DOCUMENT RESUME

ED 394 949 SP 036 650

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TITLE	Teacher Development in Technology Instruction: Does Computer Coursework Transfer into Actual Teaching Practice?
PUB DATE	96
NOTE	54p.; Paper presented at the Annual Meeting of the Southwest Educational Research Association (Dallas, TX, January 25, 1996).
PUB TYPE	Reports - Research/Technical (143) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Beginning Teachers; *College School Cooperation; *Computer Literacy; Computer Uses in Education; Elementary Education; *Faculty Development; Higher Education; Knowledge Base for Teaching; *Preservice Teacher Education; Professional Development Schools; Student Teachers; Teacher Education Programs; Teaching Methods; *Theory Practice Relationship
IDENTIFIERS	Computer Users; *Technology Integration; Technology Utilization; *University of Houston Clear Lake TX

ABSTRACT

This study examined the technology preparation component of two University of Houston-Clear Lake (UHCL) preservice teacher education programs: the traditional teacher education program and the Teacher Education Advancing Academic Achievement Model (TEAM) Collaborate teacher education program. Some characteristics of TEAM were: a year-long site based internship, university and site-based mentor teams, professional development of public school teachers and university faculty, higher education and public school collaboration in professional development schools, and infusion of technology into the public school and education curriculums. The traditional program and TEAM were compared by measuring the extent to which graduates transferred their newly acquired computer-technology skills and knowledge into their first-year of actual teaching practice. Responses to a technology use questionnaire indicated that a greater mean percentage of the 15 first-year TEAM graduates: (1) acquired greater knowledge of the functions and features of computer software and hardware, (2) learned how to use a variety of computer software and hardware tools to enhance their performance, and (3) developed skills and knowledge necessary to integrate computer software and hardware with instruction when compared to 15 traditional UHCL education graduates. Six recommendations to help preservice and inservice programs, school districts, and local schools ensure commitment to the long-term use of computer software and hardware are suggested. (Contains 33 references.) (Author/ND)

Running Head: TEACHER DEVELOPMENT

Teacher Development in Technology Instruction: Does Computer Coursework Transfer into Actual Teaching Practice?

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Abstract

This study examined the technology preparation component of two University of Houston - Clear Lake teacher pre-service education programs. The traditional UHCL teacher education program and the TEA^{3}M Collaborate teacher education program were compared by measuring the extent that graduates transferred their newly acquired computer-technology skills and knowledge into their first-year of actual teaching practice. Based on the responses to a Technology Use Questionnaire, a greater mean percentage of fifteen first year TEA^{3}M graduates: (1) acquired greater knowledge of the functions and features of computer software and hardware, (2) learned how to use a variety of computer software and hardware tools to enhance their performance, and (3) developed skills and knowledge necessary to integrate computer software and hardware with instruction when compared to fifteen traditional UHCL education graduates. Six recommendations to help pre-service and in-service programs, school districts, and local schools ensure commitment to the long-term use of computer software and hardware are suggested.

Note: This paper represents a condensed version of the entire study. For a full description of the study and its results, please contact the author.

Teacher Development in Technology Instruction: Does Computer Coursework Transfer into Actual Teaching Practice?

How well are schools of education making sure that the next generation of teachers have prerequisite knowledge and skills to use computer hardware and software in teaching practice? Not well enough according to six different surveys (Becker, 1993; Martinez and Mead, 1988; Becker, 1987; Weiss, 1987; Kherlopian & Dickey, 1985; Lehman, 1985) discussed in the review of literature. These surveys revealed that only 15 to 40% of teachers reported using computer technology. However, four other studies (Ellis, 1992; Keirns, 1992; Sanders, 1992; Ronen, 1990) discussed, provided evidence suggesting that if a well-designed technology course is available to student teachers, then there can be successful transfer into their first-year of actual teaching practice.

Unfortunately, improvements in teacher knowledge and attitudes do not necessarily mean immediate changes in behavior (Baird, Ellis, & Kuerbis, 1989). The process of changing teachers' actual behavior takes considerable effort and time. For example, Hord and Huling-Austin (1986) found that teachers needed three or more years of support to make a substantial change in instruction. This assertion is also supported by four national surveys (Hadley & Sheingold, 1993; Honey & Henriquez, 1993; Brady, 1991; Sheingold & Hadley, 1990) of "accomplished" teacher technology integrators and telecommunications enthusiasts discussed in the review of literature.

The University of Houston - Clear Lake

UHCL School of Education seeks to produce thoughtful, skilled, and humane educators by providing its students with a solid foundation of liberal arts and general studies. The School of Education offers its students an extensive choice of certification and endorsement programs in graduate and undergraduate specializations. Certificates to teach or serve in other professional roles in the public schools of Texas are issued by the Texas Education Agency upon completion of approved program requirements and recommendations by the UHCL School of Education (University of Houston - Clear Lake, 1994).

University of Houston - Clear Lake School of Education faculty work to produce educators that are well-qualified in the subjects taught. School of Education faculty are committed to integrating technical competence, pedagogical skill and theoretical knowledge in the coursework offered. The essential abilities of managing classrooms, working with people, and supervising learning situations are required of all UHCL education graduates. The School of Education seeks to combine these accomplishments with the insights gained from study of the historical, philosophical, social, and psychological bases of education with the intention of producing educational leaders (University of Houston - Clear Lake, 1994).

University of Houston - Clear Lake Pre-service Technology Preparation

During the 1993-94 academic year, the University of Houston - Clear Lake School of Education pre-service teacher preparation programs instituted teacher technology preparation in their curriculum. The following two University of Houston - Clear Lake teacher preparation programs sought to produce teachers who could address the highly diverse needs of today's students and prepare them for the challenges of living in an information-based, technology-driven society.

Traditional University of Houston - Clear Lake education program. During the 1993-94 academic year, traditional UHCL education students were offered one course in Classroom Computer Usage (INST 3133). This is the only technology education course offered in which traditional UHCL student teachers were taught how to use personal performance tools, such as word processors, databases, spreadsheets, and telecommunication applications. In this course, student teachers were also taught how to locate, evaluate, and integrate computer-based educational programs and provided the knowledge of how to find and critically examine research studies on computer use in education (Hirumi, Harmon, & Palumbo, 1994).

University of Houston - Clear Lake TEA^{3}M education program. During the 1993-94 academic year, the Texas Education Agency (TEA) and the State Board of Education chose the University of Houston - Clear Lake as a Center for Professional Development and Technology (CPDT) site. The University of Houston - Clear Lake, in collaboration with Houston area school districts and communities, NASA, and IBM, established the TEA^{3}M teacher education program as an alterative to its traditional teacher education program. The Teacher Education Advancing Academic Achievement Model (TEA^{3}M) was established as a new and innovative route for achieving teaching certification.

The TEA^{3}M teacher education program differs from the traditional UHCL teacher education program in the sequence of some of the required professional development courses. A subsequent $900,000 TEA grant established: (1) a year long site-based teacher training program, (2) university and site-based mentorship teams, (3) professional development of public school teachers and university faculty, (4) higher education and public school collaboration, and (5) infusion of **technology** into the public school and education curriculum (Mayo, Jones, & Cornell, 1993). A year-long internship replaced some coursework and student teaching. TEA^3M interns still had to meet all academic requirements and were subject to the same policies and procedures as described for the School of Education in the University of Houston - Clear Lake catalog.

During the 1993-94 academic year, eight local area schools agreed to become Professional Development School (PDS) sites and committed their time and resources to educating future teachers. PDS sites provided one of their experienced teacher to work full-time with TEA^3M interns. TEA^3M interns were also mentored by their assigned teaching team. UHCL faculty spend one day a week on PDS sites to work with interns and offer seminars and coursework on campus. These experiences translated into equivalent semester credit hours for the courses traditional UHCL student teachers complete (Coppenhaver, 1994).

With regards to technology preparation, TEA^3M interns were required to take the Classroom Computer Usage course (INST 3133) and also meet the following TEA^3M technology standard (Center for Professional Development & Technology, 1995b):

> During the planning, delivery, and analysis of instruction, the teacher selects, applies, integrates, and evaluates the appropriate instructional and information technologies to promote student learning and higher-order thinking. As a result, students are able to use

a variety of technologies to explore ideas, pose questions, gather and disseminate information, and support one another in learning. The teacher actively seeks information on the application of emerging technologies from variety sources (e.g., journal, on-line databases, colleagues) to improve student learning. The teacher also uses technology to stimulate their own professional growth, facilitate communications, and enhance overall productivity. Relevant technologies include, but are not limited to:

(1) productivity tools (e.g., word processors, databases, spreadsheets, graphics)

(2) telecommunication tools (e.g., e-mail, TENET, Gopher, Newsgroups, WWW)

(3) learning tools (e.g., Commercial education software: tutorials, simulations, CD-ROM, Laserdiscs)

(4) management and support tools (e.g., electronic gradebooks, test item generators)

(5) authoring tools (e.g., HyperStudio, HyperCard, Asymetrix Toolbook)

(6) programming tools (e.g., BASIC, Logo)

(7) collaborative tools (e.g., electronic brainstorming, decision making). (p. 6)

During its inaugural year (1993-94), fifteen TEA^{3}M interns experienced an entire school year in a team-oriented teaching-learning environment at three innovative local participating public schools with diverse student populations. TEA^{3}M interns were: (1) observed in classes in all subject areas, (2) team-taught with experienced teachers, (3) attended ARD meetings, (4) worked on parental involvement programs, (5) and taught or tutored individuals and small groups of students. Some TEA^{3}M interns assumed responsibility for teaching a class with the support of their mentor teachers (Mayo, Jones, & Cornell, 1993).

