A QUALITATIVE STUDY: STUDENT PRODUCTION OF MULTIMEDIA PROJECTS IN HIGH SCHOOL BIOLOGY - USING TECHNOLOGY IN A SMALL, RURAL SCHOOL

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TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

Schools today are in a process of change. As institutions, they have been very slow to reflect drastic alterations in our society. In part due to rapid advances in communication technologies, there has been more change in our lives and work in the past fifty years than in the previous 500 (Looms, 1990). Most established institutions seem to resist change and strive to maintain the status quo. This is especially true of schools in the United States. They have traditionally been conservative institutions. Daniel E. Kinnaman (1991) stated, "Changing the structure of schooling is as difficult as trying to turn a supertanker in a very small harbor" (p. 21). The innovators that have come along have had great difficulty establishing and maintaining their reforms. In general, most of the reforms have merely added to or extended the existing educational structure. Today, however, vast changes in our society and rapid technological advances are forcing changes in our schools.

Need for Reform

The call for educational reform in the United States has been heard by almost everyone (Bruder, Buchsbaum, Hill, & Orlando, 1992). Advocates of reform see it as the only way of reversing our declining ability to properly prepare students (Kinnaman, 1991). Although there are many good things going on in American education, it has been widely criticized. Part of the criticism stems from the failure to recognize the difference between educating all persons through secondary school, as the United States attempts to do, and the elitist method of most countries, in which only the more able students are educated through secondary school and beyond. However, until all students are educated to the full extent of their potential, schools must expect criticism and must respond to it by a continual process of change and improvement.

Many facets of our educational system have come into question. For example, our practice of breaking up knowledge to be transmitted to students into separate disciplines, each with its own rigid time slot, may contribute to the lack of comprehension seen in some students. Their learning is fragmented and they do not always see the relationships among the pieces (Elliott, 1990). As long ago as 1938, John Dewey argued that learning was hampered by the artificial separation of knowledge into discrete disciplines (cited in Schubert, 1986). While it may simplify administrative problems and teacher assignment, it does not produce a desirable learning situation. Since the solution of most problems requires the integration of knowledge from several disciplines, students would learn more effectively by using a problem-solving approach that combined methods and knowledge from a variety of disciplines. These and other problems point to the need for a complete restructuring of our schools.

Technology and Restructuring

The increasing importance of technology in today's world is another factor pointing to the need for restructuring. While technology has prompted many changes in modern life, it has not yet changed schools significantly. Schools lack the technological diversity found in other parts of our society. Few classrooms have even a telephone. Nearly 80% of all jobs presently involve the use of computers, but in schools the student-computer ratio is about 30 to 1 (Ray, 1991). For schools to fulfill their mission of preparing students for the future, significant change is needed, and this change must incorporate technology.

Educational resources must be reliable, easy to use, and inexpensive to gain wide acceptance (Looms, 1990), and educational technology fails on at least one of these, expense of use. Nonetheless, the increasing power of educational technology is one of the driving forces behind educational reform (November, 1990). Educational technology today has possibilities that are limited only by the prevailing organization of the educational system (Ray, 1991), but thus far that has been a critical limitation. While it is estimated that between 1978 and 1988 schools spent two billion dollars on technology purchases (Perelman, cited in Ray, 1991), there is little evidence that this has produced meaningful changes in schools as a whole.

Cost of use must include extensive teacher training and reorganization to provide appropriate use of the technology available in a school. Teacher training for interactive use of multimedia hardware and software can be a lengthy and thus expensive process (Looms, 1990). Merely adding technology without extensive in-service training for teachers and without accompanying changes in the basic design of schools has failed to produce substantial results. The educators who are leaders in the use of technology have not typically been the same as those involved in restructuring efforts (Ray, 1991), resulting in attempts at reform that often ignore technology.

The Council of Chief State School Officers [CCSSO] (1989)divided restructuring into four main categories: (a) school governance (including decentralized authority and school choice), (b) reforming the nature and organization of curriculum and instruction, (c) new professional roles for educators, and (d) accountability (especially new methods of assessment and direct state intervention). Educational technology has the power to assist in at least two of these areas, and possibly in all four. The use of computers, videodiscs, videotapes, compact discs and other forms of educational technology, either separately or together, can play an integral role in changing the nature and organization of curriculum and instruction and this in turn will dictate new professional roles for educators.

In schools or single classrooms where technology has been used creatively, teachers have found themselves in the new role of facilitator of learning rather than transmitter of knowledge (Elliot, 1990). As more technology is used, especially if it is used with insight, students begin to take more responsibility for their own learning. Not only does it seem to be undesirable for the teacher to remain the resident expert in the classroom, but it becomes almost impossible given today's explosion of new knowledge, and of the hardware and software of technology.

Cost of Restructuring with Technology

Relatively few schools have been able to acquire significant amounts of new technology and put it to use in restructuring. Given the high cost of obtaining and implementing it, a cost involving both time and money, multimedia and other innovative uses of technology are missing in many schools. Only particularly wealthy school districts, or those who have received grants from government or industry have been able to invest the money and time needed for sufficient equipment and teacher training. Rural schools, which could particularly benefit from some technologies, especially telecommunications, have generally been included in the "have-nots".

Multimedia technology has been marketed with an emphasis on benefits. This emphasis rather than an emphasis on costs, makes it difficult for schools to implement emerging technologies in a natural manner, with more complex multimedia use gradually evolving from simpler uses. The newest, cutting-edge technology may not be required for students to begin receiving benefits from the use of technology. Lower cost solutions would allow them to begin the application of multimedia and to progress when they had the means, both financial and experiential (Looms, 1990).

Science, Technology, and Restructuring

Science is one of the areas that has been targeted for restructuring. While student performance in science increased during the 1980s, these increases barely made up for losses during the 1970s and show little if any net improvement over the last 20 years according to Trends in Academic Progress, a report by the National Assessment of Educational Progress (cited in "NAEP Science Performance," 1992).

Since 1987 states have become more active in developing or revising state curriculum frameworks and new methods of student assessment in science (CCSSO, 1992), and national science education standards are being developed. The National Research Council's National Committee on Science Education Standards and Assessment developed the process to be used in arriving at these standards. National and state organizations will be allowed to participate in the critique and consensus process in order to develop the standards ("NRC Committee," 1992). The standards, originally slated to be finished by 1994, were released in final form in December of 1995 ("NSTA To Spearhead," 1996). Local school districts are also focusing on science reform in many cases.

A National Science Teachers Association Position Statement on the use of computers in science education adopted in 1992 states "Computers have become an essential tool for the acquisition, analysis, presentation, and communication of data in ways that allow students to become more active participants in research and learning" (p. 5). Science education should reflect the increasingly important role played by computers in scientific research (Gittinger, 1989).

Computer simulations that allow students to conduct investigations that would otherwise require too much time, expensive equipment and supplies, or endanger the student are one important use of technology in science classrooms. They can revolutionize learning opportunities as well as help provide more democratic access (Looms, 1990). Collaboration on research through telecommunication is another. The many readily available images on videodiscs have made laser videodisc players an important piece of technology in many science classrooms. Though adding these technologies to the classroom may replace some expensive equipment and supplies, they are themselves very expensive and require a certain amount of teacher training for effective use. Schools, especially rural schools, often do not have funds for acquiring equipment and software. When they do, they must often purchase it one or two pieces at a time, making long-range planning and restructuring difficult.

