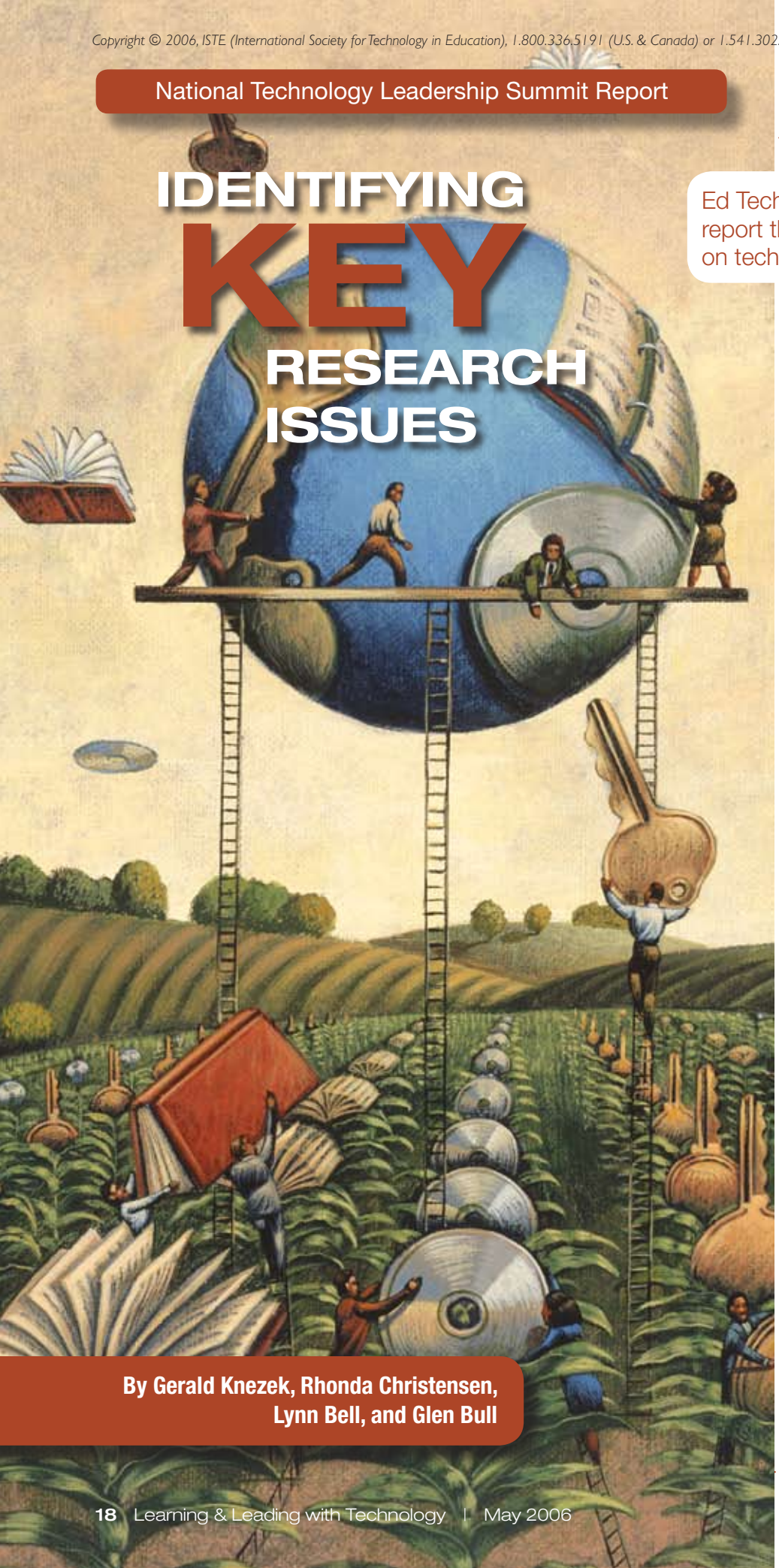
IDENTIFYING KEY RESEARCH ISSUES



Ed Tech and curriculum area leaders report the key issues for future research on technology's effects on learning.

By Gerald Knezek, Rhonda Christensen, Lynn Bell, and Glen Bull

Every school that attempts to integrate technology into its curriculum knows that this effort consumes dollars in the school budget and hours of teacher time. School leaders invest these resources because they, like us, believe that technology can help address meaningful learning problems. Yet, in many cases, our beliefs about the potential of technology are primarily supported by anecdotal evidence.

