APPLE CLASSROOMS OF TOMORROW

**Teacher Beliefs and Practices
Part I: Patterns of Change**

**The Evolution of Teachers'
Instructional Beliefs and
Practices in
High-Access-to-Technology
Classrooms
First–Fourth Year Findings**

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Research

Apple Classrooms of Tomorrow (ACOT)[SM] *is a collaboration—initiated in 1985— among public schools, universities, research agencies, and Apple Computer, Inc. In ACOT classrooms, students and teachers have immediate access to a wide range of technologies, including computers, videodisc players, video cameras, scanners, CD-ROM drives, modems, and online communications services. In addition, students can use an assortment of software programs and tools, including word processors, databases, spreadsheets, and graphics packages. In ACOT classrooms, technology is viewed as a tool for learning and a medium for thinking, collaborating, and communicating.*

ACOT's research has demonstrated that the introduction of technology to classrooms can significantly increase the potential for learning, especially when it is used to support collaboration, information access, and the expression and representation of students' thoughts and ideas.

Realizing this opportunity for all students, however, requires a broadly conceived approach to educational change that integrates new technologies and curricula with new ideas about learning and teaching, as well as with authentic forms of assessment.

The Apple Classrooms of Tomorrow (ACOT) research project explores learning when children and teachers have immediate access to interactive technologies. ACOT's longitudinal research and development efforts examine the impact of technology on teaching and learning and create more powerful applications.

Soon after ACOT was established in 1985, the project began collecting data on the teachers' transition from computerless to technology intensive classrooms.

ACOT teachers are committed to educational change, yet they maintain conventional beliefs about schooling based on life experiences within the traditional system.

Consequently, ACOT teachers go through intense inner conflict as they explore alternative approaches that sharply contrast their beliefs about teaching and learning.

The current research focuses on ACOT teachers' development over the first four years. This report, Part I, presents overall patterns of change in teachers' beliefs and practices.

Preface

The Apple Classrooms of Tomorrow (ACOT) research project has been gathering data since 1986 on what happens when teachers and students have constant access to technology. Analysis of the collective data has clarified a number of hunches about how teaching and learning change in these innovative environments, what factors inhibit change, and what support is needed to promote and sustain fundamental changes in education.

Part I of this research summarizes the developmental phases ACOT teachers go through as they gradually replace their traditional beliefs and practices with new ones (see ACOT Report #8). The report represents the teachers' development as five phases: Entry, Adoption, Adaptation, Appropriation, and Invention. In this model, the teachers' traditional text-based curriculum is delivered in a lecture-recitation-seatwork mode is first strengthened through the use of technology and then gradually replaced by far more dynamic learning experiences for students.

The original research report, "The Evolution of Teachers' Instructional Beliefs and Practices in High-Access-to-Technology Classrooms," was presented at the 1990 meeting of the American Education Research Association and is available through the ERIC Document Reproduction Service, 3900 Wheeler Avenue, Alexandria, VA 22304; (703) 823-0500.

Introduction

In 1985, Apple Classrooms of Tomorrow (ACOT) began as a collaboration between Apple Computer, Inc. and several school districts around the country in an effort to explore the impact of computer saturation on teaching and learning in K–12 classrooms. The research focused on examining what happens when teachers and students have constant access to technology.

Recognizing that the impact of converting traditional, computerless classroom to high-tech exploratoriums would be unprecedented, ACOT began collecting data to document these changes over the short and long term. Analysis of the collective data over four years has brought in focus a richly detailed representation of the instructional changes that occurred in ACOT classrooms, including individual portraits of teachers who struggled with their own belief systems as they worked within these unique environments.

ACOT teachers have been, and continue to be ardently committed to this ambitious project whose goal is to fundamentally change teaching and learning. Yet they carry with them a common set of beliefs about schooling, built upon years of participating in the traditional system as former students and now as teachers. It is this age-old view of schooling, based on the lecture, recitation, and seatwork model of instruction, that persists despite the best efforts of activists in the school reform and restructure movements. Consequently, when teachers work in ACOT classrooms, they experience intense inner conflict as they explore alternative approaches that sharply contrast their beliefs about classroom management, curriculum, collaborative learning, and other such issues.