Significance of the Problem

Rural schools in particular have often found it difficult to provide necessary supplies and equipment, as well as qualified personnel, to give science students the laboratory experiences they need. A shortage of the hardware and software of technology is also commonplace. These factors make it important to examine ways rural schools and other schools with limited resources can provide needed improvements through restructuring.

School boards and the tax-paying public have a right to expect that education dollars will be spent in the most advantageous manner possible. For many reasons, technology has not always been used in this manner by schools. Insufficient teacher training is undoubtedly one of the major reasons. Rural schools in particular have difficulty funding and staffing appropriate uses of technology. The study of technology projects can contribute to the growing body of evidence relating to technology use in schools and should be helpful in determining if there are benefits that warrant the acquisition of new skills by teachers and the expenditure of funds for technology. Those in charge of a school's budget need to know that their technology dollars will be well spent.

While there are ways for schools, or individual teachers within a school, to begin the use of technology even without much of the necessary equipment and software, these are somewhat make-shift and very labor-intensive for the teachers involved. Such an approach involves collecting pieces of equipment from around the school and putting the pieces together to provide students with access to at least some technology (D'Ignazio, 1989). The student products may not have quite the elegance and appeal of those created with videodisc players, CD ROM, video digitizers, and other high technology pieces of equipment. However, these efforts may be very important in showing how effective the use of technology and student-generated products can be as a component of restructured schools.

Statement of the Problem and Purpose

The choices teachers make among alternative instructional approaches significantly affect the attitudes, knowledge, and skills that students carry into adult life. Although every teacher and every class is different, there are enough important similarities that the detailed description of a single class involved in the use of technology may be of use to other teachers and students. The purpose of this research was to conduct a qualitative examination of a method for beginning restructuring through technology, with a particular focus on secondary science in rural settings. The study was conducted in a small rural school with little technology available. The case study method was used to thoroughly examine the learning situation in this high school biology classroom. Qualitative analysis of a detailed, descriptive nature was the means of evaluation.

Specific questions addressed by the study include the following:

1) Do students show more active involvement and increased responsibility for their own learning in science classes when developing their own multimedia projects?

2) Is the way students respond to the use of technology related to personality type?

3) Are student-generated technology projects effective in motivating students?

4) Is it feasible for schools with limited funds and limited technology to begin implementation of technology and restructuring?

This study examined one aspect of technology use in school restructuring: student-produced multimedia projects.

Definition of the Terms

Case study. a type of research which "focuses on a bounded system, whether a single actor, a single classroom, a single institution, or a single enterprise--usually under natural conditions--so as to understand it in its own habitat" (Stake, 1988, p. 256).

Ethnographic. related to the work of describing a culture or understanding another way of life from the native point of view (Spradley, 1980).

Hypermedia. a type of multimedia that has non-linear structuring allowing for multiple paths through a program.

Interpretative paradigm. a perspective in which the central issue is to understand the subjective world of human experience.

Multimedia. the integration of text, audio, graphics, still images, and moving pictures into a single, computer-controlled product (McCarthy, 1989).

Naturalistic research. the careful study of human activity in its natural and complex state" (Stake, 1988, p. 263).

Participant observation. a type of field work in which observers engage in the activities which they set out to observe.

Qualitative research. "research that produces findings not arrived at by means of statistical procedures or other means of quantification" (Strauss & Corbin, 1990, p. 17).

Restructuring. educational reform that involves broad system-wide changes in structure, function, and organization that produce significantly different learning environments.

Triangulation. "the use of two or more methods of data collection in the study of some aspect of human behavior" (Cohen & Manion, 1994, p. 233).

CHAPTER II

RELATED LITERATURE AND RESEARCH

The areas to be examined by this study include efforts at restructuring schools, the use of educational technology in the restructuring of schools, and the impact of the two on secondary science classes in rural schools. The place of student-generated multimedia products in the secondary science curriculum will also be considered.

Restructuring

[Whatever the career goal is] "the schools are generally regarded as the place where that goal begins. Education is viewed as the key to fulfillment" (Hawk, 1987, p. 139). Schools and schooling are regarded by most of the members of our society as being very important, even though they are often taken for granted. Decisions relating to significant changes in schools are important to almost everyone.

Schools have changed very little in the last 100 years. The buildings, classrooms, and ways of delivering instruction have remained remarkably static through extensive changes in our society (David, 1991; Hawk, 1987). Even though schools as we know them are deeply embedded in our culture, each year sees them becoming more out of step with society. The technology in homes and businesses gets more and more pervasive and sophisticated, and socio-cultural changes, especially changes in the family unit, have altered the context of schooling. New knowledge makes it more and more difficult to incorporate what is known into existing educational programs (Hawk, 1987). In view of these problems and repeated cries of failure from numerous observers, many educators and public schools are considering or implementing plans involving extensive reorganization or restructuring. They hope to better prepare students to function productively in tomorrow's world. Up to now most schools have responded to the pressures produced by societal changes by adding new personnel or programs or by strengthening standards and requirements. These may have a "Band-Aid" effect, but do not alter schools significantly enough to align them with modern society (Ray, 1992).

Efforts at restructuring schools vary considerably. A new Dade County, Florida public school (Bruder, March, 1992) even operates in partnership with a private business in Minnesota. Most efforts include producing more student involvement in learning experiences, new and more flexible ways of grouping students, greater use of technology, a new concept of the role of teachers, and a new look in classrooms.

Newman (1991) indicates that we must determine the nature of the present system's failures before attempting to restructure. He reports two main evidences of failure referred to by reformers. The first is the large proportion of students who fail in school or perform poorly on standardized tests. The other is that our students do not "cope successfully with the demands of personal, vocational, and civic life in contemporary society" (p. 459). Two additional problems pointed out by Newman are 1) a difficulty in motivating today's students, and 2) the impossibility of traditional efforts to teach lists of fragmented facts in view of the explosion of knowledge. He believes that the two are related and are most detrimental to students who do not succeed in schools as they are presently organized. The failure of these students may be due to low income, lack of social support, or cultural background, but their failure becomes that of the school system.

Many authorities suggest that restructuring should begin with agreement on the educational ends or goals to be achieved rather than on the organizational structures used to achieve these ends (Doyle & Levinson, 1993; Newman, 1991). For reform efforts to succeed, they must have the support of all major stakeholders from the beginning ("Coalition offers tips, 1993). Newman (1991) suggests two goals: 1) what he calls "authentic" achievement, in which students perform activities that are "worthwhile, significant, and meaningful", and 2) "substantive conversation in teaching" (p.459). Jane L. David (1991) sees the problem as one of creating more demanding goals for students and stimulating their thinking and problem-solving skills. She states that all parts of the system must change, but that limited resources and a natural resistance to change make this very difficult. Dyrli and Kinnaman (1995) state, "Education improvement will not come from trying to fit technology into the industrial-age model of schooling" (p. 100).

An important dimension of restructured schools is the master-apprentice approach. This requires that the teacher, as master, model the skills desired in the student, including higher-order cognitive skills, collaborative education, and life-long learning (Ray, 1991) . The student, as apprentice, must be given learning tasks that are appropriate and meaningful, and that produce, rather than reproduce, knowledge. This type of achievement would have a greater motivating value than mere grades and would be more likely to develop higher-order thinking skills. With increased use of technology, the teacher's role becomes that of collaborator, mentor, researcher, facilitator, diagnostician, and long-range planner. Students become more active, skilled, self-directed learners and often become teaching partners, helping their peers to develop skills. They make decisions, solve problems, and assess their own work. There is a complete restructuring of the teacher-student relationship (National Foundation for the Improvement of Education, 1991; Farley, 1993).