Technology can provide windows to the world that could not have even been imagined a decade ago. It is pervading every aspect of life beyond school. Yet critics both within and outside the U.S. Department of Education have appropriately challenged educational technology professionals to provide evidence of its positive effects on education.

The National Technology Leadership Coalition (NTLC) has brought together representatives from a number of teacher educator associations to address this very issue. We believe we need to do a better job of providing rigorous research that identifies specific learning issues best addressed by specific technologies and that illuminates best practices for teaching with technology. This kind of research can better ensure that limited dollars are well spent and that teachers' time is well used.

Considering Core Content Areas

Different technologies are designed to address different content areas and even specific concepts within a given subject area. Tools such as graphing calculators are obviously better suited for mathematics teaching than for language arts.

About NTLC

The National Technology Leadership Coalition (NTLC) is a consortium of 10 teacher educator associations representing the core content areas as well educational technology. Each year ISTE and the Society for Information Technology and Teacher Education (SITE) cosponsor a National Technology Leadership Summit (NTLS) that brings together NTLC leaders, editors of educational technology journals, directors of nonprofit foundations, government officials, and corporate leaders.

The editors of six participating periodicals are collaborating on identification of protocols designed to encourage and stimulate needed educational research. The research issues involved are discussed in greater detail in editorials that appear in the Spring 2005 issue of ISTE's *Journal of Research on Technology in Education* (http://www.iste.org/jrte/).

One of the most crucial steps in advancing this agenda is to ensure that research builds on the foundation of prior work and is relevant to schools. Gerald Knezek and Rhonda Christensen have been coordinating dialog on this topic emerging from the most recent summit. Both were founding members of the AERA Special Interest Group on Technology as an Agent of Change in Teaching and Learning. They are currently serving as vice president and associate vice president for research and evaluation of SITE, and in this capacity they are working with colleagues serving on the technology committees of partner associations in related content areas.

Through these joint efforts, technology and content organizations are collectively working to identify a research agenda relevant to schools in each of the content areas. If key research issues can be identified, it will be considerably easier to make progress in a systematic way.

The generic question, "Does technology improve learning?" is too broad to be answered in a meaningful way. The use of technology in each subject area needs to address the learning issues specific to that subject area. Therefore, the important research questions will be different for each subject area.

Learning with technology should not be about the technology itself but about the learning that can be facilitated through it. Technology should provide an instructional method or learning environment that would not be possible through a non-technology method. We believe that technology can best be studied as an integrated part of the content area curriculum. We also believe that technology has a particular capacity to foster higher cognitive functions.

Prospective Advantages

Scholars have pointed out that the key issue is not whether technology can work, but rather under what precise conditions and for which educational goals it works. ISTE's Center for Applied Research in Educational Technology (CARET, http://caret.iste.org) has begun to provide some relevant answers in this area.

According to CARET, technology improves student learning when it:

- directly supports the curriculum objectives being assessed
- provides opportunities for student collaboration
- adjusts for student ability and prior experience, and provides feedback to the student and teacher about student performance or progress with the application
- is integrated into the typical instructional day
- provides opportunities for students to design and implement projects that extend the curriculum content being assessed by a particular standardized test
- is used in environments where teachers, the school community, and school and district administrators support the use of technology

Researchers have carefully made the case that we must demonstrate that technology's benefits outweigh potential negative aspects such as cost, constraints on classroom configurations, or potentials for distracting from the learning objectives.

Research Relevant to Schools

When educational research is inaccessible to teachers and the solutions offered appear impractical to them, the effect on teaching and student learning will be limited. The purpose of the NTLC initiative and the content area articles that follow is to facilitate effective research that is relevant and accessible, working in partnership with teachers and schools.

Authentic research that is relevant to schools requires close collaboration between schools and universities. Some of the research that is most useful to teachers is best conducted in the classroom. However, the rigorous safeguards developed to protect the rights of human subjects involve considerable inconvenience—forms to be completed, permission slips to be signed by parents, and so on. The research itself may take time from the busy classroom schedule. Consequently, it is important to ensure that research questions are relevant to the needs of schools. Discussion with practitioners who are technology leaders—teachers, media specialists, and technology coordinators—can help ensure that such sacrifices are rewarded with useful information.

Each of the associations represented by these articles is working to identify the important questions regarding instructional technology that need to be answered by the research. In the following sections, leaders in teacher education in the content areas of science, mathematics, social studies, and English/language arts offer visions of the key research questions that should

be addressed when studying the integration of technology into each of their fields.