This, then is the arena into which Apple Classrooms of Tomorrow has entered. In its inception, the project's philosophy was to provide technology and actively support teachers in the directions they chose to go. However, after three years of observation, ACOT developed a decided bias towards a constructivist view of learning[1] and began actively educating and encouraging teachers to implement knowledge construction in their classrooms. Although the direction of change in ACOT classrooms is promising, the pace of change is slow, for even when innovative teachers alter their practices and beliefs, the cultural norms continue to support lecture-based instruction, subject-centered curriculum, and measurement-driven accountability.

This report summarizes an analysis of research findings from multiple studies and data sources collected since the beginning of the ACOT project. The analysis focuses on ACOT teachers' development over the four-year period. Part I presents overall patterns of change experienced by the ACOT teacher group and offers a five-phase model of teacher development in high-tech classrooms oriented to fundamental change in education. Part II presents two personal examples of the conflicts teachers experience while in the process of change, and offers a model for administrative support at each phase of development that can foster innovations over the long term.

The Study

Overview

This study focuses on ACOT teachers at five sites over a four-year period, from 1986–89. Each of the sites began with one grade level in the fall of 1986, adding classrooms, staff, and students in subsequent years. By 1989, the project included 32 teachers and 650 students in four elementary and one high school whose demographics range from inner-city to rural, and low to high socioeconomic status. Together the schools represent the diverse populations and conditions currently found in the nation's public schools.

ACOT classrooms in each of these settings offer students constant access to interactive technologies. The elementary classes are equipped with Apple® IIe, IIGS,® and Macintosh® computers. The high school is an all Macintosh installation. In addition to computers, each class is equipped with printers, scanners, laserdisc and videotape players, modems, CD-ROM drives, and hundreds of software titles.

The technology is used as a tool to support learning across the curriculum. No attempt is made to replace existing instructional technologies with computers. By design, the classrooms are true multimedia environments where students and teachers use textbooks, workbooks, manipulatives, white boards, crayons, glue, overhead projectors, televisions, musical instruments, etc., as well as computers. The operating principle is to use the media that best supports the learning goal.

This four-year study examines ACOT teachers at five public school sites from 1986–89. The schools reflect the nation's diverse populations and conditions; the ACOT classrooms within these schools provide teachers and students with immediate access to interactive technologies.

1 The constructivist view of learning asserts that learners "construct" their own meaning/knowledge from the information they acquire. This differs from the traditional view which assumes a teacher can "deliver" knowledge to a learner.

Data Collection and Analysis

The research draws on a rich, multi-perspective body of data composed of personal reports from teachers; weekly site reports; classroom observations; interviews with students, parents, and teachers; and cross-site assessment data provided by the districts and supplemented by additional measures.

Teacher Journals

Teachers record their personal observations of events in t classroom and their reflections on those events on audiotape, producing an average of two 60-minute tapes per month. The tapes are mailed to Apple where they are transcribed and entered into a database. Instructions about content on the tapes are purposefully left vague, leaving teachers free to report what is most salient at the time to each of them.

Weekly Reports

The teaching staff at each site communicates weekly on major events and developments in a written summary that is electronically distributed among all project participants via Apple Computer's corporate networking system. Again the content of the reports is left to the determination of the teachers at each site. Because these reports are publicly accessible to everyone connected with the project, they tend to be more self-conscious than the personal, frequently introspective reports contained in the audiotape journals. Together, these two sources of data provide interesting contrasts on events at the sites.

Both the teacher audiotapes and the electronically communicated weekly report are monitored by graduate students who digest the source information into discrete "episodes," and index them according to content. The resulting four-year database contains 13,081 episodes (7,976 audiotape episodes and 5,105 episodes from weekly reports). The indexing system allows sorting and rapid retrieval of descriptive, qualitative data along a number of dimensions for the construction of narrative reports about the project. Through indexing, sorting, and comparing episodes, important themes and events emerge.

Classroom Observations and Interviews

In 1986, ACOT began awarding grants to researchers interested in basic assessment and instruction issues and various problems associated with the introduction of technology to classrooms. These projects, some ongoing for a number of years in the ACOT sites, utilized observation and interview techniques as data gathering procedures (e.g., Baker, Herman, & Gearhart, 1988; Damarin & Bohren, 1987; Fisher, 1988; Herman, 1988; Hiebert, 1987; Phelan, 1988, 1989; Levine, 1988; Ross, Smith, Morrison, & Erikson, 1989; Tierney, 1987, 1988). These data and reports provide further, independent perspectives on teacher and student experiences at the sites.

The Findings

In the early days of the introduction of computers to classrooms, implementers focused on the innovation—computers and software. They gave little thought to the elements that would most likely remain the same—instruction and assessment. Educators and the public hoped that the introduction of technology would bring about the same kind of successful transformation that had been seen in science and industry, but goals and means in the education arena were vague.

