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Preparing Tomorrow's Teachers to Use Technology: Perspectives of the Leaders of Twelve National Education Associations

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The U.S. Department of Education has concluded that preparing technology-proficient educators to meet the needs of 21st-century learning is a critical educational challenge facing the nation. More than two thirds of the nation's teachers will be replaced by new teachers over the next decade. Therefore, it is crucial to ensure that the next generation of future teachers emerging from the nation's teacher education programs is prepared to meet this challenge.

Teacher educator associations representing the core content areas, as well as educational technology, have established an alliance to explore the most effective means of accomplishing this goal. Members of this alliance include the Association for the Education of Teachers in Science (AETS), the Association of Mathematics Teacher Educators (AMTE), the College and University Faculty Assembly (CUFA) of the National Council for the Social Studies, the Conference on English Education (CEE) of the National Council of Teachers of English (NCTE), and the Society for Information Technology and Teacher Education (SITE).

These associations represent the teacher education faculty who prepare future teachers to teach science, mathematics, English, and social studies. They have jointly undertaken a National Technology Leadership Initiative (NTLI) in concert with the U.S. Department of Education, with support from the Preparing Tomorrow's Teachers to Use Technology (PT3) grant program. Among other activities, members of the NTLI alliance and the U.S. Department of Education sponsored two National Technology Leadership Retreats (NTLR) that brought together the leaders of a dozen national education associations.

These deliberations produced conclusions and recommendations about approaches to effectively preparing teachers to use technology, as well as continuing discussion and collaboration designed to extend best practices. This article describes ongoing conversations about information technology and teacher preparation taking place among leaders of social studies, mathematics, science, and English educator organizations and their respective teacher organizations. Their conclusions should be of interest to anyone who works with teacher educators, preservice teachers, and in-service teachers from multiple content areas.

Cross-Disciplinary Dialog

To encourage discussion between and among content area associations, an initial National Technology Leadership Retreat (NTLR 2000) was held in September 2000. A total of 17 national education associations sent leaders to the retreat ' four content-specific teacher educator associations, five content-specific teacher associations, two educational technology associations, and six general (non-subject-specific) teacher and teacher education associations.

The objectives of the leadership retreat were (a) to review and discuss draft content area guidelines for the preparation of social studies, mathematics, science, and English teachers to use information technology (which were developed by representatives from CUFA, AMTE, AETS, and CEE); and (b) to plan formal mechanisms for feedback to extend and continue the dialog initiated at the retreat.

A second retreat, NTLR 2001, was convened in March 2001 to continue the dialog between teacher educator associations and their related teacher associations. Thirteen organizations were represented at this retreat (a list of participating organizations is included in the [appendix](#)). In addition to various presidents, board members, and executive directors of teacher educator and teacher associations, participants included members of some associations' technology committees, content area editors of the online journal *Contemporary Issues in Technology and Teacher Education*, and teacher educators on the NTLI Task Force.

This article summarizes discussions held by each of the four content area groups, who met separately and then reported the results of their discussions to the entire group of retreat participants. The notes from their discussions were transcribed and compiled. Then participants from CUFA, AMTE, AETS, and CEE collaborated in clarifying and expanding on points recorded in this article. The article describes perspectives of each content area group about goals for integrating appropriate information technology use in teacher preparation, definitions of technology by content area, issues surrounding technology in teacher preparation, and questions that still need to be answered. Draft recommendations for appropriate uses of information technology for each content area are described further in the online journal *Contemporary Issues in Technology and Teacher Education*, Volume 1, Issue 1 (www.citejournal.org/).

Goals for Integrating Technology in Teacher Preparation

Participants met in groups by content area and developed a list of broad goals for promoting appropriate technology use in teacher education. The content area teacher educator associations would play the primary role in developing action plans for and implementing these goals.

Mathematics Education

- Prepare preservice teachers to appropriately incorporate technology into their teaching, in regular classrooms equipped with graphing calculators and a computer and in computer labs, to enhance students' conceptual understanding of mathematics and its applications.

