Toledo, C. (2005). A five-stage model of computer technology integration into teacher education curriculum. *Contemporary Issues in Technology and Teacher Education, 5*(2), 177-191.

A Five-Stage Model of Computer Technology Integration Into Teacher Education Curriculum

Cheri Toledo
Illinois State University

Abstract

Three teacher education programs were studied to explore the process of integrating computer technology into the curriculum. The focus of this study was to define the stages that schools, colleges, and departments of education experienced as faculty and students moved from lower to higher levels of computer technology use and integration. Data were gathered at the participating sites from three sources: teacher education faculty members, key informants, and focus groups. In-depth interviews were conducted with the key informants and with focus groups (administrator, key informant, faculty member(s), computer technology support person, and student). The gathered data were used to answer the research question: What are the defining characteristics of the stages of development that departments of education experience as they infuse computer technology into the teacher education curriculum? The findings of this research resulted in the emergence of a Five-Stage Model for computer technology integration into teacher education programs: pre-integration, transition, development, expansion, and system-wide integration.

The issue of computer technology integration in teacher education has reached the national level, resulting in standards for schools, colleges, and departments of education (SCDEs) that address the integration of computer technology as a tool to enhance student learning. As a result, to meet these standards faculty members at SCDEs are faced with the challenge of developing computer technology use and integration skills in preservice teachers. This study explored the practice of integrating computer technology into the curriculum of three teacher preparation programs. By studying the process of computer technology infusion, this research study focused on defining the developmental stages SCDEs experienced. As a result, a Five-Stage Model of computer technology integration was produced.

Theoretical Framework

Technological changes in the past quarter of a century have challenged professional educators to reevaluate their instructional skills and to reconstruct their delivery as they assist students in integrating new technology tools. This resulting phenomenon is described by change theorist Everett M. Rogers as the diffusion of an innovation and served as the theoretical framework for this study.

Rogers (1995) defined diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (p. 5). An innovation is "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p. 11). Rogers' rate of adoption model, most applicable to this study, states that innovations are diffused over time in a pattern that resembles an S-shaped curve. An innovation goes through a period of slow, gradual growth before experiencing a period of relatively dramatic growth. Following this the innovation's rate of adoption gradually stabilizes and eventually declines. The rate of adoption is the culmination of the decision-making processes of users regarding their implementation of the innovation. Rogers established that individuals could be divided into innovation adopter types: innovators, early adopters, early majority, late majority, and laggards. He then specified that the early adopters are the key players in bringing the innovation to the point of being self-sustaining.

Gladhart (2001) developed a Levels of Adoption model by adapting the Apple Classrooms of Tomorrow (ACOT) study by Dwyer, Ringstaff, and Sandholtz (1992). Gladhart's model addressed the issues of teacher behavior, student behavior, and technology tools regarding computer integration. The teacher behavior part of the model lists the following five levels of computer technology integration: entry, adoption, adaptation, appropriation, and invention.

Russell (1996) identified six stages that learners move through as they learn to use technology: awareness, learning the process, understanding the application of the process, familiarity and confidence, adaptation to other contexts, and creative applications to new contexts. Russell's action research specifically addressed the use of email by over 400 teachers in postgraduate study. The students emailed metacognitive reflections regarding their experiences, resulting in the emergence of six categories "learners typically go through as they learn to use technology" (The Study section, ¶4).

Table 1 provides a comparison of the three models regarding the stages an adopter follows as an innovation is implemented. The models of Rogers, Gladhart, and Russell show several similarities. Stage 1 for all three models involves the initial step of becoming aware of and acquainted with the innovation. All three authors alluded to the individualism of this stage; that is, the potential adopters' feelings, lack of communication with others about the innovation, and an overall attitude of observation rather than activity.

Stage 2 varies considerably among the three authors. Rogers' Stage 2 involves the forming of a positive or negative attitude about the innovation. Russell emphasized the use of the innovation and the development of new skills. In Stage 2, Gladhart saw users applying their new technology skills to their teaching.

In Stage 3, Gladhart and Russell stressed that the increase in skill levels allows the adopter to apply the use of this new technology to their teaching. In addition, with

confidence in their skills, adopters are able to provide creative integration activities for their students. To Rogers this stage shows evidence of an individual involved in activities leading to the decision to adopt or reject the innovation.