Newman (1991) outlines four conditions that he feels are essential for students to complete authentic accomplishments: collaboration, access to tools and resources, alternatives which allow students a feeling of ownership over their work, and flexible use of time. Two of these, collaboration and alternatives, are often under direct teacher control and can be implemented to a degree without formal restructuring at a school or district level. However, they would be greatly facilitated by restructuring. The other two, access to tools and resources, and flexible use of time, are very much dependent upon funding and administrative control and therefore would probably require genuine restructuring efforts at a district level, if not a state level.

Newman's (1991) second requirement of substantive conversation requires greater involvement on the part of the student than is usual in classrooms today. Instead of listening to the teacher and responding to intermittent questions, a true dialogue between the student and teacher and between students would be established. In fact, this conversation would probably require frequent, sustained communication, not only with teachers and other students, but also with other adults and with well-programmed computers. These additional sources would expand students' opportunities for "expression and feedback" (p. 461). Such communication forces the student to reconstruct declarative knowledge into practical, integrated knowledge.

There are a great many obstacles to change within institutions such as schools that are so thoroughly embedded in our culture (Mecklenberger, 1989). There is a great resistance to change, in part because of the expense involved. In addition, many school patrons are unconvinced that change is needed. They feel that the kind of education they received is satisfactory for today's students, especially in view of the fact that a large proportion of students do succeed. There must be wide-spread agreement that a problem with the system exists before large-scale reform can be accomplished. There have been many attempts at reform efforts in the past, but all have failed to fundamentally change the system (Newman, 1991). Many of these efforts will undoubtedly influence restructuring efforts of the future. Studies of schools involved in restructuring show that a great deal of time is required for the change process. In each of nine districts studied by Jane David, the process had been on-going for over seven years (cited in Polin, 1991).

Restructuring efforts often actively encourage the involvement of parents and the community (Ward, 1991). When parents call for change, educators have important allies in their efforts. In many communities today, parents are not supportive, simply because they had bad experiences in school. Schools must change this outlook into one that views school as a good and productive place. Part of this can be done by getting parents into the school, showing them positive changes and involving them in those changes. Some schools are opening their doors in the evenings and on Saturdays and acting as community-based service centers. This increases a feeling of ownership for the school among those using its facilities after hours (Bruder, January 1992). In providing parents and others with useful, productive school experiences, these schools build a support base.

Restructuring differs from previous attempts at educational reform in two ways. First, it establishes challenging goals for students, and second, it involves the entire system. Previous reforms have often tried to change what goes on in the classroom without changing schedules, funding, administrative rules, state laws, or any of the many other structures that influence schools. Restructuring, however, requires individuals at all levels of the educational system to change, but also builds on what has been learned from previous reform efforts (David, 1991). One of the biggest changes seen as schools restructure is the recognition by teachers and administrators that they must continue to learn and try new ways throughout their careers (Ray, 1992).

Certain ingredients appear to be critical to restructuring success. These include: 1) a reason or occasion for change, 2) decentralization of authority and flexibility (beyond token site-based management), and 3) access to knowledge with ongoing learning for students, teachers, and administrators (David, 1991). Restructuring requires examination of the entire school organization (Bruder, October, 1990) and often requires years for completion. Changing teacher behaviors, learner expectancies, organizational patterns, and building arrangement all take time, planning, and effort. It is especially important that plans for restructuring involve teachers, for that has been found to be a key ingredient of success. As those most closely involved with students and learning, teachers are a critical component of any restructuring effort. Past attempts have failed largely due to the failure of reformers to recognize the influence of teachers (Bruder, February 1992).

Restructuring tends to focus on results, but not results that are amenable to today's main form of evaluation, the standardized test. Individual learner outcomes relating to student learning and behavior must be addressed (Gillespie, 1992). Most efforts at restructuring require much more complex measures of performance than standardized tests allow. There is considerable interest in the use of student portfolios of work as a means of evaluating their progress. This would require many changes, not the least of which would be new requirements for college admission. College officials are unlikely to accept such evaluation measures because of the difficulty in comparing them efficiently to determine admissions. It may be possible to use computers to produce a graphical or pictorial student profile containing information about the student. This would be consistent with the colleges' desire for efficiency and also with the more complex evaluation preferred by restructuring experts (David, 1991). In fact, it is likely that the masses of information generated by restructured education could only be managed through the use of computers. Following the educational development of a single student through a school system and maintaining a record of objectives achieved and projects completed would be almost impossible without the data-storage and manipulation capabilities of computers.

Technology and Change

"A yardstick of technological restructuring is the measurement of the student's ability to do something that was not possible before," according to Rudowski and Hofmeister (1991, p. 24). The best uses of technology today do not "attempt to fit promising innovation into traditional practice" (Pearlman, 1989, p. 45). Schools involved in significant reform are redesigning the educational process to get into more experiential learning. There is a paradigm shift toward more active learners, more focus on learning and less focus on teachers and what they do. However, contrary to what might be expected, this changed emphasis expands the role of teachers and their expertise becomes more critical in facilitating student learning. They need greater access to new technology and more training in its use (Pearlman, 1989).

Technology is more and more becoming an essential part of both the managerial and instructional processes in education (Gillespie, 1992) and newly available educational technology makes restructuring much easier than ever before, even though knowledge is burgeoning at such a rapid rate. The use of technology is really the only feasible way to keep abreast of today's information explosion. Telecommunication and the use of compact discs greatly extend the information available to students and teachers and give them much more current sources of information.

Immense amounts of information are available through the use of technology. Large databases on many different topics are available as are optical discs containing encyclopedias or collections of literary works. With telecommunications even more information from around the world is available almost instantly. This makes covering any one topic, much less the whole realm of knowledge, impossible. We are no longer able to teach a comprehensive sample of all worthwhile knowledge. Increased depth of knowledge, even at the cost of less breadth, fosters the development of higher order thinking skills. Instead of a surface knowledge of many areas, students may have enough knowledge in a few areas to allow them to pose and address important questions, real-world questions (National Foundation for the Improvement of Education, 1991). There will always be a need for a certain breadth of knowledge, but this, as always, will be the responsibility of the school and the individual teacher.

Four general areas in which technology can be an aid to learning have been identified. They are: 1) to help students develop fluency, 2) to provide problem-solving contexts, 3) to allow students to create products interesting to themselves and others, and 4), the most commonly cited effect, student motivation (Bransford et al., 1989). In addition, technology is frequently used to simplify management, record-keeping, and communications with parents for both instructional and administrative purposes (David, 1991).

Technology is certain to be central to the lives of students in our schools today. Jobs in computer-related fields have shown the most growth in recent years. Nearly 47% of the American workforce now use computers at work and two-thirds of those workers with college degrees use computers for their jobs ("Computer literacy," 1994). The classroom environment should reflect this. Students should have frequent opportunities to use technology in their school lives as most will in their work lives (Held, Newsom, & Peiffer, 1991). Technology is rapidly changing the very nature of work that students will do during their adult lives. An appropriate preparation for this work must include technology (Bruder, February 1992). However, the use of technology alone does not guarantee effective restructuring. It is effective only as one component of change that includes parental and community involvement, changes in teachers attitudes and teaching strategies, a focus on individual students, and a pro-active administration committed to the transforming the school setting.

New technology can stimulate the need for reform by forcing organizational and instructional changes in classrooms and schools. It alone has the capability to support the complexity of individually tailored learning and decentralized authority (David, 1991). When schools have a wide range of available technology: scanners, CD-ROM drives, video cameras, videodisc players, video digitizers, and music and speech synthesizers, they have a better opportunity to reach all learners (West, 1995). Students will be learning to use real-world tools with power and versatility and the ability to capture the imagination. The use of technology in schools could increase productivity as it has in businesses (Doyle & Levinson, 1993).