- Prepare preservice teachers to become savvy using, evaluating, and choosing technologies.
- Prepare preservice teachers to modify their curricula and develop materials to capitalize on available technologies.
- Prepare preservice teachers to learn how to be resourceful and learn how to lobby to get what they need.
- Prepare preservice teachers for a changing educational world; emerging technologies will have curricular and instructional implications.
- Develop professional development models for both teachers and teacher educators (e.g., workshops and panel discussions at AMTE and the National Council of Mathematics Teachers, on-line courses for mathematics teacher educators, virtual subgroup meetings).
- Develop mechanisms for teachers and teacher educators to share materials and successful efforts.
- Develop a research agenda to investigate the effects of effective technology use on students' learning of mathematics.

Science Education

- Convince teachers/educators that appropriate technology can make their jobs easier.
- Encourage teachers to teach in ways they have not taught before.
- Develop technology innovations that appeal to a large variety of learning styles.
- Because research will follow practice, science education needs to find advocates who are committed to developing appropriate uses ' compelling cases. Researchable situations are necessary, and agreement on important research questions would be helpful. There is currently no shared vision for education research, in general.
- Technology must be an enabler. Right now it is often an end in itself. It is still not recognized for the useful means that it can be.
- Help teachers/educators develop a vision for ways technology can help accomplish what we think is important to accomplish.
- Determine what technology is needed to help science educators teach what they think is important to teach. If they ask for it, maybe they will get it.
- Train science teachers to be discriminating about using technology appropriately. Science educators must help preservice teachers navigate the market environment we all live in whether we agree with it or not.
- Take advantage of opportunities to learn how to learn with technology.
- Set up foundational knowledge in technology, because if new teachers get past the first couple of years, they may be able to incorporate it later in their career.

Social Studies Education

- Develop case studies of "best practices" in the integration of technology in the social studies classroom. Develop teachers who are "change agents" in K-12 schools. Work with NCSS members on presentations and publications focusing on teacher partnerships and classroom projects, especially in schools with inadequate resources, that teach, for example, online deliberation skills or critical evaluation of websites.
- Encourage more research in context: How technology integration happens, influences on preservice teachers and students, and so forth.
- Social justice and technology issues should come together within CUFA. Look for ways to broaden the audience of this discussion, especially at future CUFA conferences. More focused discussion topics would include:
 - Access and equity concerns.
 - The notion that environmental differences will change as a result of technology (physical infrastructure, classroom interactions, learning strategies).
 - Student learning outcomes (incremental assessment).
 - Helping other faculty integrate technology into their research (mentoring).
 - "Visions of the Possible" ' what is needed to make technology integration a reality?
 - Interdisciplinary collaboration opportunities.
 - Continue data collection and analysis on the CUFA study, 'Survey of Social Studies Faculty: Technology Beliefs and Practices.'

English Education

In order to successfully integrate technology into English methods courses, the use of technology needs to become part of our 'professional conversations,' part of the culture of English educators who belong to the National Council of Teachers of English and the Conference on English Education. Toward those ends, the Conference on English Education has developed these goals:

- Support the re-development of NCTE's technology infrastructure, notably the move of all teacher journals online.
- Increase the number of technology-mediated conference presentations and to study further methods of mediating the higher cost of increased numbers of technology-focused conference presentations.
- Develop a task force charged with developing guidelines for 'best practice' in teaching English online.