At the completion of the TEA^{3}M program, each intern had to demonstrate proficiency in the following seven professional standards: (1) Professional Responsibility, (2) Nature of the Learner, (3) Command of the Subject Matter, (4) Curriculum and Instruction, (5) Classroom Management and Organization, (6) **Technology**, and (7) Community and Parental Involvement (Center for Professional Development & Technology, 1995b).

To help TEA^{3}M interns meet the required technology standard (p. 6), the University of Houston - Clear Lake TEA^{3}M teacher education program invested $400,000 of the initial $900,000 TEA grant into computer hardware, software, and training. During the 1993-94 academic year, this initial investment included: (1) a computer for each mentor teacher, (2) a portable laptop computer for each site coordinator, TEA^{3}M intern, and UHCL faculty, (3) productivity tools and educational software, (4) an electronic classroom at UHCL, (5) support staff to develop and deliver training, (6) a multimedia workstation for each participating school, and (7) installation of a school-wide and district-wide computer network.

All TEA^{3}M internship projects were related to working with students and included academic classes, tutorials, and extracurricular school programs. As part of the TEA grant, each intern received a new laptop computer to help with these projects and to use during the school year. TEA^{3}M interns received training and used their laptop computer to prepare school projects and to communicate with UHCL faculty and other school sites through TENET, the TEA interactive communication network (Mayo, Jones, & Cornell, 1993).

To be responsive to the on-going needs of educators at each of the collaborating Professional Development School (PDS) sites, coursework, workshops, and seminars were given by UHCL faculty, school district staff, Region IV Education Service Center, and computer vendors. Surveys of PDS educators and TEA^{3}M interns were also taken on a continual basis to determine what types of workshops and seminars were necessary in the future (Center for Professional Development & Technology, 1995a).

To provide the knowledge and skills necessary for effective teaching, education coursework was offered at the PDS sites in a non-traditional format. Both TEA^{3}M interns and in-service teachers studied the needs of the learner in a 3-credit hour course and attended a one-hour seminar focusing on current trends and issues. Seminars were presented by the Independent School District personnel, University of Houston - Clear Lake faculty, or Texas Education Agency Region IV specialists. Topics addressed included Gender Equity, Changes in Schools, Texas and School Law, Journal Writing, and Portfolio Assessment (Mayo, Jones, & Cornell, 1993).

During the 1993-94 academic year, eight workshops and seminars were given at Professional Development Schools (PDS) and at UHCL for staff and faculty. The eight workshops included: (1) two sessions with fifteen teachers from Carver Elementary school on the use of Microsoft Works; (2) two sessions with twenty representatives from the PDS on the use of the TENET; (3) one session with sixteen TEA^{3}M interns and university faculty on the use of DOS and Windows; (4) one session with twenty-five PDS teachers and university faculty on interactive multimedia; (5) one session with twelve teacher and university faculty on the general topic of integrating computer technology into the classroom (Center for Professional Development & Technology, 1995a). Throughout the workshops and seminars, TEA^{3}M interns were encouraged to develop the self-confidence that will enable them to use their own best judgement, under any changing circumstances, to provide for their students' best educational interests.

The integration of technology at each of the PDS sites also required some site-based training and support. In addition to the instruction provided by courses, workshops, and seminars, one-on-one support was also provided in the early stages of the TEA^{3}M initiative. Both TEA^{3}M interns and PDS in-service teachers required training, particularly in the areas of networking and the use of learning management systems (Center for Professional Development & Technology, 1995a).

Since TEA^{3}M interns were expected to create innovative uses of technology in their classroom, the first goal of TEA^{3}M interns was to become technology proficient. During the first year of the TEA^{3}M program, site coordinators and computer vendors provided 20 hours of training to Professional Development School faculty and TEA^{3}M interns. The plan was to give TEA^{3}M interns sufficient skills so that they could provide practicing educators with the support and training necessary to use computer hardware and software (Center for Professional Development & Technology, 1995a).

This study determined the extent that TEA^{3}M and traditional UHCL teacher education graduates transferred their newly acquired computer-technology skills and knowledge into their first year of actual teaching practice. The Technology Use Questionnaire, developed by the researcher, was the tool used to assess TEA^{3}M and traditional UHCL graduates during their first year of actual teaching practice. As a result, the Technology Use Questionnaire was added to the output phase of the TEA^{3}M Evaluation Framework.

Statement of the Problem

During the 1993-94 academic year, two University of Houston - Clear Lake School of Education pre-service teacher preparation programs instituted teacher technology preparation in their curriculum. Traditional UHCL education students were offered one course in Classroom Computer Usage (INST 3133). The Teacher Education Advancing Academic Achievement Model (TEA^{3}M) program required that its interns meet the TEA^{3}M technology standard (p. 6). To improve teacher performance and preparation, the TEA^{3}M teacher education program invested in computer hardware, telecommunication technology, in-service instruction, on-campus resources, and software.

With this initial investment, TEA^{3}M graduates were expected to have greater computer hardware and software knowledge and skills than traditional UHCL graduates. TEA^{3}M teacher education graduates were also expected to have transferred a greater amount of newly acquired computer-technology skills and knowledge into their first-year of actual teaching practice than traditional UHCL education graduates.

This study compared the technology preparation component of the traditional UHCL teacher education program and the TEA^{3}M Collaborate teacher education program by measuring the extent that graduates transferred their newly acquired computer-technology skills and knowledge into their first-year of actual teaching practice.

Purpose of the Study

The purpose of this study was to determine the extent that TEA^{3}M and traditional UHCL teacher education graduates transferred their newly acquired computer-technology skills and knowledge into their first year of actual teaching practice. The Technology Use Questionnaire, developed by the researcher, was the instrument used to assess TEA^{3}M and traditional UHCL graduates during their first year of actual practice. As a result, the Technology Use Questionnaire was added to the output phase of the TEA^{3}M Evaluation Framework. Assessment of TEA^{3}M intern transfer of knowledge and skills also established a foundation for comparing the TEA^{3}M program to other university teacher education programs in the state of Texas and/or nationally.

Research Questions

To help interns meet the TEA^{3}M technology standard (p. 6), the TEA^{3}M teacher education program invested in computer hardware, telecommunication technology, in-service instruction, on-campus resources, and software to improve teacher performance and preparation. With this initial investment, first year TEA^{3}M graduates were expected to have greater computer hardware and software knowledge and skills than traditional UHCL education graduates. Did TEA^{3}M graduates transfer a greater amount of newly acquired computer-technology skills and knowledge into their first year of actual teaching practice than traditional UHCL teacher education graduates?

Based on the primary research question, the following three specific research questions were generated:

1. As measured by the Technology Use Questionnaire, did a greater mean percentage of TEA^{3}M graduates transfer computer hardware and software knowledge into their first year of actual teaching practice than traditional UHCL education graduates?
2. As measured by the Technology Use Questionnaire, did a greater mean percentage of TEA^{3}M graduates transfer their computer hardware and software use skills into their first year of actual teaching practice than traditional UHCL education graduates?
3. As measured by the Technology Use Questionnaire, did a greater mean percentage of TEA^{3}M teachers transfer their computer hardware and software integrative skills into their first year of actual teaching practice than traditional UHCL education teachers?

Significance of the Problem

This study, that compared graduates from two teacher preparation programs, was conducted for five reasons. First, the findings of this study provided an incentive for developers and administrators of universities to restructure their teacher pre-service and in-service education programs to accommodate a greater emphasis on computer-technology preparation. Second, the TEA^{3}M teacher education program received feedback on how well it had achieved its technology standard (p. 6) and decided if its technology evaluation rubric had to be revised. Third, TEA^{3}M and traditional UHCL first-year teachers used the findings of this study as feedback on how they were using technology in their teaching. Fourth, this study broadened the base of evaluative evidence, concerning effective technology integration in schools, by including pre-service teacher preparation programs. Finally, this study has become a source of new hypotheses and spawned further investigations into the TEA^{3}M program and other teacher education programs that attempt to impart their students with technology skills and knowledge.

Limitations of the Study

This study, that compared graduates from two teacher preparation programs, has four limitations. First, it was not possible for the researcher to randomly assign both groups of subjects to a particular teacher education program. Both groups of subjects self-selected themselves to participate in the TEA^{3}M or traditional UHCL education program.

Second, TEA^{3}M interns' questionnaire results may be a reflection of the Hawthorne Effect (Borg & Gall, 1989). Before selecting the TEA^{3}M program, interns were aware that they would have to meet an intensive and detailed technology standard (p. 6). On the other hand, traditional UHCL student teachers were offered a course in Classroom Computer Usage (INST 3133) that could be applied towards graduation and teacher certification. Therefore, based upon their self-selection, TEA^{3}M interns perhaps had greater motivation to develop their technology knowledge and skills than traditional UHCL education students.

Third, TEA^{3}M interns possibly showed interest and excelled in the TEA^{3}M program because of they had greater prior technology skills, knowledge, and experiences when compared to traditional UHCL graduates. This is evident in the finding that all TEA^{3}M graduates (100%) had more experience using a computer (2-7 years) while 88% of traditional UHCL graduates had used a computer only one to four years. The remaining 12% of traditional UHCL graduates had been using a computer for more than seven years.