The use of computers, especially for applications other than drill and practice, gives students chances to develop problem-solving skills because there are always difficulties in learning new programs and procedures. Malfunctioning equipment, program bugs, and operator error provide abundant problems to be analyzed and solved (David, 1991). In addition, much recent software is specifically designed to develop problem solving skills, in contrast to the predominantly drill and practice software of a few years ago. Computer simulations, interactive video programs, and networks such as National Geographic's Kidsnet, that allow students in distant schools to collaborate on science projects, reports, and other activities, motivate students and present them with significant problems with which to develop their critical thinking skills (David, 1991).

Databases constitute one application that has been used in many classes where teachers were striving to improve students' thinking skills. The students use computers to analyze raw data. Studies have shown that students must have specific practice in the use of information processing skills such as those that help them recognize what data is relevant. Use of the database alone is insufficient. The use of computers and programs such as databases alone, without specific training in the use of thinking skills, is inadequate (Elder & White, 1989).

Contrary to what once was expected, the use of technology makes teaching more complex, not simpler (David, 1991). This is because it makes much more complex and more effective methods possible. Lecturing to an entire class is much simpler than organizing individual and small-group instruction. The latter, however, is more motivating to students and allows them to take more responsibility for their own learning as well as being more like their future life in society and in the world of work. In the use of technology as in other educational practices, the role of the teacher is central. At present many lack the knowledge or the motivation to use educational technology. Miller (1992) states, "Plain and simple, multimedia is not going to succeed in education unless teachers adopt it as their own (p. 12)." Teachers must be trained in the use of new technology. Only when large numbers of them are comfortable with it will we see significant progress in the use of educational technology.

The faculties of education colleges have not yet integrated educational technology very extensively, at least in some areas. Teacher education must be reoriented to include more training in the use of technology for the use of technology in schools to become widespread and effective. These changes in teacher education will be expensive in terms of staff and equipment (Waggoner, 1990).

The reality in many schools today does not live up to the potential that many have expressed with respect to the use of technology. Creative, futuristic uses tend to be in the isolated classrooms of interested teachers and lack the system-wide commitment needed for true restructuring and effective use of technology. In a study begun in 1989, Ray found that in 14 schools involved in restructuring, neither teachers nor administrators viewed the use of technology as being either important or crucial in their restructuring efforts.

Placing computers and other technology in classrooms even where finances permit, does not effect change. This is because "human understandings, attitudes, values, and beliefs are at the core of change" (p. 14). The teachers and administrators who will use that technology must be convinced of its value, trained to use it and given time for experimentation and innovation for it to begin to have a dramatic impact (Ray, 1992). In addition, sufficient equipment must be acquired to make the technology readily available to teachers and students. To make a difference, technology must be in the hands of teachers and their students (Gillespie, 1992), allowing them to experiment and innovate. An investment in technology requires a concomitant investment in the training and support that keeps it in use (Gillespie, 1992). Without this investment, resources will be wasted or inefficiently used.

Bruder (April, 1992) described one school that has involved technology in restructuring. It reorganized into multi-age "houses," each with 80 to 100 students and four teachers. These groups function as families of learners. One of the houses is a pilot for technology in the district. It has an intense individual focus, extensive technology resources, and a flexible schedule with large blocks of time. Students pursue studies that break down subject matter boundaries. These changes illustrate the way substantive reform completely changes the concept of school.

Teachers are beginning to use a project-based approach to instruction in many of the schools. Students produce multimedia or hypermedia projects using presentation software. These projects are often inter-disciplinary in nature and require students to reorganize and synthesize information. They require students to develop and use higher-order thinking skills. Collaboration and peer-tutoring often result as students use real-world tools to develop their projects (Rockman, 1993).

Change in conservative institutions like schools must be driven by people who believe strongly in its utility and in their own ability to master it. Educators who feel inadequate and insecure with technology will not back it strongly enough to produce significant change. The same is true of restructuring. Until a sizable core of knowledgeable educators and school patrons demand it because of their strong belief that it is essential, little will happen. Increased access to technology will help develop this core of knowledgeable educators committed to change, and it will produce parents that have an understanding of the importance of technology in schools today and in the future. It may only give students a "taste" of what is possible, but the enthusiasm generated could go a long way toward stimulating real change with technology and restructuring in partnership. As with restructuring, the use of technology influences learning only to the degree that certain essentials are present. These seem to echo some of those for restructuring: collaboration, cross-discipline and project-based courses, and an emphasis on applying skills and problem solving (David, 1991).

Restructuring efforts limited to single schools are unlikely to produce the desired results due to their dependence on district and state regulations and requirements. In like manner, the use of technology by a few schools or teachers is not completely effective because they lack the necessary authority to develop funding, change schedules and institute new methods of evaluation (David, 1991). Doyle and Levinson (1993) stated, "If the technology is to be effective, then the organizational and instructional changes to support it must be managed at the same time" (p. 27).

Both restructuring and learning to use technology are difficult because both require learning new ways to do things and changing all parts of the educational system. But together they have a synergistic effect and magnify their potential. Only together can they allow schools to achieve the vision of a more effective, revitalized future. Continuing attention to challenging student goals and long-term change, supported by finances and personnel, will bring this vision into reality (David, 1991).

In a 1989 study of 14 schools that chose to make substantial changes: social, educational, technological, and organizational, Ray (1992) observed many uses of technology that were compatible with restructuring, but noted that there were serious organizational barriers not only to the use of technology, but also to restructuring. In most of the schools technology was being used very little. That use was by a few enthusiastic educators deeply involved in technology. Even these progressive schools that had taken a lead in restructuring and were attempting to redefine the meaning of school, failed to recognize the importance of technology in restructuring. Their efforts may be doomed to failure if they ignore one of the most important facets of our world today: technology. "Technology by itself will not restructure schools; but they cannot restructure successfully without it" (Ray, pg. 17).

One critical component of innovative uses of technology is time. Time is required for teachers to learn the technology and integrate it into their classrooms. As much as six years may be necessary for mastery of the hardware, software, and appropriate pedagogical techniques (National Foundation for the Improvement of Education, 1991). Larger blocks of time in the school day are also needed as students work on desk-top publishing, multimedia presentations, and other projects that do not easily sub-divide into 45- to 55-minute lessons.

As teachers become skilled users of technology, they see more opportunities for using it to challenge, motivate, and empower students. They may begin with drill and practice, but as they learn more about the technology, many of them add other activities that go far beyond these beginnings. According to the National Foundation for the Improvement of

Education (1991), "Technology becomes a catalyst for the restructuring of schools by facilitating and increasing opportunities for constructive changes in the learning environment" (p. 6). Instead of being presenters of information, they become organizers of the large and varied informational sources. The restructuring of schools is essential for optimum use of technology, and the converse may also be true. Technology may be essential to true restructuring of schools in today's information age.

American public schools spend over $150 billion yearly, but only a very small portion of this is spent for technology. Schools and educators are "dabbling" in technology while the rest of society is wading right in to the vast stream of new technological products and using them for work and play. These new electronic toys and tools emulate and extend the human mind and are unquestionably educational whether used by the educational establishment or not. Television and the videocassette recorder, along with electronic games and toys, mold the minds of children long before they make contact with the schools. However, little technology has made it into the mainstream of our school systems (Mecklenberger, 1989). Mecklenberger stated, "Technology in the schoolhouse gets its own niches, labs, and centers, so as not to disrupt the ongoing lecturing, testing, mainstream business" (p. 183).