In many ways the early progress of ACOT repeated the same error. Although the sheer number of computers in ACOT classrooms radically transformed the physical environment, for the most part student learning tasks remained unchanged. Gradually, however, new patterns of teaching and learning emerged at all sites. ACOT has labeled the stages of evolution in its classrooms: Entry, Adoption, Adaptation, Appropriation, and Invention (see diagram on page 16). In this model, text-based curriculum delivered in a lecture-recitation-seatwork mode is first strengthened through the use of technology and then gradually replaced by far more dynamic learning experiences for students.

Entry

The point to acknowledge in this phase is that an instructional technology already existed in each of the ACOT classrooms at the time the project began. The technology was text-based and the common tools were blackboards, textbooks, workbooks, ditto sheets, and overhead projectors. These tools were used in combination to support lecture, recitation, and seatwork. Traditional schooling was firmly in place. Teachers, who were beginning their tenure with ACOT, had little or no experience with computer technology and were in various stages of trepidation and excitement.

Prior to the beginning of the school year in 1986, classrooms were rewired a some were air-conditioned. Blackboards were replaced with white boards to reduce the amount of classroom dust. Student desks were rearranged into rows or clusters or replaced with modular computer furniture. The first weeks of the project at each site were given over to unpacking boxes, running extension cords, inserting cards, formatting disks, checking out home systems—generally trying to establish order in radically transformed physical environments.

At the beginning of the project, the arrival of multiple computers radically altered the physical nature of the classrooms, but instruction remained almost the same.

Over time, new patterns of teaching and learning emerged at all sites. These changes occurred in stages that ACOT has labeled: Entry, Adoption, Adaptation, Appropriation, and Invention.

As the teachers moved through these stages, traditional methods were first strengthened by technology and then gradually replaced by more active and engaging learning experiences.

ACOT teachers began with little, if any experience using technology, yet most were experienced users of traditional methods and materials.

Computers radically changed their classroom environments and they spent most of their time establishing order and learning to use the equipment. Early problems included discipline, resource management, and personal frustration.

Once instruction began, experienced teachers found themselves facing first-year-teacher problems: discipline, resource management, and personal frustration. (See ACOT Report #10 for a discussion of classroom management issues.) ACOT staff clearly had second thoughts. For example, one teacher noted:

If I had my druthers, I don't think I would ever look at a computer again. One of my students got into the Corvus network and lost lots of information because he doesn't know what he is doing. It's a typical situation, and it's caused a major problem because now the computers are down. There are so many variables like this that we deal with on a day-to-day basis that I didn't anticipate being part of this program. I'm anxious for the weekend so I don't have to do anything with computers.

Adoption

Teachers' struggles to accommodate the new technology seemed to abate during their first year with the project. Computer-based issues were far from over, but the balance of their concerns began to tilt towards using computers rather than connecting them. What the research team witnessed during this period was the adoption of the new electronic technology to support text-based drill-and-practice instruction. Students continued to receive steady diets of whole-group lectures and recitation and individualized seatwork. Although much had changed physically in the classrooms, more remained the same.

Damarin's (1988) study of the project's first year at one of the sites not only recognized a failure to move forward instructionally but documented some of the constraints under which the teachers labored, such as a district plan that reflected state-mandates and standardized testing.

The teachers had long experience and finely-tuned methods of working within these constraints and maximizing their effectiveness in that context; they had little incentive or direction for making changes which might jeopardize . . . performance on existing criteria. Although the district planners sought (and achieved) a plan which serves as a model for equitable implementation of a radically different instructional environment, they did not seek to create new approaches to instructional excellence.

During this phase, one might anticipate significant disruption of student learning while teachers reformulated instructional management strategies and while both teachers and students mastered the many skills and ideas that successful computer use requires. Surprisingly, traditional measures of achievement showed no significant decline or improvement in student performance aggregated at the classroom level (Baker, Herman, & Gearhart, 1988), while teachers reported individual students performed better. Self-esteem and motivation were measured and reported to be strong at all sites (Baker, et al). Student attendance was up and reported instances of discipline problems in ACOT classrooms ranged from zero to few.

Later in the year, teachers' concerns focused on using computers rather than connecting them. They adopted the technology to support familiar methods and materials.