For Rogers, Stage 4 was the action phase of the adoption of an innovation. Here the individual makes the decision to adopt or reject the innovation. Russell observed an increased adopter confidence in technology use and troubleshooting. Gladhart saw teachers shifting their instructional methods to use of technology to provide a learner-centered approach.

Stage 5 is the final stage for Rogers and Gladhart. Rogers simply stated that it is in this stage that the individual uses the innovation. Rogers added that users seek reinforcement for their decision. Gladhart noted that adopters change their instructional methods to include technology as an active, creative, and socially interactive approach. In Stage 5, Russell described the use of technology as applying to multiple circumstances relating to curriculum. She identified the transference of knowledge and experience as occurring at this stage.

Only Russell included a sixth stage in her model: this creative application of the technology and innovation beyond what has been done before.

Table 1
Summary of Models of Stages of Adoption of an Innovation

Stage	Rogers Innovation-Decision Process	Gladhart Adoption Rubric for Computer Technology Integration	Russell Learning to Use Technology
1	Knowledge	Entry	Awareness
2	Persuasion	Adoption	Learning the process
3	Decision	Adaptation	Understanding and application of the process
4	Implementation	Appropriation	Familiarity and confidence
5	Confirmation	Invention	Adaptation to other contexts
6			Creative application to new contexts

These three models all dealt with individual adoption of an innovation and served as the context from which this study was developed. This researcher relied on the individual adoption foundation to assess a systemic level application of the adoption of an innovation; that is, the integration of computer technology into the teacher education curriculum.

Research Methods

This research used a descriptive case study design (Yin, 1989) to examine the three teacher education programs. By using the case study method, this researcher was able to "retain the holistic and meaningful characteristics of real-life events [including] organizational and managerial processes" (Yin, 1989, p. 14).

The participating programs were chosen based on their use of the computer technology infusion model, rather than the stand-alone course model. The infusion model refers to the inclusion and utilization of computer technology by faculty members and students throughout the teacher education coursework. In the stand-alone course model one required course provides instruction for preservice teachers on computer technology literacy and integration skills. The three teacher education programs were determined to be at different levels of the infusion process by an analysis of their documentation and the results of the School Technology and Readiness (STaR) Chart (CEO Forum, nd). The participating programs are from private institutions in northern and southern California, with enrollments ranging from 1,250 to 7,000 students. The two schools with enrollments of 7,000 are located in urban settings; the third, with an enrollment of 1,250, is in rural northern California. All three institutions are accredited by the Western Association of Schools and Colleges.

A well-rounded description was developed by triangulating data sources from the three programs. Evidence was gathered from existing documents, survey instruments, key informant interviews, and focus group interviews to answer the research question: What are the processes that occur as departments of education move toward the infusion of computer technology into the teacher education curriculum?

Existing Documents

In an attempt to bring teacher credentialing requirements into compliance with national trends and standards, several California State Assembly and Senate bills addressed the issue. Standard 20.5 - Use of Computer-Based Technology in the Classroom, adopted in 1998, required that "candidates are able to use appropriate computer-based technology to facilitate the teaching and learning process" (Swofford, 2000). To meet Credential Standard 20.5, each university teacher education department submitted an implementation plan to the California Commission on Teacher Credentialing (CCTC). The CCTC evaluated, accepted or rejected, and oversaw each university's plan. For this study, the Standard 20.5 proposals were secured from 11 teacher education programs. Three programs met the study design criteria and were accommodating to participation in the research.

Survey Instruments

Four survey instruments were used in this research: The STaR Chart, a faculty demographic survey, the Stages of Adoption survey (Stages), and the Levels of Use (LoU) survey.

The STaR Chart (CEO Forum, nd) is a self-assessment tool which assists SCDEs in determining the level of technology integration in the teacher education program. The Chart provides a matrix defined by three levels of technology integration and eight categories involving administration, faculty, students, and alumni. The tool can be used to assess an institution's current technology integration status and assist in planning for the future. The STaR Chart was used to determine the level of computer technology integration of each participating teacher education program and was completed by the key informants on the CEO Forum Web site. Key informants emailed the results to the researcher. The STaR Chart findings classified one program in each of the following stages: Early Technology Level, Developing Technology Level, and Advanced Technology Level.