- Build on the work of the task force mentioned above by using the guidelines to develop additional online professional development opportunities for English teachers and teacher educators.
- Reach consensus on an initial document that represents the fields understanding of best practice in the integration of technology into English education methods courses.
- Form a CEE Commission to support ongoing research, application, and assessment of the integration of technology into English courses charged with the following objectives:
 - Define and undertake praxis-oriented research related to the integration of technology into English courses.
 - Develop technology-focused articles to submit to CEE's analog and online journals.
 - Compose, draft, and publish for peer review a list of hardware and software deemed necessary for the effective preparation of English language arts teachers.
 - Draft recommendations for technology-related revisions to the Guidelines for the Preparation of English Language Arts Teachers.
- Develop and maintain a portion of the CEE website (or an alternative website) devoted to issues related to technology including, for instance, an annotated bibliography of relevant articles, software and hardware reviews, grant opportunities, conference and workshop announcements, and refereed lists of online resources.

Appropriate Uses of Technology

Some uses of technology are employed in much the same way in every discipline. These generic tools include use of videoconferencing to link students at different locations, use of communication tools such as electronic mail and Internet discussion groups, and productivity tools. In every case the degree of access to technology, available bandwidth, and convenience of use affects the extent to which it will be used.

As a result of these discussions, it became clear that, although some uses of technology transcend academic disciplines, other uses are more applicable in specific content areas. The widespread use of graphing calculators has transformed secondary mathematics education. Increasing access to primary on-line sources has similar potential to transform social studies and history. The use of simulation software enhances the learning of complex concepts in science education. Access to audiences for written works could potentially change aspects of English education. These uses are particularly suited for specific disciplines ' graphing calculators were designed to support mathematics education, not English education.

As a corollary, it is often the case that teacher education faculty are most familiar with uses specific to their academic discipline. This section describes how the retreat participants in each content area defined technology.

Mathematics Education

Technology should be used to support exploration, conceptual learning, and applications of mathematics. Some specific tools would include the following:

- Graphing calculators, fraction calculators, and other handheld technologies.
- Spreadsheets.
- Probeware (e.g., CBL).
- Dynamic geometry programs (e.g., *Geometer's Sketchpad*).
- Probability and statistics software (e.g., *Fathom*).
- Topic specific software (e.g., *Green Globes*).
- Computer algebra systems.
- Mathematics related websites.

As well as

- Communication tools (e.g., e-mail, video-conferencing).
- Presentation tools.
- Digital video.

Science Education

Science educators participating in the retreat look for technology that promotes inquiry learning and makes scientific views more accessible to students. Tools science educators are currently using include

- Digital microscopes.
- Simulation software (e.g., *Starry Night Pro*).
- Weather stations.
- Web sites with simulators and data collections.
- Spreadsheets.

- Graphing calculators.
- Presentation software.

Social Studies

Social studies educators who participated in the retreat promote the use of technology tools that extend learning opportunities in a context specific to the social studies, provide opportunities for students to study relationships among science, technology, and society, and foster the development of the skills, knowledge, and participation as good citizens in a democratic society. Some of these tools include the critical use and application of the following:

- Electronic discussion groups in methods classes.
- Digital resource centers with primary resources.
- Digital video cameras.
- Handheld computing devices.
- Videoconferencing/electronic whiteboards.
- Spreadsheets.
- Quantitative and qualitative statistical software packages.
- Internet2.
- Presentation software.

English Education

English educators see technology as a tool both for communication and creation—a place where literacy is used, developed, and even redefined. They often cite the shift in literacy that has come through reading and writing—i.e., that people read and write/decode and create not just from left to right but also in and out, up and down. This literacy shift is major for considering the impact of technology on meaning-making and creation.

English educators generally define technology as a tool—a tool for learning, creating, communicating, thinking, representing, and researching. Like mathematics and the other content areas, English educators use technology to 'do' English—i.e., writing, reading (decoding and encoding), attending (listening and speaking), and viewing (evaluating). While English often focuses on process, it also focuses on product—quality products grow from quality processes. In the English community 'technology' refers not only to computer technology but also video,

musical, and tactile'all of which, of course, can be combined in computer technology with multimedia functions.