Fourth, this study has limited external validity because it was not possible to randomly select subjects for the TEA^{3}M group. It was possible to randomly select a comparison group of fifteen traditional University of Houston - Clear Lake teacher program graduates (1993-94) because there was a larger population of 93 graduates. However, the TEA^{3}M teacher education program certified and placed only fifteen teachers in permanent teaching positions at the end of its inaugural academic year (1993-94). As a result, this study was limited to fifteen TEA^{3}M graduates because there was not a large enough population in order to randomly select subjects.

Since the number of subjects in both groups was small, the generalizability of this study's findings to the population of all first-year teachers may be limited. Nevertheless, the primary goal of this study was not to generalize its findings to all first-year teachers. The primary goal of this study was to compare the extent that TEA^{3}M and traditional UHCL teacher education graduates transferred their newly acquired computer-technology skills and knowledge into their first year of actual teaching practice.

Method

Subjects

Two groups of subjects were recruited for this study based on the University of Houston - Clear Lake teacher education program completed:

- Fifteen UHCL TEA^{3}M teacher education program graduates
- Fifteen traditional UHCL teacher education program graduates

All subjects had to have: (1) graduated from a University of Houston - Clear Lake teacher pre-service education program, and (2) have worked in their first year as a full-time teacher.

TEA^{3}M graduate demographic data. In its inaugural year (1993-94), the TEA^{3}M teacher education program certified and placed fifteen teachers in permanent teaching positions. The TEA^{3}M Project Director's Office provided telephone numbers and mailing addresses to contact the fifteen TEA^{3}M graduates. Unfortunately, all fifteen TEA^{3}M graduates could not participate in this study. Twelve (80%) TEA^{3}M teacher education program graduates responded to an initial telephone call to participate. It was not possible to contact the remaining three (20%) TEA^{3}M graduates because the mailing addresses and telephone numbers, provided by the TEA^{3}M Project Director's Office, were not current. Some TEA^{3}M graduates perhaps relocated without providing a forwarding address.

Eleven (92%) TEA^{3}M teacher education program graduates, that responded to an initial telephone call to participate, held current teaching positions and participated in the survey. The remaining one (8%) TEA^{3}M graduate no longer held a current teaching position and could not participate in the study. Of the participating eleven TEA^{3}M graduates, nine (82%) were female and two (18%) were male. Ten (91%) TEA^{3}M graduates were between 23 and 27 years old and one (9%) TEA^{3}M graduate was 37 years old or above. Ten (91%) TEA^{3}M graduates taught one specific grade level, that ranged from grades one to eight, and one (9%) TEA^{3}M graduate was responsible for teaching more that one grade (e.g., first, second, and third grade).

Traditional UHCL graduate demographic data. A comparison group was comprised from a random selection of fifteen traditional UHCL teacher program graduates (1993-94) out of a larger population of 93 graduates. The UHCL School of Education provided phone numbers and mailing addresses to contact the fifteen traditional teacher education program graduates. All fifteen (100%) randomly selected traditional UHCL teacher education program graduates responded to an initial telephone call to participate. Twelve (80%) graduates held current teaching positions and participated in the survey. The remaining three (20%) traditional UHCL graduates could not participate in the study because they no longer held current teaching positions.

Of the participating twelve traditional UHCL graduates, eleven (92%) were female and one (8%) was male. Eight (67%) traditional UHCL graduates were between 23 and 27 years old. Two (17%) traditional UHCL graduates were 37 years old or above, and two (17%) were evenly dispersed between 28 and 36 years old. All fifteen (100%) traditional UHCL graduates taught one specific grade level, that ranged from grades one to eight, and none were responsible for teaching more that one grade (e.g., first, second, and third grade).

Instrumentation

The Technology Use Questionnaire was designed to collect practicing first-year teachers' responses on a variety of technology issues. The Technology Use Questionnaire has three sections, each with a combination of multiple-choice and open-ended questions. Survey instruments developed by Ellis (1992), Sanders (1992), Keirns (1992), Lee and Johnson (1995), and Mohaiadin (1995) were reviewed when the initial layout and construction of the

Technology Use Questionnaire was determined. The following are six categories of questions measured by the Technology Use Questionnaire:

- Subject demographic data (Question 1, 2, 3, 25)
- Knowledge of computer software and hardware (Question 11, 12, 23, 25, 26, 27, 28, 29, 30)
- Use of computer software and hardware (Question 4, 5, 6, 7, 9, 16, 17, 20)
- Integration of computer software and hardware (Question 8, 10, 13, 14, 15, 17, 18, 19, 22)
- Incentives to using computer software and hardware (Question 21)
- Barriers to using computer software and hardware (Question 24)

Questions that addressed the preparation provided by a particular University of Houston - Clear Lake teacher education program were included in the knowledge category.

The focus of the Technology Use Questionnaire was to measure three levels of computer-technology proficiencies (knowledge, use, and integration) and the questions developed were based a classification scheme developed by Hirumi and Grau (in press). Hirumi and Grau's (in press) classification scheme was developed during content analyses of current State certification standards, computer-literacy textbooks, and journal articles. The content analyses by Hirumi and Grau (in press) produced a recommended list of ten computer-technology categories for K-12 teachers and suggested that each computer-technology category had the following classification scheme: (1) acquire knowledge of the functions and features of software and hardware, (2) learn to use software and hardware to enhance their performance, and/or (3) develop the skills and knowledge necessary to integrate software and hardware with instruction to enhance student learning. The Technology Use Questionnaire used this classification scheme to develop survey questions.

Before conducting the actual study, a group of five teachers, not included in the study, pilot tested the Technology Use Questionnaire. The pilot test results helped the researcher refine the questionnaire by ensuring that the questions were clear and concise. Based on the feedback of the pilot group, minor revisions to the draft questionnaire consisted of: (1) modifying the wording of questions, (2) limiting the number of total questions, (3) general layout of questionnaire, and (3) grouping of questions. When the Technology Use Questionnaire was administered, it took subjects 10-20 minutes to complete. There were no foreseeable risks (physical, psychological, and/or social) to subjects completing in this survey evaluating their transfer of technology use to the classroom.

Procedure

First, TEA^{3}M and traditional UHCL teacher education graduates were contacted by phone, briefed on the purpose of this study, and asked to participate. Subjects who were eligible and agreed to participate were allowed the option to complete the survey by mail, site visit, or telephone. Before completing the Technology Use Questionnaire, each subject was asked to read a transmittal letter and sign a letter of informed consent. Each subject took 10 to 20 minutes to complete the Technology Use Questionnaire and their participation was strictly voluntary. Even though there were no foreseeable risks, subjects were allowed to discontinue their involvement at any time and at any point in the study without penalty.

To guarantee anonymity, subjects were asked not to write their name on any part of the questionnaire. Subjects were assigned code numbers to ensure that their responses were anonymous. Knowledge of subjects' identifying information was available only when contacting and arranging meetings with them. All responses to the Technology Use Questionnaire were dealt with complete confidentiality and any writings on this subject contained no references to individuals or schools. Attempts to match completed questionnaires with names did not occur at any time during the study.

During the analysis phase, an item analysis was conducted on each multiple-choice survey question by calculating mean percentage results for each multiple-choice question. For open-ended survey questions, a coding scheme was developed, by the researcher, to group and summarize subjects' perceptions of their technology skills and knowledge and pre-service educational experiences.