Each of the associations represented in this article is working to identify the important questions regarding instructional technology that need to be answered by the research. In the following sections, leaders in teacher education in science, mathematics, social studies, and English/language arts offer visions of the key research questions that should be addressed when studying the integration of technology into each of their fields.

Gerald Knezek (University of North Texas) is co-vice-president of the Society for Information Technology and Teacher Education Research Committee and co-chair of the National Technology Leadership Coalition's Task Force on Key Research Issues in the Core Content Areas.

Rhonda Christensen (University of North Texas) is co-vice-president of the Society for Information Technology and Teacher Education Research Committee and co-chair of the National Technology Leadership Coalition's Task Force on Key Research Issues in the Core Content Areas.

Lynn Bell (University of Virginia) served as co-chair of the seventh National Technology Leadership Summit (NTLS).

Glen Bull (University of Virginia) served as co-chair of the seventh NTLS.

Science

By John C. Park

Research in science education has examined the administration of technology, teaching science using technology, and student learning using technology. We believe the research on student learning using technology should be driving the research in the other two areas. Student use of technology in science education can be classified into four broad categories:

- retrieving existing scientific information
- data collection and analysis
- creating and using scientific models
- communication

Data collection and analysis would include the use of scientific visualization, image analyses, and probeware. Modeling includes finding patterns in student-collected data and finding patterns using simulations. Educational technology tools are quite useful in these areas and have been researched in the past 25 years.

Early research on the use of probeware reported that real-time interactions lead to understandings of abstract representations. For example, in their 1987 *Journal of Research in Science Teaching (JRST)* article, Janice R. Mokros and Robert F. Tinker found that if pupils walked back and forth in front of a motion detector while they were watching the graph of their motion, they could quickly learn to interpret position graphs. The same year, Heather Brassel reported in *JRST* that the simultaneous display of the real-time data resulted in significant learning, whereas a delayed display of the data did not. Subsequent research in the 1990s reported that the use of probeware promoted a better understanding of specific science concepts.

The use of probeware in itself is not the magic pill for learning in science education. Purposeful designs of data collection and representation technology are required for best results. Marcia Linn and Sherry Hsi report in their 2000 book *Computers, Teachers, Peers: Science Learning Partners* that using real-time data collection in a 12-week thermodynamics curriculum resulted in a 400% increase in pupil understanding of the differences between heat and temperature. However, this result occurred only after a series of eight iterations of changes. This research leads to a new framework called *scaffolded knowledge integration* that offers principles of experimental design for learning science and practices that promote knowledge integration, which Linn discussed in her 2003 article in the *International Journal of Science Education.*

The power of probeware is real-time data collection. For most explorations, users begin the data collection, turn their attention to the event to watch it to completion, and then turn back to the computer to see the results. The next generation of probeware merges visualization with analysis. If a digital video captured the event as the data is being collected with the probe, the resulting digital video can by synched to the data. Pupils can scroll across the graph and view the movie simultaneously, stopping and starting, or replaying critical regions of the graph to see exactly what is happening in the event during interesting points on the graph. Research on the effects of synchronized movies with collected data should be the next step in understanding student learning with probeware.

The National Science Foundation has commissioned a monograph on digital technologies in the science

classroom, which I will be working on with Randy Bell (University of Virginia). The intent is to provide a readable introduction to current themes and research directions that are likely to contribute to students' learning of science. These include:

- use of probeware tools for science investigations
- use of computer simulations to support classroom inquiry
- science inquiry projects on the Web
- acquiring online data for scientific analysis
- extending inquiry with geotechnologies in the science classroom
- use of digital images and videos for learning science
- online assessment of science learning
- the virtual science classroom

We are at a crucial moment—many of the elements of the technological infrastructure for effective science teaching are now in place. However, this capacity depends on teachers' understanding of best practices and effective uses. For that reason, this overview will be made available by the National Science Foundation to any science teacher without charge when it is completed.

Resources

Brassel, H. (1987). The effect of real-time laboratory graphing on learning graphic representations of distance and velocity. *Journal of Research in Science Teaching*, *24*(4), 385–395.

Linn, M. C. (2003). Technology and science education: Starting points, research programs, and trends. *International Journal of Science Education, 25*(6), 727–758.

Mokros, J., & Tinker, R. (1987). The impact of microcomputer-based labs on children's ability to interpret graphs. *Journal of Research in Science Teaching*, *24*(4) 369–383.

John C. Park (North Carolina State University) is a member of the Association for Science Teacher Education Technology Committee and serves as the association's representative to the National Technology Leadership Coalition.

