Will New Teachers be Prepared to Teach in a Digital Age?



A National Survey on Information Technology in Teacher Education

Research Study by the International Society for Technology in Education

Commissioned by and in partnership with the Milken Exchange on Education Technology

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Foreword: Will new teachers be ready to teach in a digital age?

"Teachers are being asked to learn new methods of teaching, while at the same time are facing even greater challenges of rapidly increasing technological changes and greater diversity in the classroom... [given such challenges] relatively few teachers (20%) report feeling well prepared to integrate educational technology into classroom instruction."
U.S. Department of Education, National Center for Education Statistics.
Teacher Quality: A Report on the Preparation and Qualifications of Public School Teachers, January 1999

There is much rhetoric today about the inability of teacher preparation programs to fully prepare new teachers to use technology effectively in their professional practice. A year ago, the Milken Exchange on Education Technology, an initiative of the Milken Family Foundation, set out to establish baseline data on the status of technology use in teacher-training programs in the United States.

It was with this goal that the Exchange commissioned the *International Society for Technology in Education* (ISTE) to survey teacher-preparation institutions. Results were gathered from 416 respondents, representing approximately 90,000 graduates per year, who reported on the extent to which future teachers were being exposed to technology in their classes, field experience and curriculum materials.

The report finds that, in general, teacher-training programs do not provide future teachers with the kinds of experiences necessary to prepare them to use technology effectively in their classrooms. With the federal government's projected need for 2.2 million new teachers over the next decade, the time to examine and reengineer our teacher preparation programs is now.

The findings in this report should be a wake-up call for higher-education institutions and policymakers across the country. Today's students live in a global, knowledge-based age, and they deserve teachers whose practice embraces the best that technology can bring to learning.

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The Milken Exchange on Education Technology serves American public education as an honest broker of research, analyses and new insights into the effective use of technology in teaching and learning. Through partnerships with such prestigious groups as the National Governors' Association, *Education Week* and the International Society for Technology in Education, the Exchange is bringing to light the complexity and reengineering it takes to use technology in ways that bring added value to today's learners. Check the Web site at www.milkenexchange.org for specific initiatives.

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The International Society for Technology in Education (ISTE) is the largest teacher-based, non-profit organization in the educational technology field. Its mission is to help teachers in K-12 classrooms and teacher-preparation institutions to share effective methods for enhancing student learning through the use of technology. Check the Web site at www.iste.org for specific initiatives.

Information Technology in Teacher Education

Executive Summary

Survey: Information Technology in Teacher Education

In the spring of 1998, the Milken Exchange on Education Technology commissioned the International Society for Technology in Education (ISTE) to survey schools, colleges, and departments of education (SCDEs) in the United States about how they were preparing new teachers to use information technology (IT) in their work. ISTE had previously worked with the National Council for Accreditation of Teacher Education (NCATE) to produce IT standards for preservice teachers. This current initiative is timely for several reasons:

- Information technologies—computer hardware and software, networks, peripherals—are increasingly available in schools. Recent studies suggest that K-12 schools in the United States have approximately one microcomputer for every five students.
- Past studies have documented that teacher professional development—preservice and inservice—has not kept pace with the rapid changes in the quality and quantity of information technology.
- The teacher work force is expected to experience rapid turnover in the next decade.

This survey commissioned by the Milken Exchange was intended to gather baseline information about the IT preparation that preservice teachers receive, and to develop a means of rating programs and program components as to their IT capacity.

With the assistance of a national advisory committee of teacher educators, researchers, and educational administrators, ISTE developed a 32-item survey that asked respondents to rate their teacher training institutions on coursework, faculty capacity and use of IT, facilities, field experience opportunities, and the skills of graduates. Four hundred and sixteen institutions, or about a third of U.S. SCDEs responded, representing approximately 90,000 graduates for the 1997-1998 school year. There were no significant differences in overall scores for public vs. private institutions, NCATE members vs. nonmembers, respondents' job types (dean, faculty, or technology coordinator), IT job functions (instructional, coordination, or none), different regions of the country, or institutions with different Carnegie classifications (Research, Doctoral, Masters, Baccalaureate, Teachers, Business, Theological).

Because the wide range of items on the survey made total scores difficult to interpret, factor analysis was used to identify meaningful subscales and independent items. Survey items clustered into four main groups: facilities; faculty/student integration of technology in learning; skills with particular applications; and opportunities for IT-related field experience. Six questions relating to IT credit hours, distance learning, and technology planning were not closely correlated with any of the main factors.

Analysis of the survey data indicates:

1. Most institutions report that their technology infrastructure is adequate or better in terms of carrying out their current programs. About a third feel their programs are limited by deficiencies in their IT facilities.

2. Faculty IT skills tend to be comparable to the IT skills of the students they teach; however, most faculty do not model use of those IT skills in teaching.

3. Distance education and computer-assisted instruction currently affect only a small proportion of students in teacher training institutions.

4. Most teacher-preparation programs do not have a written, funded, regularly-updated technology plan. The presence of a technology plan has a positive, but low, correlation with other measures of capacity.

5. Most institutions report that IT is available in the K-12 classrooms where student teachers get their field experience; however, most student teachers do not routinely *use* technology during field experience and do not work under master teachers and supervisors who can advise them on IT use.

6. The number of hours of IT instruction integrated into other courses has a moderate correlation with other scores on the survey; however, the number of hours of formal IT instruction does not.

7. The *Integration factor*—composed of items that addressed graduates' classroom skills and the actual use of IT during college training—was the best predictor of other scores on the survey. The best predictor of integration scores was basic technology proficiency as represented by the questions in the *Applications factor*.

In general, the technology infrastructure of education has increased more quickly than the incorporation of IT tools into teaching and learning. Survey respondents generally rated their technology facilities "adequate," but many faculty do not model technology use, and certain types of activities—Internet sessions and computer presentations—are not possible in a large number of classrooms because of a lack of equipment or wiring. More practicum students find themselves in technology-equipped K-12 classrooms than actually apply their IT knowledge during practice teaching under the guidance of technology-using supervisors or cooperating teachers.

The most important finding of the survey is that formal stand-alone IT coursework does not correlate well with scores on items dealing with technology skills and the ability to integrate IT into teaching. IT coursework is a component of current technology standards for colleges of education and was cited by many survey respondents as a notable feature of their programs. Yet the current data do not support the idea that additional technology-specific coursework will greatly improve aspects of IT use in education.

About half the IT instruction that teacher trainees receive is delivered as part of other classes, such as methods and curriculum courses. These instructional hours are more highly correlated with other variables in our survey than are IT-specific credits. This supports the contention that, to increase the technology proficiency of new teachers in K-12 classrooms, training institutions should increase the level of technology integration in their own academic programs. In particular:

- IT instruction should be integrated into other courses and SCDE activities, rather than being limited to stand-alone classes.
- Institutions should engage in technology planning that focuses not only facilities but on the integration of IT in teaching and learning.
- Student teachers need more opportunities to apply IT during field experiences under qualified supervision.
- Faculty should be encouraged to model and integrate technology. No strategy for accomplishing this is addressed in the current survey, but other studies, including a 1997 Task Force Report by the National Council for Accreditation of Teacher Education, recommend increased emphasis on faculty professional development—including incentives outside the traditional academic rewards system.
- In order to provide models for change, researchers, professional societies, and education agencies should—on an ongoing basis—identify, study, and disseminate examples of effective technology integration that reflect the current needs in both teacher education and K-12 schools.

A large amount of self-reported survey data has been collected on SCDEs since 1996. It would be useful now to focus in greater depth and seek to understand the details of how programs achieve specific outcomes. Important questions at this stage include:

- What are the most effective models for learning how to integrate IT into classroom practice? This research should look for concrete evidence of effectiveness, including observations in SCDES and K-12 classrooms, interviews with SCDE graduates who have gone into teaching, technology-based lesson plans and student work samples.

- Where and how do education students acquire their basic technology skills? What is the role of precollege training, junior college training, training in other university programs, and informal self-directed learning?

- How did high-scoring SCDEs in the Milken/ISTE survey achieve their levels of capacity? Were particular professional development activities or incentives necessary to achieve integration? What types of applications and activities that offer technology-rich field experiences are used in K-12 classrooms? How does field experience articulate with the college coursework, and what types of collaborative structures are necessary to achieve that articulation?

Public agencies and foundations should develop and solicit research proposals that will address these issues, and should ensure timely and widespread dissemination of new knowledge as it becomes available. In addition, SCDEs should explore using instruments such as the Milken Exchange/ISTE survey for their own needs assessment and action research.

Introduction

In the spring of 1998, the Milken Exchange on Education Technology commissioned the International Society for Technology in Education (ISTE) to survey schools, colleges, and departments of education (SCDEs) in the United States about how they were preparing new teachers to use information technology in their work. This was one of a series of initiatives sponsored by the Milken Exchange to study the role of technology in education.

Information technology *includes* computer hardware and software, the networks that tie computers together, and a host of devices that convert information (text, images, sounds, motion) into common digital formats. However, information technology is not just hardware, wires and binary code, but also the effective use of digital information to extend human capabilities.

For the field of education, information technology is the stock in trade. There is a large researcher-based and practitioner-based collection of knowledge on effective educational uses of IT for Pre-K to grade twelve (President's Committee, 1997; Sandholtz et al., 1997; Wenglinsky, 1998). And yet national reports for many years have also documented the fact that modern information technology in schools is used less than in the world beyond the school walls. In particular, teachers report a need for more time and training in both technology skills and technology-based pedagogy (Office of Technology Assessment, 1995). It would seem logical that this kind of training would be a part of every teacher's initial preparation, but in the past that has not been the case. Teacher knowledge of IT tends to be acquired on the job, along with all the other new skills required to work in a classroom and school.

We are now at the beginning of a decade of rapid teacher turnover at the K-12 level. In addition, the total number of students is increasing and there is an emerging movement toward decreasing average class size, particularly at the primary school levels. The federal government estimates that these conditions will require our educational system to hire approximately 2.2 million new teachers over the next decade (Riley, 1998). These teachers will include returning veterans and products of alternative certification programs, but a large proportion will be new or recent graduates of colleges of education (Feistritzer, 1998). This is obviously a great human-resource challenge, but it is also an opportunity to infuse schools with new ideas and practices—including better use of information technology.

The survey presented in this report was intended to gather baseline information about the IT instruction that preservice teachers receive in their programs of study. In addition, we hoped to develop an instrument that could be used to rate programs and program components on IT capacity for both research purposes and program evaluation.

Background

IT in K-12 Education

Computers and other information technologies are used in schools in a number of different ways to aid instruction and learning. Uses of technology for teaching and learning can be divided into technology-assisted learning, tool applications, and computer and information science.