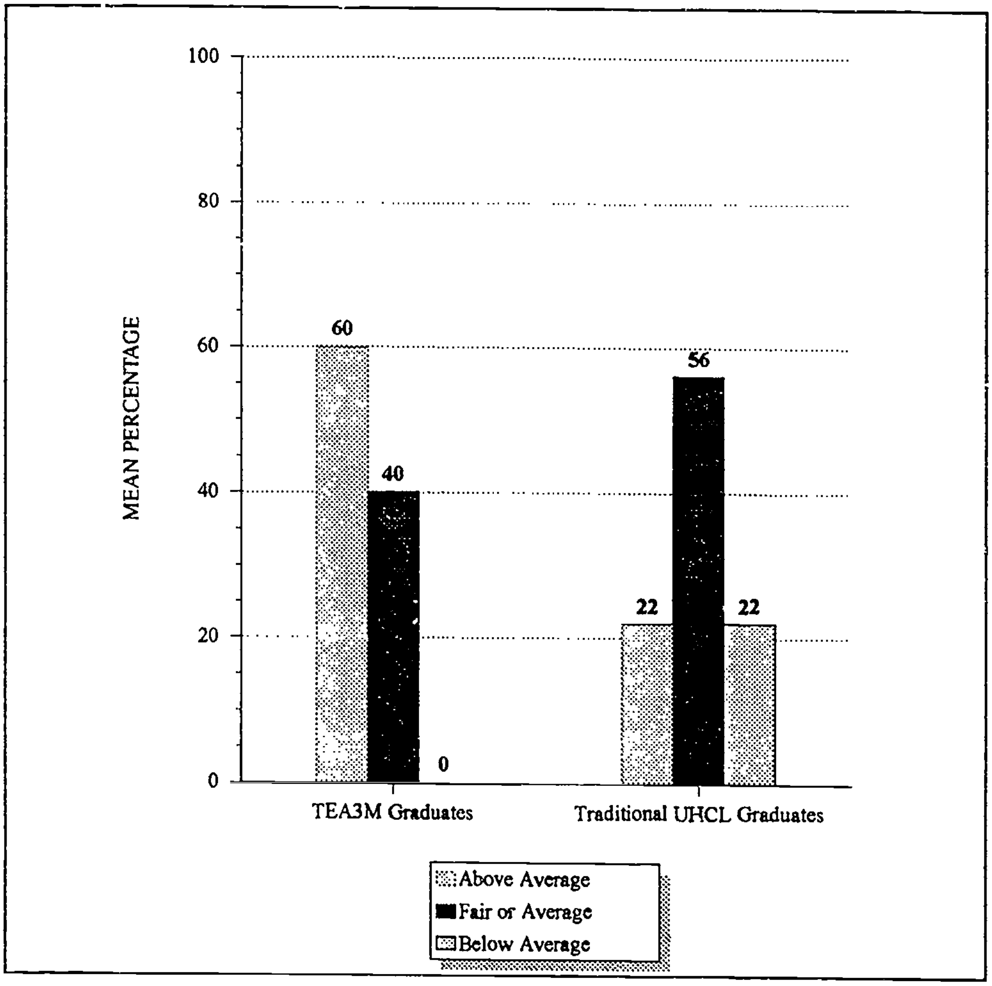
Results

TEA^{3}M and traditional UHCL graduates' Technology Use Questionnaire results are presented in the following five parts: (1) knowledge of computer software and hardware, (2) use of computer software and hardware, (3) integration of computer software and hardware into the curriculum, (4) incentives to use computer software and hardware, and (5) barriers to using computer software and hardware.

Knowledge of computer software and hardware. Both the TEA^{3}M and traditional UHCL School of Education pre-service programs provided their graduates with knowledge of the functions and features of software and hardware. However, the TEA^{3}M Collaborative instilled a wider variety of theoretical and practical computer software and hardware knowledge in its interns because of its well-designed technology training component. The traditional UHCL pre-service program also produced knowledgeable teachers; however, the extent of their computer software and hardware knowledge was limited.

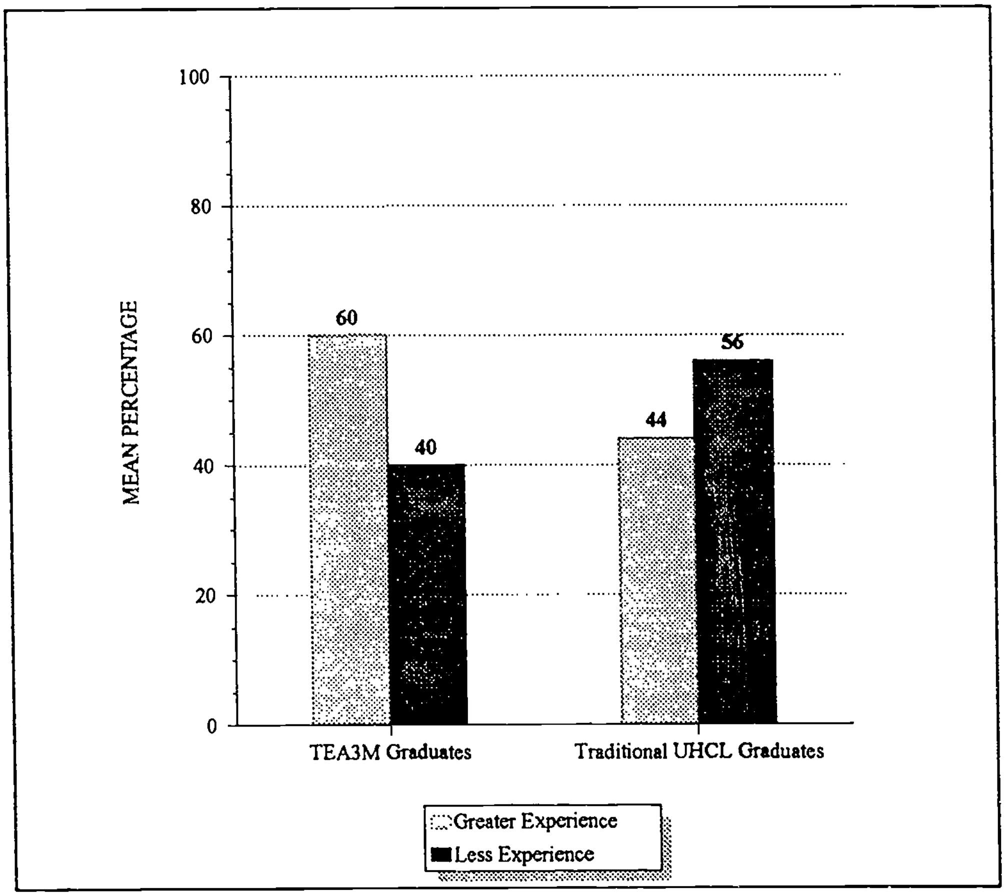
According to the following survey results, both groups of graduates had different results during their first year of teaching. For example, 60% of TEA^{3}M graduates rated their overall computer skills as above average compared to only 22% of traditional UHCL graduates who felt the same way. Forty percent of TEA^{3}M graduates rated their overall computer skills as fair or average compared to 56% of traditional UHCL graduates. Unfortunately, 22% of traditional UHCL graduates rated their computer skills as below average compared to 0% of TEA^{3}M graduates (see Figure 1).

Figure 1. How do you rate your overall computer skills?



When comparing their computer experience with other teachers at their school, 60% of TEA^{3}M graduates found that they were more experienced compared to 44% of traditional UHCL graduates who reported the same situation. Only 40% of TEA^{3}M graduates reported that they did not have more computer experience than teachers in place at their school while 56% of traditional UHCL graduates reported the same situation (see Figure 2).

Figure 2. Did you find you had more computer experience than the teachers in place at your school?

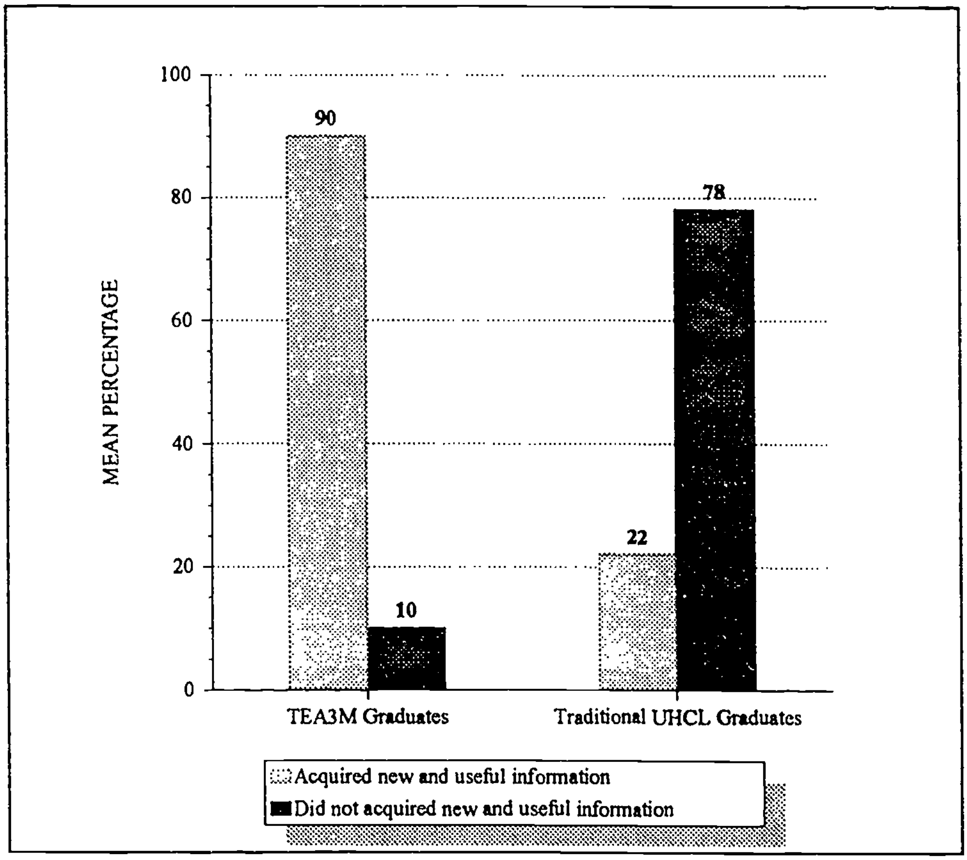


When questioned about how they continued to learn about using and integrating technology into their teaching, 90% of TEA^{3}M graduates reported self-taught exploration and learning (e.g., textbooks, software manuals) while only 56% of traditional UHCL graduates used the same method. Seventy percent of TEA^{3}M graduates used peer teaching to continue learning about using and integrating technology into their teaching compared to 56% of traditional UHCL graduates. It is only with in-house workshops that similar percentages of

TEA^{3}M graduates (40%) and traditional UHCL graduates (44%) continued to learn about using and integrating technology into their teaching.

With regards to their teacher education program experiences, 90% of TEA^{3}M graduates felt that their program provided them with new and useful information about using technology (e.g., enhancing personal tasks and/or student learning) while only 22% of traditional UHCL graduates felt the same way. On the other hand, only 10% of TEA^{3}M graduates felt that their program did not provide them with new and useful information about using technology (e.g., enhancing personal tasks and/or student learning) compared to 78% of traditional UHCL graduates (see Figure 3).