Surprisingly, with all these adjustments, students' achievement test scores did not decline, and their motivation and self-esteem were strong. Discipline was rarely a problem by this stage.

Adaptation

In this phase, productivity emerged as a major theme. Students produced more faster. In a self-paced math program, for example, sixth-grade students completed the year's curriculum in 60% of the time normally required to complete the course of study and test scores remained as strong as in previous years. The extra time led to increased opportunities for teachers to engage students in higher-order learning objectives and problem solving in math.

In high school science, for instance, the instructor and his supervisor both reported that students were learning much faster, more accurately, and with greater understanding.

Writing was another area that drew frequent comment from the sites in the Adaptation phase. A fourth-grade teacher wrote that students increasingly used word processing to prepare their assignments and that many could type faster than they could write. A special education teacher reported that her students were writing with greater fluency due to keyboarding skills, and that they composed their stories directly on the computer rather than writing them by hand first.

A six-month study of the writing of ACOT third graders (Hiebert, 1987) concluded that students maintained a high level of enthusiasm for writing, computers made the compositions much more presentable which further encouraged learning, and students wrote more and better as a result of high accessibility to computers. (See ACOT Report #2 for more information on this writing study.)

Increased productivity in writing led to a bounty of text that allowed teachers to work with even young students on narrative skills. Willingly, students reworked their papers, a rare occurrence in paper and pencil classrooms. The same outpouring of text overwhelmed ACOT's teachers and led to the need for new strategies for instruction, feedback, and evaluation.

Change in the quality of student engagement in classroom tasks was another notable factor during the Adaptation phase. For example, one teacher reported:

We are finding that the students are coming in to use the computers during lunch and staying late to complete their HyperCard assignments for social studies on the countries they are researching. This degree of commitment and engagement is really unusual in a group of quite ordinary kids.

Appropriation

Movement to this next phase occurred for the first cadre of ACOT teachers in the second year of the project across all sites. Change hinged on each teacher's personal mastery of the technology. Appropriation is the point at which an individual comes to understand technology and use it effortlessly as a tool to accomplish real work.

The Appropriation stage has been seen in very few classrooms outside the project because very few teachers or students have enough access to technology to reach a point where computers become natural tools with which to work (Becker, 1987; Office of Technology Assessment, 1989).

Instruction shifted to include team teaching, collaborative learning, and interdisciplinary projects. Students were more actively involved in both teaching and learning the new lessons they and the teachers designed.

The first group of ACOT teachers reached this stage after more than a year; the second group arrived in several months. This is because the later group had local experts (more experienced ACOT teachers and students) and a supportive environment to accelerate their growth.

As teachers independently reached this stage, their roles began to shift noticeably and new instructional patterns emerged. Team teaching, interdisciplinary project-based instruction, and individually-paced instruction became more and more common at all of the sites. To accommodate more ambitious class projects, teachers successfully changed at least one stalwart foundation of the traditional school day—the master schedule. An example was a city study that culminated in the construction of a scale model of an urban business district. The final construction sat on a 10 x 20 foot base and incorporated four-foot tall models of buildings and robotic elements run by 12 or more Macintosh computers. The lead teacher in this project orchestrated the collaboration of teachers in all disciplines such that separate class periods and separate subjects were blended into a full working day.

At both ACOT's elementary and secondary schools, this type of teamed, project-based learning opened opportunities for teachers to step back and observe their students. What they saw was their students' highly evolved skill with the technology, students' ability to learn on their own, and students' movement away from competitive work patterns toward collaborative ones. From the sites:

> *It's amazing to me how much these kids are learning. . . . Kids are doing things that are not assigned. The excitement is that they are motivated, seeing the power of the things which they are learning how to use, creating for themselves solutions to problems for other things. That is the goal of the educator. That the student be motivated to solve problems important to him, not to go after points. You never see this in regular classes.*

> *The applications teacher asked the students to design a calculator using HyperCard. It was just so gratifying to see that as soon as one student finished they would go look at another student's, saying, "How did you get it to do that?" Sharing strategies: "Didn't you do the extra credit?" "You know how to do square root? Let me show you." It was just that sort of give and take, that sort of excitement, contagious enthusiasm, high level of engagement that makes me feel that this really is a good model for the classroom of the future.*

The district technology supervisor at one of the schools, observing the extent of peer interaction in the ACOT classroom, noted that by allowing students to teach each other, teachers' roles were changing as well; they were becoming facilitators rather than dispensers of knowledge.

