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ABSTRACT

This study presents a descriptive account of the effects of two computer based tutorial programs used in high school Pre-Algebra and English classes via an interactive computer technology laboratory environment. The laboratory settings described, joint enterprises developed by a state university, the United States Air Force, and two public school districts, were pilot test sites for these programs. The data reported, gathered over a two-year period, is reflective of student and teacher interactions with these programs as well as their reactions to the interdiction of a technology based learning environment. Conclusions drawn from this study include: teachers may be reluctant to use this type of technology and software unless there is a direct applicability to the at-hand curriculum; in order for interactive technology to be successful, the role of the teacher and time spent in school need to be redefined; teachers must be active participants in the learning process; and teachers and students need to know how to apply their knowledge of computer technology in an appropriate mode. (Contains 7 references.) (JLB)

The Socio/Cultural Effects of a Technology Based Intervention In School Environments

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ABSTRACT

The study reported in this paper presents a descriptive account of the effects of two computer based tutorial programs used in high school Pre-Algebra and English classes via an interactive computer technology laboratory environment. The laboratory settings described, joint enterprises developed by a state university, the United States Air Force, two public school districts, were pilot test sites for these programs. The data reported, gathered over a two year period, is reflective of student and teacher interactions with these programs as well as their reactions to the interdiction of a technology based learning environment.

The Socio/Cultural Effects of a Technology Based Intervention in School Envioronments

Overview

The findings reported in this paper present a descriptive account of the effects of two computer based tutorial programs used in high school Pre-Algebra and English classes via an interactive computer laboratory environment. The settings described, joint enterprises developed by a state university, the United States Air Force, and two public school districts were pilot test sites for these programs.

The development and testing of the tutorial programs discussed here are part of a five year fundamental skills research and development project to design, develop, evaluate and transfer prototype adaptive instructional systems from the military research and development community to education and industry. The overall goals of this project are to: (1). support public education, (2). conduct research on automated training systems, and (3). transfer technology, under federal technology guidelines into public sectors.

This study's major emphasis sought to provide an accurate socio/cultural picture of events that unfolded during the first two years use of these tutors in terms of their effects on the learning environment and the actions of those interacting with it. Recent writings by Tuman (1992), Kell (1990), Cobbs, and Wilmoth (1990), and Yeaman (1990), for example, have described similar type data. In this study besides descriptive accounts of events, paradigms, or models of teacher and student behaviors that occurred within the technological environments used as field sites, were also developed.

Field Site - Participants - Demographics

The field sites for the project were two comprehensive high schools. High School Number #1, identified as Smith High, is located in a mid to upper middle class neighborhood of a large city in the southwestern United States. Its student population of nearly 2,500 is drawn from a community that has high academic and socio-economic aspirations for its graduates. Ethnically, the school has approximately 50% Anglo, 40% Hispanic, 7% African-American and 3% other students. These demographics are not reflective of the surrounding metropolitan community whose population is 58% Hispanic and 8% African-American. Both Pre-Algebra and

English classes from Smith were observed as part of this study.

High School #2, identified as Jones High, is within the same metropolitan community as Smith but is in an adjoining school district. Its attendance area comprises one of the poorest economic sections of the city. The student population of 1,300 is 95% African American, 4% Hispanic and 1% Anglo. Only Pre-Algebra classes at Jones were observed as part of this study.

Smith High School was asked to participate in this study by a team of researchers who were given entree via interested school district administrators who had learned of the ongoing research in fundamental skills that the Air Force was conducting and asked if they could participate in the proposed study of its effectiveness in school settings. After discussions with district officials, Smith's administrative staff and teachers, who would be part of the study, were asked if they were interested in participating. With both administrators and staff in agreement, school board approval was then secured.

Jones High School was asked to join with Smith in a like manner during the following school year. As with Smith both district officials and school administrators and teachers were briefed as to their project responsibilities. Like Smith, the Jones school community, including its school board, agreed to participate.

The rationale for selection for both schools was based primarily on access to field sites and the agreement, on the part of both school districts, to support the computer laboratories with technical expertise and financial help in terms of construction and maintenance of facilities during the life of the project. Both districts were also provided with hardware and software that would remain at the school sites at the conclusion of the research venture.

Over the two year period discussed here participants in the study, from both settings, included: twenty classroom teachers using the tutorial programs; over 1,200 students involved in project activities; school administrators; and others working in the project, or lab locale, who engaged in project activities.

Study Questions

The issues under investigation during this inquiry centered on the effects of the introduction of a technological environment, including hardware and a curriculum driven through technology, in a secondary school. Specifically, the research questions focused on: how would students as well as teachers react to the use of technology as an integral part of instruction in terms of student interactions and teacher use of the hardware; the use, and reaction to, the computer tutorials that had been developed for this project; and how the technology and its associated curriculum might be integrated within ongoing school and curricular activities.