Figure 3. Did your teacher education program provide you with new and useful information about using technology (e.g., enhancing personal tasks and/or student learning)?



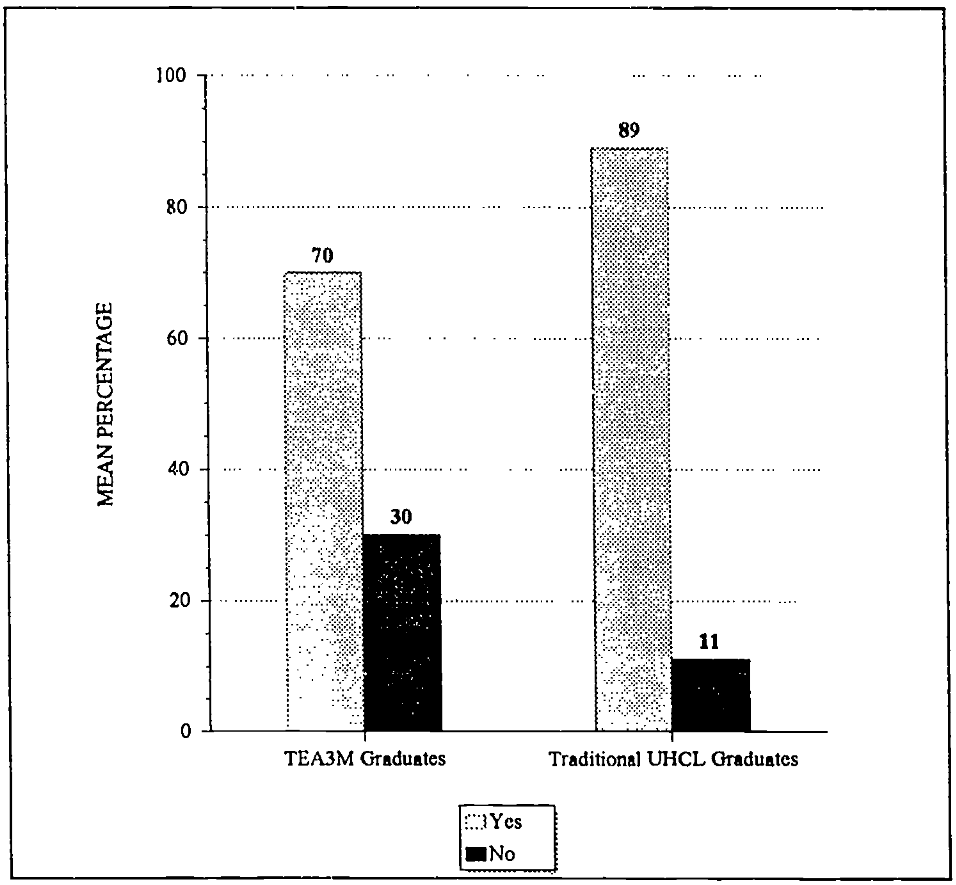
TEA^{3}M graduates reported learning many useful ideas for incorporating technology into their instructional activities; however, 60% of the time they were not implemented because the necessary computer hardware and software was not available at their schools. Nevertheless, TEA^{3}M graduates reported using the following instructional ideas: using the Internet (40%), making visual presentation materials (40%), making worksheets (30%), using CD-ROMs (20%), and ClarisWorks (20%). On the other hand, traditional UHCL graduates reported learning significantly fewer useful ideas for incorporating technology into their instructional activities. Only 11% of traditional UHCL graduates reported using ClarisWorks, to make tests and class materials, and HyperCard, on the Macintosh computer platform.

Regarding how their teacher education program influenced their opinions concerning the educational use of the computer, 80% of TEA^{3}M graduates reported positive opinions. TEA^{3}M graduates offered the following positive opinions, that were developed by their teacher education program: " I believe technology can enhance learning and enhance my ability to grow as a teacher." "I enjoyed the mobility of using Macintosh powerbooks to generate portfolios." On the other hand, only 33% of traditional UHCL graduates offered positive opinions, that were developed by their teacher education program. For example: "I now want all students to have a computer." "The UHCL Educational Application of Computers course was extremely informative." "I have come to learn that kids love technology."

Twenty percent of TEA^{3}M graduates felt that their teacher education program did not change or influence their opinions concerning the educational use of the computer while 67% of traditional UHCL graduates felt the same way. For example, traditional UHCL graduates described the Classroom Computer Usage (INST 3133) course as not providing enough depth. One traditional UHCL graduate specifically complained, "My computer literacy course was a survey of the (then) latest/most popular programs." One TEA^{3}M graduate's enjoyment in using a computer had already been established prior to their pre-service instruction. The remaining traditional UHCL and TEA^{3}M graduates' opinions, concerning computer use in the classroom, were neutral or unchanged.

Concerning the technology component of their teacher education program, 70% of TEA^{3}M graduates believed their program needed minor modifications. On the other hand, a greater percentage of traditional UHCL graduates (89%) reported that their program needed extensive modifications. Thirty percent of TEA^{3}M graduates and 11% of traditional UHCL graduates were completely satisfied with the technology component of their teacher education program and would not change a thing (see Figure 4).

Figure 4. If you could, would you modify the technology component in your teacher education program?



The following ideas were reported by TEA^{3}M graduates for changing the technology component of their teacher education program: "Need more equipment with in-servicing on how to use it." "More training on how to use technology and training on how to use it directly in teaching." "Training on how to access more outside resources (e.g., TENET, Internet)." "A computer for every student." "Need more hands on training." "Make the UHCL computer class a higher level course." Traditional UHCL graduates offered the following ideas for changing the technology component of their teacher education program: "I would like to have access to software programs that the kids use, so I could pick and choose appropriate instructional material." "Give teachers the opportunity to take a computer literacy courses with Macintosh computers because that is basically what most schools use."

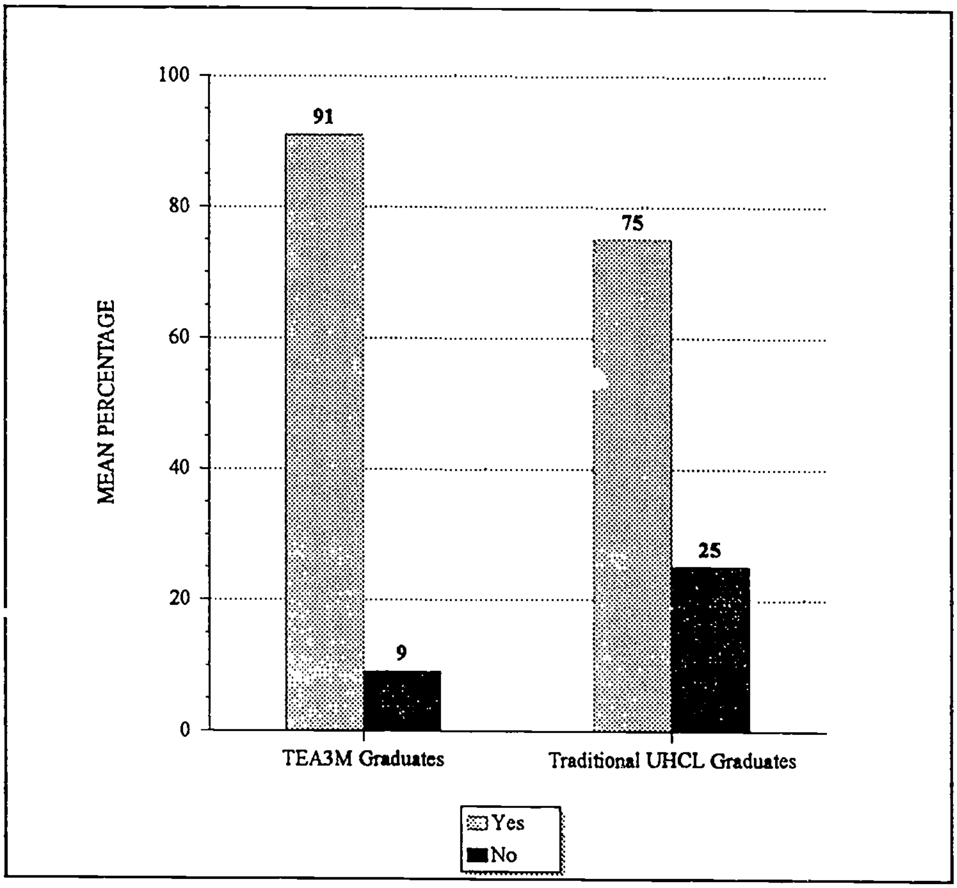
Both groups of subjects were asked to list what they believed were the top three most important technology related topics that all teacher education programs should teach. TEA^{3}M graduates' top choices included: basic computer literacy (40%), word processing (40%), the Internet (30%), and using technology in the classroom (30%). On the other hand, traditional UHCL graduates listed a wider variety of technology related topics that perhaps reflected their greater need for technology training. Traditional UHCL graduates' top choices included: electronic gradebooks (56%), basic computer literacy (44%), Internet/network access (44%), instructional software (44%), and generating classroom materials (44%).

Use of computer software and hardware. Both the TEA^{3}M and traditional UHCL School of Education pre-service programs provided their graduates with the skills to use computer software and hardware to enhance their performance. However, the TEA^{3}M

Collaborative instilled a wider variety of computer software and hardware technical skills in its interns because of its well-designed technology training component. The traditional UHCL pre-service program also produced skillful teachers; however, the extent of their "hands on" computer software and hardware skills were limited.