Mathematics

By the AMTE Technology Committee

The Technology Principle in the National Council of Teachers of Mathematics (NCTM) *Principle and Standards for School Mathematics* states, "Technology is an essential tool for teaching and learning mathematics effectively; it extends the mathematics that can be taught and enhances students' learning." In "The Use of Technology in the Learning and Teaching of Mathematics," the NCTM further asserts:

> Calculators, computer software tools, and other technologies assist in the collection, recording, organization, and analysis of data. They also enhance computational power and provide convenient, accurate, and dynamic drawing, graphing, and computational tools. With such devices, students can extend the range and quality of their mathematical investigations and encounter mathematical ideas in more realistic settings.

The Association of Mathematics Teacher Educators in its January 2006 Technology Position Statement similarly notes:

> The computational and graphical capabilities of current technologies enable users to efficiently generate and manipulate a variety of representations of mathematical ideas and processes. Activities that engage students in connecting multiple representations (e.g., graphical, numerical, algebraic, and verbal), and those that invite students to analyze or create images, visualizations, and simulations provide wide-ranging opportunities for mathematical exploration and sense-making.

Although many mathematics teachers and educators are incorporating technology into their teaching, key research issues that remain to be explored include the following:

- How can technology best be used to enhance mathematics learning?
- How should mathematics curricula be revised to take full advantage of technology?
- What experiences best prepare teachers to teach mathematics effectively with technology?

Of course, researchers have been studying the implementation of technology in classrooms. However, because this research has been conducted in different settings, using diverse methodologies, and reported in a variety of journals, what is now needed is a consolidated review and analysis of findings.

Resources

Association of Mathematics Teacher Educators: http://www.amte.net

Koedinger, K., & Anderson, J. (1999). *PUMP Algebra Project: AI and High School Math.* Available: http://act.psy.cmu.edu/awpt/awpt-home.html

National Council of Teachers of Mathematics: http://www.nctm.org

The AMTE Technology Committee consists of Joe Garofalo (University of Virginia), Maggie Niess (Oregon State University), David Pugalee (University of North Carolina—Charlotte), Shannon Driskell (University of Dayton, Ohio), Oscar Chavez (University of Missouri), Marcia Weinhold (Purdue University-Calumet, Indiana), and Gary Martin (Auburn University, Alabama). Maggie Niess is AMTE's representative to the National Technology Leadership Coalition.

Social Studies

By David Hicks, Kathy Swan, and John Lee

Social studies educators and researchers recognize the potential of instructional technologies to transform the nature of teaching and learning within social education. Social studies education literature continues to emphasize the importance of the Internet, with its virtually unlimited access to a wide range of resources, individuals, and groups over time and space. At the heart of the literature is a belief that the appropriate and thoughtful utilization of digital technologies within the social studies classroom will create new environments for teachers and students to implement technology as a tool for inquiry. However, for the past 15 years, research has consistently argued that:

- There is a lack of technology integration within the walls of the social studies classroom.
- There is limited empirical research in the field of technology and social studies.
- Educators must foster research examining how technology affects the social studies classroom.

In his chapter in the 2001 book *Critical Issues in Social Studies Research for the 21st Century,* James P. Shaver stressed the need within the social studies for "the evolution of a research culture that would provide the framework for coordinated, long-term, programmatic design related research that could yield products with proven impacts on social studies outcomes." Currently, the Persistent Issue in History Network (http://pihnet.org) developed by John Saye and Tom Brush serves as a powerful example of this type of critical ongoing research. Their work examines the effects of multimedia scaffolding to support historical inquiry within the social studies classroom. Based on eight years of classroom research, Brush and Saye's framework uses interactive technology to scaffold problem-based historical inquiry into fundamental civic issues. Brush and Saye's research continues to yield valuable insights into how interactive technologies can scaffold and overcome the challenges of engaging in historical inquiry.

Although efforts are clearly ongoing to help facilitate the use of technology, there is a need to conduct classroom research examining the effectiveness of technology to improve social studies instruction. At a macro level, the most pressing issue/question for social studies teacher educators is one brought up by Larry Cuban in his 2001 book *Oversold and Underused:* "In what ways can teachers use technology to create better communities and build strong citizens?" To fully answer this question, social studies educators must begin to (a) examine how, and to what extent, social studies teachers can implement digital technologies as a tool for inquiry in order to scaffold and facilitate active, relevant, and meaningful learning; and (b) conduct research that illuminates how social studies teachers are currently using technology to enhance student learning within a standards-based setting.