Technologies used to accommodate this definition include the following:

- Internet publishing
- Electronic journaling and discussion groups
- E-mail
- Web sites
- Electronic portfolios
- Internet research
- Applications for communication to self and others
- Videoconferencing for cultural communication exchanges
- Text creation through word processing, graphics, and numerous other applications
- Word processing

Dissemination and Integration Issues

Participants from each of the four content areas discussed issues related to integrating information technology in the preparation of teachers. Some issues mentioned are specific to a content area, but most of them are common across content areas, and many are interrelated. Common issues are presented first, follow by content-specific issues.

Common Issues

In discussing dissemination and integration issues, participants found the following to be common to all four content areas represented at NTLR 2001.

1. Accreditation standards require schools and colleges of education to incorporate educational technologies into their teacher preparation curricula. However, this is often handled in separate sections or courses within the curriculum, with little integration with the methods courses that preservice teachers take. Educators often view technology as a foreground element, making it an additional topic to be taught rather than a background element. Faculty confront the reality that the curriculum of methods courses is full, with little room for additional topics.

2. Even when methods faculty attempt to integrate technology into methods course rather than treating it as a separate topic, the startup costs associated with doing this in an authentic way are substantial.
3. Technology is perceived as being a segmented topic to be added on to an already full methods class curriculum and a long list of NCATE and content-specific standards teacher educators are expected to address. It is often relegated to a low priority goal, if not ignored altogether. In the classroom, the related issue is accountability to standards and high stakes testing. Again, teachers perceive that there is no room to 'add on' technology instruction.
4. A limited body of knowledge exists that examines technology's benefits to student learning, and many teacher educators are unfamiliar with the literature that has been published. Much of the literature discussing technology use in teacher preparation is based on anecdotal evidence. Because learning to use technology is often so time intensive, many teacher educators are reluctant to take on innovative technology when they are not convinced of its immediate educational benefits. Also, claims that technology is necessary because learners are different is not sufficiently convincing to most educators. The effects of technology use must be assessed and publicize
5. In too many cases, poor examples of technology in education have turned off teachers and educators. 'Poor examples' would include technology used just for the sake of using technology (i.e., the concept could be learned just as well without the technology) and technology that is difficult to learn or fails to work when needed. Some educators/teachers of all content areas take this as an excuse to dismiss all technology.
6. Even when preservice teachers are trained to integrated technology in their instruction, many face the barrier of access to technology in their schools. In many instances, if classrooms have a computer at all, they usually have only one, and computers labs are often overbooked. Schools fortunate enough to have computers may still have difficulty keeping up with hardware and software upgrades or with maintaining reliable Internet connections.

Some of the issues identified by the participants are not specific to technology integration but arise when efforts of any sort are made to reform teaching.

1. Changing teacher beliefs is a difficult ask and takes time and mentoring.
2. Research has shown that even when beliefs are changed teachers do not teach a certain way just because they know about how to teach that way or believe it is a good way to teach. Sometimes this is true of teacher educators, as well. Effective use of technology requires teachers to act differently, and the more the technology asks teachers to act differently, the harder it is for teachers to incorporate it into their instruction. They often revert to teaching the way they were taught. They also operate, to some degree, under the premise that everyone learns the way they learn.
3. As is true with any teaching reform, educators/teachers must internalize the value of

learning with a new strategy before they will begin to use the strategy. Until preservice teachers and teacher education faculty experience learning 'with technology in this case' we cannot expect their teaching to change. They need an authentic rationale for its use: 'What can I do with this technology that I couldn't do without it?' The technology must be worth the effort.

4. When new teachers enter the classroom, they often face resistance from in-service teachers, their administration, and sometimes parents, who may support a more traditional teaching style. During practicums and the early years of their career, teachers may feel pressured to 'fit the mold' and to abandon progressive teaching practices, including technology-enhanced instruction.

Issues Specific to Content Areas

The following issues regarding dissemination and integration of technology in teacher preparation are more specific to the culture of each content area.

