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# A Study of the Adoption of Computer Technology by Teachers

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**ABSTRACT**

Public Schools are installing computer technology in classrooms at an alarming rate. However, the training for this infusion of technology does not always transfer to integration of the technology into the curriculum. Helping staff use technology effectively may be the most important step in realizing the current and future investments in technology. To address the lack of technology training and staff's reaction to computer technology usage, this study used the Model of Diffusion (Dooley, 1995) to determine the benefits of computers and the impediments to their use in one rural school district in Texas. Diffusion and change studies can be translated into a variety of different contexts and to a vast array of innovations. With the introduction of computers in schools, there are significant changes in the school organization and the roles of the teachers, administrators, parents and students. In order for education to institute change, it is imperative that school personnel understand the diffusion process and its implications for success or failure of innovations. This framework provides guidance for professional development strategies for all training settings.

**Keywords**

Computer Technology, Teacher Training, Telecommunications, Case Study Research in Schools

## Introduction

Since January 1997 the Center for Distance Learning Research (CDLR) has provided technology training to teachers in over 50 school districts in Texas and New Mexico. Most are small, rural districts and many are recipients of grants from the Texas Telecommunications Infrastructure Fund (TIF) and Technology Integration in Education (TIE) initiatives that support technology implementation.

Training is usually conducted at the school district sites by two trainers. Up to 20 teachers may participate in training sessions, provided that there is a computer workstation per participant. The CDLR encourages districts to use the train-the-trainer model, so CDLR trainers conduct a series of training sessions with a group of master teachers who will then train other teachers.

The only one of these recommendations that has been strictly enforced and consistently followed is having one computer workstation per participant. In spite of strong recommendations to keep participation to 20 or fewer master teachers, many small district administrators insist that everyone be trained. The consequence is a large group of teachers with a broad range of proficiency levels. The result is numerous training needs that often should be dealt with on a one-to-one basis. Unfortunately, large groups will not allow individualized instruction. Also, when administrators mandate that everyone be trained, many participants resent having to participate in training, particularly if it occurs on a Saturday or during the summer.

The CDLR had developed a training brochure, entitled "Teaching and Learning with Technology," with 11 training modules from which to choose. The brochure states, "These technology training modules are designed to help teachers (trainers) develop the skills and strategies for using emerging technologies in instruction and management." (1997, CLDR) The brochure was used as a menu and helped clients to identify training needs, but CDLR trainers have also conducted needs analyses to customize training to needs beyond menu offerings.

During the first year, most of the training focused on the brochure menu items that were organized as modules, and included basic computer applications. In 1998, training emphasis moved from basic computer applications to telecommunications applications. The "Web-Across-the-Curriculum" became the most popular training topic, even for those with little or no experience with technology. A second popular training topic was "Web Publishing", where individuals developed skills and strategies for adapting course materials to the Web. To respond to the growing interest in distance learning, the brochure was redesigned from its modular format into three strands in the areas of "Technology and Teaching", "Distance Learning", and "Putting It All Together". Each of these strands includes several topics. The new brochure states, "These strands are designed to help educators develop skills and strategies for a distance learning environment." (1998, CDLR).

## Theoretical Framework

The Office of Technology Assessment (OTA) issued a report on the integration of technology in our nation's schools (1995). Schools in the United States had 5.8 million computers for use in instruction, about one for every nine students. While 75 percent of public schools had access to some kind of computer network, and 35 percent of public schools had access to the Internet, only 3 percent of instructional rooms were connected to the Internet (OTA, 1995). Currently, most funds for technology have been spent on hardware and software. On average, schools have devoted no more than 15 percent of technology budgets to training. Helping staff to use technology effectively may be the most important step in realizing the benefits of current and future investments in technology (OTA, 1995).

To address the lack of technology training and to assess reaction to computer technology usage, this study used two theoretical underpinnings: Diffusion *of Innovations* (Rogers, 1983) and the Concerns-Based Adoption Model (CBAM) (Hall, Wallace, & Dossett, 1973). This framework provides guidance for professional development strategies for all training settings. It is imperative that we further adopt computer technology and telecommunications as an innovation in business, industry, government, health care, etc. As more and more entities move towards technology driven training, and follow-up studies, we must understand when and if transfer is taking place.