Ninety-nine per cent of all elementary and secondary schools in the United States have installed computers and 85 per cent of all U.S. students use them, but about half of these computers are older eight-bit machines, mainly Apple IIs. Educational software is no longer being developed for them and they lack the power for use with most multimedia and networks ("Many Computers," 1994).

The great enthusiasm shown by our society for entertainment via television, videotape and electronic games has created educational problems. Commercial entertainment may have more impact on shaping learning than most of our instructional efforts in schools. Compare the familiarity of the average student with television commercials or jingles with their familiarity with last week's science or social studies lesson (Mecklenberger, 1989). School's must find ways of utilizing aspects of these media for education.

In the vanguard of restructuring are a few schools that have begun a significant process of change. Such schools have typically involved the entire educational community, and at times the community as a whole, in determining needed changes. In many, courses become cross-disciplinary and planned around themes or projects, students work both individually and in groups, teachers emphasize problem-solving skills and concepts, and there is a decentralization of authority. School faculties are encouraged to be creative and innovative (David, 1991). Students apply what they learn in purposeful activities and develop products for a real audience.

Today much more than in the past, learning occurs wherever the learner is. Much of education is increasingly portable. There is less need for the organizational lock-step classrooms of the past. Many distance-learning projects link students and teachers far removed from each other. Libraries of books, films, and still images are available on videodiscs and compact discs. So far, however, schools as a whole have made only minimal usage of the vast array of new technology. In the main they still use decades old curricula, tests, and methods (Mecklenberger, 1989), while the rest of society is using fax machines, mobile telephones, telecommunication, cable television, videotapes, and software for business, educational, and recreational purposes. There are informative videotapes on practically every subject, and news, nature, and learning channels on television. Most homes have two or more televisions and a videocassette recorder, and many have camcorders and computers as well. It is not impossible to view a future with no organized schools, but with students remaining at home and using compact discs, computers, cable television, and videodiscs to complete their education.

If schools do not move forward with technology and society, other delivery systems may well fill the void and perhaps replace schools as we know them. Whether or not this would be a desirable possibility is open to debate, but many educators would not see this as good for students or for society. For one thing, many of our cultural institutions are already being undermined without any significant replacements. Most people would prefer changed schools rather than having the schools suffer the deterioration of influence seen in the family, the church, and in political institutions. There is no doubt that electronic learning is burgeoning, though much of it is not occurring in the schools. Schools must be re-invented to apply the power of new technological tools to curricula. It is time for schools to take a major role in using new tools rather than watching their use and development from the sidelines (Mecklenberger, 1989).

While technology offers great possibilities for facilitating changes in schools, there are several issues that limit its impact. They include: limited access to current technology, teacher attitudes and lack of experience using technology, and cultural beliefs about school work (Cuban, 1995). Parents, administrators, school boards, and teachers must come to recognize that the real work of learning can be done in front of a computer monitor or a video screen.

The use of computers in education introduces a new view of literacy. Several new vocabularies and skills are needed when individuals use computers. These are added to the tasks of reading and writing and have considerable effect on them. Reading screen text is not the same as reading the printed page. Students making the transition from reading text on a printed page to reading it on a screen must change the ways they read, write, and make meaning from the information. A reader of printed material can judge its length and organization by flipping pages. Movement through screen text is more difficult, at least for those who learned to read in a book-dominated world. Screen text has been shown to be more difficult to get a sense of, makes it harder to locate specific information, and is more difficult to proofread than printed text. Much of a person's business and academic success today depends upon their ability to use screen-based information. More and more, students, teachers, and employees are required to learn computer systems quickly, often without formal training. Considering these factors, it is important to see that all students, not just those in more affluent schools, or those whose parents can afford a home computer, get training in computer use and an equal chance to develop technological literacy (Selfe, 1992).

Although there are examples of many kinds of creative uses of technology in today's schools, they remain the exception, rather than the rule. Chalkboards, lectures, and textbooks continue to be the principal modes by which our students are expected to acquire knowledge. Students in our schools outnumber available computers by 20, 30, or even 40 to 1. Many of these computers are outmoded, and newer technologies, including compact disc, videodisc, and modems, are even more scarce (Mecklenberger, 1990). Computers are still mainly used for drill and practice, even though they are best used for providing open-ended, interactive experiences (Strommen, 1995). Many innovative uses for educational technology have been developed, but they are far from universal. A growing body of research points to achievement gains when students use technology (Rockman, 1993), but scattered benefits to a small percentage of our students is not enough to produce a twenty-first century education system. In an undertaking that potentially will change our entire system, small-scale changes and the piece-meal addition of new technologies to older is not effective. To produce a large-scale impact and radically change our educational system requires broad-based, large-scale action (Mecklenberger, 1990).

Technology, Restructuring, and Rural Schools

Rural schools have by necessity used cooperative learning, multigrade classrooms, interdisciplinary studies, peer tutoring, and other educational techniques that are presently being advocated as part of school change. They typically have close student-teacher relationships. These communal qualities and the low student-teacher ratios are conducive to reform ("Poorly funded rural," 1994). While rural schools have many problems, in these ways they are ideally suited for restructuring. Individuals involved in whole-school reform recommend breaking large schools into smaller decision-making units and emphasize the importance of small class size ("Coalition offers tips," 1993). These conditions are already available in most rural schools.

When innovation was not possible, rural schools have been forced to cut programs and often lost experienced teachers to better-paying jobs. The remaining teachers were younger, not as well educated, and received less pay than either urban or suburban teachers. These remaining teachers had heavy work loads and often taught subjects in which they did not major ("Poorly funded rural," 1994).

Among the many educational, social, and political implications of technology in schools are those relating to equal opportunity and education. All schools have difficulty funding technology, but this is particularly true of rural schools. Most rural schools lack basic equipment and have few teachers with an understanding of technology. Though they would greatly benefit from on-line access, telephone companies generally resist laying expensive, high-speed telephone lines in rural areas. On-line resources that would allow them to use information sources available to most of America are too expensive in part because they must pay long-distance toll charges (Holland, 1995).

Rural communities face social and economic trends of loss common to the rest of society: the failure of the traditional family structure, the scattering of families from one part of the country to the other, and the loss of employment and income security with changing patterns of employment. In addition they face a loss of identity if small local schools are consolidated to form larger units (Jackson, 1990). The use of technology provides the possibility for rural schools to function effectively without consolidation. Distance learning, with newer technologies providing two-way communication, allows rural schools to offer classes that they could not otherwise offer because of small class size or the lack of teachers. This is very important since state governments have added requirements in answer to reform movements (Jordahl, 1991).

Today there are other solutions to the problem of helping masses of people to learn. Classrooms and schools were developed to facilitate the efficient education of large numbers of students, but they are no longer the only alternative. Because of telecommunications and on-line information services, television instruction using videotapes, live interactive television, cable or satellite reception, and simulations using computer software, much of the school curriculum can be taught anywhere. New patterns of organization other than the classroom become feasible. Today's experiments with distance learning may produce a completely different concept of schooling, especially if schools do not change to much more wide-spread use of technology (Mecklenberger, 1990). Rural schools are particularly at risk. "In a nation committed to educational equity for all students, the distribution of opportunity for electronic learning is crucial" (p. 108).