- **IT-assisted learning**. This category includes three different uses of IT to directly support learning. 1) *Computer-assisted learning (CAL)* is the interaction between a student and a computer system designed to help the student learn. Once limited to drill-and-practice software, CAL now includes tutorials, simulations, and virtual-reality environments that can present complex learning situations. 2) *Computer-assisted research* is the use of IT as an aid to doing library and empirical research. It has become increasingly important as the growth of the World Wide Web has created a virtual library that can only be accessed by the technologically literate. 3) *Distance learning* is the use of telecommunications designed to facilitate student learning. Distance learning has involved various technologies over the years, including telephone and noninteractive closed-circuit television. Current technologies include e-mail, interactive Web sites, and two-way audio/video teleconferencing.
- **Technology-as-a-tool.** This includes a large array of hardware and software—word processors, graphics packages, scanners, digital cameras, presentation applications, databases, spreadsheets, and more. The common characteristic is for hardware and software not to have a limited educational purpose, but rather be designed to help people extend their abilities to do work. Some tools—digital science probes, for instance—are more specialized than others, i.e. word processors.

Some IT tools are facilitating major changes in academic disciplines. The 1998 Nobel Prize in chemistry was awarded to two "computational chemists." In many areas of science, there are three approaches: theoretical, experimental, and computational. At the precollege level, students use technology to compose and perform music, create multimedia, carry out sophisticated scientific experiments using microcomputer-based laboratory facilities, and learn to solve problems that formerly required one or more years of college-level preparation.

IT tools can support constructivist education. The theory underlying constructivism is that students learn by building on their current knowledge. Among other benefits, technology enables students to take on more complex tasks with greater independence, and tends to promote collaborative roles for both peers and teachers (Means & Olson, 1995).

- **Computer and information science.** Before the personal-computer software industry developed, using a computer meant learning to program it. Today, computer and information science is a specialty area of study for students with particular interests in technology. However, many general purpose IT tools include a level of programming in the form of scripts and macros that automate tasks.

These three categories overlap. For instance, there is a class of "learner-centered" tools that focus on "learning to learn." The original example was the Logo programming language developed at MIT, which is still widely used. Current multimedia and Web authoring software have similar characteristics. Students practice problem-solving and creative strategies, including designing, testing, and debugging sets of instructions, as they use the software to create documents and presentations.

Teacher Education and Information Technology

In the early days of educational computing, dating roughly from the launch of Sputnik in 1957 to the advent of personal computers, teacher training institutions addressed professional development needs for technology through inservice programs. Teachers attended workshops or returned to graduate school to obtain advanced degrees. In 1983, when the report *A Nation at Risk* recommended that students be required to take a high-school computer course, it was still unusual for a preservice program to offer technology training for new teachers. With an average of about one microcomputer per 125 students in K-12 schools, it was unlikely that most teachers would have the opportunity to apply computer skills with students, even if the training had been available.

During the past 15 years, the amount of information technology in PreK-12 education has grown rapidly. One estimate is that we now have approximately one multimedia computer per 13 students and Internet access in about 85 percent of schools and 44 percent of classrooms (Jerald, 1998). Becker, et al. (1998) estimate that the total number of computers in private and public schools is slightly more than one per five students. This is a 15-fold increase in 15 years. Inservice and preservice education systems have struggled to keep up with this rapid pace of change. Willis and Mehlinger (1996), reviewing the literature on information technology and teacher education, wrote that most of it "could be summarized in one sentence:"

> Most preservice teachers know very little about effective use of technology in education and leaders believe there is a pressing need to increase substantially the amount and quality of instruction teachers receive about technology. The idea may be expressed aggressively, assertively, or in more subtle forms, but the virtually universal conclusion is that teacher education, particularly preservice, is not preparing educators to work in a technology-enriched classroom (p. 978).

The studies Willis and Mehlinger reviewed indicate that while a large number of students in teacher education programs were taking some coursework in IT, by and large this instruction was not tied to curriculum, methods, field experience, or practice teaching.

Federal reports, in particular the Office of Technology Assessment's (OTA) 1995 *Teachers and Technology: Making the Connection,* focused additional attention on the shortcomings of preservice education. In response to concerns raised in the OTA report, the American Association of Colleges of Teacher Education (AACTE) sponsored a survey to assess how its member institutions were doing in regard to student use of technology, faculty use of technology, and institutional capacity (Persichitte, Tharp, & Caffarella, 1997).

The AACTE study found that "SCDEs generally have very well-equipped classrooms and their information infrastructure is generally part of a budgeted plan for purchase, replacement, and upgrades." The areas most in need of improvement had to do with use, rather than provision, of technology. "Too few students are expected to use computers, televisions, and VCRs to share information in their campus classroom settings. Students do not use SCDE Web sites to obtain assignments and syllabi, implying that SCDE faculty are not making best use of the available information infrastructure" (p. 31 AACTE study).

One response to the perceived shortcomings in teacher training has been the development of local, state, and national standards for what teachers should know about technology and its integration into the classroom. Since 1995, the National Council for Accreditation of Teacher Education (NCATE), working with the International Society for Technology in Education (ISTE), has been incorporating technology standards into its accreditation protocols for colleges of teacher education (International Society for Technology in Education, 1998). As with the earlier OTA report, the ISTE/NCATE standards have generated follow-up studies. In 1997, NCATE conducted its own review of its accreditation program with regard to technology. A task force on technology in teacher education found that college faculty were not making extensive use of technology in their own research and teaching, and thus underestimated its impact on teachers' jobs:

> As a result, colleges and universities are making the same mistake that was made by K-12 schools; they treat "technology" as a special addition to the teacher education curriculum—requiring specially prepared faculty and specially equipped classrooms-*not* as a topic that needs to be incorporated across the entire teacher education program. Consequently, teachers-in-training are provided instruction in "computer literacy" and are shown examples of computer software, but they rarely are required to apply technology in their courses and are denied faculty role models who employ technology in their own work (National Council for Accreditation of Teacher Education, 1997).

The NCATE task force explained that these continuing problems are the result of insufficient technology and technical support, a lack of faculty technology training, some higher education faculty being out of touch with the K-12 school environment, and an academic reward system that does not provide incentives for technology innovation. Among other changes, the task force recommended that NCATE require SCDEs to have "a vision and plan for technology that reinforces their conceptual model of teacher education." The task force also recommended that SCDEs incorporate current telecommunications (in particular Web technologies) into regular operations, and that professional organizations should "identify and make available to all interested parties exemplary practices of technology use" (National Council for Accreditation of Teacher Education, 1997).

In 1997, five of the six Regional Technology in Education Consortia (R*TECs) surveyed SCDEs in their regions to determine to what extent the standards are accepted and are being implemented. Reports from the Northwest Educational Technology Consortium (NETC) and Southeast and Islands R*TEC (SEIR*TEC) had been published by spring of 1998 when the current Milken Exchange/ISTE project began.

The SIER*TEC reported that introductory courses in technology are relatively common. Integration of technology in teaching is not. The types of technology most commonly modeled were word processors and VCRs. More advanced use of interactive technology for instruction, either as tool or for computer-assisted learning, was relatively rare. Predictably, student skills with technology tended to mirror the technologies they were exposed to in their training (Instructional Technology Resource Center, 1998).

The NETC report emphasized areas in which deans of northwest colleges of education needed to improve to be in compliance with NCATE accreditation. Of particular concern to the deans in the northwest were budget issues, availability of technical support staff, not having enough teaching staff, and the need to add additional courses. The Northwest deans also felt that lack of technology within their colleges was a limitation on their ability to meet the new standards (Queitzsch, 1998). Considering this in light of the earlier AACTE study that found SCDEs to be generally well-equipped, this may reflect a regional difference or a general raising of the bar for technology infrastructure.[1]

[1] Because of the constant changes in technology, questions about the adequacy of hardware and software are always relative to what institutions need to accomplish. Several members of the Advisory Committee on this report noted that, in their experience, perceived adequacy of facilities tends to decline as users become more sophisticated and aware of what they could do with additional equipment—regardless of how much hardware an institution already has installed. Self-reports that infrastructure is "adequate" (which include the data presented in this paper) are thus best interpreted to mean that something other than numbers of computers or network connections (such as professional development) is the limiting factor at the moment. It is probably safe to say that all institutions need to regularly upgrade their technology and that all technology users could make better use of the equipment they already have.

Milken Exchange/ISTE Survey on Information Technology in Teacher Education

In commissioning the Survey on Information Technology in Teacher Education, the Milken Exchange's intent was two-fold: first, to establish baseline data on the use of information technology in teacher preparation; and second, to devise an instrument for rating institutions on their capacity to prepare teachers for using technology in the classroom.

Development of the Survey

In January 1998, the Exchange enlisted an advisory committee of college deans, researchers, teacher educators, and education agency officials to help ISTE generate questions for a survey of SCDEs in the United States. ISTE also collected recent survey instruments and technology standards documents. The advisory committee members brainstormed a list of elements they felt contributed to successful use of technology in teacher education. ISTE staff used those results to develop questions about course requirements, faculty technology skills and practices, technology infrastructure, field experience opportunities, and the technical and pedagogical skills of program graduates. The focus of the survey was somewhat more narrow than previous studies in that it focused on "electronic digital technologies" rather than older technologies such as television and videocassette recorders. The survey form with scoring guide is attached as Appendix 1.

Most items asked respondents to estimate the percentage of individuals or facilities with certain skills or experience (e.g., modeling technology use in teaching) or the relative level of different kinds of capacity (e.g., technical support). Responses were converted to Likert-type scale scores. To help provide additional context for each institution, the survey asked for short narratives about what respondents felt were the notable features of their programs. Initial versions of the form were piloted with education graduate students and with SCDE faculty at educational conferences, and revisions were made to improve the survey's clarity and comprehensiveness.

Limitations of the Approach

The advisory committee and the Milken Exchange acknowledge that there are limitations to investigating a subject as complex as teacher education with a short-answer survey. The responses are subjective. They represent individuals' beliefs about their institutions, but do not necessarily represent direct observation of teaching behaviors or particular levels of technology infrastructure (see the footnote on "adequacy" in the preceding section). It is difficult—perhaps impossible—to locate any one individual who is completely knowledgeable about the wide range of topics addressed in the survey. The respondent sample is necessarily heterogeneous, as survey forms at each institution were forwarded to the individual or individuals best able to provide information. These included deans, faculty members, and technology support staff. Each of these groups may have certain biases that affect responses. In cases where surveys were completed for several different departments within the same institution, respondents from different programs often gave different ratings of the same items (see the discussion of multiple submissions, below). This suggests uncontrolled individual variability, true differences in technology capacity of different departments, or an interaction between the program and capacity, such that the same facilities are more useful to one group of faculty and students than to another. These limitations, which affect most self-report surveys to some degree, mean that conclusions based on this work need to be tested against case studies and outcomes for program graduates.