According to the following survey results, both groups of graduates had different results during their first year of teaching. For example, 91% of TEA^{3}M graduates used technology in their classroom instruction or preparation compared to 75% of traditional UHCL graduates. On the other hand, only 9% of TEA^{3}M graduates did not use technology in their classroom instruction or preparation compared to 25% of traditional UHCL graduates (see Figure 5).

Figure 5. Do you use technology (e.g., computer, laserdisc player, scanner, Internet) in your classroom instruction or preparation?



Regarding previous computer experience, all TEA^{3}M graduates (100%) had more experience using a computer (2-7 years), than 88% of traditional UHCL graduates who had used a computer for only one to four years. Only 12% of traditional UHCL graduates had been using a computer for more than seven years. On an average, 70% of TEA^{3}M graduates spent one to three hours per day using a computer for productivity tasks compared to 44% of traditional UHCL graduates.

With regards to computer hardware used, 40% of TEA^{3}M graduates used a variety of computer platforms (e.g., IBM compatible, Apple II, Macintosh, etc.) in their school compared to 33% of traditional UHCL graduates. Sixty percent of TEA^{3}M graduates only used one computer platform in their school compared to 67% of traditional UHCL graduates. Computers available at TEA^{3}M graduates' schools included: IBM compatible (50%), Apple II (40%), and Macintosh (20%). For traditional UHCL graduates, there were more Macintosh (56%) computers available at their schools than IBM compatible (44%) and Apple II (22%) computers.

TEA^{3}M graduates used the following computer technology in their teaching: computer (100%), printer (50%), laserdisc player (30%), Internet (20%), and CD-ROM player (20%). Traditional UHCL graduates used the following similar computer technology in their teaching: computer (100%), printer (56%), laserdisc player (33%), and CD-ROM player (22%); however, they did not report using the Internet (see Table 1).

Table 1

What computer equipment do you use in your teaching?

	TEA^{3}M graduates	Traditional UHCL graduates
Computer	100%	100%
Printer	50%	56%
Laserdisc Player	30%	33%
CD-ROM Player	20%	22%
Internet	20%	0%

Both TEA^{3}M graduates and traditional UHCL graduates used similar kinds of computer software to enhance their productivity and classroom management tasks. All or most TEA^{3}M graduates used the following kinds of computer software: word processor (100%), spreadsheet (40%), electronic gradebook (20%), and test-item bank (20%). All or most traditional UHCL graduates used the following similar kinds of computer software: word processor (100%), spreadsheet (33%), electronic gradebook (33%), and a test-item bank (22%) (see Table 2).

Table 2

What type(s) of personal software do you use to enhance your productivity and/or classroom management?

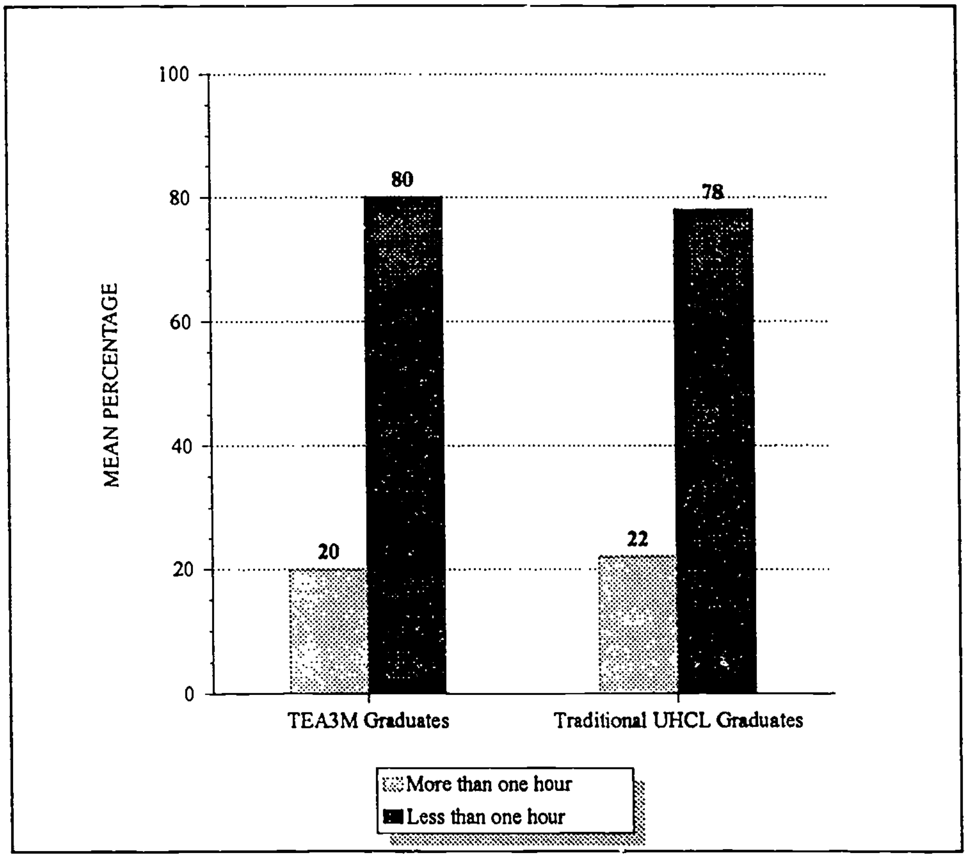
	TEA^{3}M graduates	Traditional UHCL graduates
Word Processor	100%	100%
Spreadsheet	40%	33%
Electronic Gradebook	20%	33%
Test Item Bank	20%	22%

While TEA^{3}M graduates and traditional UHCL graduates did not exactly use the same kind of computer technology to simplify or enhance their personal performance, they used what was available to them to the fullest. TEA^{3}M graduates reported enhancing their productivity and classroom management tasks by: (1) using CD clip art to create activities, (2) organizing student information, and (3) producing "more professional looking" documents and papers to send to parents and peers. Traditional UHCL graduates reported enhancing their productivity and classroom management tasks by: (1) developing forms, (2) grading tests and homework, (3) using an electronic gradebook, and (4) creating worksheets and tests.

Integration of computer software and hardware into the curriculum. Both the TEA^{3}M and traditional UHCL School of Education pre-service programs provided their graduates with the skills to enhance student learning by integrating software and hardware with instruction. The TEA^{3}M Collaborative instilled a wider variety of integrative skills in its interns because of its well-designed technology training component. The traditional UHCL pre-service program also produced teachers with computer software and hardware integration skills; however, the extent of their skills were limited.

According to the following survey results, both groups of graduates had mixed results during their first year of teaching. For example, both TEA^{3}M (80%) and traditional UHCL graduates (78%) reported that their students spent less than one hour per day using a computer. On the other hand, only 20% of TEA^{3}M and 22% of traditional UHCL graduates reported that their students spent more than one hour per day using a computer (see Figure 6).

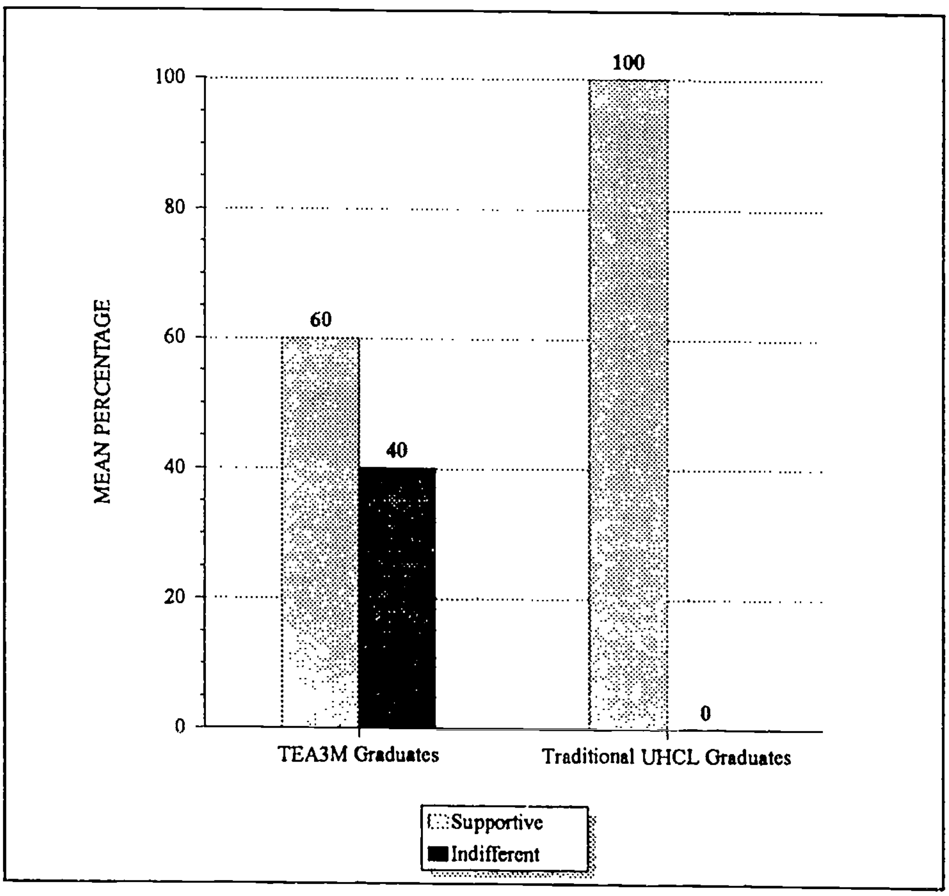
Figure 6. On an average, how many hours per day do your students spend using the computer?