Rogers defined an innovation as an "idea, practice or object that is perceived as new by an individual or other unit of adoption" (1983, p. 11). Diffusion is the "process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 1983, p. 10). The innovation-decision process is the "process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision" (Rogers, 1983, p. 20). This process consists of a series of actions and choices over time with varying stages. There are also influences on the process, such as the prior conditions, characteristics of the decision-making unit, the perceived characteristics of the innovation, and communication channels (Dooley, 1995).

All individuals in a social system do not adopt an innovation at the same time, therefore it is helpful to place individuals into adopter categories, (classifications of members of a system on the basis of their innovativeness). The innovativeness dimension, as measured by the time at which an individual adopts an innovation, can be partitioned into five adopter categories: innovators, early adopters, early majority, late majority, and laggards (Rogers, 1983).

Another adoption model, Concern-Based Adoption Model (CBAM), was developed by Hall, Wallace and Dossett in 1973. The concept of "concerns" has been described as "the composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task. Depending on the personal make-up, knowledge, and experience, each person perceives and mentally contends with a given issue differently; thus there are different kinds of concerns" (Hall & Hord, 1987, p. 59). This model views change as a process rather than an event and examines the various motivations, perceptions, attitudes, and feelings experienced by individuals in relation to change (Hall et al., 1973). Change entails an unfolding of experience and a gradual

development of skill and sophistication in the use of an innovation. An individual's concerns can move in developmental progression from those typical of non-users of an innovation to those associated with fairly sophisticated use.

The theory and research of Hord and associates showed that there was a general pattern to the intensity of the different stages of concern, and that changes in this pattern can be linked to the change process as it unfolds (Hord, Rutherford, Huling-Austin & Hall, 1987). At the beginning of a change process, the typical "non-user" has concerns that are relatively high in *Awareness*, *Information*, and *Personal* (self-concerns). Non-users or low users are more concerned about gaining information about the innovation and about how change will affect them personally. As they begin to use the new program or innovation, concerns become more intense in the area of *Management* (task concerns). As a teacher becomes more experienced and skilled with an innovation, the tendency is for concerns at the lower stages to decrease in intensity while those in higher stages such as *Consequence*, *Collaboration* and *Refocusing* become more intense (impact concerns).

Concerns theory and research reveal that concerns change over time in a fairly predictable, developmental manner (Hall & Hord, 1987; Hord et al., 1987). If we can predict how concerns will change throughout the phases of the change process, we can design in-service and other intervention activities to address those needs (Dooley, 1995).

The success or failure of a training innovation clearly rests with the trainers. Training programs must integrate technology very early to be effective. Train-the-trainer programs must model how to use the technology in the teaching and learning process. The idea is not only to teach them how to use the hardware and software, but how to integrate it seamlessly into the curriculum. Otherwise, it doesn't work..."(Siegel, 1994, p. 34). Thus, hardware, software, and professional development share an interdependent relationship (Dyrli & Kinnaman, 1994; OTA, 1995).

## Purpose of the Study

The purpose of this study was to determine the role of professional development and training in the adoption of computer technology and telecommunications in a training case study. Research questions included:

1. What were the percentage of concerns that were self, task, and impact concerns among high, middle and low-using computer technology and telecommunications users?
2. To what extent did the findings match or not match Rogers' diffusion of innovation research (1983) and the Concern-Based Adoption Model (Hall, Wallace & Dossett, 1973) for innovation and diffusion?
3. What were the factors that made an impact in the diffusion process and how might these training environments further enhance professional development and interventions for diffusion?

## Case Description

Calvert Independent School District (CISD) is a good example of a complex partnership between the CDLR and a school district. The partnership includes technology planning and program development, technical support, and training for teachers, administrators and technology coordinators.