Distribution and Returns

The survey was initially distributed in April 1998 to deans and faculty at SCDEs on a commercially available mailing list. Over the next three months, ISTE collected additional contacts from a variety of sources, including the ISTE Special Interest Group for Teacher Education (SIGTE), the American Association of Colleges of Teacher Education (AACTE), and NCATE. By July 1998, an average of five appeals had been made to each of 1,326 institutions.[2]

As of October 15, 1998, ISTE received surveys from 446 individuals representing 416 institutions—about a third of U.S. SCDEs—with about 90,000 education graduates in the 1997-1998 school year. Approximately half of the surveys were completed on the Web and half returned by mail. Three hundred and twenty-eight respondents (74 percent) were college faculty (42 percent of those had responsibilities as department chairs or program directors). Fourteen percent of respondents were deans. The remainder consisted of technology coordinators and administrative staff. Sixteen percent of respondents were involved in IT instruction, 23 percent had primarily a coordination or oversight role regarding IT, and 20 percent were involved with both IT instruction and coordination. Three percent of respondents had no particular IT duties. On the remaining surveys (38 percent), the job function was not described.

The institutions covered a range of annual numbers of graduates (two to 1,753 for single-site campuses; 3,500 for the 22-campus National University in California, which asked to be represented by a single survey). The median number of graduates was 120. Respondents represented a variety of Carnegie classification

[2] Precise tallies of teacher preparation institutions and the numbers of graduates they produce turn out to be surprisingly hard to pin down. The NCATE State Update for Fall 1997 lists 1,336 state-approved teacher training institutions, similar to the number that ISTE gathered in 1998. However, NCATE staff informed ISTE that their count varies from year to year depending on institutions' inclusion or exclusion of branch campuses. The National Center for Education Statistics' 1997 *Digest of Education Statistics,* lists 106,079 Bachelor's degrees and 101,242 Master's degrees in education, but that total of 207,321 is surely greater than the number of new teachers being prepared, as some number of the graduate students are veteran teachers returning for advanced degrees. See Feistritzer (1998) for more on the debate over counting new teachers.

types—research, doctoral, masters, baccalaureate, teachers college, tribal college, business school, and theological seminary. Most were in the Masters and Baccalaureate classifications. All Regional Educational Technology Consortia (R*TEC) regions were represented, with the largest number of schools coming from the southeast (see Appendix 2.1 for a table of sample characteristics).

Scoring Issues

The survey had 32 scored items. Respondents checked off a percentage or performance level and the responses were converted to point scores by the Web form or (in the case of mailed and faxed forms) by data entry staff. The scoring guide is included in the sample survey provided as Appendix 1; however, the point values did not appear on the actual survey forms mailed to institutions and available on the Web.

Missing Data

It became obvious during piloting the questionnaire that most individual respondents would not have the information to answer all questions on the form. We asked respondents to indicate "don't know" when they felt they could not provide an answer. On the final survey, only 147 of 446 individuals (33 percent) provided answers for all 32 items. "Don't know" responses presented two problems. First, they contributed no points, and thus penalized the institution's score for one individual's lack of knowledge. Second, a single missing response would result in an entire questionnaire being dropped from certain statistical procedures. Consequently, missing data was estimated based on the mean percentage of possible points a respondent earned on each item. The mean number of questions answered was 30, and the mean proportion of estimated points was eight percent. Unless noted otherwise, statistics in this report include surveys with estimated points. The effect of estimated points is discussed further in the following Results section.

Multiple Submissions

As noted earlier, ISTE received multiple submissions from some institutions. In cases of widely disparate answers, staff contacted the respondents for clarification. In cases where a survey represented a small number of graduates from a single department that was also represented in another survey for the entire institution, the more comprehensive institution survey was used. In cases where one of two surveys covering the same program had a large number of unanswered items, we retained the more complete survey. Finally, where several departments with little overlap responded, the item scores were averaged across surveys on a new composite form. The analysis presented in this report is based on 416 surveys, one per institution, including 17 composites. Combining surveys enabled us to fill in data for several "don't know" responses, bringing the final set of surveys with complete answer sets and no estimated points to 150.

Results

Although the scale scores for each item can be summed to yield a total score, this overall figure was not used by itself as a measure of IT capacity. The survey advisory committee raised theoretical concerns from the beginning of the project about how valid a single score could be, considering the wide range of questions asked. The survey awards more points for more capacity as reported on each question. However, the tacit assumption that "more is better" is not always appropriate. For instance, one respondent noted in regard to the first question about IT course requirements, "We have no computer use courses separate from pedagogy courses, as we feel the use of computers is as basic as the use of a pen and paper." In this case, the meaning of the item-1 score (0), is ambiguous, representing lower capacity of one type, but possibly higher program quality. To address this type of concern, we decided to focus our analysis and interpretation on individual items and subscales of the total survey that addressed different aspects of capacity.

However, total scores did define the general psychometric properties of the survey. The mean score for the 416 institutions that completed surveys was 85.6 and the standard deviation was 18.4. Scores ranged from 27 to 128 points out of a possible 151. The distribution was negatively skewed, with more scores above the mean than below.

Total scores were used to check for response bias in various types of respondents. Program size, in terms of numbers of graduates, made little difference, correlating only .03 with total score. An analysis of variance turned up no significant differences in overall scores for public vs. private institutions, NCATE members vs. nonmembers, respondents' job types (dean, faculty, or technology coordinator), IT job functions (instructional, coordination, or none), different regions of the country, or institutions with different Carnegie classifications (research, doctoral, masters, baccalaureate, teachers, business, theological) (Appendix 2.2). The reliability coefficient alpha, a measure of internal consistency, was computed at .91 (Appendix 2.3). That is a relatively high value for alpha, suggesting that, despite the range of questions, most items on the survey are related to a common construct.

Because of concern that the practice of estimating points for missing items would artificially elevate inter-item correlations, we re-ran the coefficient alpha calculations using only the 150 surveys with responses to all 32 questions. Results were similar, with alpha computed at .90.

The mean total score for surveys with complete response sets was 88.2 versus 84.2 for surveys with estimated points. That difference in means, while small, is statistically significant at the .05 level. That is, even for the questions they did answer, respondents who could not answer all questions tended to give lower ratings to the their institutions' technology capacity. (Complete surveys earned 58 percent of possible points, while incomplete surveys averaged 56 percent of possible points for the questions answered.) We might conjecture that faculty and staff at institutions with greater IT capacity are more likely to complete an IT survey because of that capacity, in that the technology is pervasive and visible.

Factor Analysis

To reduce the number of survey questions (some of which are quite similar) for analysis and interpretation, factor analysis was used to group highly correlated items together. Although the survey form was divided into sections on Coursework, Facilities, Field Experience, and Preparation of Graduates, these groupings had no strong theoretical basis. They were created for the convenience of respondents so that questions that required similar types of information or expertise would be close together on the questionnaire page. We found that 26 of the items could be grouped into four factors. Most of the Facilities scores were highly correlated, as were those for Field Experience questions. The other two factors might be described as Applications Skills (i.e., ability to use word processors, e-mail, Web browsers, and electronic gradebooks) and Integration (i.e., the modeling of technology use in teaching and the ability to design technology-based lessons). Six items loaded on no factor. Table 1 indicates which questions clustered under each of the factors (rotated factor loadings for all variables appear in Appendix 2.4). Once again, we repeated this analysis using only the 150 surveys with full response sets. The results were similar, with the exception that IT course completion (question 3) and distance learning hours (question 6) now loaded on the Integration factor, and the ability to design project-based lessons (question 28), loaded on both the Integration and Application Skills factors.

Table 1. Survey Items Grouped by Factors (see Table 2.3 for complete list of Survey Items)

Factor 1 "Facilities"	Factor 2 "Integration"	Factor 3 "Application Skills"	Factor 4 "Field Experience"
Survey Item #	**Survey Item #**	**Survey Item #**	**Survey Item #**
8. Classroom Internet access	5. Use of IT in teaching	24. Word processing skills	20. IT field experience availability
9. Classroom physical arrangement	7. Use of CAI	25. E-mail skills	21. IT application in field experience
10. Student IT quantity	28. Project-based learning	26. Web skills	22. Cooperating teachers model IT
11. Student IT quality	29. Problem solving	27. Electronic gradebook skills*	23. Supervisors advise on IT
12. Student IT access	30. Students with special needs	*also loaded on factor 2	
13. Student IT support	31. Teaching about technology		
14. Faculty IT quantity	32. Range of IT environments		
15. Faculty IT quality			
16. Faculty IT access			
17. Faculty IT support			
19. Continuing funding			

Variables loading on no factors

1. Required IT course
2. IT in other courses
3. Completion of IT courses
4. Faculty IT capacity
6. Distance learning hours
18. Technology plan
19. Continuing funding

We reran the investigation of demographic variables as a multivariate analysis of variance with the newly identified factors as independent variables (Appendix 2.5). For most variables, there were no significant effects for program characteristics. There were scattered differences: Public institutions and NCATE member institutions were more likely to report using distance learning. NCATE member institutions tended to report more IT instruction integrated into other courses. In terms of applications skills, research institutions (as per Carnegie classification) tended to claim the highest percentage of capable students, and the few teacher's colleges, tribal colleges, business schools, and seminaries in our sample tended to report the lowest percentage. SCDEs in our sample from the Pacific Southwest tended to report significantly lower levels of Field Experience opportunities and, along with Northeastern SCDEs, to allow students to complete IT coursework later in their programs. Additional findings included that NCATE-affiliated SCDEs were more likely to have technology plans than were non-NCATE institutions (Appendix 2.6). Numbers of graduates correlated .10 with the Facilities factor and with having a technology plan (Appendix 2.7). That is, larger institutions were somewhat more likely to report better facilities and a technology plan. No other correlation with numbers of graduates was statistically different from 0 at the $p = .05$ level.

The Baseline Profile

Table 2, beginning on the next page, shows the response distributions for each of the 32 scored items on the survey. The modal responses appear in bold face. The right hand column shows the median response for each item. (See the survey form in Appendix 1 for the complete text of the questions and response options.)

IT Facilities

The mean and median response for classroom Internet access was 26-50 percent of classrooms online. The distribution of responses concerning Internet access was bimodal: the highest frequencies were at one-25 percent and at 100 percent.[3] This suggests that there may be a "have/have-not" situation in terms of Internet in classrooms. However, Green (1998) points out that higher education students and faculty (who have shown a steady increase in e-mail and Web use) access the Internet in many settings. Thus, lack of Internet in classrooms is mainly a limitation on ability to model technology use during teaching than it is a limitation on individual access.

The mean/median for computer projection capability was 51-75 percent of classrooms. The overall hardware and software infrastructure (including technical support) was most often rated as "adequate" to the current program. That is, respondents were not prevented in undertaking current projects by limitations on infrastructure, but only 29 percent felt they had the capacity to expand their IT-based activities with the existing technology base. (We need to keep in mind that "adequate" was defined in terms of each institution, not against a standard checklist of facilities; see the footnote on page 5). Most institutions did not have a written technology plan in force, and only 31 percent had half or more of their IT funding as a regular item in annual budgets.

