Scientifically Based Research: Establishing a Research Agenda For The Technology in Teacher Education Community

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Abstract

The U.S. Department of Education sponsored a summit that addressed the need for scientifically-based evidence on the use of technology in teaching and learning. One hundred leaders from the Preparing Tomorrow's Teachers to Use Technology (PT³) federal initiative were invited to participate in the meeting, held in Fall 2003. The recommendations from that meeting offer a framework for future discussion of this topic. These educational leaders agreed on the need for identification through research of the best practices in the use of technology in teacher education. Studies to determine the generalizable effects of technology in teacher preparation programs are essential because of the key role of the teacher in education and because of the existing evidence on the need for in-depth preparation of teachers to use technology effectively.

The full range of research approaches and methodologies are essential to find out what works in the Information Society, where rapidly increasing adoption of technology is having complex system-wide effects. Both quantitative and qualitative measures will be essential in this research. The evidence used to identify effective practice should include a variety of outcome measures that encompass preservice teacher and faculty portfolios, classroom observations of teacher candidates during their preparation program and into their induction years, and the achievement of their K–12 students over the years.

Teacher education must be a strong force to promote appropriate uses of technology to support educational renewal and to prepare a skilled work force for our Information Society. Identification of the best practices in information technology in teacher education through large-scale, well-designed research programs is essential and will require substantial state and federal resources.

BACKGROUND

In 1998, the United States Department of Education instituted a major project to encourage the effective infusion of technology into teacher education. The Preparing Tomorrow's Teachers to Use Technology (PT³) implementation and catalyst grants address a growing challenge in modern education: nearly all elementary and secondary schools are now "wired" to the Internet, but most teachers still feel uncomfortable using technology in their teaching. Since 1999, PT³ has awarded more than 400 grants to education consortia to help address this challenge. These grants include projects designed to transform teaching and learning through:

- Faculty development
- Course restructuring
- Certification policy changes

- Online teacher preparation
- Enriched-Networked-Virtual
- Video case studies
- Electronic portfolios
- Mentoring triads
- Embedded assessments

Teacher education graduates from these programs are just now beginning their teaching careers, and preliminary data suggest that the work of the PT^3 community has been successful. More than one million teachers and future teachers, several million K–12 students, and thousands of teacher education faculty have been positively affected by the work of PT^3.

Coinciding with the term of the PT^3 program, the education community worldwide and the leaders within the federal government have become increasingly dissatisfied with the perceived credibility of research in teacher education. The National Research Council initiated the movement with its call for "scientifically based research" (National Research Council, 2002), and the No Child Left Behind legislation further defined the phrase with its evaluation requirements. The call for scientifically based research is a voice being heard clearly in the education community.

The descriptions of innovations and the anecdotal evidence resulting from innovation and change in teacher education supported by technology dominate in the literature and indicate the need for a set of principles and an agenda to guide research on technology in teacher education (Roblyer & Knezek, 2002).

Leading researchers in education widely agree that more theory and evidence-based research in education is needed (Feuer, Towne, & Shavelson, 2002; Roblyer & Knezek, 2002). These researchers have also suggested that scientifically based research needs to be defined within the context of specific academic disciplines. Feuer et al. have pointed out that "each field has features that influence what questions are asked, how research is designed, how it is carried out and how it is interpreted and generalized" (p. 7). Jared Diamond, recipient of the National Medal of Science, the Pulitzer Prize for his book "Guns, Germs, and Steel," and the McArthur genius award, has expanded upon this assertion as follows:

> Remember that the word "science" is not derived from the Latin word for "replicated laboratory experiment" but from the Latin "scientia," meaning "knowledge." In science, we seek knowledge by whatever methodologies are available and appropriate. There are many fields that no one hesitates to consider sciences, even though replicated laboratory experiments in those fields would be immoral, illegal, or impossible. We cannot manipulate some stars while maintaining other stars as controls; we cannot start and stop ice ages; and we cannot experiment with designing and evolving dinosaurs. Nevertheless, we can still gain considerable insight into those fields by other means (2003, p. 31).