The demographic questionnaire collected information from the teacher education faculty members in each program. Personal information such as age, gender, education level, and position status were compiled. The following items regarding computer technology use were collected: computer access; computer, software, and e-mail use; training; and Web site authoring. The mean scores of each of the items were used in the triangulation procedure to provide a thorough understanding of the characteristics of the teacher education faculty.

The Stages survey (adapted from Christensen, 1997) is a self-assessment measure that describes the adoption behaviors of an innovation user on one of eight progressive levels. Users select a single level that best describes their position along the continuum of adopting computer use. The Stages survey was used in this study to indicate the stage of computer technology use of the teacher education faculty members in each program. A mean score of the technology use levels of the faculty at each site was determined.

The LoU survey (adapted from Griffin & Christensen, 1999) is a self-assessment measure that describes the computer technology use behaviors on one of seven progressive levels. Respondents select a single level that best describes their levels of computer technology use. The LoU was used to indicate the computer technology use of the teacher education faculty in each program. A mean score of the technology use levels of the faculty at each site was determined.

The teacher education faculty members from the participating institutions were contacted through the key informants and asked to complete the demographic questionnaire, the Stages survey, and the LoU survey. Information was gathered from faculty members who integrated and who did not integrate computer technology into their teaching. Faculty members were given the choice of completing the surveys online or by hard copy.

Key Informant Interviews

After initial telephone contact with the institutions, the key informants (those individuals with the most information about computer technology integration in their university teacher education programs) were identified. Key informants at each institution participated in an in-depth interview.

Focus Group Interviews

The focus groups at each site were comprised of at least two teacher education faculty members, one department of education administrator, one support staff individual, and one teacher education student. Key informants at each site assisted in identifying focus group members.

Data Analysis

Documents

Implementation Plans for the California Credential Standard 20.5 were assessed to determine the method for developing computer technology skills in preservice teachers. Those universities indicating in their plan the use of the infusion model were considered for the study. From these institutions, one Early Technology site, one Developing Technology site, and one Advanced Technology site were identified. The 20.5 Plan from the Early Technology program indicated they were using a stand-alone model. However, the Department Chair indicated they were in the process of adopting the infusion model.

Surveys

The 19-item STaR Chart report, completed by the key informant at each site, identified the stage of technology integration of each participating teacher education program. As stated previously, one of the participating programs was found to be in each of the categories, Early, Developing, and Advanced Technology.

The demographic questionnaire and each of the three surveys completed by the faculty participants were scored, compiled, and analyzed individually and corporately. Thirty teacher education faculty members completed the survey process, with a 100% response rate. Demographic information was used in the triangulation procedure to provide a thorough understanding of the characteristics of the teacher education faculty at the three sites.

The LoU and Stages self-report, single-item surveys do not require statistical interpretation. Mean scores on each survey for each participant and mean scores for each site were determined.

Interviews

Key Informant. In-person interviews with the key informant at each site were recorded and the text transcribed verbatim. Each informant was asked a standard set of open-ended questions (see Appendix A). A qualitative assessment procedure was applied to the key informants' answers. The text was read and an interpretive statement was written that captured the essence of the key informant's quote. Those interpretive statements were sorted into categories. In each of the categories, themes were identified and then paired with corresponding quotations from the key informant.

Focus Group. A focus group, consisting of four to six teacher education stakeholders, was interviewed to explain further stages and processes of infusing computer technology into the teacher education curriculum. The focus group participants were asked a standard set of open-ended questions (see Appendix A). The focus group interviews were recorded and the text transcribed verbatim. The text was analyzed with the same approach used with the key informant interviews.

The existing documents, survey instruments, key informant interviews, and focus group interviews provided this researcher with a wide range of data from which to address the research question.

Results and Discussion

As a result of the data analysis, defining characteristics for each program were identified. These revolved around themes of leadership, support, resources, and faculty and student computer technology use and integration. A five-stage developmental model of computer technology integration emerged. The stages are as follows:

- Stage 1: *Pre-integration*
- Stage 2: *Transition*
- Stage 3: *Development*
- Stage 4: *Expansion*
- Stage 5: *Systemwide Integration*

Each stage in the model (see Table 2) consists of distinctive characteristics, tasks, and actions that occur as SCDEs move toward the system-wide integration of computer technology into the teacher education curriculum.