[3] Each survey scale score corresponds to a range of percentages, so we can only estimate an average level of Internet access from our data. If we assume each scale score represents the midpoint of its range (e.g., a score of one for the range one-25 percent represents 13 percent), we could multiply those midpoint figures by the percentages in Table 2 and sum the products to obtain an estimated mean of 45 percent of SCDE classrooms with Internet access. That would suggest that percentages of Internet-equipped classrooms are now similar in K-12 and higher education.

Table 2: Response Distributions and Median Responses for Survey Items, by Factor.

Item — % response at each level (mode in bold face)
Except as noted, 0 = 0%, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-99% 5 = 100%

Factor 1: Facilities	**0**	**1**	**2**	**3**	**4**	**5**	**DK**	**Median response**
8. Classroom Internet access	8%	**38%**	12%	9%	11%	21%	1%	(2) 26-50% of classrooms have Internet access.
9. Classroom physical arrangement	3%	**27%**	18%	16%	14%	20%	1%	(3) 51-75% of classrooms are equipped for computer projection systems.
10. Student IT quantity	5%	29%	**43%**	23%			0.5%	
11. Student IT quality	4%	21%	**44%**	31%			0.7%	For items 10-17, 1= “severely limiting,” 2 =
12. Student IT access	4%	27%	**43%**	27%			0.2%	“limiting,” 3 = “adequate,” 4=”well suited.”
13. Student IT support	7%	28%	**40%**	24%			0.2%	The median response for items 10-17 was
14. Faculty IT quantity	5%	26%	**38%**	31%			0.0%	the same as the mean and mode:
15. Faculty IT quality	5%	22%	**42%**	31%			0.5%	(3) Facilities are adequate to the needs of the
16. Faculty IT access	5%	23%	**38%**	33%			0.5%	current program.
17. Faculty IT support	9%	28%	**35%**	28%			0.2%	(2) 26-50% of the IT budget is funded on a
19. Continuing funding	12%	**26%**	7%	11%	11%	9%	25%	continuing basis. (Note 25% don’t know)

Factor 2: Integration	**0**	**1**	**2**	**3**	**4**	**5**	**DK**	**Median response**
5. Use of IT in teaching	1%	**35%**	31%	22%	8%	1%	2%	(2) Faculty model IT in 26-50% of courses.
7. Use of CAI	35%	**40%**	5%	4%	5%	5%	7%	(1) 1-25% of students take as much as 10 clock-hours of computer-assisted instruction.
28. Project-based learning	0%	13%	17%	24%	**25%**	10%	11%	(3) 51-75% of graduates can design project based lessons incorporating IT.
29. Problem solving	0%	15%	18%	24%	**25%**	6%	11%	(3) 51-75% of graduates can help students do IT-assisted problem solving.
30. Students with special needs	1%	**25%**	20%	18%	15%	5%	15%	(2) 26-50% of graduates can help students with special needs using IT.
31. Teaching about technology	0%	14%	19%	24%	**28%**	8%	6%	(3) 51-75% of graduates can teach age-appropriate IT skills to K-12 students.
32. Range of IT environments	0%	16%	21%	**28%**	21%	6%	8%	(3) 51-75% of graduates can work in a range of IT environments (labs, classrooms, etc.)

Factor 3: Application Skills	**0**	**1**	**2**	**3**	**4**	**5**	**DK**	**Median response**
24. Word processing	0%	0%	3%	10%	36%	**49%**	1%	(4) 76-99% of graduates can use a word processor to develop lesson plans.
25. E-mail	0%	0%	5%	8%	37%	**48%**	2%	(4) 76-99% of graduates can use e-mail to communicate with colleagues.
26. Web browsing	0%	1%	5%	10%	39%	**43%**	2%	(4) 76-99% of graduates can use the World Wide Web to retrieve information.
27. Electronic grade book	1%	10%	13%	22%	**24%**	18%	12%	(3) 51-75% of graduates can use an electronic gradebook.

Factor 4: Field Experience	**0**	**1**	**2**	**3**	**4**	**5**	**DK**	**Median response**
20. IT field experience availability	0%	16%	23%	**26%**	20%	8%	6%	(3) 51-75% of students do practice teaching in K-12 classrooms with IT available.
21. IT application in field experience	0%	23%	**24%**	19%	18%	4%	11%	(2) 26-50% of students routinely apply IT in their practice teaching.
22. Cooperating teachers model IT	0%	**36%**	30%	14%	5%	0%	14%	(2) 26-50% of classroom teachers model IT use for students during field experiences.
23. Supervisors advise on IT	2%	**32%**	24%	21%	9%	3%	10%	(2) 26-50% of field experience supervisors can advise student teachers on IT use.

Table 2: (cont.)

Item	(0 = 0 qtr. hrs., 1 = 1-2 qtr. hrs., 2 = 3-4 qtr. hrs., 3 = 5-6 qtr. hrs., 4 = 7-8 qtr. hrs., 5 = 9-10 qtr. hrs., 6 = >10 qtr. hrs.)								
Variables loading on no factors	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**DK**	**Median response**
1. Required IT course credits	14%	7%	**50%**	9%	3%	8%	3%	7%	(2) Students are required to take 3-4 quarter-hours of instruction in IT-specific courses.
2. IT credits in other courses (Scored as variable 1, above)	17%	12%	**21%**	4%	3%	5%	9%	28%	(2) Students take 3-4 quarter-hours of IT as part of other required courses. (Note 28% don't know.)
3. Completion of IT coursework (1 = not during program, 4 = before entering the program)		9%	37%	**39%**	12%			4%	(3) Students will have completed at least 3 credit-hours in IT by midway in the program.
4. Faculty IT capacity (1 = comparable to students beginning IT coursework; 2 = comparable to students part-way through; 3 = comparable to students completing IT coursework; 4 = exceeds that of students completing IT coursework.)		1%	19%	**65%**	12%			3%	(3) Faculty have IT skills comparable to those of students completing their IT coursework.
6. Distance learning hours	**47%**	40%	5%	2%	1%	0%		5%	(0) No students spend at least 10 clock hours taking coursework via distance learning.
18. Technology plan (0 = No, 4 = Yes)	**54%**				35%			11%	(0) The program has no written, multi-year, regularly updated technology plan.

Integration of Technology

The mean and median estimated proportion of faculty using IT in teaching was 26-50 percent. Computer-assisted instruction (CAI) was reported used at least 10 clock hours by about one-25 percent of students—when it was used at all. More than a third of institutions reported that no students used CAI. In terms of graduates' abilities, about 51-75 percent were reported able to teach technology skills to K-12 students, to organize student projects that use information technology, to help students use technology in problem-solving activities, and to work in a variety of technology environments. Twenty-six to 50 percent were reported able to work effectively with specialists to select and use adaptive technology for students with special needs.

Applications

When we asked what proportion of program graduates had basic wordprocessing, e-mail, and Web skills, the most common response was that all did. The median responses were only a little lower: 76-99 percent. The median response for electronic grade book use was 51-75 percent of graduates.

Field Experience

The median response was that up to 75 percent of student teachers have their field experience in classrooms where information technologies are available. However, the actual use of that capacity is less certain. Less than half of teacher trainees routinely apply IT use with K-12 students, and less than half of field experience supervisors or cooperating classroom teachers are able to advise on and model educational technology use.

Coursework and Faculty

Scores on most coursework questions did not load on any factor and did not correlate highly with one another. The mean number of required credits in IT is three to four quarter-hours—essentially one class for a quarter, or a series of short workshops. The number of IT credit-hour equivalents in other classes is similar. That is, students are getting about half their formal IT training in a specific IT course, and the other half as part of methods courses and other instruction. At least three IT credit-hours are typically completed by midway through the program. Narrative comments on the surveys suggest that required IT-specific courses are generally completed early, while the integrated hours are earned throughout the course of study. In most cases, students take less than 10 clock-hours of instruction through distance education. In those institutions that do offer distance education, participation is 25 percent of students or less.

We asked about faculty IT capacity in relation to the student coursework described above. Despite the ongoing changes in technology, faculty seem to be keeping up with their recently-trained students. Two thirds of SCDEs reported that faculty members have IT skills comparable to those of students who have completed the required IT coursework. Most of the other faculty have skills comparable to students who are midway through taking their IT coursework.

Key Variables in IT Preparation

The profiles described above provide a baseline against which to measure progress. To get a better idea of what variables are most important in the IT-preparation of teachers, we took a closer look at relationships within our data. Table 3 shows the intercorrelation of the main factors and the remaining variables.

Table 3: Simple Correlations of Survey Factors and Nonloading Items.

Variable	Req. IT hours	1. IT other courses	2. Completion	3. Faculty capacity	4. Distance learning	6. Tech. plan	18. Facilities	Integration	Applications	Field Exp.
1. Req. IT hours	1.00	0.20	0.34	0.06	0.22	0.08	0.16	0.17	0.11	0.16
2. IT other courses	0.20	1.00	0.20	0.21	0.23	0.22	0.18	0.33	0.19	0.23
3. Completion	0.34	0.20	1.00	0.16	0.08	0.07	0.06	0.22	0.16	0.08
4. Faculty capacity	0.06	0.21	0.16	1.00	0.16	0.13	0.28	0.34	0.24	0.23
6. Distance learning	0.22	0.23	0.08	0.16	1.00	0.19	0.14	0.23	0.07	0.1
18. Tech. plan	0.08	0.22	0.07	0.13	0.19	1.00	0.20	0.23	0.10	0.19
Facilities	0.16	0.18	0.06	0.28	0.14	0.20	1.00	0.41	0.44	0.35
Integration	0.17	0.33	0.22	0.34	0.23	0.23	0.41	1.00	0.62	0.52
Applications	0.11	0.19	0.16	0.24	0.07	0.10	0.44	0.62	1.00	0.34
Field Exp.	0.16	0.23	0.08	0.23	0.14	0.19	0.35	0.52	0.34	1.00

All correlations are low to moderate, suggesting that the factors actually measure distinct constructs. One factor that stands out is Integration. The Integration score is the highest-correlating variable with six of the nine other variables. That is, of all the post-factor-analysis variables in our survey, Integration explains the largest proportion of variance in other variables and is in turn easiest to predict from the other variables. The correlations do not tell us whether there is a cause/effect relationship (e.g., whether increasing applications skills leads to greater ability to integrate technology, or vice versa). In any case, improving Integration scores would seem to be a worthy goal for an SCDE. The Integration factor is probably the closest thing in our survey to an "outcome measure," in that its seven questions come closer to addressing actual classroom experiences and teaching skills than most other items.

