

**Deborah Smith** is a focus teacher at Woodcreek Elementary Magnet School for Science, Math and Technology in Lansing, Michigan. Previously she served as the director of the Curriculum Development Lab in the College of Education at the University of Delaware and was a co-principal investigator for science for the Delaware Statewide Systemic Initiative. She then served as organizer and facilitator of the Averill Elementary School Science Study Group, whose classrooms are featured in the Annenberg series "Shedding Light on Science." She had a postdoctoral fellowship with the Carnegie Academy for the Scholarship of Teaching and Learning. She is author and co-principal investigator for a project on teacher reten-

tion and renewal. She has a B.A. in biology from Boston University, an M.A. in teaching science education from the Harvard Graduate School of Education, and a Ph.D. in curriculum and instruction (science education) from the University of Delaware.

**William (Bill) Thomas** is director of educational technology for the Southern Regional Education Board (SREB). He provides leadership on educational technology issues and topics impacting K-12 and postsecondary schools and colleges in the 16-state region served by the board. Through his leadership, the SREB Educational Technology Cooperative, comprised of 37 K-12 and higher education state education agencies, was created and implemented over the past 11 years. Previously he served as coordinator of technology services, a classroom teacher, and a school administrator. He has also taught undergraduate and graduate courses and authored a series of papers on educational technology topics, including "Online Professional Development—Why SREB States Need It and Standards of Quality for Online Teaching." He has served on numerous state, regional, and national committees and panels on a range of educational technology topics.

**David Zarowin** is executive director of WIDE World (Wide-scale Interactive Development for Educators), an innovative professional development program based at the Harvard Graduate School of Education. Previously he spent 15 years in various editorial, marketing, business development, and general management positions at Prentice Hall and its parent company, Pearson Education. Prior to his Pearson years, he was a labor and industrial historian for the Commonwealth of Massachusetts, where he served on a team of historians and archaeologists who documented the history of several Massachusetts cities and towns for preservation planning purposes. He has a B.A. in philosophy and American literature from the State University of New York at Purchase and an M.A. in American studies from Boston University.