Calvert, Texas, is approximately half way between Dallas and Houston. It has a population of approximately 2,000 and is located about 30 miles north of the CDLR, and is 30 miles from the nearest moderate sized community. Both Robertson County and the community of Calvert are rural in nature with a farm-based economy. Calvert has no non-agricultural based industries. The nature of the terrain limits farming, so the land is basically used for grazing by food animals.

The school district has two schools and an enrollment of 333 total students. Over 92 percent of students have been identified as economically disadvantaged based on eligibility for free and reduced priced school lunches. Ethnic diversity of students is as follows: 81 percent African American, 10 percent Latin American and 9 percent European American.

The Texas Education Agency categorizes CISD as a "property poor" district. For example, the junior high/high school building was constructed in 1920. With a small economic base and low tax income, Calvert had lagged behind other districts in implementing an effective technology program.. Prior to 1997, technological assets at

the high school consisted of 35 computers in laboratory settings, none of which were capable of accessing the Internet.

The overriding problem for Calvert students and community members continues to be the perpetuation of poor academic achievement from generation to generation. This is evident through minimal ability to meet state academic standards. The district's most serious academic deficiencies are in reading and mathematics as evidenced by scores on the Texas Assessment of Academic Skills test (TAAS). In spring 1997, only 45.8 percent of students met minimum expectations on the reading portion of the TAAS, and 38.7 percent met minimum expectations on the mathematics portion.

In fall 1996, the CDLR began providing technology planning assistance to CISD. District administrators drafted a proposal for Technology Infrastructure Funding, and requested assistance in editing and refining the proposal and developing its technology component and budget. The technology planning and grant writing process involved close working relationships between CDLR staff and the Calvert superintendent and secondary principal; several visits occurred between the two sites. Calvert met the TIF selection criteria in that more than 70 percent of its students are economically disadvantaged and the district did not have direct connection to the Internet at the time of the proposal. Consequently, the junior high/high school campus received a TIF grant in the amount of $385,000 in the first round of funding.

Calvert Independent School District contracted with the Center for Distance Learning Research to provide both technical support and training. Technical support included installation of a local area network and computer equipment. In addition to a fully networked laboratory, a computer with Internet access was installed in every classroom, and the principal's office. The training component included at least 10 days of teacher training, 2 days of administrator training, and 4 days of technical training. The teacher training dates were scheduled before the technology was completely installed.

Administrator training included system administration and expansion strategies as well as development of strategies for supporting teachers in integrating technology into instruction and management. Administrator training occurred in a 2-day workshop conducted at the CDLR. The Project Manager and Technology Coordinator received at least 4 days of technical training that included skills and knowledge for maintaining equipment and software, such as routine maintenance, administrative tasks, troubleshooting procedures, and system upgrading procedures. Technical training occurred informally as needed during visits to the school campus by CDLR technical personnel.

The first three teacher training programs were completed before the technology system was actually installed at the school site. This group was very excited about receiving the grant and the administration hoped to engage the staff in training while the excitement was sustainable. Ten administrators and teachers came to CDLR for one day of initial training in May 1997. Two trainers took the group through the *Using Windows 95* curriculum. A month later, one of the trainers met with the high school principal and provided two hours of one-on-one training.

In July, thirteen teachers and administrators attended two days of training held in the computer lab of College Station High School. Two trainers took the group through *Point and Click (Navigating in Windows 95 Environment), Word Processing with Word 97, and Classroom Presentations with PowerPoint* curriculum. The evaluations from these sessions of training were very positive and enthusiastic.

By the scheduled August training, the computer lab had been installed in Calvert ISD. Two trainers took sixteen participants through a review of word processing skills and *Spreadsheets using Excel 97* curriculum. The review proved to be very beneficial, as many participants had not had the opportunity to practice skills learned in earlier training and several had not attended the previous training sessions. The group was taught how to develop their grade books using Excel software; each teacher received his/her student lists and set up their class roles. Discovering how easy it proved to be to average grades was a selling point for several doubtful teachers - this new technology system was indeed worth it!