The extent to which teachers not only became comfortable with student expert in their classes but actually began to depend on their students was evident through reports of students taking responsibility for developing curriculum and for teaching. At the high school site students even participated in the summer technology training institute as teaching assistants.

An independent observer studying one of the elementary sites (Phelan, 1989), also commented on changes in communication patterns and the extent of collaborative work among even the very young students.

> *Lines of communication ran between children and computers and between children rather than between the children and the teacher. The work mode orientation was frequently cooperative rather than individualistic. Interestingly, the teacher expressed delight at the amount of cooperative learning that took place: "I could never have anticipated that much cooperative learning going on. Some of it's screwing around, but a lot of it is helping each other. I just think it's wonderful. I mean, it drives me crazy when I'm trying to work with a reading group and they're back here chatting away and I do my share of, 'You will say nothing else.' But I'm really pleased."*

Again, the critical event that triggered this most dramatic change at the sites is the personal appropriation of the technology tools by individual students and teachers. As noted, the first cadre of ACOT teachers and students acquired this level of competence after more than a year with the project. Importantly, the second cadre of teachers accelerated through the evolution in a matter of several months. Explanation lies in their ready access to teachers and students—local experts—who had already appropriated the technology. Perhaps most important in this phase was an increasing tendency of ACOT's teachers to reflect on teaching, to question old patterns, to speculate about the causes behind changes they were seeing in their students. At the beginning of her third year with the project, one of the project's high school English teachers recorded the following:

Being on hall duty this year, I have a chance to hear how, in class after class, the teachers' voices drone on and on and on. There is very little chance for the student to become an active participant. In today's schools there is little chance for the individual teacher to actually change the curriculum, but we can make the way we deliver the curriculum very different. And that's where the technology comes into play: to make it more interactive, to encourage collaborative learning, to encourage exploration. The technology can adjust to fit the curriculum, I think, whatever it is.

Invention

The final stage in this model of instructional evolution is really a placeholder for further development by ACOT teachers and for the new learning environments that they will create. Entry, Adoption, Adaptation, and Appropriation can be viewed as stages that build a readiness for purposeful change.

The final, invention stage is still ahead for ACOT teachers at the time of this research. The growth they experienced has prepared them for building entirely new learning environments that utilize technology as a flexible learning tool. They have come to view learning as an active, creative, and interactive process, and they see knowledge as something learners must construct rather than receive from someone else.

In the earliest stages, ACOT teachers demonstrated little penchant for significant change and in fact, were using their technological resources to replicate traditional instructional and learning activities. During Appropriation, however, they seemed to gain a great deal of perspective on just how profoundly they could change the experience of learning for their students. When they reached this phase, teacher quotes communicated a working comfort with beliefs about teaching and learning that were not common among the staff at the project's outset. For the most part, ACOT teachers have become more disposed to view learning as an active, creative, and socially interactive process than they were when they entered the program. Knowledge tends to be viewed more as something children must construct and less like something that can be transferred. The nature of these teachers' classrooms, the permissions they have granted their students, and their own instructional behaviors demonstrate that shift in action.

ACOT teachers are ready to implement more fundamental changes in teaching an learning. They are ready to invent interdisciplinary learning activities that engage students in gathering information, analyzing and synthesizing it, and ultimately building new knowledge on top of what they already know.

Conclusion

Teachers are, by the nature of their work, pragmatists. They must survive the day; they must be ready for the next. Confronted by large numbers of computers or not, they arrive at their classrooms the very first day of their careers with a deeply-rooted belief about schooling that will help them weather the storm of demands they face.

The idea that deeply held beliefs can stand in the way of change is certainly not new. This research contributes to the evidence that teachers' beliefs about instruction and schools is an important factor that underlies the institution's resistance to change and argues that this fact must inform planning and implementation of significant change efforts. This issue gains bold relief in a program where teachers are personally dedicated to the investigation of the potential of modern technology but are held in check by the principals of 19th century instruction.

Implementing change in education must include changing teachers' practices a beliefs. This does not mean abandoning beliefs but gradually replacing them with more relevant beliefs shaped by experiences in an altered context. And it is this altered context that may make the difference. When teachers work with colleagues and administrators who actively support fundamental change, there is far greater opportunity for successful growth of new beliefs and practices.

Part II of this research presents the personal development of two ACOT teachers as they confront their traditional beliefs and practices in a radically altered classroom environment. The critically different outcomes of the two teachers' experiences demonstrate the need for support from both colleagues and administrators that is appropriate at each of the five phases.

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