Technology has the potential to solve the three main problems faced by rural schools: location, distance, and size (Johnson & Vaughan, 1992). Large-scale use of technology will help lower prices and put it within the reach of even more people, both in and out of schools. It has become obvious that the education of the future will depend on technology. Schools, including rural schools, must restructure to control the changes necessary to use technology efficiently and effectively.

Multimedia and Hypermedia

Multimedia, as it is used here, refers to the integration of text, audio, graphics, still images, and moving pictures into a single, computer-controlled product (McCarthy, 1989). Technology in general and multimedia in particular are seen by some as a means to attack problems such as motivation, the drop-out rate, and preparation for a future in the world of work (Elliott, 1990). Teachers must capture and hold the attention of students who spend hours watching MTV and playing video games. Multimedia is one way to do so (McMillan, 1990). It has the power to change curricula, student interactions, and perhaps even the nature of learning ("Listening to Multimedia," 1994). Multimedia allows for individualized learning and promotes the active involvement of the learner. The ability of the individual to interact with the computer and control the flow of information allows learners to produce their own unique path through the lesson (Sculley, 1993). Multimedia stimulates learning by offering multiple modalities of information (Gates, 1993) for the many different ways people learn.

In a study of math-delayed sixth graders, Bransford and his colleagues (1989) used excerpts from the movie "Raiders of the Lost Ark". Their purpose was to contrast typical methods of learning to solve word problems with an approach that emphasized the qualitative aspects of the problem before considering the numbers involved. Typically, math-delayed children ignore the qualitative aspects of the problem and pull out the numbers and perform some operation with them, with little regard to whether or not that operation is appropriate or not. After viewing the excerpts, one group was taught to solve problems relating to the film. A second group was taught individually with feedback, but with no reference to problem-solving in the context of the film. The group instructed in the context of the film did much better on a post-test of problems including those related to and those not related to the film. Viewing the film sequence alone would be unlikely to produce the same effect since in the trial it was accompanied by considerable guidance and feedback. However, the video seemed to form an important part of the treatment and helped the students to understand the problems.

Bransford and his colleagues (1989) reported a similar study by Sherwood, Kinzer, Bransford, and Franks in 1987. It was conducted with college students. Here again the video group out-performed the control group when asked to solve problems related to the film context and to non-related problems. The results of these and other studies indicate that video sequences can provide a context which can be used to integrate information across curricula. By teaching students how to apply what they have learned in one area to other areas, they can increase their critical thinking skills and problem-solving ability. This application of skills and information is very important to learners and seldom happens without specific instruction. These are applications that could be used in almost any school.

These studies center about a theme referred to as "shared contexts for learning" (Bransford et al., 1989, p. 20). These shared contexts, in this case provided by study of problems taken from a video segment, provide the learner with problems in the context of meaningful activities and use a mediator to explicate the context of the situation in a way appropriate to the learner. The teacher functions as the mediator and the film clip provides a shared learning situation which involves the learner in actively solving problems.

A very interesting way of using technology with students involves allowing them to create or produce products such as video reports using video, text, graphics, and sound. This is in agreement with Newman's (1991) restructuring goals which call for students to produce authentic achievement, in part through the creation of things and performances and through producing rather than reproducing knowledge. In the view of Bransford and his co-authors (1989), they are producing information, not just consuming it.

Student-generated products are as varied as the students creating them and use any technology available from simple to complex. Many of the most exciting products involve interactive video using computers, videodiscs, scanners, digitizers, and other equipment scarce in schools. However, some teachers have achieved good results with "scrounged" equipment put together in ways that allowed students to produce their own multimedia experience. Regardless of the sophistication of the available technology, these activities tend to put students in charge of their own learning. They become more active learners, partners in the learning process, rather than passive receptacles for information (Thomas & Knezek, 1991).

There are numerous types of software that are designed to enable students to succeed at this type of endeavor. *Logo*, developed by Seymour Papert and his colleagues is one. It is a computer language designed for the use of children. A later version, *Logowriter*, is designed to allow its users to produce text and graphics in an easier, more natural way than other computer languages. Even a very young child can do interesting things with *Logowriter*, though it also can be challenging for older or more able students. When properly used it seems to facilitate the learning of problem-solving skills and is also very motivating, especially to younger students (Bransford et al., 1989).

Other software products such as Apple Computer's *Hypercard* and IBM's *Linkway*, allow students to create interactive video presentations which link the computer and a videodisc player (McCarthy, 1989). Media-linking software such as this serve as multiple-purpose tools that allow teachers or students to construct their own lessons or courses or use pre-programmed lessons included in commercial multimedia packages. They make it possible for students and teachers to access, link, and present information by association, rather than in the linear format typical of videotapes or textbooks (Thomas & Knezek, 1991), producing what is known as hypermedia.

When teachers involve their students in projects of this sort, they are often surprised by the quality of the work the students produce and by how interested they are in other students' productions. While not as surprising, most teachers also note that students are very motivated by this type of activity. In fact, the most impressive thing about multimedia composition is the way it motivates students to create interesting products (Bransford et al., 1989).

Since many schools do not have the equipment to allow students to create full-fledged multimedia products, teachers are taking the advice of Fred D'Ignazio (1989), and putting together what he refers to as "scavenged multimedia" (p. 26). Students use a camcorder to shoot footage. Next they use a computer and programs for word processing or graphics production to create text, titles, and visual effects. Teachers can often locate devices about a school that can be added to their production equipment as they learn about technology. They begin with a computer, but may add televisions, videocassette recorders, camcorders, tape recorders, and music keyboards (McCarthy, 1989).

For those with the high technology available (CD ROM, powerful computer, videodisc player, video digitizer, and appropriate software), the possibilities are even more exciting. In addition to student development of products, there are a number of products that have been developed to be used by the student. One example of the sort of product that can be designed is the "Palenque Project", a prototype developed by The Center for Children and Technology at Bank Street College of Education, in collaboration with the David Sarnoff Research Center in Princeton, New Jersey. The project filmed the site of a Mayan ruin in the Yucatan and digitized it so that it could be entered into a computer. With animated video guides, the user can select various options that allow a very realistic simulated trip through the site and an associated "museum." During the "trip", or when in the "museum" the user can select objects (such as a monkey) and find out more about them, including realistic sound effects like that of a howler monkey (McCarthy 1989).

Exciting commercial products have been developed using existing film footage and storing it on videodisc for use with a computer to create provocative, interactive programs. One of these is called "The '88 Vote:

Campaign for the White House." It was produced by Optical Data Corporation, Warren, New Jersey, in conjunction with ABC News Interactive. It uses film footage of the conventions and debates with news anchorman Peter Jennings to allow teachers or students to customize lessons by selecting topics and starting, stopping, jumping in at any frame desired to reinforce text or discussion (McCarthy, 1989).

Software companies such as Broderbund are developing many products which allow students to create titles and special effects for videotapes, CD-ROM products which have video footage, clip art, text, and sound effects including bird calls (McCarthy,1989).

Critics fear that multimedia in the hands of students may turn into mere entertainment. There is that possibility, but when students are actively involved using the technology and creating multimedia products, they are forced to be active learners and make choices. It is far different from passively watching television (McCarthy, 1989).

Another possible problem mentioned with respect to student multimedia projects is that students will know one small topic in depth, but will not have a broad view of what they are studying. It is true that random learning is not the goal. It is up to the teacher to give the students and their projects a built-in direction and sufficient scope to allow them to develop some understanding of the large picture. In this as in most other aspects of education, an informed, competent teacher is the key to success (McCarthy, 1989).