Table 2
Five-Stage Model for Computer Technology Integration Into Teacher Education Curriculum

Stage	Characteristics, Tasks, Actions
Pre-Integration	• lack of university leadership • few faculty using computer technology • stand-alone classes offered to meet credentialing requirements • lack of infrastructure to provide funding, support, and resources
Transition	• change in support of leadership at the university, school, and/or departmental levels • increased interest and vision for the use and integration of computer technology filters down to the teacher educators • requirements of technology standards produces shift
Development	• SCDEs begin to complete tasks that enable them to infuse computer technology throughout the curriculum o acquisition of technical resources such as computers for faculty, computer labs o hiring of education technology faculty and specialists o planning and implementation of new faculty development programs

Expansion	• further movement in the department toward providing the needed education technology hardware, software and systematic training for faculty success in computer technology integration o strengthening of the relationships between the support personnel and the faculty o presence of these relationships produce positive impact on the faculty levels of use and integration o creation of an environment in which faculty are encouraged to risk trying new technologies and methodologies
Systemwide Integration	• evidence of the integration of standards proficiencies for students indicated • computer technology being imbedded into each of the teacher education courses • faculty and students enthusiasm for integration increases

Stage 1, Pre-Integration, is marked by a need for university leadership at all levels to support integration, both monetarily and organizationally. At this level, faculty members show limited professional and personal computer technology use. In addition, standalone classes are the only means used to meet credentialing requirements. Last, no infrastructure has been developed to provide funding, support, and resources.

In the second stage, Transition, major changes regarding administrative support at the university, school, and/or departmental levels occur. There is an increased interest and vision for the use and integration of computer technology on the part of teacher educators. Increased use and integration of computer technology is happening in this stage due to the requirements of external standards at state and national levels. Administrators are using the requirement to meet the standards to assist in the procurement of funding and additional technical support.

In the third stage, Development, SCDEs begin to complete the tasks that enable them to integrate computer technology throughout the curriculum. They acquire technical resources such as computers for faculty and computer labs, and they hire education technology faculty and specialists to assist faculty members in beginning the infusion process. In addition, the planning and implementation of faculty development programs for integration training emerge in this stage.

Expansion, the fourth stage, is marked by further movement toward providing the needed technology hardware, educational software, and faculty training leading to proficiency in computer technology integration. The development and deepening of the relationships between the support personnel and the faculty can also be seen in this stage. The quality of these relationships can positively impact faculty levels of use and integration. This occurs with the creation of an environment in which faculty members dare to risk experimentation with new technologies and methodologies. At the Developing and Advanced Technology Levels, the existing supportive relationships were striking. Strong

ties had been established between the support personnel and the faculty, enabling the faculty members to attain higher skill levels and a better understanding of the place of computer technology in their teaching. Faculty members reported the importance of this one-on-one availability of a personal resource to assist them in their use and integration of computer technology. This need for individualized support for faculty was mentioned at the Early Technology Level, although it had not been made available for the entire faculty.

In Stage 5, Systemwide Integration, evidences of the integration of the state and International Society for Technology in Education (ISTE) standards proficiencies for students are evident, and computer technology is imbedded into every teacher education course. A systematic approach to faculty development through supportive relationship-based mentoring comes to fruition in this stage, as both faculty members and students are enthusiastically involved in the infusion process.

It was found that the Early Technology site was working through Stage 3 – Development; the Developing Technology site was in the beginning of Stage 5 – Systemwide Integration; and the Advanced Technology site set the benchmarks for Stage 5. The specific experiences of these programs occurring during the processes of integration can be seen in Appendix B.

Conclusions

Pressures from both the society at large and the standards movement are increasing the need for SCDEs to ensure that the teachers they are training are capable of integrating computer technology into the K-12 curriculum. This Five-Stage Model provides a template for teacher education programs seeking to meet that goal.

The use of this model with the most potential for impact is for SCDEs to identify their current stage position and then to develop a plan to move through the remaining stages. This type of application of the model can result in a reduction of time, the maximization of resources, and the creation of effective faculty development programs.