Mathematics Education. Issues of concern to the mathematics education participants included the following:

1. The traditional approach to mathematics teaching has emphasized procedural skills, and many teachers, students, parents, administrators and others still favor this type of mathematics instruction. Many adherents to the procedural approach see technology use as a threat to students' development. Others see no role for technology.
2. Teachers who use technology to help students develop conceptual understanding must make efforts to help students connect technologically based experiences, such as data collection and computer explorations, with formal mathematics.
3. Technology makes some mathematics topics less important, others more accessible and still others more important. Mathematics curricula must be continually revised to take advantage of technology.

Science Education. The science educators participating in NTLR 2001 identified the following issues in their field

1. The science education community needs to clarify key terminology for instance, the meaning of the phrase, 'hands on.' For decades, the science education community has been encouraging learning that allows students to observe natural phenomena firsthand, as well as experience the work of science, and they already have a set of familiar 'technologies' (e.g., a Van de Graaff generator). Some science educators and teachers may believe that new information technologies get in the way of hands-on learning. The science education community needs to determine whether, for example, a computer simulation of an otherwise invisible phenomenon equates with hands-on learning. In addition, many in the science education community have too narrow a definition of technology that is limited to computers and graphing calculators.

2. The science education community for years has been struggling to reform science teaching and learning. The *National Science Education Standards* and the *Benchmarks for Science Literacy* call for science teaching to develop scientifically literate citizens. This goal involves developing meaningful understandings of science that is connected to everyday life and decision making. The science education community as a whole has not clarified how information technology complements and promotes the goals of science teaching. Educators question how, or if, technology provides or enhances authentic experiences with natural phenomenon. Before jumping on the technology bandwagon, science educators want to consider the content and skills they want children to learn and the ways technology can help children learn.

Social Studies Education. Social studies educators identified a concern about the digital divide, which they defined as being more than students having access to hardware and software, but having access to appropriate resources online and having appropriate Internet connections so they can explore the world of ideas related to social studies content. The two primary uses of technology in the social studies are connecting to other people so they can access multiple viewpoints and perspectives and connecting to resources, such as primary documents and social science data. It is necessary for students to be able to download resources from the Internet without great delays; it is also necessary for students to have access to resources online that reflect the multicultural backgrounds of our students. This issue of a 'cultural divide' on the Web in itself has become part of the social studies content. Social studies educators face the challenge today of not only addressing the digital divide with their own students, but helping their students find methods of addressing this issue in their own teaching. Helping students use technology resources critically, especially in examining material they obtain from the Internet is especially crucial, as well.

English Education. English language arts teachers and teacher educators focus on the study of language. The infusion of technology into English methods courses has raised such fundamental questions for English teacher educators as these: Is technology influencing the way we define language and literacy? Is it changing our definition of text? How has and is the infusion of technology into our culture changing the way we communicate with one another? How is it influencing our notions of reading, writing, representing and comprehending? Although there are too many discipline-specific issues technology raises for English educators to recount fully here, the following are representative of the concerns of English educators:

1. English educators find themselves questioning their definitions of 'texts.' Many English teachers were educated in an era in which texts seemed simply defined: texts were linear arrangements of letters, words and sentences in paragraphs on pages and if of sufficient length bound in a cover. Today, these educators are confronted by 'texts' that are neither linear nor sequential, that embed graphic images and sound, that make the selection of color and typeface an integral part of the message. English educators are debating the types of texts they will ask their students to read and write, the skills students will need to read and compose these new texts, and the advantages and disadvantages of teaching these new reading and composing strategies.
2. English educators continue to grapple with the ability to design writing assignments that preclude a student's ability to download a paper from the web. Access to technology clearly has heightened teachers' concerns about plagiarism. In addition, access to

information that has not been scrutinized by editorial teams at major publication houses (although such a path does not guarantee that a text has credibility) has also necessitated the development of coursework on methods of determining source credibility and reliability, as students use websites to support research they are conducting. As students are required to turn to the web to complete course assignments, English educators are grappling with new questions about censorship, and the teacher's and school's responsibility, if any, to monitor students access to various websites. Finally, the student is not the only one accessing information; as teachers invite students to post their work on websites or to contribute to class websites, many educators have become concerned about protecting students from potential predators.