Data Gathering Techniques

The types of data gathering techniques employed in this study were derived from a qualitative research perspective. They included: direct observation - through either non participant or participant modes; interviews - either formal or informal, although in both cases the questions used were for the most part open ended; and the review of extant documents - including school records, teacher and student products, curriculum materials, and any other relevant material.

Non participant observations were carried out in offices, one of which, at Jones High, was equipped with a two way mirror, located in the rear of the computer labs, in the computer laboratories themselves, and in regular classrooms. In this mode field notes were taken directly from viewing ongoing behaviors, recorded in logs and then latter transcribed onto data discs. No interactions with study participants were allowed during these sessions.

Participant observations were carried out in like areas and in similar manner as the non participant observations. The difference between the two was that during the participant observations discussion between the observers and study groups occurred. These also occurred when students asked direct questions about the study or the curriculum.

As with the observations two types of interviews were conducted during the study. The first was a formal, structured, interview in which prepared questions, based on observations, were asked of the study group. These occurred during the end of each six week grading period (total of 12 during the two year cycle). The second, an informal type of interview, was also used. These usually occurred after a class when the researcher saw something unusual or sought a direct response to a query raised by a set of interactive or individual behaviors. These interviews became immersed within the observational data and were difficult to calculate in terms of gross numbers of occurrences.

Documents were reviewed as background information for the at hand study. It was felt that a through familiarization with the schools, their students and teachers was important. As this study progressed the only recurrent documents that were reviewed were student grades. This was done to compare observational inferences about student performance with actual teacher evaluation.

Research Cycle

The research cycle for Smith High School began before the onset of the 1991-92 academic year. During this time period, student and teacher records were reviewed, administrators interviewed, and baseline demographic data collected. At this time, observations, interview schedules, and study questions were also developed. Observations commenced during the first week of October, 1991 and continued throughout 1992-93 academic year.

Research at Jones High School began in August, 1992. Study guidelines that were developed and used at Smith High School were followed as much as possible. Observations began at Jones during the first week of October, 1992 and continued throughout the 1992-93 academic year.

The first series of data collection activities at both sites was conducted in newly constructed computer laboratories. Each of these laboratories is equipped with 30 networked computers, a file server, a teacher's host computer, and a research/observation subroom. Both were used throughout the regular school day on Mondays, Tuesdays, and Wednesdays. Thursdays and Fridays were set aside for makeup days or extra sessions. Approximately 125 students used the lab per assigned day (M-W) at each site.

The students observed throughout this study ranged in age from 14 through 19, were in grades 9 through 12, in either Pre-Algebra or freshman English classes. In both school districts the Pre-Algebra course was a prerequisite for those students who did not have the mathematical skills background to enter Algebra I. As a consequence, academic and social skills varied greatly both within individual classroom environments, and among the entire population set.

The observed English classes were "regular" track high school freshman English classes. Within the English study site, both honors and remedial classes are available for freshman students. These were not used as part of this study.

The classes included in this study were selected by teacher participation. That is, a set of preselected instructors were asked prior to the beginning of the project if they wished to participate in the field testing of both tutors. After agreeing to take part, these teachers were then given inservice training in both hardware and software applications.

Students were told about the field testing of the tutor at the beginning of the school year. Letters to parents explaining the testing procedures were mailed in which they were also given the option of placing their children in regular classes that would not be part of this project.

After introductory observations it quickly became apparent that an examination of the kinds of content and discourse connections between laboratory and classroom work was of great importance. As such, concurrent observations of teachers and students in both regular classroom and laboratory settings began within one month of the initial observations. These classrooms became the second milieu of the study. Both laboratory and classroom observations continued from month two of the study throughout the end of the study cycle. Eventually, over 1100 hours were spent at the field sites collecting data.

The types of lessons that students engaged in through the word problem solving tutor centered on a conceptual framework that emphasized understanding and solving word problems. The activities developed through the use of at-hand technology included learning how to set up word problems; development of a series of skills that taught the components of problem solving variables; and applications of basic algebraic knowledge structures in a variety of problem settings.

The reading and writing tutor's goals were to prepare students to analyze information in written texts and to generate a written composition which develops and supports a central theme. This tutor's activities focused on the implementation of activities, using the required English curriculum, that would assist students in the development of their writing and vocabulary skills.

Data Analysis

As Duncan Waite (1993) notes: "The term analysis when applied to a qualitative study is somewhat misleading, as it applies to a discrete term of a research project." He goes on to note that "the term understanding or understandings is preferable as it allows for growth of a phenomenon beyond some specific phase of a research project."

While there are several analytical models that might be employed when discussing qualitative data, the design used in this study was the "key incident" approach (Erickson, 1977). In this process the observer tracks events that seem to shape interactions, record repetitive instances, and look at the totality of outcomes. To accurately follow this pattern, at the close of the school year all of the data that had been obtained throughout the study year was examined in terms of times of occurrence and cause/effect relationships (Bogdan and Biklen, 1982).