Resources

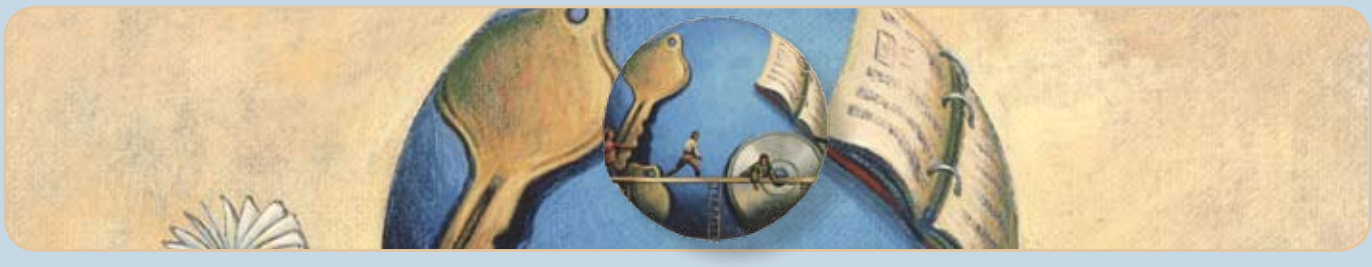
Brush, T., & Saye, J. (2004). Supporting learners in technology-enhanced student-centered learning environments. *International Journal of Learning Technology, 1*(2), 191–202.

Persistent Issues in History Network: http://pihnet.org

Saye, J., & Brush, T. (2004). Scaffolding problem-based teaching in a traditional social studies classroom. *Theory & Research in Social Education, 32*(3), 349–378.

Shaver, J. (2001) The future of research on social studies—For what purpose? In W. B. Stanley (Ed.), *Critical issues in social studies research for the 21st century* (pp. 231–252). Greenwich, CT: Information Age.

David Hicks (Virginia Tech), Kathy Swan (University of Kentucky), and John Lee (Georgia State University) are members of the National Council for the Social Studies College and University Faculty Assembly Technology Committee. David is the assembly's representative to the National Technology Leadership Coalition.



Language Arts

By Janet A. Swenson

In language arts education, as in other disciplines, we require additional research to help us better understand the knowledge and pedagogies associated with newer technologies that will most benefit teachers and their students. Many current approaches to "teaching technology" resemble check-off lists and are devoid of the complexities teachers face when they attempt to integrate technology in meaningful ways into their classrooms.

Newer technologies have the potential to inform the research questions language arts educators have historically asked: How can we make the study of language and communication purposeful and engaging for our students? How can we help our students continue to grow as readers, writers, listeners, speakers, and thinkers? How can we help our students understand the benefits of language diversity? How can we help a new generation of students use language to create a safer, more tolerant, more humane world?

Not only do these technologies have the ability to inform our profession's long-standing research questions, they are also raising new research questions for us: How can we help students choose and combine multiple sign systems (e.g., alphabetic texts, animation, color, space, music, sound, and graphic elements) to create the most effective messages possible? How might creating such texts influence students' interpretion of such texts? Should visual design be introduced into the curriculum, and if so, how and when? When and how should such issues as security, copyright, intellectual property, and plagiarism be introduced? Because time is finite, as the subject matter of the language arts curriculum expands, how are other areas of the curriculum affected?

In ancient Western rhetoric, audience, ethics, mode, and delivery were primary areas of study. Technology will likely heighten interest in them again. When audiences for student "writing" include those from very different cultures, how will we prepare students for sensitive and generative interactions with their distant neighbors? How will we respond to issues of privacy? Do we have a role in discussing ethical behavior in the use of emotionally charged pictures and/or music? Is a language arts teacher's primary role the teaching of only traditional print texts? Or communication?

Missing from much of our national talk about education, however, is a dialogue about the disengagement of many of our students from serious school-sponsored study. These students vary from those whose bodies are in the building, but whose minds are elsewhere, to those who go through the motions of learning out of respect for (or fear of) adults. Our nation is unlikely to make the global and substantive gains in education it desires until we learn how to engage all students in their own learning. Newer technologies have the potential to change the relationship between teacher and student and between teacher, student, and the broader community. They have the capacity to enable students to engage in study that has real consequence rather than study that is "merely academic." Perhaps the most universal research question we might ask is, "How can newer technologies help us to reawaken in our students a sincere passion for learning in and across disciplines?"

In May 2005, more than 50 past, present, or future leaders of the Conference on English Education gathered at Georgia State University for a national summit on the future of language arts education. Additional insights might be gleaned by reviewing summit white papers to be published in a forthcoming issue of *English Education.*

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