Student-generated Multimedia Products

Fred D'Ignazio (1989) has described the five main areas of multimedia publishing as: 1) desk-top publishing, 2) electronic slide shows, 3) audio publishing, 4) video publishing, and 5) hypermedia publishing. Any or all of these are appropriate for student use in developing projects. Students can use desk top publishing to create pamphlets or reports on almost any topic. For example, in a biology class they could write about and illustrate the life cycle of the malaria parasite, *Plasmodium*, the characteristics and habitat of animals such as the Atlantic anemone, or perhaps the structure and medicinal uses of certain plants. Electronic slide shows may be stored on a computer disc or may be transferred to videotape. Generally a combination of text and graphics is used to present a story, essay, or scientific report.

In audio publishing, students may write a script using a word processor and use the script to tape a “radio show.” Or they may tape stories of local history narrated by older persons and later write them up using a word processor. In video publishing students can use a video camera to record a play, a science experiment, or a cooking demonstration. They would be able to add a title, credits, and special effects with appropriate hardware and software.

Hypertext is a computer environment in which the user has the option of selecting from multiple paths. Hypertext allows authors to link information in many ways. Different users then create different paths through the software. Hypertext may be linked to other media such as videodisc or CD-ROM, producing hypermedia (Jonassen, 1988). In the production of hypermedia, non-linear branching presentations are developed that allow users to choose their own pathway. It is the most high-technology form of multimedia (Elliot, 1990). Because it can provide users with quick access to large amounts of information, and because it does not compel the user to follow set paths, hypertext can be an advantage to learners (Jonassen, 1988). There are a number of software programs available that allow students to develop hypermedia.

When a teacher decides to use multimedia and has assembled the necessary hardware and software, he or she must choose topics to be used, the type of presentation, and the scheduling of time involved (Elliot, 1990). Many teachers have found a student-centered approach which allows students to participate in these decisions to be an important step in producing pro-active learners. Giving students more control over their own learning helps to develop a sense of responsibility (Eliot, 1990).

The advantages of multimedia have more to do with the minds of students than with the specific technology tools used (Bruder, 1991). Students developing multimedia, especially with hypermedia possibilities, are forced to think about relationships, construct meanings, and organize information which links new information and their existing knowledge. According to the principles of cognitive psychology, learning is a reorganization of knowledge structures. Thus multimedia projects, especially with hypermedia, have a strong likelihood of enhancing learning (Jonassen, 1988). The interactive multimedia project engages students in part because it gives them control, challenges, images, and sounds, much as video games do. Part of its power is due to the fact that it allows for meanings to be structured from the particular to the general which differs from usual subject matter learning (Riskin, 1990). Regardless of how the multimedia experience is organized and experienced, students will need time to learn about the software and equipment before they begin their projects (Elliot, 1990).

Ebert-Zawasky and Abegg (1990) reported a quasi-experiment they conducted with students in an introductory college biology class. Students were divided into groups to produce fifteen-minute lessons using an authoring system, a Macintosh computer, and a videodisc player with a color monitor. A control group viewed instructor-prepared lessons on the same topics. The experimental group viewed a single demonstration lesson prior to their lesson development and viewed the lessons created by their classmates after their completion. No significant differences were found in the Scholastic Aptitude Test scores of the groups either before or after the treatment. The students in the experimental group successfully completed their lessons, maintained a level of performance equal to that of the control group, and had a very positive attitude toward the assignment. While they were anxious when given the assignment, most students recommended that it be retained as a task for future classes. In this study the most obvious effect was in the affective domain. Students reacted positively to the project although it took them twelve to fifteen hours to complete the fifteen-minute presentations. As a side effect, some of the students undoubtedly acquired computer skills that would be useful in other situations. In addition to its benefits for the students, the use of such an assignment could help the instructor accumulate a library of videodisc lessons to use with future classes.

Students producing multimedia reports are almost forced to collaborate because of the great amount of time and effort required to produce them. In addition, the great cost of the equipment means that only a limited number of multimedia centers will be available. This collaboration, along with the necessity for using complex equipment requires students to take responsibility. Riskin (1990) said, "An unanticipated consequence of this technology and the teaching it allows is the instant community it creates among students and the potential for very widespread and continuous communities of producers" (p. 11). The end result over a period of time is a more student-centered and less teacher-centered classroom.

Multimedia projects tend to cross subject-area boundaries when students follow their interests during their research. In this way multimedia projects can support a more holistic, process-centered approach and help teachers avoid the fragmented approach that has left many students with isolated bits of information that they fail to relate to anything else. Some flexibility in allowing students to select or modify their topics may result in a better product and one with more meaning to the students.

Many multimedia projects are suitable for integration across usual curriculum boundaries. An example given by Elliot (1990), uses a sixth or ninth grade class which would be given a book such as The Secret of Nimh by O'Brien to read. Various multimedia projects (or a single large project), relating to science or social studies could be developed. The students could use software to create an illustrated report on rats, either on paper using desk top publishing, or on screen using an interactive slide show, or both. The class could be divided into groups with each group responsible for some component of the report. Possible sub-topics might include species of rats and their range, rat habitat, rat anatomy, and so on. The student groups would each create their section of the report. One group might be responsible for putting this together using a title page or screen that allows the user to select the desired topic.

Elliot's (1990) rat example could be developed in other ways, depending on student interest and the availability of technology. One possibility would be to create a videotape presentation showing rat behavior, or perhaps close-ups of a rat dissection. If a scanner was available, they could digitize photographs to add to their electronic slide show. These projects would involve reading, writing and research skills, creative arts, problem-solving and managerial skills. Language arts, social studies, science and art are all related in one project. Such presentations are limited only by the technology available and the creativity of the students and teacher.

A great deal of time is required for students to become familiar with the software and equipment and to research, write, and produce their multimedia presentations. One way to find this time is to use cross-curricular projects that allow students to use time set up for more than one discipline (Elliot, 1990).

The Use of Multimedia in Science Teaching

There is evidence that science and science education is on the decline (Litchfield, 1990; Reecer, 1987). A 1985 study by the Association for Supervision and Curriculum Development found that elementary students spent nearly twice as much time studying mathematics and four times as much time studying reading as they spent in studying science (Reecer, 1987). Even that time may not have been well spent, since fewer than one-third of elementary teachers consider themselves "very well qualified" to teach science according to A Profile of Science & Mathematics Education - 1993, a report prepared by Iris Weiss under a National Science Foundation grant (cited in "Science and Math," 1995). According to this report most high school teachers had an adequate science background. However, high school teachers were less willing to use new teaching techniques such as cooperative learning, heterogeneous ability groups, and multidisciplinary teaching.

Instead they used the traditional lecture and textbook technique most of the time. Ninety-four per cent required students to listen to lectures and take notes and 86 per cent required students to answer questions from a textbook every day ("Science and Math," 1995). Rote memorization is still the main learning method used by teachers, perhaps because only five per cent of all exam questions required more than memorization ("NSF Releases," 1995). The National Assessment of Educational Progress (cited in "NAEP Science Performance," 1992) reports that student performance averages in science have changed little in the past 20 years though there have been some improvements in minority and female students. This result was verified by the National Science Foundation's Indicators of Science and Mathematics Education - 1992 (cited in "Long-Term Trends," 1994) which reported that there was little progress from 1970 to 1990. Though student science scores on the National Assessment of Educational Progress have risen significantly in the last ten years, they have not yet risen significantly above 1970 levels. Achievement of students in the United States was relatively poor compared to the achievement test scores of students from seven other technically advanced countries. In addition, few students in the United States have taken the most advanced classes ("NSF releases," 1995).