The information from the differing data gathering techniques was then compiled on computer discs, labeled as to source, and then compared, through a key word search as to how many times the behavior occurred, where it occurred, the participants involved, and the ways in which the data was collected. The extant data that had been recorded was then analyzed and classified into two paradigms: 1. Teacher/Curricular/Environmental Interactions; and 2. Student/Technology/Teacher Interactions. The conclusions noted below are impressions, reactions, and analysis of these findings.

Paradigm 1 - Teacher/Curricular/ Environmental Interactions

Although the tutor was a common bridge among all the instructors in this project, each teacher developed their own pedagogical style of technological application. For instance, some used the tutors only in conjunction with other classroom activities while others used the tutors as a method of introducing new concepts or reenforcing old ones. This type of behavior was directly associated with the "comfort level" teachers had with both the technology and curriculum. Teachers, at both schools, who indicated to that they had previously used technology as part of their instructional sequences or had been introduced to the uses of technology through their educational background were more likely to go beyond the bounds of required classroom activities.

Much of the application and use of the tutors was based on previous classroom applications of existing curriculum. Little, if any, adjustments were made for variant learning styles that the computer technology might offer both the teacher and the student. This was especially true for those teachers using the word problem solving tutor.

In several instances, at both schools, word problem solving teachers merely lead their students in opening classroom exercises, logged them onto to the computers, and sat back and watched their students work problems generated by the WPS curriculum. They assumed that the computer would manage any questions in regards to student content understanding and concept development.

Enthusiasm about the possibilities that technology offered for student learning and application of the at hand technology and tutors worked in concert. Those teachers, for example, who were reluctant to use the tutors in any more than a cursory manner did not seem to have an understanding of how to apply technology to the curriculum. These instructors tended to be very classroom dominant teachers who needed full locus of control in their environments. In both the Pre-Algebra and English classes these instructors tended to use the text book as their major pedagogical guide. These same instructors also had difficulty in providing analogies and examples beyond what was provided in the textual materials and teachers guides within regular classroom settings.

Teachers who invested time with the tutorial programs, both in class and as part of their preparation time had the most "success". These teachers, about 80% of the total, had access to a computer outside the laboratory setting. They took parts of the curriculum out of the lab and examined how they might use it.

The single biggest teacher attributal factor in successfully integrating each of these tutors within the total learning process was the teaching style employed by the instructor. Those teachers who were more problem oriented and less concerned with classroom control problems seemed to have the greatest degree of application success. For example, teachers who lectured, and required a large segment of individual seat work in their classes were less successful than those who used cooperative learning techniques and discussion modes.

Teachers who were successful in application and integration modalities were also enthusiastic and knowledgeable about educational technology, in general, and understood benefits that might arise from its use. These same instructional qualities were also evident in their regular classroom environments.

Within this teacher population it was clear that the success of this type of technological application required a teacher who was willing to act more as a mentor/guide, rather than one from a traditional background that was a pure purveyor of information. Those teachers who were active in engaging students and not passive in their interactions had the most success in getting students to see the applicability of the curriculum they were using in the lab to classroom experiences. These teachers actively worked with students in the laboratory and were not passive observers. They acted as part of a learning team, encouraging as well as engaging students. For these teachers merely getting the correct answer was not enough. They wanted student understanding of mathematical concepts. They sought creativity in the reading and writing process. This implies that for success to occur using technology as a major pedagogical tool the teacher using it engage not only in a rethinking of their instructional roles, but that global school changes, including a possible redesigning of school structures that will allow students to truly work at their own pace, also occur.

Paradigm 2 - Student/Technology/Teacher Interactions

From the onset of this study, students, in both sites, appeared comfortable in the laboratory environments. All knew how to access their computers, their files, the lesson at hand, and were keenly aware of the potential usefulness of the technology in the educative process. When asked most of the students had used a variety of forms of educational technology within the past year. All of the students, at both sites, had been required to take a computer literacy course as part of their middle school curriculum requirements.

Students quickly learned how to use the computer for communicative, aesthetic, and learning purposes. Embedded within all of the programs was a notebook/diary available for student use. The students used these to discuss lessons with their teachers as well as to express themselves in a nonthreatening mode. Indeed, several students talked about their family and school problems on a daily basis.

Diary entries ranged from the mundane, discussing whether they liked the lesson that they were working on, to the emotional where in one instance a student related their being evicted and having no place to sleep that night. Several students told of home related problems and one noted his fear of gang activities.

Observation of the word problem solving tutor revealed that while many students understood the problem solving patterns that the tutor required for success, it was clear that many of them lacked an understanding of basic arithmetic concepts. Many of the students, in this study, had been placed in the pre-algebra classes because there was no other mathematics class available to them. These students, some of whom had language and learning disabilities, could not function within the tutor's objectives. These students became frustrated with the technology.