On September 8, two trainers introduced email to seventeen participants. The system was not totally stable; therefore participants were introduced to email on Microsoft Outlook and were able to email among themselves within their own network. This training was scheduled from 3:00 to 5:00 PM, after classes had dismissed, however students were still present on the campus. Therefore, the teachers were not able to focus on the training. The training team returned on September 20 and by this time the system was more stable. The two trainers reviewed the email process and introduced the Internet. Participants continued to request more time on

the computers to practice and explore new sites. One of the favorite web sites that this group discovered and continued to enjoy was the Blue Mountain Electronic Greeting Cards. For months following the training, the group sent each other and friends animated, on-line greeting cards from this site. Trainers received cards from the teachers as well as various requests for assistance by email.

Two additional trainers, an undergraduate student worker and a graduate assistant, were added to the team for the October training sessions. The team taught the participants to employ key word searches using various web search engines. The curriculum utilized Yahoo, Infoseek, AltaVista, Excite, the ERIC database, and several on-line dictionary and encyclopedia services. The afternoon was spent exploring collaborative web based projects. Using the curriculum, *Virtual Architecture: Designing and Directing Curriculum-Based Telecomputing* (Harris, 1997), as a guide, the group located and reviewed web sites that involved information exchange. It was at this point that members of the group began to experience the overwhelming amount of resources that were now available to them and to their students through the Internet.

Three of the training team members returned to Calvert during a regular school day later in the month. The trainers met individually with each teacher during his/her conference period to address specific staff development needs. Many of the teachers reported they appreciated this individualized attention and asked questions they were not comfortable asking in front of the large group.

In November, three trainers continued to guide the participants through the remaining two activity structures: information collection and analysis and problem solving. The session commenced with the group in a brainstorming activity, identifying powerful learning experiences. At points during the training, the participants shared with the group interesting web-based educational projects they had reviewed and related them to powerful learning experiences that had been identified earlier. The training concluded with guidelines to design a collaborative web-based project.

## Methodology

This study used naturalistic inquiry as the methodology. This methodology allowed the researcher to develop working hypotheses and grounded theory within the context of the schools. The interview process began with the school principal and superintendent and then site technology coordinators, technology trainers, learning specialists, external consultants, and high, middle, and low-using computer technology teachers were interviewed. A total of 13 teachers from the school district were interviewed. A sample of some of the questions used as an interview quide can be found in Table 1. All of the respondents and school levels were coded to ensure confidentiality by using a one or two letter designation and number corresponding to the type of position in the school and the consecutive order of the interview.

For this study a variety of qualitative methods were implemented to “ensure truth value, applicability, consistency, and neutrality:” 1) prolonged engagement and persistent observation, 2) interview protocol development, 3) the interview process, 4) member checking, 5) triangulation, 6) and a reflexive journal (Erlandson, Harris, Skipper & Allen, 1993). The constant comparative method was used for the data analysis (Lincoln & Guba, 1985). This method includes four stages: 1) comparing incidents applicable to each category, 2) integrating categories and their properties, 3) delimiting the construction, and 4) writing the construction. For the first stage, the researcher studied the transcriptions and reconstructions to determine trends in the data from the varying perspectives. Each idea (unit) was initially listed without placement into categories. The investigator drew upon tacit knowledge in making these initial judgments for early category formulation.

The transcriptions were analyzed (Newlove & Hall, 1976) to give a glimpse of the individual concerns and innovation-decision process. As concerns were identified in the interview transcriptions, tally marks were made to determine percentages of concerns (self, task, and impact). Delimiting of the construction occurred as the data sources became saturated and the categories integrated.

The analysis of the interviews of principals and technology trainers provided additional insight into needed professional development strategies. This data will be discussed in the concluding sections.

## Sample Questions in Interview Guide

1. How many years have you been teaching?
2. What subjects/grades have you taught?
3. What is your educational background?
4. What prior experience do you have with computer technology? How did you learn?
5. Are you using the computer technology your school purchases?
6. Have you observed enhanced student achievement?
7. How have you integrated computer technology into your teaching?
8. How do you share ideas with your peers?
9. Are there any barriers to your use of technology/telecommunications?