It is important to note that each of the participating programs in this study varied in their movement through the stages, leading to the conclusion that the stages are not necessarily linear nor are they interdependent. While many of the tasks are completed in succession, there are factors that influence program movement through the stages; for example, the provision of substantial funding will assist programs in bypassing lower level tasks that are funding dependent.

To meet the integration goal, teacher education faculty members are called upon to explore, evaluate, and create teaching strategies that enable preservice teachers to use technology in K-12 classrooms. As shown through this model, success is dependent upon supportive leaders who provide assistance in funding, access to adequate facilities, and systematic faculty development. In addition, many students are entering their teacher education programs with increased levels of computer use and with the expectation of the use and integration of computer technology by their instructors. When combined with strong administrative support, this top-down/bottom-up phenomenon can be the most effective method in the push toward systemwide integration. As students are asking for more computer technology integration and administrators are providing access and training, teacher education faculty members must seize every opportunity to ready their preservice teachers for computer technology integration into their future classrooms.

Obviously, the choice not to use computer technology in classrooms is no longer an option. Instead, the issue is how to best prepare future teacher educators to meet the demands of teaching and learning in a technology rich world. SCDEs must employ the most effective method for assisting future generations in meeting these demands. The Five-Stage Model provides SCDEs with a detailed description of how to move to the system-wide integration of computer technology into the teacher education curriculum. As shown by the Advanced Technology program, this goal can be accomplished with sound leadership, a dedicated faculty, and a definitive plan.

References

CEO Forum. (nd). *Teacher prep STaR chart*. Retrieved June 16, 2005, from http://star.aacte.org

Christensen, R. (1997). *Effect of technology integration education on the attitudes of teachers and their students*. Unpublished doctoral dissertation. University of North Texas, Denton, TX.

Dwyer, D. C., Ringstaff, C., & Sandholtz, J. H. (1992). *Innovation and interaction: The relationship between technological innovation and collegial interaction* [Apple Classrooms of Tomorrow Report No. 13]. Apple Computer. Retrieved June 16, 2005, from http://www.apple.com/education/k12/leadership/acot/library.html

Gladhart, M. (2001). Models. Retrieved September 13, 2004, from http://education.wichita.edu/m3/models/teachered/integrationgrid.htm

Griffin, D., & Christensen, R. (1999). *Concerns-based adoption model (CBAM) levels of use of an innovation (CBAM-LoU)*. Denton, TX: Institute for the Integration of Technology into Teaching and Learning. Retrieved June 16, 2005, from http://www.iittl.unt.edu/pt3II/WordFiles/cbam.doc

Rogers, E. M. (1995). *Diffusion of innovation* (4th ed.). New York: Free Press.

Russell, A. L. (1996). *Six stages in learning new technology*. Retrieved September 13, 2004, from http://www.fed.qut.edu.au/russell/Stages.htm

Swofford, S. W. (May 19, 2000). *Coded correspondence 00.0016 - subject: Changes to credentialing as a result of AB466 (Mazzoni)*. Retrieved June 24, 2005, from http://www.ctc.ca.gov/notices/coded/2000/000016.pdf

Yin, R. K. (1989). *Case study research : Design and methods*. Newbury Park, CA: Sage Publications.

Author Note:

Cheri Toledo
Illinois State University
Email: catoled@ilstu.edu

Appendix A
Questions for In-Depth Interviews

Questions for Key Informants

1. Let's start with some background information. Can you share what you know of the history of computer technology use and integration in your teacher education program?
2. How do you see the 20.5 Standard fit into this chronology? How did the Standard 20.5 requirements affect the computer integration process in your department?
3. What do you see as the department's philosophy of integration? What is the university's philosophy of computer technology integration?
4. What is the department's vision of computer technology infusion? How was it developed? Who was involved?
5. When you completed the STaRTP Chart, your answers placed your school in the early, developing, or advanced stage. In your own words, describe that stage in regards to how computer technology is being used by faculty and students.
6. What did computer integration look like at the earlier stage(s)? What steps brought you where you are from where you were?
7. What do you foresee in the future stages? What is needed to take you to that point?
8. Describe how the faculty are encouraged to integrate technology into their teaching. What type of support do they receive for integrating technology into their teaching?