The primary reason TEA^{3}M graduates gave for the lack of student computer time was the low number of computers in their classrooms. Seventy percent of TEA^{3}M graduates had only one computer in their class compared to 33% of traditional UHCL graduates. Forty-four percent of traditional UHCL graduates had two to four computers in their classroom while 30% of TEA^{3}M graduates did not have any computers at all. One TEA^{3}M graduate reported having access to a Macintosh or Apple II computer in their classroom once every four weeks.

Both TEA^{3}M (100%) and traditional UHCL (100%) graduates described their students' response to technology as a teaching tool, as extremely supportive (e.g., "They love it!"). However, both groups reported mixed results when they described peer (teacher) response to technology as a teaching tool. Sixty percent of TEA^{3}M graduates described their peers (teachers) as "supportive" compared to 100% of traditional UHCL graduates. Forty percent of TEA^{3}M graduates described their fellow teachers as "indifferent" while no traditional UHCL graduate reported the same situation (see Figure 7).

Figure 7. How receptive are your fellow teachers to the concept of technology as a teaching tool?



TEA^{3}M graduates primarily used the following types of educational software with their students: games (100%), drill and practice (80%), word processor (70%), and tutorials (50%). Traditional UHCL graduates were more evenly dispersed among the following types of educational software: drill and practice (33%), games (33%), tutorials (33%), word processor (33%), and educational CD-ROMs (33%) (e.g., Living Books, Grolier's Encyclopedia).

For both TEA^{3}M (70%) and traditional UHCL (67%) graduates, English, Language Arts, and Reading were the subject areas in which they had their most successful use of technology in the classroom. Activities reported by teachers included: (1) Edmark's reading software, (2) Intellig-keys spelling program, (3) reading and writing poetry, and (4) vocabulary lessons. For 30% of TEA^{3}M graduates, Science was the second most popular subject area in which they had their most successful use of technology. For 22% of traditional UHCL graduates, Social Studies was their second most popular subject area in which they had their most successful use of technology.

Both TEA^{3}M and traditional UHCL graduates reported needing the same amount of time to develop their most successful use of technology in the classroom. Sixty percent of TEA^{3}M graduates and 56% of traditional UHCL graduates required "on going" development time for their use of technology. For one traditional UHCL graduate, "on going" development time was defined as "daily." Thirty percent of TEA^{3}M graduates and 33% of traditional UHCL graduates were specific about the amount of development time they required. One TEA^{3}M graduate required only 15 minutes and one traditional UHCL graduate did not need any development time at all because their students used the computer as a research tool (e.g., Apple's CD-ROM bundles, Grolier's Encyclopedia).

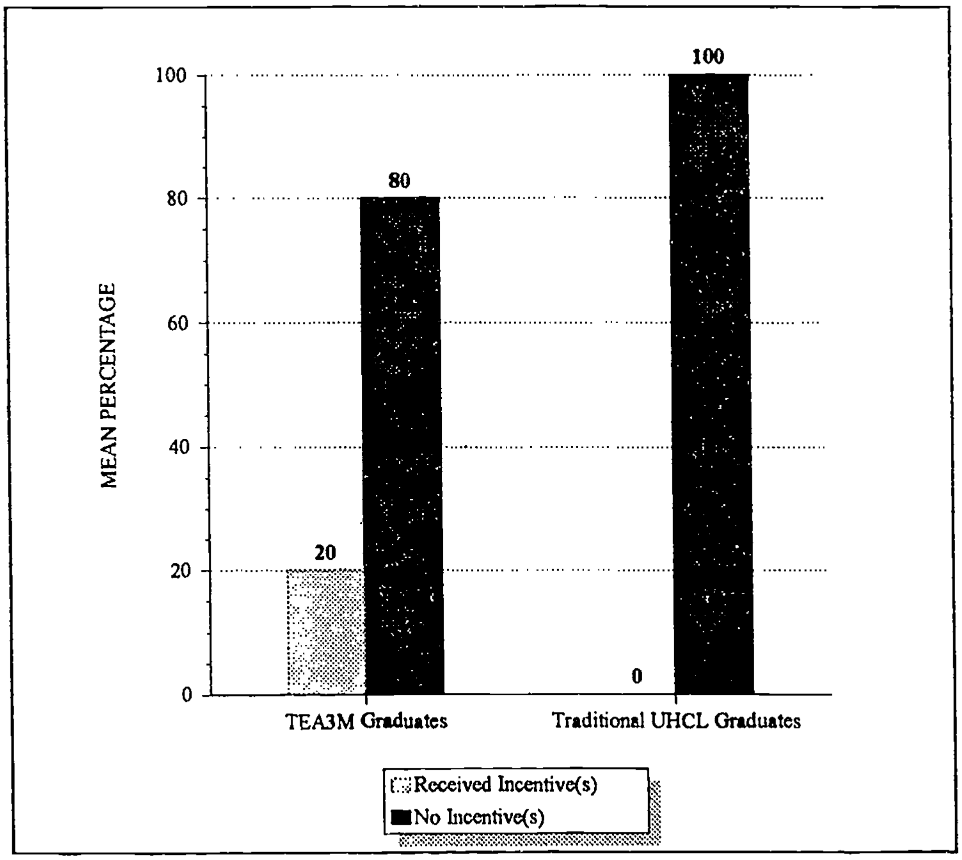
TEA^{3}M and traditional UHCL graduates measured the success of their use of technology in teaching in similar fashion. Sixty percent of TEA^{3}M graduates and 56% of traditional UHCL graduates used student achievement as a measure of success. Particular measures of student achievement included student grades and performance rubrics. Thirty percent of TEA^{3}M graduates used motivation or student eagerness as a measure of success.

In comparison, 33% of traditional UHCL graduates simply observed students to measure the success of their use of technology. One traditional UHCL graduate determined the success of technology knowledge and skills based on student engagement or non-engagement. A smaller number of TEA^{3}M graduates (20%) used student confidence as a measure of success while 11% of traditional UHCL graduates had no need to measure achievement directly because technology was used as a research tool (e.g., ERIC, Encyclopedia).

By integrating technology into their teaching, TEA^{3}M graduates had more positive results outside of their classroom. For example, 50% of TEA^{3}M graduates served as mentors to teachers interested in using technology in their teaching and 20% served on a technology committee. On the other hand, only 22% of traditional UHCL graduates served as mentors to teachers interested in using technology in their teaching while the remaining 78% did not report any significant positive results outside of their classroom.

Incentives to use computer software and hardware. Both groups of subjects, were comprised of teachers who accepted the challenge of learning new technologies and integrated them into their curriculum and preparation; however, their schools provided little or no incentives (e.g., reward or recognition) to encourage them to continue their efforts (see Figure 8). Eighty percent of TEA^{3}M graduates received no recognition for their efforts while 100% of traditional UHCL graduates faced the same lack of support. Only 20% of TEA^{3}M graduates reported receiving a letter of recognition and/or attended a TCEA conference for their efforts.

Figure 8. What type(s) of incentives (e.g., reward or recognition) you have received in your school for using technology in your classroom instruction or preparation?



Barriers to using computer software and hardware. Both groups of subjects described similar barriers that limited or prevented their use and integration of computer technology in their school (see Table 3). For TEA^{3}M graduates, their primary barriers were a lack of: funding (60%) available computers (40%), training (30%), and incentives to motivate teachers to use technology (30%). For traditional UHCL graduates, their primary barriers were a lack of: funding (56%), training (44%), available classroom space for computers (22%), and incentives to motivate teachers to use technology (22%).

Table 3

What do you think are the barriers that limit or prevent the use of computer technology in your school?

	TEA^{3}M graduates	Traditional UHCL graduates
Funding	60%	56%
Training	30%	44%
Incentives	30%	22%
Available Computers	40%	0%
Available Space	0%	22%

Discussion

This study, that compared graduates from two teacher preparation programs, has four findings. These findings are based on the Technology Use Questionnaire results, that summarized subjects' perceptions of their technology skills and knowledge and pre-service educational experiences.

First, based on the responses to the Technology Use Questionnaire, a greater mean percentage of first year TEA^{3}M graduates transferred: (1) greater knowledge of the functions and features of computer software and hardware, (2) greater skills on how to use a variety of computer software and hardware tools to enhance their performance, and (3) developmental skills and knowledge necessary to integrate computer software and hardware with instruction when compared to traditional UHCL education graduates. The TEA^{3}M technology training component was well designed because there was evidence of student intern successful transfer of computer software and hardware knowledge and skills into their first-year of teaching. However, there was evidence that the traditional UHCL pre-service program also produced teachers who had knowledge, used, and integrated computer hardware and software, but the extent of their training and skills were limited.

Second, TEA^{3}M program graduates reported that it was difficult to continue to be technology proficient and create new and innovative uses of technology for their classes because their schools did not have the necessary computer hardware and software. For example, the primary reason TEA^{3}M graduates reported for the lack of student computer time was the low number of computers in their classrooms. TEA^{3}M graduates reported learning many useful ideas for incorporating technology into their instructional activities; however, the majority of time they could not be implemented because the necessary computer hardware and software was not available at their schools. One TEA^{3}M graduate reported having access to a Macintosh or Apple II computer in their classroom once every four weeks.