*Table 1.*

## Research Findings

The researcher did not pre-determine the profiles of the subjects in this study. Respondents were selected based on the nominations of their peers or supervisor, regardless of subject matter taught, total number of years teaching, and how they were trained or received exposure to technology; an 87% response rate was obtained in this study. The findings of this research are summarized into years of teaching experience, percent concerns expressed (self, task, and impact), and how teachers received their technology training/experience. The profiles of high, middle and low using teachers provide a snapshot of the use of computer technology and telecommunications.

Teachers were placed into user categories; by combining the data into high, middle and low teacher profiles, trends were more obvious. Average totals were included at the end of each user category. Notable trends were found in years of experience, percent concerns and technology exposure.

| Code | Years of Experience | Subject | Concerns | | | User of Technology | | |
|---|---|---|---|---|---|---|---|---|
| | | | Self | Task | Impact | High | Medium | Low |
| 1 | 18 | Reading | [ | | | | [ | |
| 2 | 9 | Math | [ | | | | | [ |
| 3 | 16 | Administrator | | [ | | [ | | |
| 4 | 14 | Science | | | [ | | [ | |
| 5 | 20 | English | | [ | | | [ | |
| 6 | 6 | English | | | [ | | [ | |
| 7 | 14 | Business | | | [ | [ | | |
| 8 | 5 | Math | | [ | | [ | | |
| 9 | 31 | Administrator | | | [ | [ | | |
| 10 | 20 | All Subjects | | | [ | [ | | |
| 11 | 5 | Science | [ | | | | | [ |
| 12 | 23 | Science | | [ | | [ | | |
| 13 | 19 | History | | [ | | [ | | |

*Table 2.*

Years of experience revealed differences between high, middle, and low users of technology. High users averaged 17.5 years of experience compared with low users at 10.0. Teachers who were relatively new to the profession, but who felt comfortable in their teaching and/or technology, were most often high users.

In the areas of concerns and training exposure, concerns of **high** users were most often **impact** and **task** concerns as compared to **low** users whose largest concerns were **self**. Middle users fell in between. Specific examples of expressed concerns were used to develop the recommendations at the conclusion of this paper. In addition, training/exposure to technology showed that 11 out of 13 high users of computer technology and telecommunications had access to a computer prior to this study. Most "learned by doing" rather than courses or workshops.

## Conclusions

Conclusions are based upon the original research questions. In responding to research question #1, the percentage of concerns that were self were 23%, for task were 38% and for impact, were 39%. As to how the teachers fell on the continuum of users of computers and telecommunications, 23% were high users, 46% were middle users and 31% were low users. Those responding with high concerns for self most often submitted arguments as to why they felt their positions would not ever be replaced with a computer.

In the second research question, the findings closely matched Rogers' diffusion of innovation research and the Concern-Based Adoption Model for innovation and diffusion. The high users in this study matched Roger's innovators and early adopter category by demonstrating more opinion leadership and risk taking tendencies. Higher users of technology had a more favorable attitude toward change, were more able to cope with uncertainty and risk, less fatalistic, had higher levels of motivation, more social participation, and greater exposure to communication channels. Higher users of computer technology actively sought information about training, software, and applications to the classroom and were more likely to be participating in leadership positions, such as technology or site based management teams. The middle users were more deliberate, succumbed to peer pressure and were more skeptical and cautious. The low users matched Roger's laggards with less interest, more suspicion and resistance.

The stages of concern were an indicator of the diffusion process in a different way. For example, the interactions with a person who has high *self* concerns may be quite different from those with someone with high *impact* concerns. Movement through the stages of concern cannot be forced, but, with appropriate support and assistance, can be facilitated. At the same time, a lack of assistance or the wrong kind of support can interfere with developmental changes in concerns. Concerns are influenced by participants' feelings about an innovation, by their perception of their ability to use it, by the setting in which the change occurs, by the number of other changes in which they are involved and, by the kind of support and assistance they receive as they attempt to implement change (Hord et al., 1987).