If the Integration questions stand out because of their high correlation with other measures, the credit-hour and technology planning questions are remarkable for their lack of relation to other items. This is particularly true of hours spent in IT-specific courses (question 1). By itself the number of credit-hours explains less than three percent of the variance in each of the major factors. We assumed formal course work would correlate with (or, to impute causality, lead to) higher scores on using applications and the ability to integrate technology into instruction. This is not the case. Technology training incorporated into other courses is more highly correlated with the main factors, in particular Integration, where it explains about 11 percent of variance ($r = .33$).

Based on the prominence education writers (including, it should be noted, the present authors) have given to technology planning, we also expected a strong correlation between having a technology plan and higher scores on other items. There is a relationship: Institutions with technology plans have higher scores on all four of the main factors, and the differences are significant for Facilities, Integration, and Field Experience (Appendix 2.8). However, the maximum factor correlation (with Integration) only explains about five percent of variance.

Summary of Survey Findings

1. Most institutions report that their technology infrastructure is adequate or better in terms of carrying out their current programs. About a third feel their programs are limited by deficiencies in their IT facilities.

2. Faculty IT skills tend to be comparable to the IT skills of the students they teach; however, most faculty do not model use of those IT skills in teaching.

3. Distance education and computer-assisted instruction currently affect only a small proportion of students in teacher training institutions.

4. Most programs do not have a written, funded, regularly-updated technology plan. The presence of a technology plan has a positive, but low, correlation with other measures of capacity.

5. Most institutions report that IT is available in the K-12 classrooms where student teachers get their field experience; however, most student teachers do not routinely use technology during field experience and do not work under master teachers and supervisors who can advise them on IT use.

6. The number of hours of IT instruction integrated into other courses has a moderate correlation with other scores on the survey; however, the number of hours of formal IT instruction does not.

7. The Integration factor—composed of items that addressed graduates' class room skills and the actual use of IT during college training—was the best predictor of other scores on the survey. The best predictor of Integration scores was basic technology proficiency as represented by the questions in the Applications factor.

Discussion of Findings

The Milken Exchange/ISTE Survey on Information Technology in Teacher Education confirmed certain observations from other research. The 1998 survey also produced some findings that merit further investigation.

One finding that has been common to other recent studies is that the technology infrastructure of education has increased more quickly than SCDE ability to incorporate new tools into teaching and learning. This comes out in the disparities between facilities and integration. The technology infrastructure is generally deemed "adequate," but many faculty do not model technology use, and certain types of activities—Internet sessions and computer presentations—would not be possible in a large number of classrooms. It may be that many respondents have low expectations for what can be achieved with technology. Or it may be that facilities really are not the main limitation, and IT integration depends on other factors, such as faculty professional development or course-development time.

The situation in the college classrooms to some extent mirrors the situation in K-12 classrooms. There is apparently more opportunity to be in technology-equipped K-12 classrooms than there is to actually apply IT skills in those classrooms or to work under IT-proficient supervision. Some members of the project advisory committee who are involved in teacher training pointed out that during initial classroom experiences, curriculum and classroom management occupy so much of a teacher's attention that there is little opportunity to concentrate on technology. However, that only begs the question: how are new educators going to learn to integrate technology in teaching and learning if not in actual classrooms?

This brings us to what may be the most interesting finding of the survey: the lack of relation between formal IT coursework and other measures of capacity. Eighty-five percent of respondents who answered the first question on our survey had specific IT course requirements. In narrative comments about the notable features of their programs, many respondents cited their introductory technology classes. Yet the current data do not support the idea that additional technology-specific coursework will greatly improve any other aspect of IT use covered in our survey. Even applications skills, which might seem most appropriate for teaching in standalone courses, have little correlation ($r = .11$) with IT coursework.

We did not systematically collect information on the content or quality of the IT courses or on how those courses articulate with other aspects of teacher education. It may be that many of the credits reported in our survey are for generic "computer-literacy" courses that are not well aligned with other work that students need to do. Another possibility is that an introductory technology course of three to four quarter-hours (the most common response in this survey) is indeed important for preparing students to make the most of their programs, but that additional hours beyond that make little difference. However, in that case, we would expect institutions with no standalone IT instruction to report significantly lower ratings in main factors such as applications skills and integration. They don't. The only significant difference between variable means for institutions with and without formal IT coursework was in distance education. Students in programs with IT course requirements were more likely to have part of their coursework through distance education (Appendix 2.9).

So the possibility remains that standalone IT courses are generally not an efficient way to help new teachers use technology in schools. The ISTE/NCATE standards recommend that teacher candidates "complete a well-planned sequence of courses *and/or experiences"* (emphasis added) that will help them understand and apply technology in education. About half the IT instruction teacher trainees receive is delivered as part of other courses, and, as noted in the previous section, these "experiences" are more highly correlated with technology integration than are hours of IT-specific coursework. Educational reformers have long noted that teachers teach as they were taught (Barron & Goldman, 1994). If we want to encourage the use of technology as a tool for learning and problem solving, it makes sense that we would want teachers to model this activity for students at all levels and in all appropriate contexts.

Moving most IT instruction to an integrated model would constitute a substantial change in pedagogy and course structure for many institutions and instructors. It would imply that faculty, most of whom do not now model technology use, would need to increase their personal level of technology use in teaching. Adoption of IT is a complex innovation, and probably will not occur without a combination of individual initiative, top-down mandates, and consensus by program faculties (Rogers, 1995).

Increased integration would mean that more programs would need to develop and implement technology plans that cover faculty professional development, placement of computers and network connections, new or modified curriculum, and expected student outcomes. The NCATE Task Force report cited earlier, which also emphasized the importance of technology integration, recommended that a vision and plan for technology be made a requirement for SCDEs.

Recommendations

In general, in order to increase the technology proficiency of new teachers in K-12 classrooms, training institutions should increase the level of technology integration in their own programs. In particular:

- IT instruction should be integrated into other courses and SCDE activities, rather than being limited to standalone classes.
- Institutions should engage in technology planning that focuses not only facilities but on the integration of IT in teaching and learning.

- Student teachers need more opportunities to apply IT during field experiences under qualified supervision. Considering the apparent shortage of technology mentors during field experiences, this may be an area where distance education (in the form of distance mentoring) could play an important role by linking new teachers to qualified supervisors or master teachers at other colleges and K-12 school sites.

- Faculty should be encouraged to model and integrate technology. No strategy for accomplishing this is addressed in the current survey, but other studies, (National Council for Accreditation of Teacher Education, 1997; Willis & Mehlinger, 1996), recommend increased emphasis on faculty professional development, including incentives outside the traditional academic rewards system to support IT adoption. Organizations such as NCATE and ISTE, through their roles in establishing and disseminating standards for educational technology, have an important part to play in encouraging and facilitating change.

- In order to provide models for change, researchers, professional societies, and education agencies should, on an ongoing basis, identify, study, and disseminate examples of effective technology integration that reflect the current needs in both teacher education and K-12 schools.

Directions for Future Research

A large amount of self-reported survey data has been collected on SCDEs since 1996. It would be useful now to focus in greater depth and seek to understand the details of how programs achieve specific outcomes. Important questions at this stage include:

- What are the most effective models for learning how to integrate IT into classroom practice? This research should look for concrete evidence of effectiveness, including observations in SCDE and K-12 classrooms, interviews with SCDE graduates who have gone into teaching, technology-based lesson plans and student work samples. On the basis of this survey, we would predict that a study of the effects of standalone IT courses versus increasing use of technology in all courses would show that teachers trained in the latter environment will be better able to use IT in their work. However, standalone courses may be necessary in certain contexts, such as bringing students up to speed on basic skills. They may be appropriate for older students entering a teacher education program who have not grown up with technology as a regular part of school and work (note, however, that this current survey did not find a strong correlation between reported application skills and hours of IT-specific coursework).

- Where and how do education students acquire their basic technology skills? What is the role of precollege training, junior college training, training in other university programs, and informal self-directed learning? Knowing these parameters would help us identify those gaps in IT knowledge and skill that would be best addressed by SCDEs.
- How did high-scoring SCDEs in the Milken/ISTE survey achieve their levels of capacity? For instance, in the nine percent of institutions in our survey that reported 75-100 percent of faculty model technology use, were particular professional development activities or incentives necessary to achieve that level of integration? In the four percent of institutions where student teachers regularly apply IT during field experience, what types of applications and activities are used in the K-12 classrooms? How does field experience articulate with the college coursework, and what types of collaborative structures were necessary to achieve that articulation?

Public agencies and foundations should develop and solicit research proposals that will address these issues, and should ensure timely and widespread dissemination of new knowledge as it becomes available.

Another type of inquiry—harder to generalize, but easier to apply to individual institutions—is the use of this survey or similar instruments as tools for internal needs assessment and action research. Some respondents noted that the process of completing the survey form made them more aware of their own program's strengths and weaknesses and provided a format in which to communicate with colleagues about ways to make improvements.

Limitations of the survey for cross-institution comparisons—such as individuals' lack of information or the irrelevance of certain questions—can be made moot in an internal needs assessment where action researchers have access to an entire faculty and student body over a period of time and can tailor the set of questions to reflect a particular program. Perhaps best of all, this type of research requires no large-scale grants or national initiatives, but only the desire of faculty and administrators to improve their understanding and use of information technology in teacher education.

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Appendix 1: Survey Form

This is the survey distributed in spring and summer 1998 by the International Society for Technology in Education (ISTE) for the Milken Exchange on Education Technology. The document that appears here is a text version distributed by e-mail. A printed version of the instrument was distributed by surface post, and an HTML version was available on the World Wide Web as a fill-in form. The shaded boxes include a point-value key for each scored item and the percentages of respondents who checked that level of the item. Respondents did not know the point values of their responses at the time they completed the survey.

INFORMATION TECHNOLOGY IN TEACHER EDUCATION

A survey conducted for the Milken Exchange on Education Technology by the International Society for Technology in Education.

DIRECTIONS:

- Please complete the text form below for your teacher education institution and return by e-mail to tbielefe@oregon.uoregon.edu.
- See the cover letter at http://www.iste.org/Research/Milken/coverlet.htm for information on the Milken Exchange teacher education project.
- An interactive version of the form is available at http://www.iste.org/Research/Milken/, or a print version can be ordered from Talbot Bielefeldt, ISTE, 1787 Agate St., Eugene, OR 97403-1923; Phone 541/346-2405; Fax 541/346-5890.
- In this questionnaire, information technology (IT) refers to the full range of electronic digital technologies—including computer productivity tools, multimedia, telecommunications, and educational software—as applied in curriculum and instruction in your program.

- Unless otherwise noted, please check only one choice per item.
- If you don't have enough information to answer a question, please check "Don't know."
- Although this survey consists largely of multiple-choice items, we welcome additional comments on any of the questions. Please use the comment area at the end of the form.