3. Many English educators believe that the most effective literature and language development curricula are best developed in context, preferably in conversation with students. As technology becomes more of a presence in educational settings, teachers are becoming aware that they will need to address the proliferation of computer-based, standardized, 'teacher-proof' English language arts curriculum marketed to schools and school districts.
4. Many English teachers are still debating the merits of using rubrics to assess student compositions and projects. Many feel even more ambivalent about how to assess multimedia projects. Some worry that technology-rich environments encourage students to rely more on clip art than creativity and to emphasize form over substance.

Questions About Integrating Technology in Teacher Preparation

In their discussion about integrating technology in teacher preparation, the participants raised many questions relevant to educators' and teachers' reluctance to embrace technology. Many of these questions should be addressed by research. The answers to some of the questions will become clearer over time, as educators gain more experience modeling technology use and observing their preservice teachers' experiences with technology.

Although some questions were similar between content areas, all the questions are presented within the content area category in which they were raised.

Mathematics Education

- How do mathematics teacher educators help preservice teachers see the potential of technology to improve mathematics teaching?
- How do mathematics teacher educators structure methods courses so that preservice teachers learn how to use a variety of technologies and develop sound pedagogy?
- How do mathematics teacher educators prepare preservice teachers for the future, where emerging technologies will have implications for their roles and their curricula?

Science Education

- Does technology help students accomplish the recommendations of the science education standards?

- If we teach preservice teachers to use appropriate technology, will they teach more in the way we want them to teach?
- Does technology enable students to ask questions they would not have thought of asking before?
- Do students learn science differently with technology? Is the quality, nature, or efficiency of learning improved?
- Are students learning different science content or concepts with the technology than they would have otherwise?
- Does technology enhance inquiry learning? Can technology provide an inquiry environment?
- If science educators determine that technology is worthwhile, what do they need to do, or what experiences do they need to provide, to convince preservice teachers of its benefits?
- What are the stages teachers have to go through to appropriately use technology in learning? (Some take the technology and teach the content in the same old way.)
- Can technology help educators maintain an ongoing relationship between education faculty and new teachers in the classroom?

Social Studies Education

- How are things in schools really changing as a result of the technology? Is technology simply "glitzy," all style and no substance?
- Is technology changing the way children learn? How do we know this? If it is changing the way children learn, how do we adapt our pedagogy?
- What does diversity really mean for access and different types of learning?
- What are some ways of bringing inexpensive technologies into the classroom and making connections to people around the world?
- How can we address the growing digital divide?
- How can we teach children to be critical consumers of information found in cyberspace?
- How can we maintain children's safety and privacy on the Internet?
- How can we collaborate with in-service teachers to help our preservice teachers learn more about integrating technology and teacher education?

English Education

When English teachers and English teacher educators contemplate the useful integration of technology into their courses, they face one stark reality: ability has preceded knowledge. That is, the ability to purchase and integrate technology, particularly computer technology, into

classrooms has preceded the research that would help English educators have firmer answers to questions such as these:

- In what ways is computer technology influencing our conceptions of 'language' and literacy?
- Does the introduction of computer technology change the way our students read, write, listen, speak and represent their understandings in ways that are as or more beneficial than representing those understandings without access to technology?
- What opportunities are inherent in the use and study of computer technology in English courses? What challenges are inherent in their use?
- Does the infusion of computer technology into our classes create unnecessary hurdles for our students?
- Does failure to integrate technology into our classes create unnecessary hurdles for our students?
- How does computer technology change the ways in which we and our students organize information? How we process information?
- How does it influence instructional competence and attainment?
- What constitutes 'appropriate' use of technology into English courses?
- In what ways can technology be thought of as both pedagogy and content, and when is it appropriate to use it as either?
- How do we conduct critical evaluations of our teacher education programs that are infusing technology into students' course experiences?
- How can technology help us more fully experience diversity as a positive attribute?
- How can technology help us to engage diverse learners more fully?