It was also evident that knowing how to apply a concept, or understanding problem solving skills, were difficult notions for about 10% of the student population within this study in both the pre-algebra and English classes. The tutor did not provide learning experiences to help overcome these deficiencies.

As the study progressed, despite the tutor's user-friendly approach, some students could not overcome conceptual entry level difficulties. In fact, these deficits became more demonstrable as the word problems increased in conceptual difficulty and more complex writing tasks were assigned. This was clearly noticeable as the number of times students required assistance via a teacher or other adult did not decrease throughout the year.

A pattern of the same type basic understanding inquires emerged. In the case of the WPS tutor these focused on the use of basic arithmetic operations and their application to word problems. The students using the Reading and Writing tutor who fell into this category had difficulty understanding grammatical constructs. While questions regarding advanced concepts might have spurred this on, the actual questions asked, in most cases, were still at a basic understanding level.

The most difficult task these students seemed to have had, in both study sites and in both the mathematics and English classrooms, was transferring what they learned from one problem, and set of facts, to another, similar, problem with a different set of facts. Many students told the researchers that they were taking a "computer class" on the days that they were in the lab and did not recognize the interrelationships of the concepts being taught in this site to their "regular" class.

Initial knowledge/transfer observations that were noted in the laboratory setting were reinforced through matching observations in regular classroom environments. When references were made in these settings about lab work, it was as if some students had never been in the lab. Many students could not see the connection between the skills they were learning in the lab and ongoing classroom activities even when these were reinforced through teacher interdiction and grade requirements.

The degree to which the two were interconnected varied as to teacher skill and interest in the project. Those who had more of an investment in the project worked harder towards an inclusonary curriculum effort. Some of these teachers set aside part of their class time to discuss lab activities while others "counted" lab activities as much as 10% of the overall course grade.

There also seemed to be a direct proportional relationship between the level of frustration in using the tutorial program and the degree of negative socialization in the laboratory settings. In both school settings the vast majority of students in the laboratory environments were actively engaged in the learning process and were consistently on-task, no matter what subject or concept was being presented. Those students who did lose interest tended to act out. It must be noted, however, that the negative behaviors within the laboratory settings were markedly lower than within regular classroom environments.

School behavior problems are often associated within student apathy and lack of interest in the curriculum. Many of the students in both the observed pre-algebra and English classes needed constant stimulus reinforcement, otherwise they became easily distracted and disinterested. This could be a function of the curriculum, lack of student understanding of the concepts being presented or both. These behaviors were parallel in both the laboratory and classroom settings at both sites.

Some Concluding Thoughts

Based on the data and concurrent analysis, several conclusions may be drawn from this study:

1. Teachers may be reluctant to use this type of technology and software unless their is a direct applicability to the at-hand curriculum. Simply overlaying part of the curriculum with a technological innovation will not increase an instructor's enthusiasm about the subject nor change their teaching patterns.

2. In order for interactive technology to be successful in school based environments, a redefinition of the role of the teacher and a redesign of the time spent in school must take place. Within laboratory settings, such as the ones described in this paper, the teacher should be a learning guide helping students through a variety of instructional experiences. To accomplish this the teacher needs to let the student be at the center of instruction.

In this model, class time becomes irrelevant. Those who can complete the task in a shorter period of time need to be allowed to go on to other projects while those needing help should have an expanded learning schedule available to them. The notion of a lockstep hourly based information acquisition system, normally part of most secondary schools learning designs, is not amenable in this arena.

3. For interactive technology-based curricula to be most effective, teachers

must be active participants in the learning process. Modeling effective learning behaviors through a positive hands on approach becomes an essential element if this type of curricula is to be successful.

4. More time must be spent showing students the applicability and transferability of technology based lessons to other parts of the curriculum. For example, how does the ability to solve algebra word problems relate to English, science, or social studies ? Is the ability to write well important in other subjects beyond English? If students can't understand the transferability of concepts, they will not be able to see knowledge as a whole and instead view what they've learned as discrete subsets of information.

5. Students and teachers, in this study, were still "baseline" computer/technology literate. In general, they both had adequate knowledge of hardware and were not afraid to use it, but lacked an understanding of the role and importance of software applications.

The results of this study further note that while great strides have been made in the installation computer based instructional delivery systems and the development of software programs that are both interesting and relevant to student needs, much work still needs to be done in upgrading teacher computer and technological application skills. While most teachers are computer literate, in the narrowest sense, many still do not understand how to use and apply this technology in an appropriate, and successful, mode. Until these application concepts are integrated into the knowledge base of both pre and inservice elementary and secondary teachers, all of the hardware and software breakthroughs will be meaningless.

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