Questions for Focus Groups

1. Describe the way computer technology is integrated into the teacher education curriculum. Are you teaching applications or integration? What computer technologies do the instructors use? What computer technologies do the students use?
2. I'm interested the steps that you have seen the teacher education program take toward infusing computer technology into the curriculum. I want each of you to tell me from your perspective. Faculty member, what steps have you taken to adjust their teaching methods to model technology integration? Students, what steps have you seen? Technology person, can you give me a specific example of someone who you've seen make progress toward infusion?
3. From your perspective, what has led to the current level of computer technology integration into your teacher education curriculum? How did it actually come about? Faculty, could you talk about the first class where you integrated technology? Student, what changes have you seen?
4. What are some of the extrinsic and intrinsic barriers that inhibit the faculty from integrating computer technology into their teaching? Time? Access? Training? What other problems do you see?
5. What steps are being taken (or should be taken) to rectify these challenges?
6. Once the faculty has bought into technology integration, what actions need to be taken in order to increase the effective integration of computer technology into your program?
7. What is your vision for a fully integrated teacher education program? What would it look like when you walk into a classroom? What would the teacher be doing? What would the students be doing? How does all this match up to the department's vision?

8. What is the question I haven't asked? What doyou really want to tell me about the stages and processes of integrating computer technology into the education curriculum?

Appendix B
The Processes Experienced by the Early, Developing, and Advanced Technology Level Programs in Their Move Toward Integration

EARLY	DEVELOPING	ADVANCED
Stage 1 – Pre-Integration		
• Provost not pro-technology • Limited use of Web CT • Few education faculty using computer technology, those were not asking for more • 20.5 response written by one faculty member • One stand-alone course for credential	• No supportive leadership • Only desktop computers on campus: Dean's office • No funding, technology plan, training, or hardware/software; faculty bought their own computers • One stand-alone course for credential • CCTC* visit noted lack of computer technology	• Little or no integration - Power Point & Internet used • One stand-alone course for credential • Director of MA in Ed Tech was in charge of course • Infrastructure needed to implement standards
Stage 2 – Transition		
• Computer lab installed in Education building • CCTC report writing process found some faculty pushing for infusion • Search for ed tech faculty to lead the department • Ed tech faculty member hired • Ed tech specialist assigned by academic computing • Faculty decided to infuse • Faculty needs assessment completed • Faculty development • Faculty becoming	• Faculty given up-to-date hardware and software • Standardization of software for all faculty • Program in compliance with CCTC standards • Lowered levels of faculty resistance to integration • Increased availability of peripherals	• 1-year grant facilitator hired • Faculty member with IT skills hired • Collaboration between the two for planning and building of *smarter* classrooms with cutting edge technology • Faculty development planning and implementation

more aware of computer technology possibilities • Some faculty resistance remained		
Stage 3 – Development		
• Computer lab installed in Education building • CCTC report writing process found some faculty pushing for infusion • Search for ed tech faculty to lead the department • Ed tech faculty member hired • Ed tech specialist assigned by academic computing • Faculty decided to infuse • Faculty needs assessment completed • Faculty development • Faculty becoming more aware of computer technology possibilities • Some faculty resistance remained	• Faculty given up-to-date hardware and software • Standardization of software for all faculty • Program in compliance with CCTC standards • Lowered levels of faculty resistance to integration • Increased availability of peripherals	• 1-year grant facilitator hired • Faculty member with IT skills hired • Collaboration between the two for planning and building of *smarter* classrooms with cutting edge technology • Faculty development planning and implementation

Stage 4 – Expansion		
	• Purchasing technology beyond current skill levels and providing the ongoing training for faculty • Online educational portal employed for future use • Online masters' program exploration • Informal support through relationships between high and low-skilled users	• Smarter classrooms equipped • Faculty member becomes Technology Director • Hiring of technology specialist • Development of relationships between support personnel and faculty
Stage 5 – Systemwide Integration		
	• Infusion of standards proficiencies in some courses • Imbedding of computer technology in some courses	• Infusion of standards proficiencies in all courses with congruent systematic faculty development • Imbedding of computer technology in some courses

* California Commission on Teacher Credentialing