Expanding Our Opportunities for Dialog

The presidents, executive directors, and other leaders of more than a dozen national education associations have now come together for two National Technology Leadership Retreats. These leaders examined best practices, discussed draft guidelines for use of technology in teacher education in each content area, established technology strands at their annual conferences, and established an on-line journal, *Contemporary Issues in Technology and Teacher Education (CITE Journal)*.

The gathering of this group of leaders to discuss technology and innovation in teacher education

was unprecedented. The retreats served as an opportunity to compare use of technology in different disciplines and highlighted the fact that lessons may be learned both from similarities in technology use across disparate disciplines and from their differences.

The joint sponsorship of an academic journal by five professional associations, with independent editorial boards for each content area, is a substantial and unprecedented accomplishment. The logistics were formidable, since each association has a different governing structure and organization. The success of this collaboration provides a foundation for other advances.

One finding that emerged from the leadership retreats is that more communication among representatives of different disciplines and between content associations and educational technology societies is needed. While representatives of each area are well versed in the literature of their own discipline, often teacher education faculty from different disciplines do not connect the dots and draw conclusions about technological innovation, because no one has the opportunity to see the overall picture.

It is not logistically possible to bring the collective membership of the respective associations and disciplines together physically for exploration and comparison of ideas in the same manner that the leaders came together. However, other strategies to accomplish this goal may emerge from the retreats.

The leaders of the National Technology Leadership Initiative (NTLI) are proposing an award for an exemplary paper presented at the annual conferences of the teacher educator associations representing the core content areas ' AMTE, AETS, CEE, and CUFA. If approved by these associations, the recipients of each award will be invited to the annual *Technology and Teacher Education* conference sponsored by SITE each year. This will provide an opportunity for ambassadors from mathematics education, science education, English education, and social studies education to meet one another and discuss technological innovation across their respective disciplines. At the end of the pilot period of five years, a total of 20 *NTLI Technology Fellows* will have been appointed. This group will collectively constitute an expert panel that can identify, assess, and recommend other innovations in teacher education.

Faculty in all content areas are most familiar with the literature and journals in their own discipline. Another strategy for advancing cross-disciplinary discussion about technology in teacher preparation that is under consideration involves cross-publishing across disciplines. Authors publishing in their content area journals could refer to a sister article published in another discipline. For instance, a bibliography of technology and science education articles could be published in *CITE Journal*, while a literature review based on this bibliography could be submitted to a science education journal, such as the *Journal of Science Teacher Education*.

The U.S. Department of Education and a private foundation, Atlantic Philanthropies, have also provided support for establishment of a Technology and Teacher Education *Digital Scholarship Portal*. The portal will offer a common web site for print and electronic publications related to technology and teacher education, as well as discussion and scholarly dialog associated with them. The portal would become an access point for digital scholarship related to technology and teacher education and will provide a venue for peer-reviewed research and findings resulting from the *Preparing Tomorrow's Teachers to Use Technology* initiative.

In 1965 the founder of Intel, Gordon Moore, observed that the density of integrated computer circuits doubles every 18 months. In practical terms this means that a handheld computer that costs \$300 today will be \$150 in 18 months and \$75 in three years. The physical limits of wafer

fabrication technology will not be approached for 20 years. Moore's Law is therefore expected to hold true for at least that length of time.

During the course of their careers, teachers beginning to teach today will enter a future in which every child has a tablet-sized computer connected to a wireless network. The technological capacity for innovation will be available to future educators. The educational benefits of coming technological innovations will depend upon how we plan for this future. The collaborative efforts of the teacher educator associations representing the core content areas are designed to help ensure that those benefits are realized.

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Appendix

National Technology Leadership Retreat II Participants March 2001

Teacher Educator Subject-Specific Associations

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