Thank you for your help with this important effort. For additional information, contact:

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Part 1:
Your Teacher Education Program

1.1 Identification of program.

Institution:

Department:

Address:

Address (cont.):

City:

State:

ZIP:

Phone:

Fax:

Web:

1.2 Check the boxes that best describe your higher education institution.

☐ Private	**55%**
☐ Public	**45%**
☐ Research/Doctoral	**(55% no response. Because of low response, this information was acquired from the Carnegie Foundation listings for each institution. See Appendix 2.1)**
☐ Comprehensive/Liberal Arts	

1.3 Number of education graduates expected in current calendar year:

Elementary Education ________	**42,961 total**
Secondary Education ________	**24,526 total**
Special Education ________	**10,593 total**
Other: ________	**15,551 total ("Other" includes administrators and content specialists, as well as graduates whose areas of focus were not reported.)**
(describe:) ________________________	

1.4 Multiple programs. If teacher education at your institution is comprised of several large distinct programs, we would prefer that a separate copy of this questionnaire be completed for each. (If you are working from a printed copy of the questionnaire, please make a copy of the form.) Please tell us below which programs are covered by the data in this form:

☐ All programs listed in 1.3	**70%**
☐ Elementary only	**6%**
☐ Secondary only	**2%**
☐ Special Ed. only	**3%**
☐ Other: ____________________	**4% (13% no response)**

1.5 Your contact information:

First name:
Last name:
Position:
Address:
Address (cont.):
City:
State:
ZIP:
Phone:
Fax:
E-mail:

1.6 Your Information Technology duties or roles:

1.7 About your program. Tell us about information technology features of your teacher education program that are noteworthy or exemplary.

☐ Check this box if your program should be considered for a Milken Exchange case study.

Part 2:
Coursework and Faculty

2.1 Required courses about information technology. How many credit hours of instruction do students receive in required courses that have a primary focus on information technology as described in the Directions? Examples might include required courses on computer literacy or Internet use.

_______ Quarter Hours or _______ Semester Hours _______ Don't know

All responses convert to quarter hours and are scored:

0 hrs.= 0	1-2 hrs.= 1	3-4 hrs.= 2	5-6 hrs.= 3	7-8 hrs.= 4	9-10 hrs.= 5	>10 hrs.= 6	DK = 0
14%	7%	50%	9%	3%	8%	3%	7%

2.2 Instruction about IT in other required courses. How many credit hours of information technology do students receive in required non-technology courses where a large part (but not all) of the instruction involves technology training? For example, a three-credit methods course in which about 1/3 of the coursework is devoted to training in multimedia authoring would count as one credit.

_______ Quarter Hours or _______ Semester Hours _______ Don't know

All responses convert to quarter hours and are scored:

0 hrs.= 0	1-2 hrs.= 1	3-4 hrs.= 2	5-6 hrs.= 3	7-8 hrs.= 4	9-10 hrs.= 5	>10 hrs.= 6	DK = 0
17%	12%	21%	4%	3%	5%	9%	28%

2.3 Completion of IT courses. At what point in the teacher education program will at least 80 percent of students have completed a total of at least three credits from 2.1 and 2.2 above?

(Check one)

☐ Not during the program	☐ By program completion	☐ By midway in the program	☐ Before entering	☐ Don't know
1	2	3	4	0
9%	37%	39%	12%	4%

2.4 Faculty IT Capacity. Approximately what percentage of your faculty would fall in each of the following categories?

_____% LOW CAPACITY.

IT knowledge and skills comparable to that of students beginning the IT coursework described in 2.1 and 2.2 above.

_____% EMERGING CAPACITY.

IT knowledge and skills comparable to that of students midway through the IT coursework described in 2.1 and 2.2.

_____% ADVANCING CAPACITY.

IT knowledge and skills comparable to that of students completing the IT coursework described in 2.1 and 2.2

_____% HIGH CAPACITY.

IT knowledge and skills significantly beyond the content of the IT coursework described in 2.1 and 2.2

_____ DON'T KNOW

Score = (Low % x 1) + (Emerging % x 2) + (Advancing % x 3) + (High % x 4).
Maximum points = 4 (100% faculty rated as 4: high capacity).

1	2	3	4	DK
1%	19%	65%	12%	3%

2.5 Use of IT in teaching. In what percentage of courses in your program do faculty model effective technology use in their teaching?

(Check one)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	DK
1%	35%	31%	22%	8%	1%	2%

2.6 Distance learning. What percentage of your graduates will have spent at least 10 clock hours taking coursework via Distance Learning while in your program?

(Check one)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	DK
47%	40%	5%	2%	1%	0%	5%

2.7 CAI. What percentage of your graduates will have spent at least 10 clock hours taking coursework via Computer-Assisted Instruction while in your program?

(Check one)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	DK
35%	40%	5%	4%	5%	5%	7%

Part 3: Facilities and Support

3.1 Classrooms. Consider all classrooms used by the teacher education faculty. For these classrooms, what percentage:

A. Have Internet connectivity?

(Check one)

☐ 0%	☐ 1-25%	☐ 26-50%	☐ 51-75%	☐ 76-99%	☐ 100%	☐ Don't know
0	1	2	3	4	5	0
8%	38%	12%	9%	11%	21%	1%

B. Have lighting, window shades, electrical power, and other physical arrangements well suited to use of a computer projection system?

(Check one)

☐ 0%	☐ 1-25%	☐ 26-50%	☐ 51-75%	☐ 76-99%	☐ 100%	☐ Don't know
0	1	2	3	4	5	0
3%	27%	18%	16%	1%	20%	1%

3.2 Technology Facilities. Consider all hardware, software, and connectivity available to students and faculty. Please use the following scale to rate how well your IT facilities meet the needs of your program.

- SEVERELY LIMITING. Individuals are unable to undertake or complete important program activities because of significant deficiencies in this area.
- LIMITING. Individuals have difficulty completing important program activities because of deficiencies in this area.

- ADEQUATE. Facilities meet the needs of the current program.
- WELL-SUITED. Facilities meet the needs of the current program and are capable of absorbing program expansion and development of new activities.

Facilities for STUDENTS

(check one in each row)	Severely Limiting	Limiting	Adequate	Well Suited	Don't know
A. Quantity (numbers of computers and other devices, such as projection systems).	☐ 1 5%	☐ 2 29%	☐ 3 43%	☐ 4 23%	☐ DK 0.5%
B. Quality (technical features, ability to upgrade, how well maintained).	☐ 1 4%	☐ 2 21%	☐ 3 44%	☐ 4 31%	☐ DK 0.7%
C. Convenience of access (including scheduling and physical location).	☐ 1 4%	☐ 2 7%	☐ 3 43%	☐ 4 27%	☐ DK 0.2%
D. Technical support and individual help.	☐ 1 7%	☐ 2 28%	☐ 3 40%	☐ 4 24%	☐ DK 0.2%

Facilities for FACULTY

(check one in each row)	Severely Limiting	Limiting	Adequate	Well Suited	Don't know
E. Quantity (numbers of computers and other devices, such as projection systems).	1 5%	2 26%	3 38%	4 31%	DK 0.0%
F. Quality (technical features, ability to upgrade, how well maintained).	1 5%	2 22%	3 42%	4 31%	DK 0.5%
G. Convenience of access (including scheduling and physical location).	1 5%	2 23%	3 38%	4 33%	DK 0.5%
H. Technical support and individual help.	1 9%	2 28%	3 35%	4 28%	DK 0.2%

3.3 Technology Plan. Does your program have a written multi-year technology plan that is updated periodically?

_______ Yes _______ No _______ Don't know

0	4	DK
54%	35%	11%

(If yes, please send a copy to ISTE, 1787 Agate St., Eugene, OR 97403-1923;
Attn: Talbot Bielefeldt. E-mail: tbielefe@oregon.uoregon.edu)

3.4 Funding. What percentage of your program's yearly technology spending is funded on a continuing basis through regular appropriations?

(Check one)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	0
12%	26%	7%	11%	11%	9%	25%

Part 4: Field Experience and Practice Teaching

4.1 Availability. What percentage of your students have field experiences and do their practice teaching in learning environments where information technologies are readily available for use with K-12 students?

(Check one)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	0
.5%	16%	23%	26%	20%	8%	6%

4.2 Application. What percentage of your graduates routinely apply information technology in their field experiences and practice teaching?

(Check one)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	0
.5%	23%	24%	19%	18%	4%	11%

4.3 Cooperating teachers. What percentage of the classroom teachers who accept your students for field experience and practice teaching model effective use of information technology with K-12 students?

(Check one)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	0
.5%	36%	30%	14%	5%	0%	14%

4.4 Supervising teachers. What percentage of supervisors of field experience and practice teaching are able to advise your students on effective use of information technology with K-12 students?

(Check one.)

☐ 0%	☐ 1-25%	☐ 26-50%	☐ 51-75%	☐ 76-99%	☐ 100%	☐ Don't know
0	1	2	3	4	5	0
2%	32%	24%	21%	9%	3%	10%

4.5 Exemplary K-12 schools. Among the districts you serve, is there a school you consider exemplary in terms of its use of information technology in teaching and learning? (If necessary, use the Comment area at the end of the form to cite additional schools.)

School:
Contact first name:
Contact last name:
Position:
Address:
City:
State:
ZIP:
Phone:
Fax:
E-mail:
Web:

Part 5: Preparedness of Graduates

5.1 Professional Productivity. What percentage of graduates can use:

A. A word processor and graphics to develop lesson plans?

(Check one)

☐ 0%	☐ 1-25%	☐ 26-50%	☐ 51-75%	☐ 76-99%	☐ 100%	☐ Don't know
0	1	2	3	4	5	0
0%	0%	3%	10%	36%	49%	1%

B. E-mail to communicate with colleagues?

(Check one)

☐ 0%	☐ 1-25%	☐ 26-50%	☐ 51-75%	☐ 76-99%	☐ 100%	☐ Don't know
0	1	2	3	4	5	0
0%	0%	5%	8%	37%	48%	2%

C. World Wide Web to retrieve information?

(Check one)

☐ 0%	☐ 1-25%	☐ 26-50%	☐ 51-75%	☐ 76-99%	☐ 100%	☐ Don't know
0	1	2	3	4	5	0
0%	1%	5%	10%	39%	43%	2%

D. An electronic grade book?

(Check one)

☐ 0%	☐ 1-25%	☐ 26-50%	☐ 51-75%	☐ 76-99%	☐ 100%	☐ Don't know
0	1	2	3	4	5	0
1%	10%	13%	22%	24%	18%	12%

5.2 Project-based Learning. What percentage of graduates can construct and implement project-based learning lessons in which students use a range of information technologies?

(Check one)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	0
.5%	13%	17%	24%	25%	10%	11%

5.3 Problem Solving. What percentage of graduates can help students learn to solve problems, accomplish complex tasks, and use higher-order thinking skills in an information technology environment?