Third, because of the wide-range of technological applications that may be used to enhance both student and teacher performance, traditional University of Houston - Clear Lake graduates reported that it was difficult for a single course (e.g., Classroom Computer Usage) to provide the necessary technology instruction to successfully use and integrate technology into the classroom. The traditional University of Houston - Clear Lake education program only offered its student teachers one Classroom Computer Usage (INST 3133) course. As a result, the majority of traditional UHCL education graduates reported being unsatisfied and frustrated with their training because one course limited the number of prespecified computer proficiencies they could achieve.

For example, traditional UHCL graduates described the Classroom Computer Usage (INST 3133) course as not providing enough depth. One traditional UHCL graduate complained that, "My computer literacy course was a survey of the (then) latest/most popular programs." Seventy eight percent of traditional UHCL graduates felt that their program did not provide them with new and useful information about using technology (e.g., enhancing personal tasks and/or student learning) and 89% of traditional UHCL graduates reported that their program needed extensive modifications.

Finally, there are seven possible reasons why TEA^{3}M graduates transferred a greater amount of technology knowledge and skills into their first year of actual teaching practice than traditional UHCL pre-service graduates. This transfer has made a significant improvement in TEA^{3}M graduates' professional technology development and student learning.

First, unlike the traditional University of Houston - Clear Lake teacher education program, TEA^{3}M interns had to meet the TEA^{3}M technology standard (p. 6).

Second, the TEA^{3}M pre-service program made a substantial investment in computer hardware and software to help TEA^{3}M interns meet the required technology standard (p. 6). This investment included: (1) a computer for each mentor teacher, (2) a portable laptop computer for each site coordinator, TEA^{3}M intern, and UHCL faculty, (3) productivity tools and educational software, (4) an electronic classroom at UHCL, (5) support staff to develop and deliver training, (6) a multimedia workstation for each participating school, and (7) installation of a school-wide and district-wide computer network.

Third, the TEA^{3}M pre-service program made a substantial investment in computer training to help TEA^{3}M interns meet the required technology standard (p. 6). TEA^{3}M interns received training on how to use computers in order to communicate with UHCL faculty and other school sites through TENET, the TEA interactive communication network. Also, TEA^{3}M interns received training on how to use their assigned laptop computer to help complete student internship projects during the school year.

Fourth, to be responsive to the on-going needs of educators at each collaborating Professional Development School site, workshops and seminars were given by UHCL faculty, school district staff, Region IV Education Service Center, and computer vendors. Surveys were also taken on a continual basis to determine what types of workshops and seminars were necessary in the future (Center for Professional Development & Technology, 1995a). Throughout the workshops and seminars, TEA^{3}M interns were encouraged to develop the self-confidence that will enable them to use their own best judgement, under any changing circumstances, to provide for their students' best educational interests.

Fifth, at the completion of the TEA^{3}M program, interns had to complete a pre-service teacher technology portfolio that was assessed by University of Houston - Clear Lake faculty and supervising teachers. Portfolios required interns to provide evidence of the following five types of products: (1) research (e.g., a review of literature on the use of a particular computer application in education), (2) a video that depicted the teacher using computer-technology in an instructional setting, (3) lesson plans that showed the inclusion of technology, (4) assessments that provided evidence of the teachers' ability to measure their students' acquisition and application of computer-technology, and (5) resources (e.g., a directory of people, software, and hardware products and services) (Hirumi, Harmon, & Palumbo, 1994).

Sixth, the TEA^{3}M pre-service program fostered computer literacy through the use of computers within the educational training courses themselves. To provide the necessary instruction to use computer technology in the classroom, TEA^{3}M faculty integrated technology into their classes to expose their interns to a variety of computer applications. To effectively encourage and integrate technology into the public school system, the TEA^{3}M program sufficiently modeled its use in higher education and professional development in-service programs. TEA^{3}M faculty ensured that teacher candidates were presented with a wide range of technology experiences by successfully infusing computer technology throughout its pre-service preparation program.

Lastly, the TEA^{3}M pre-service program provided opportunities for continuing professional development (e.g., in-service instruction, workshops, seminars) and follow-up site-based support in the classroom. The TEA^{3}M Collaborative continuously ensured that its interns and PDS educators had received training and instruction in technology use and its applications. Teacher development is an ongoing process in which professional development and improvement continues beyond one's initial education. To accomplish this, the TEA^{3}M program committed itself to providing teachers continuing professional development because in many instances "true" technology learning, experimentation, and exploration begins after pre-service preparation.

Any effective teacher education program is obligated to provide its graduates with a foundation of knowledge, attitudes, efficacy, and skills. The TEA^{3}M pre-service program successfully recognized that technology training, development, and curriculum improvement are continuous processes that cannot be fulfilled in one single pre-service course. There is never a point when the technology curriculum is perfect or when all teachers have achieved their full potential because the field of technology is in a constant state of rapid development. Continual change requires continuous adjustments. Therefore, the TEA^{3}M program was designed to produce teachers with the skills necessary to address the continuing advances in computer technology and to adapt to rapid change.

Recommendations

The following six recommendations can help pre-service and in-service teacher education programs, school districts, and local schools (e.g., administrators, teachers) develop strategies to ensure that they are all committed to long-term use of computer software and hardware for professional development and to enhance student learning.

First, school districts should form partnerships with other school districts in their region, with institutions of higher education, and with business and industry to provide teacher development programs and implementation support to teachers in their regions. Many teacher preparation programs, such as the TEA^{3}M Collaborative, are trying to infuse the application of computer technology throughout their curriculum by forming partnerships with other school districts in their region and with business and industry (e.g., Hirumi, Harmon, & Palumbo, 1994).

Second, partnerships should provide follow-up support (e.g., in-service instruction, workshops, seminars) in the classroom. Conducting teacher development activities on educational computing will provide opportunities for teachers to participate for several years. This can lead to being responsive to the needs and interests of the teachers and provide opportunities for assumption of leadership roles.

Third, each school should build an infrastructure of people (regional teacher centers, district implementation teams, lead teachers, and school teams) and resources (hardware, software, curriculum, and teacher development activities) to support teachers as they continue to improve their use of educational computing. For example, a computer software and hardware performance support system should be established at every school to help train and support teachers on the application of computer technology. Any school can have resource personnel in a variety of areas (e.g., using the Macintosh, IBM PC, Apple GS, local area network (LAN) administration, interactive video, word processing, graphic programs, grade book programs, HyperCard, CD-ROM, Linkway, telecommunications, etc.) for on-site, long-term training or consultation (Van Horn, 1991).

It is difficult for teacher preparation programs to provide comprehensive computer training, even if computer use was infused throughout the curriculum, because new hardware and software is being continually developed. Therefore, every school should identify teachers who have particular expertise and designate them as technology resource personnel that address the multitude of applications and the changing nature of technology. Therefore, as a need arises, teachers within that particular school can approach their fellow "experts" who can then serve as a resource to successfully solve their peers' computer application problems (Adams, 1985). An essential part of this support system also includes easily accessible university faculty, computer vendors, and software companies that can provide help after initial pre-service and in-service training.

Fourth, district and school administrators must establish a system for providing incentives to encourage their teachers to meet the challenge of learning new technologies and integrating them into the curriculum. Possible incentives include a simple letter of recognition or a paid leave to attend a local or regional conference. Schools could also provide release time to teachers to review software, develop lesson plans, reflect on their own teaching, discuss ideas with fellow teachers, and observe experienced teachers using innovative applications of educational computing. If teachers are to design innovative technology rich-learning environments, they must be given the time and training necessary to develop the required computer software and hardware proficiencies.

Fifth, school district and school administrators should establish "top-down" funding initiatives from their State Legislature and business and industry. It will then be possible for administrators to allocate sufficient funds so that each teacher can have access to one or more computers in the classroom. It is also important that school districts allocate funding equally for hardware, software, and teacher developmental activities.

Lastly, teachers should establish "bottom-up" funding initiatives by locating and applying for grants. Grants will provide funding for computer software and hardware. A variety of educational grants allow teachers to acquire computer software and hardware and/or training for their classroom or school. The burden of funding should not rest solely with district and local school administrators. There are a variety of private foundations and commercial organizations (e.g., business, industry) that provide donations of computer hardware and software and funds to schools and/or teachers.

Suggestions for Future Research

While this study described a successful instance of immediate transfer of technology training, other researchers, discussed in the review of literature (Hadley & Sheingold, 1993; Honey & Henriquez, 1993; Brady, 1991; Sheingold & Hadley, 1990), found that the process of changing teachers' actual behavior takes considerable time and effort beyond their initial pre-service preparation. The review of literature also found that the computer-based practices of teachers shift over time, and usually, the teachers heavily involved with computer technology are not from the ranks of the young, new "technology generation."

Based of these findings, any improvements in teacher knowledge and attitudes do not necessarily guarantee immediate changes in behavior and researchers. For example, the review of literature found instances in which teachers needed three or more years of support to make a substantial change in instruction (Hadley & Sheingold, 1993; Honey & Henriquez, 1993; Brady, 1991; Sheingold & Hadley, 1990). Therefore it is suggested that future researchers assess teachers' behavior five to six years after the completion of their teacher education program, in order to assess their commitment to technology use and the long-term effects of a particular teacher education program.

*The author of this paper would like to acknowledge the work and contributions of the following participants: Dr. David B. Palumbo and Dr. Atsusi Hirumi.

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