The emphasis on scientifically based research and the growing amount of available data from PT[3] projects have come together to present a significant opportunity for acquiring knowledge about the effectiveness of technology in teacher education programs. In September 2003, more than 60 leaders in the area of technology in teacher education gathered in Washington, DC, to explore key issues related to technology and teacher preparation centered on scientifically based research. Although Hurricane Isabel arrived in Washington, DC, on the eve of this meeting, participants demonstrated their commitment to the issue by traveling from 38 states to participate. Speakers for the conference included researchers Kathleen Fulton and Gerald Knezek, and readings included relevant articles from *The Educational Researcher*, the *Journal of Research on Technology in Education*, the *Journal of Technology and Teacher Education*, the *Journal of Technology, Pedagogy and Education*, and *Contemporary Issues in Technology and Teacher Education*.

Working collaboratively, the meeting attendees separated into work groups to discuss issues and draft recommendations on four subtopics:

- Scientifically Based Research for Technology in Teacher Education
- A Research Agenda for Technology in Teacher Education
- Linking Teaching Preparation to K–12 Achievement
- Standards and Evaluation in Technology in Teacher Education

RECOMMENDATIONS

Suggestions from each of the workgroups were coded by theme and redrafted to improve coherence. One primary recommendation and six related recommendations within the context of this primary recommendation emerged:

The Primary Recommendation

There is a need for more scientifically based research on the effects of technology in teacher education. Scientifically based research must be defined and interpreted within the field of technology in teacher education to include:

- Robust theoretical frameworks and models
- Clear and important questions
- Clearly defined rigorous methods
- Well designed instruments validated for their purposes
- Possibility for replication
- Relevant predictions and careful generalizations

Related Recommendation 1

Both qualitative and quantitative methodologies are needed to provide scientifically based evidence for the technology in teacher education community.

Qualitative and quantitative research methods are both valid methods that should be used rigorously to provide both exploratory and confirmatory evidence that will have a strong scientific effect. These two approaches are complemen-

tary, not exclusive (Feuer et al., 2002, p. 8). Qualitative research is particularly valuable for exploring phenomena and their development. This is particularly relevant for the phenomenon of simultaneous innovations with technology in teacher education and the associated K–12 schools. In addition, evidence from quantitative research methods is more likely to be misinterpreted without complementary qualitative research to validate findings with a richer picture.

Related Recommendation 2

Research in education should use multiple measures for formative and summative assessment. Reliance solely on either phenomenological evidence or standardized test scores should be avoided.

Important data sources for assessing implementation of technology standards (e.g., competence in specific technology areas) include skills-based standardized tests, classroom observations, products documented by portfolio, performance tasks, and data related to K–12 student achievement and teacher retention. Educational research and student testing that is limited to short-term assessment of performances or mastery of discrete bits of knowledge cannot provide a robust basis of evidence. Longer-term assessment of multiple performances over time is necessary to provide a richer picture that may link K–12 student attainment to teacher training and educator and administrator practice.

Related Recommendation 3

Researchers should be encouraged to identify important new questions about technology in teacher education. Progress in the field will now permit such questions to be researched.

The PT^3 program has stimulated a massive amount of innovation with technology in teacher education across a wide variety of partnerships. The progress of these various projects provides the opportunity to design scientifically based research to answer important new questions. The audiences for these questions are educational researchers and policymakers as well as teacher educators. Examples of potential research questions include:

1. What is the effect of technology in teacher preparation on K–12 settings? How do skills from teacher preparation transfer once candidates go into the field? Specifically, how does technology affect teacher retention in the early years, teacher quality, and K–12 student achievement? The obstacles to technology implementation at the local school level should be considered in these studies.
2. What strategies for faculty development work most effectively? How do such strategies vary with the content area, level, and other responsibilities of the faculty? What are the most sustainable mechanisms for faculty development at the organizational level?
3. What are the dimensions of social justice and digital equity that affect teacher preparation? What strategies have been effective in identifying

and addressing these issues? Where has innovation with technology benefited multicultural education and has that benefit diffused to other organizations? What types of technologies can be used to "level the playing field" to address issues of equity and diversity?