(Check one)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	0
0%	15%	18%	24%	25%	6%	11%

5.4 Assisting Students With Special Needs. What percentage of graduates are able to recognize when a student with special needs may benefit significantly by the use of adaptive technology and can work with a specialist to make these facilities available?

(Check one)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	0
1%	25%	20%	18%	15%	5%	15%

5.5 Teaching About Technology. What percentage of your graduates have the ability and experience to teach their K-12 students age-appropriate information-technoloy skills and knowledge?

(Check one)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	0
0%	14%	19%	24%	28%	8%	6%

5.6 Ability to Use a Range of IT Learning Environments. What percentage of your graduates can work effectively with students in various IT environments (such as standalone and networked computers, one-computer classrooms, labs, minilabs, and distance education facilities)?

(Check one.)

☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-99% ☐ 100% ☐ Don't know

0	1	2	3	4	5	0
0%	16%	21%	28%	21%	6%	8%

Thank you for your help with this survey. Use the space below to comment on any of the response items. Please mark you comments with the number/letter of the item (e.g., "5.1.B. E-mail").

Appendix 2:
Supplementary Tables (in order cited)

2.1. Profile of Sample

2.2. Mean Total Scores for 416 SCDEs, by Program Characteristics

2.3. Item Means, Standard Deviations, and Item-total Correlations

2.4. Rotated Factor Pattern

2.5. Comparison of Factor and Nonloading Item Means Across Program Characteristics

2.6. Frequency Table of Programs With and Without Technology Plans, by Program Characteristics

2.7. Correlations of Numbers of Graduates With Other Variables

2.8. Comparison of Factor and Unloaded Variable Means for Institutions With and Without Technology Plans

2.9. Comparison of Variable Means for Institutions With and Without IT-specific Coursework

2.1.
Profile of Sample

Institution Characteristics (416 institutions)

Size

	N	%
Median number of graduates	120	—
Lowest number of graduates	2	—
Highest number of graduates	3500	—

Administration

	N	%
Public	227	55%
Private	189	45%

Level

	N	%
Elementary, Secondary, and Seacial Ed	237	57%
Elementary and/or Secondary and/or Special Education and/or other specialties	179	43%

NCATE Affiliation

	N	%
Member	25	62%
Nonmember	160	38%

Region

	N	%
North Central	83	20%
Northeast	81	19%
Northwest	26	6%
Pacific Southwest	41	10%
South Central	53	13%
Southeast	132	32%

Carnegie Classification

	N	%
Research I and II	46	11%
Doctoral I and II	48	12%
Masters I and II	181	44%
Baccalaureate I and II	105	25%
Other (Business, Theological, Tribal, Teachers)	15	4%
(Not rated)	21	5%

Respondent Positions (446 individuals)*

	N	%
Higher education faculty	328	74%
Higher education deans	61	14%
Technical or administrative staff	49	11%
Not identified	8	2%

Respondent Functions (446 individuals)*

	N	%
IT teaching	70	16%
IT coordination/leadership	102	23%
IT teaching and coordination	89	20%
No specific IT roles	14	3%
No role identified	171	38%

* Many position descriptions were ambiguous. Faculty members who also served as deans were counted as deans. Directors of technology centers and IT instructors were counted as technical/administrative staff unless otherwise noted.

2.2.
Mean Total Scores for 416 SCDEs, by Program Characteristics

Institution Characteristics

Administration	N	Mean	SD
Public	227	85.9	18.7
Private	189	85.3	18.0

NCATE Affiliation	N	Mean	SD
Member	256	86.8	18.5
Nonmember	160	83.8	18.0

Region	N	Mean	SD
North Central	83	85.9	19.2
Northeast	81	85.9	19.0
Northwest	26	89.2	13.8
Pacific Southwest	41	79.7	17.2
South Central	53	82.8	18.5
Southeast	132	87.6	18.3

Carnegie Classification (21 unrated institutions excluded)	N	Mean	SD
Research I and II	46	88.3	19.2
Doctoral I and II	48	84.6	16.9
Masters I and II	181	85.4	19.0
Baccalaureate I and II	105	85.8	17.4
Other (Business, Theological, Tribal, Teachers)	15	79.6	22.4

Respondent Positions (11 unidentified positions excluded)	N	Mean	SD
Higher education faculty	300	84.8	18.8
Higher education deans	59	87.0	18.3
Technical or administrative staff	46	87.4	17.0

Respondent Functions (83 unidentified functions excluded)	N	Mean	SD
IT teaching	69	84.9	18.8
IT coordination/leadership	158	88.6	16.5
IT teaching and coordination	98	83.4	19.1
No specific IT roles	8	82.5	28.3

2.3.
Item Means, Standard Deviations, and Item-total Correlations

α = .91 (standardized variables)

Item	Mean	Std. Dev.	Item-total Correlation
1. Required IT courses	2.27	1.47	0.24
2. IT in other courses	2.58	1.82	0.33
3. Completion of IT courses	2.52	0.83	0.20
4. Faculty IT capacity	2.47	0.58	0.38
5. Use of IT in teaching	2.06	1.02	0.47
6. Distance learning hours	0.76	0.94	0.23
7. Use of CAI	1.26	1.42	0.32
8. Classroom Internet access	2.38	1.72	0.35
9. Classroom physical arrangement	2.72	1.56	0.46
10. Student IT quantity	2.84	0.82	0.58
11. Student IT quality	3.00	0.83	0.58
12. Student IT access	2.91	0.82	0.59
13. Student IT support	2.79	0.88	0.52
14. Faculty IT quantity	2.94	0.87	0.59
15. Faculty IT quality	2.98	0.85	0.62
16. Faculty IT access	2.98	0.88	0.56
17. Faculty IT support	2.80	0.94	0.53
18. Technology plan*	1.65	1.86	0.27
19. Continuing funding	2.31	1.49	0.39
20. IT field experience availability	2.77	1.20	0.39
21. IT application in field experience	2.51	1.17	0.53
22. Cooperating teachers model IT	1.99	0.96	0.40
23. Supervisors advise on IT	2.19	1.14	0.54
24. Word processing skills	4.28	0.84	0.52
25. E-mail skills	4.25	0.88	0.55
26. Web skills	4.18	0.90	0.58
27. Electronic grade book skills	3.21	1.26	0.59
28. Project-based learning	2.98	1.19	0.69
29. Problem solving	2.85	1.15	0.65
30. Students with special needs	2.47	1.22	0.54
31. Teaching about technology	2.95	1.18	0.60
32. Range of IT environments	2.76	1.14	0.58

*Dichotomous variable with value of 0 or 4.

2.4.
Factor Analysis Summary

Factor analysis with promax rotation was performed using SAS on 316 individual and composite survey forms from the Milken Exchange/ISTE survey. Prior commonalities were estimated using squared multiple correlations. Four factors were extracted. With a cutoff of .32 for inclusion of a variable in interpretation of a factor, six variables did not load on any factor. Proposed factor labels appear in quotes.

Table 2.4. Rotated Factor Pattern (Standardized Regression Coefficients)

Item	Factor 1 "Facilities"	Factor 2 "Integration"	Factor 3 "Applications"	Factor 4 "Field Experience"
Variance explained (eigenvalues from reduced correlation matrix; total = 39.45)				
	24.37	**7.71**	**4.80**	**2.57**
V1	0.12	0.14	-0.06	0.09
V2	.09	0.30	0.08	0.09
V3	-0.01	0.29	0.00	0.07
V4	0.16	0.23	-0.01	0.09
V5	0.14	0.35	-0.04	0.15
V6	0.08	0.20	-0.12	0.09
V7	0.08	0.40	-0.14	0.01
V8	0.34	-0.03	0.11	0.05
V9	0.38	0.05	0.09	0.11
V10	0.70	0.00	0.07	0.04
V11	0.79	-0.01	0.01	0.00
V12	0.70	0.02	0.04	0.05
V13	0.65	-0.05	0.08	0.02
V14	0.83	0.09	-0.04	-0.10
V15	0.82	0.10	-0.04	-0.03
V16	0.81	0.06	-0.07	-0.04
V17	0.67	0.00	0.05	0.00
V18	0.16	0.24	-0.15	0.00
V19	0.33	-0.03	0.04	0.24
V20	0.00	-0.06	0.11	0.70
V21	-0.01	0.25	0.01	0.61
V22	0.01	-0.03	-0.03	0.81
V23	0.06	0.27	-0.05	0.55
V24	0.00	0.10	0.69	-0.02
V25	0.04	-0.14	0.92	0.06
V26	0.10	-0.10	0.93	-0.03
V27	0.02	0.35	0.47	-0.01
V28	0.06	0.68	0.24	-0.05
V29	-0.05	0.81	0.13	-0.02
V30	-0.01	0.61	0.02	0.14
V31	-0.07	0.76	0.14	-0.01
V32	-0.03	0.69	0.11	0.02