In regards to the final research question, several factors contributed to the overall diffusion of computer technology and telecommunications. The degree of computer technology and telecommunication diffusion in this case, the concerns of personnel, and administrative factors all work together in the change process. It is evident that the diffusion process is a complex, dynamic continuum, with many factors influencing the change process. By understanding the types of individual concerns and the relationship of concerns to the use of an innovation, an entity can develop a professional development model and interventions for diffusion. "Based on research with concerns-based concepts, it is clear that the day-to-day actions, or interventions, are keys to the success or failure of change attempts. Indeed, these interventions are the keys to understanding the dynamics of facilitating change" (Hall & Hord, 1987, p. 142). According to Hall and Hord, "an intervention is an action or event or a set of actions or events that influences use of the innovation" (p. 143). Intervening engages many actors who work with many targets in a variety of ways to make change happen. Formal training is obviously necessary, and informal monitoring of implementation must occur regularly.

## Recommendations

Interventions must be logically related to the needs of teachers and the use of the innovation. Through communication and information transfer, individuals begin to network informally about the possible benefits of the innovation. Through formal training and professional development, individuals gain the skills, knowledge and attitude to be successful with the innovation. Individuals must not only have training on the use of the

technology, but on how the innovation can become a part of their training or teaching repertoire. The train-the-trainer model allows individuals to develop units and teaming with technology as a tool, not the focus (Siegel, 1995). Concentration on technology to the exclusion of human factors is a prescription for failure.

There are six distinct categories of interventions: 1) developing supportive organization arrangements, 2) training, 3) consultation and reinforcement, 4) monitoring, 5) external communications, and 6) dissemination (Hord, et al., 1987). Intervening engages many actors who work with many targets in a variety of ways to make change happen. Based on this researcher's findings and data analysis, the following are recommendations for practice specific to the diffusion of computer technology and telecommunications. These recommendations are listed with consideration for the human factors first. Although these recommendations are made for the school studied, implications exist for the consideration or application of these recommendations in other environments.

Interdisciplinary teams/clusters should be formed; one teacher should be placed on each team who is more knowledgeable technologically to help integrate technology throughout the team. This could also be achieved by having at least one "tech" person on each wing/hall and or content area and preferably giving that person an extra conference period to help facilitate individuals in the vicinity of the building or academic area. This enables proximity and similar interest to help infuse the technology in a non-threatening environment. The technology leader on each team should have additional training and exemplify the characteristics of innovators or early adopters (Rogers, 1983).

Teacher training and college courses are still lacking and are not the solution for a quick fix! Teachers training teachers works best, but takes longest. For this school, informal training was most effective. The peer pressure and informal network of placing technology experts on each team will enable the low users to gain knowledge and skill, without becoming angry because it is forced upon them. If training is initially directed to those who are interested and motivated, these teachers can train the other teachers (and be placed on the interdisciplinary teams.

The school in this study had many technological resources. Most of the teachers are using the technology, at least for management tasks. Being a new teacher or a low user in these schools could be intimidating. Most teachers do not want to admit that they do not know procedures. There should be an orientation program for new teachers to demonstrate what resources are available and the procedures for using those resources. The new and low using teachers have more self concerns and need more support and guidance. A collegial mentor program, where a new or low using teacher is matched with a peer who is "just a step ahead of them," will allow these teachers to have many of their personal concerns addressed. This person should **not** be a technology trainer or high user, because the knowledge/skill gap is too great. It was indicated in this study that middle users act as helpers to the low users and are not as intimidating because they have recently been through the learning process. This collegial relationship needs to be non-threatening and related to the individual's subject area or managerial needs. If teachers see the benefit of saving time to average grades, or in the integration of technology into an existing unit, these teachers will begin to overcome the resistance.

Diffusion and change studies can be translated into a variety of different contexts and to a vast array of innovations. With the introduction of computers in schools, there are significant changes in the school organization and roles of the teachers, administrators, parents, and students. In order for education to institute change, it is imperative that school personnel understand the diffusion process and its implications for the success or failure of innovations.

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