4. What issues identified in the new National Education Technology Plan could be successfully affected by systemic approaches that include teacher preparation? What do current reform efforts from PT^3 suggest as an appropriate design for such research and implementation?
5. How can technology address preservice teacher education challenges? What is the value of experiencing diversity through video cases in a methods course? What type of pedagogic approach is most successful for using these video cases?
6. What is the potential for learning using specific emerging technologies, such as ubiquitous computing, virtual communities, and virtual reality, and what are their applications and limitations? What are the unexpected effects?
7. How do specific technologies or applications affect development of higher-order thinking skills? For example, how does the ability to make and edit video change the way preservice teachers understand media images to which they are exposed? Do they use this understanding to develop approaches to increase achievements of K–12 students?
8. What strategies for using technology can be used to support or facilitate known, effective teaching practices (e.g., enhancing student-teacher ratios, increasing community and parent involvement, and engaging in collaborative learning and problem-based learning)?

Related Recommendation 4

Researchers should synthesize knowledge gained across PT^3 projects around the country to identify what we have learned and what we know about successful preservice preparation programs.

Although evaluation data for individual PT^3 projects exist, there is a need for creating long-term, cross-project design/instrumentation for metadata analysis across projects. However, we recognize that it may be more important to first clarify approaches to enable replication and later merge data sets that are studying the same phenomena. Work defining and clarifying a replicable approach is needed (Willis, 2003). Systematic literature reviews that clarify multiple perspectives will synthesize research and provide more generalizable and relevant scientifically based evidence for the complex and continually evolving field of technology and teacher education.

Specific topics for such syntheses might include:

- The relationships between the preparation of preservice teachers to use technology and the improvement of K–12 student achievement
- Effective and sustainable faculty development systems

- Use of video cases of K–12 instruction to enhance preservice teacher education
- The use of technology to build and support learning communities
- The effect of electronic portfolios in preservice programs

In addition, byproducts of PT^3 projects could be made more accessible. For example:

- Differences in university culture created through PT^3 projects
- A compendium of useful products that were developed by PT^3 projects

Related Recommendation 5

Researchers should collect data in ways that permit it to be disaggregated by single and multiple factors—e.g., deaf Hispanic students—so that important differences in technology access and use can be identified and addressed.

Education researchers must recognize the reality that many teachers are not prepared to engage students in using technology in culturally responsive ways. Observations and other data gathering processes that do not seek to uncover such dynamics might falsely conclude that certain groups of students are less technologically competent or capable, overlooking the effect of culturally responsive learning opportunities. To address this important issue, we recommend that:

1. Data on technology use, access, and effects should be disaggregated by gender, race, ethnicity, free/reduced lunch, language minority status, culture, etc.
2. Efforts should be made to identify or develop instruments and procedures that minimize unintended bias.

Related Recommendation 6

Researchers should track PT^3 graduating teachers into their induction year through year three and investigate the achievement of their students.

Graduates of PT^3-supported programs are currently beginning their teaching careers. Research projects focused on creating knowledge about the experiences of these new teachers and the influence of their technology experiences on their teaching practice and on student learning are necessary. Some of these projects should be large scale and should include graduates of several institutions. Data from these induction years' studies will provide valuable information for improving practice in technology in teacher education programs.

CONCLUSIONS AND NEXT STEPS

The PT^3 leaders who gathered in Washington, DC in the fall of 2003 supported both the need for scientifically based research in technology in teacher education and the need to define the terms within the context of this field.

Together, the group suggested a research agenda for the field that includes large-scale studies, varied methodologies, and an emphasis on determining effective practice. The agenda suggested by this group will directly address the need to contribute to knowledge of the effects of teacher preparation programs on teacher performance and student achievement.

In summary, this paper recommends the allocation of support and resources to enable the nation's community of technology in teacher education researches to develop and test theories, and share their findings so they can arrive at robust identifications of scientifically validated professional practices.

REFERENCES

Diamond, J. (2003). A new scientific synthesis of human history. In J. Brockman (Ed.), *The new humanists: Science at the edge*. New York: Barnes & Noble.

Feuer, M. J., Towne, L., & Shavelson, R. J. (2002). Scientific culture and education research. *Educational Researcher, 31*(8), 4–14.

National Research Council. (2002). Scientific research in education: Report of a workshop. In L. Towne, R. J. Shavelson, & M. J. Feuer (Eds.), *Committee of scientific principles in education research*. Washington, DC: National Academy Press.

Roblyer, M. D., & Knezek, G. A. (2002). New millennium research for educational technology: A call for a national research agenda. *Journal of Research on Technology in Education, 36*(1), 60–71.

Willis, J. (2003). Instructional technologies in schools: Are we there yet? *Computers in the Schools, 20*(1/2), 11–33.