2.5.
Comparison of Factor and Nonloading Item Means Across Program Characteristics

		Factors				Nonloading variables**				
	N	Facilities	Integration	Applicatns.	Field Experience	Required IT courses	IT in other Courses	IT course Completion	Faculty IT Capacity	Distance Learning
Program		M = 30.7	M = 17.3	M = 15.9	M = 9.5	M = 2.3	M = 2.6	M = 2.5	M = 2.5	M = 0.8
Characteristics		SD = 7.9	SD = 6.0	SD = 3.3	SD = 3.6	SD = 1.5	SD = 1.8	SD = 0.8	SD = 0.6	SD = 0.9
		α = .90	α = .85	α = .87	α = .82					
Administration										*
Public	227	M = 30.6	M = 17.2	M = 15.9	M = 9.4	M = 2.3	M = 2.7	M = 2.6	M = 2.5	M = 0.9
		SD = 7.9	SD = 5.9	SD = 3.3	SD = 3.6	SD = 1.5	SD = 1.9	SD = 0.8	SD = 0.6	SD = 0.9
Private	189	M = 30.7	M = 17.5	M = 16.0	M = 9.6	M = 2.2	M = 2.4	M = 2.5	M = 2.4	M = 0.6
		SD = 7.9	SD = 6.2	SD = 3.2	SD = 3.6	D = 1.4	SD = 1.7	SD = 0.8	SD = 0.6	SD = 0.9
NCATE affiliation							*			*
Nonmember	160	M = 30.5	M = 16.9	M = 15.7	M = 9.3	M = 2.2	M = 2.3	M = 2.5	M = 2.4	M = 0.6
		SD = 8.0	SD = 6.2	SD = 3.5	SD = 3.5	SD = 1.4	SD = 1.7	SD = 0.8	SD = 0.6	SD = 0.9
Member	256	M = 30.7	M = 17.6	M = 16.1	M = 9.5	M = 2.3	M = 2.7	M = 2.5	M = 2.5	M = 0.8
		SD = 7.9	SD = 5.9	SD = 3.1	SD = 3.6	SD = 1.5	SD = 1.9	SD = 0.8	SD = 0.6	SD = 1.0
R*TEC Region					*			*		
North Central	83	M = 31.0	M = 17.1	M = 15.7	M = 10.0	M = 2.2	M = 2.6	M = 2.5	M = 2.5	M = 0.8
		SD = 8.6	SD = 5.9	SD = 3.4	SD = 3.3	SD =1.5	SD = 1.9	SD = 0.8	SD = 0.5	SD = 0.9
Northeast 81		M = 28.6	M = 17.6	M = 16.0	M = 9.4	M = 2.0	M = 2.6	M = 2.3	M = 2.5	M = 0.6
		SD = 7.9	SD = 6.1	SD = 3.4	SD = 3.3	SD = 1.4	SD = 1.9	SD = 0.8	SD = 0.6	SD = 0.8
Northwest	26	M = 33.0	M = 17.3	M = 16.8	M = 9.4	M = 2.5	M = 2.8	M = 2.7	M = 2.4	M = 0.8
		SD = 6.9	SD = 4.4	SD = 2.0	SD = 3.3	SD = 1.3	SD = 1.6	SD = 0.7	SD = 0.6	SD = 0.7
Pacific Southwest	41	M = 30.3	M = 15.2	M = 15.9	M = 7.7	M = 2.0	M = 2.0	M = 2.2	M = 2.6	M = 0.8
		SD =8.2	SD = 6.2	SD = 3.8	SD = 3.4	SD = 1.4	SD = 1.6	SD = 0.9	SD = 0.6	SD = 0.9
South Central	53	M = 29.4	M = 16.4	M = 15.6	M = 9.3	M = 2.2	M = 2.4	M = 2.6	M = 2.5	M = 0.8
		SD = 7.7	SD = 6.4	SD = 3.3	SD = 3.7	SD =1.4	SD = 1.8	SD = 0.9	SD = 0.6	SD = 0.9
Southeast	132	M = 30.2	M = 18.3	M = 15.9	M = 9.8	M = 2.6	M = 2.8	M = 2.7	M = 2.5	M = 0.8
		SD = 7.6	SD = 6.0	SD = 3.1	SD = 3.8	SD = 1.6	SD = 1.8	SD = 0.8	SD = 0.6	SD = 0.8

		Factors			Nonloading variables**					
	N	Facilities	Integration	Applicatns. *	Field Experience	Required IT courses	IT in other Courses	IT course Completion	Faculty IT Capacity	Distance Learning
Carnegie Classification (21 missing values)										
Research	46	M = 32.2	M = 17.5	M = 16.7	M = 9.4	M = 2.1	M = 2.9	M = 2.4	M = 2.5	M = 0.9
I and II		SD = 8.1	SD = 5.7	SD = 3.3	SD = 3.5	SD = 1.7	SD = 1.6	SD = 0.8	SD = 0.6	SD = 0.9
Doctoral	48	M = 30.4	M = 16.7	M = 15.3	M = 9.0	M = 2.3	M = 2.8	M = 2.4	M = 2.5	M = 0.9
I and II	48	SD = 7.1	SD = 6.0	SD = 3.1	SD = 3.2	SD = 1.5	SD = 1.7	SD = 0.8	SD = 0.6	SD = 0.8
Masters	181	M = 30.7	M = 16.9	M = 15.8	M = 9.7	M = 2.3	M = 2.5	M = 2.6	M = 2.5	M = 0.8
I and II		SD = 7.9	SD = 6.2	SD = 3.2	SD = 3.6	SD = 1.4	SD = 1.9	SD = 0.8	SD = 0.6	SD = 1.0
Baccalaureate	105	M = 30.3	M = 18.0	M = 16.2	M = 9.5	M = 2.2	M = 2.6	M = 2.5	M = 2.5	M = 0.6
I and II		SD = 8.0	SD = 18.0	SD = 3.2	SD = 3.7	SD = 1.4	SD = 1.8	SD = 0.8	SD = 0.6	SD = 0.9
Business, Theo-	15	M = 26.9	M = 17.8	M = 13.7	M = 9.2	M = 2.7	M = 2.3	M = 2.5	M = 2.2	M = 1.0
logical, Tribal,		SD = 8.1	SD = 17.8	SD = 4.2	SD = 4.1	SD = 1.7	SD = 1.7	SD = 1.1	SD = 0.8	SD = 1.0
Teachers College										
Respondent Positions (11 missing values)										
Higher edu-	300	M = 30.3	M = 17.4	M = 15.9	M = 9.3	M = 2.3	M = 2.4	M = 2.5	M = 2.5	M = 0.7
cation faculty		SD = 8.0	SD = 6.3	SD = 3.3	SD = 3.6	SD = 1.5	SD = 1.8	SD = 0.8	SD = 0.6	SD = 1.0
Higher edu-	59	M = 31.0	M = 17.3	M = 15.6	M = 9.9	M = 2.4	M = 3.0	M = 2.7	M = 2.6	M = 0.8
cation deans		SD = 7.8	SD = 5.4	SD = 3.4	SD = 4.0	SD = 1.5	SD = 1.9	SD = 0.8	SD = 0.6	SD = 0.8
Technical or	46	M = 32.6	M = 16.9	M = 16.1	M = 9.8	M = 2.0	M = 2.5	M = 2.4	M = 2.3	M = 0.9
administrative		SD = 8.0	SD = 5.4	SD = 3.1	SD = 3.1	SD = 1.4	SD = 1.7	SD = 0.7	SD = 0.6	SD = 0.8
staff										
Respondent Functions (83 missing values)										
IT teaching	69	M = 29.9	M = 17.6	M = 16.2	M = 9.6	M = 2.3	M = 2.2	M = 2.5	M = 2.4	M = 0.8
		SD = 7.9	SD = 6.8	SD = 3.4	SD = 3.4	SD = 1.4	SD = 1.7	SD = 0.8	SD = 0.5	SD = 1.0
IT coordination/	158	M = 32.0	M = 17.9	M = 16.1	M = 9.9	M = 2.3	M = 2.7	M = 2.6	M = 2.6	M = 0.7
leadership		SD = 7.4	SD = 5.5	SD = 3.1	SD = 3.6	SD = 1.5	SD = 1.8	SD = 0.8	SD = 0.5	SD = 0.9
IT teaching and	98	M = 30.1	M = 16.6	M = 15.9	M = 8.9	M = 2.3	M = 2.5	M = 2.5	M = 2.3	M = 0.8
coordination		SD = 8.0	SD = 6.3	SD = 3.3	SD = 3.1	SD = 1.5	SD = 1.8	SD = 0.9	SD = 0.6	SD = 1.0
No specific	8	M = 29.1	M = 17.9	M = 16.3	M = 8.3	M = 1.4	M = 2.2	M = 2.6	M = 2.7	M = 1.2
IT roles		SD = 13.8	SD = 7.3	SD = 3.8	SD = 3.7	SD = 1.2	SD = 2.0	SD = 1.2	SD = 0.8	SD = 1.5

*F test of program characteristic effect significant for this variable ($p < .05$).

**Response frequencies for item 18 (Technology Plan), a dichotomous variable, are presented in table 2.6.

2.6.
Frequency Table of 316 Programs With and Without Technology Plans, by Program Characteristics

Technology plan	No		Yes	
Institution Characteristics	**N**	**row %**	**N**	**row %**
Administration (29 missing values)				
Public	96	57%	72	3%
Private	89	67%	44	33%
NCATE Affiliation* (29 missing values)				
Nonmember	82	71%	34	29%
Member	103	56%	82	44%
Region (29 missing values)				
North Central	39	65%	21	35%
Northeast	36	61%	23	39%
Northwest	13	65%	7	35%
Pacific Southwest	24	75%	8	25%
South Central	25	68%	12	32%
Southeast	48	52%	45	48%
Carnegie Classification (42 missing values)				
Research I and II	22	61%	14	39%
Doctoral I and I	17	52%	16	48%
Masters I and II	75	59%	53	41%
Baccalaureate I and II	57	68%	27	32%
Other (Business, Theological, Tribal, Teachers)	6	86%	1	14%
Respondent Positions (29 missing values)				
Higher education faculty	140	64%	79	36%
Higher education deans	25	61%	16	39%
Technical or administrative staff	20	49%	21	51%
Respondent Functions (29 missing values)				
IT teaching	42	69%	19	31%
IT coordination/ leadership	80	56%	62	44%
IT teaching and coordination	57	63%	34	37%
No specific IT roles	6	86%	1	14%

*χ^2 significant for this characteristic ($p < .05$)

2.7.
Correlations of Numbers of Graduates With Other Variables

Facilities	Integration	Applicatns.	Field Experience	Required IT Courses	IT in Other Courses	IT Course	Completion	Faculty IT Capacity	Technology Plan
0.10	-0.08	0.04	-0.07	0.03	-0.06	-0.05	0.02	0.08	0.10

2.8.
Comparison of Variable Means for Institutions With and Without Technology Plans

Technology Plan (47 missing values)	N	Facilities*	Integration*	Applicatns.	Field Experience*	Required IT Courses	IT in Other Courses*	IT Course Completion	Faculty IT Capacity	Distance learning*
No	224	M = 29.4	M = 16.2	M = 15.7	M = 8.9	M = 2.2	M = 2.3	M = 2.5	M = 2.4	M = 0.6
		SD = 8.3	SD = 6.0	SD = 3.5	SD =3.5	SD = 1.4	SD = 1.7	SD = 0.8	SD = 0.6	SD = 0.8
Yes	145	M = 32.6	M = 19.0	M = 16.3	M = 10.2	M = 2.4	M = 3.1	M = 2.6	M = 2.6	M = 0.9
		SD = 7.2	SD = 5.7	SD = 3.0	SD = 3.6	SD = 1.5	SD = 1.9	SD = 0.8	SD = 0.5	SD = 0.9

* F test of technology plan effect significant for this variable ($p < .01$)

2.9.
Comparison of Variable Means for Institutions With and Without IT-specific Coursework

IT-specific course requirements	N	Facilities	Integration	Applicatns.	Field Experience	IT in Other Courses	Faculty IT Capacity	Distance Learning*
No	57	M = 29.0	M = 16.0	M = 15.3	M = 9.3	M = 2.2	M = 2.5	M = 0.4
		SD = 8.9	SD = 7.2	SD = 3.3	SD =3.7	SD = 1.9	SD = 0.5	SD = 0.6
Yes	359	M = 30.9	M = 17.5	M = 16.0	M = 9.5	M = 2.6	M = 2.5	M = 0.8
		SD = 7.7	SD = 5.8	SD = 3.3	SD = 3.6	SD = 1.8	SD = 0.6	SD = 1.0

* F test of IT-course requirements effect significant for this variable ($p < .01$)
Note: Variable 3, Course Completion, was considered irrelevant to
institutions without IT course requirements, and is not included in this analysis