Because many elementary teachers feel inadequate in teaching science, and because of the extra time, work, money, and safety problems involved with experimentation, most of them rely heavily on the textbook. Even secondary science teachers, who should have more confidence in their chosen field, use text books extensively. Part of this may be due to the fact that over 40 per cent of the new teachers of physical or biological science since 1983 were certified in a field other than the one in which they were teaching. Few teachers at any level spend the recommended 50 per cent of class time in experimentation (Reecer, 1987).

Problems with the United States space program and similar problems from robotics to bioengineering present yet more reasons for worry about the state of science in general (Reecer, 1987). Popular support for expensive research has waned as economic and social problems have multiplied and science is not valued as highly by most persons as in the past.

Included in the America 2000 National Goals for Education adopted by the President and the state governors in 1990 is the goal that U.S. students will be first in the world in science and mathematics achievement by the year 2000 (Council of Chief State School Officers, 1989). National science education standards were developed by The National Research Council's National Committee on Science Education Standards and Assessment ("NRC committee," 1992) and most states either have standards or are working on them.

Science educators are particularly interested in developing positive attitudes toward science. Technology is one way of doing this. Information that is personally relevant to the students affects attitudes (Matthews, 1994). This information is often more readily available through the use of computer simulations, experimentation through the use of computer probes, interactive video, and other technology. With the use of technology students can use real data and come up with answers themselves rather than just reading an explanation (Solomon, 1993). The many images available with computers, CD-ROM, and videodisc give them much more information to process than the words, diagrams, and photographs in a textbook.

Computer simulations of a wide variety of phenomena have been developed. Some are commercial programs and others are written by students or teachers. They allow students to investigate complex natural phenomena such as wave motion, behavior of gases, atomic structure, and changes in DNA over time without spending impossible amounts of time and money (Saiz, 1994).

California in 1992 added multimedia materials to its list of state-adopted science materials. School districts can use state funds to purchase these adopted materials. Tom Sachse, Special Science Projects Director for California, cited the need for different learning formats for students with different learning styles as one reason for the change (Hill, 1993). The products submitted for adoption varied from traditional print-only textbooks, to books with some add-on technology, to well-integrated technology products consisting of software, laserdiscs, and video, and included a completely computer-based system. As more states follow this trend, schools and selection committees will have to consider the problem of hardware access. Most schools just do not have sufficient hardware to implement these materials (Finkel, 1992).

Blosser and Helgeson (1990) stated, "The central goal of science education is to develop scientific literacy for all students" (p. 1). Scientifically literate citizens are very important at a time when science is a critical part of our lives. To help produce these citizens, science educators are placing a greater emphasis on inquiry-based, hands-on, project-based learning (Bruder, 1993). Science content and science process skills are both considered important, but the main emphasis at present places content knowledge acquisition secondary to the development of thinking skills. The science process skills are used within a conceptual framework that gives content importance as it contributes to the understanding of concepts. There is less emphasis on terminology and memorization (Blosser & Helgeson, 1990). Microcomputer-based laboratories with sensor probes that plug into a computer port are transforming the learning process as are collaborative telecommunications projects, multimedia projects, and other innovative uses of technology. One goal of all of these is a greater depth of understanding rather than broad superficial coverage of subject matter (Bruder, March, 1993).

Science teachers are now expected to teach to all students, not just high-achievers. This requires teachers to provide different types of learning experiences to reach students of all abilities, backgrounds, and learning styles (Texley, 1994). The interactive, visual approach using computers and videodiscs seems to particularly appeal to students today, perhaps because they have been raised with television. Whatever the reason, there is evidence that the redundancy of multiple kinds of information, from video, audio, and text, enhances student learning and improves test scores (Huang & Aloi, 1991).

As science educators and their students model the work of real scientists, the use of technology is vital. Technology has become embedded in the methods of science and is now an essential element of science as a discipline (Gittinger, 1989). In the same way it must become an essential part of science education.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this study was to examine the effect of student-produced multimedia projects in a biology class in a small, rural school. The study employed a type of research in which the teacher functioned as a participant observer, in part through the lens of a video camera. The research was naturalistic and used ethnographic techniques in a case study approach.

Rationale for the Use of Case Study Methodology

Two major paradigms exist that relate to the study of educational problems. The first of these two, the normative paradigm, involves positivist studies. Its major tenets include the idea that all behavior is governed by rules and that it should be investigated by the methods of natural science. General theories are developed and tested by complex research methodologies in an attempt to account for human behavior. It might be characterized as the scientific, experimental paradigm and research associated with it is quantitative in nature. The other paradigm, the interpretative, attempts to understand the subjective world of human experience from the perspective of those involved in the phenomena under study. Theory emerges from the study of particular situations and is “grounded” in the data, producing a set of meanings which yield insight and understanding of people’s behavior (Cohen & Manion, 1994). Interpretative studies involve qualitative research. Normative studies and positivism may provide us with the clearest ideal of knowledge, but it is not overly successful in the study of complex human behavior such as that relating to teaching and learning. Even though normative studies have predominated, interpretive studies have had a substantial impact on education for more than two decades and they “continue to illuminate all aspects of teaching and learning. The study of education and learning is not yet a mature science and it is appropriate for a science in its early stages to rely on descriptive research” (Cohen & Manion, 1994, p. 38). In some cases qualitative research may be useful in generating hypotheses which can then be tested by quantitative methods (Tuckman, 1978).

In the consideration of research problems as with other problems, it is best to focus on the problem and its characteristics and then select the appropriate method for studying or resolving the problem. The problem in this study involved a relatively new teaching/learning technique: student-produced multimedia projects. In "Disciplines of Inquiry in Education: An Overview" (1988), Lee Shulman identifies the kinds of setting frequently studied by qualitative researchers. They often involve radical or unusual educational innovations, whereas quantitative studies are more often used for studies of large and approximately random samples of individuals in order to generalize the findings. Quantitative researchers have a tendency to look at individuals and settings as they are rather than as they might be. Shulman states, "Qualitative researchers, in contrast, are often committed to demonstrating the viability of truly alternative educational approaches" (p. 14). Thus a qualitative approach seemed most appropriate in this situation.

The case study researcher generally observes the characteristics of an individual unit, or bounded system (Stake, 1988), in this case a class. The case study approach can be qualitative or quantitative in nature. The purpose of qualitative case studies is to examine in depth the many phenomena that occur in a particular case unit with a view to establishing generalizations about the wider group to which the unit belongs. Qualitative case studies are presently in wide use in educational research (Cohen & Manion, 1980) and have the potential for showing both the personal and social complexities of an educational problem (Stake, 1988). A qualitative case study research approach focusing on a search for understanding of this particular case was selected as the most appropriate means of studying this problem.

Along with the case study method, a mode of observation must be selected. There has been a wide range of data collection techniques used in case study research (Cohen & Manion, 1994). Participant observation is one of these. Advantages of participant observation identified by Bailey (cited in Cohen & Manion, 1994) include the ability to observe ongoing behavior as it occurs and the development of more intimate and informal relationships with those being observed. He also considers it less reactive than other means of data collection and more suited to the study of non-verbal behavior. Some researchers have questioned the internal and external validity of studies conducted using participant research. However, the case study using participant observation is well-suited to many problems in education (Cohen & Manion, 1980). Participant observation was selected as the most appropriate observation method in this study.

Participant observation is an ethnographic method first used by anthropologists. An anthropologist studying a primitive culture was forced to take an active role. In contrast, participant observation in classrooms often forces the observer into a passive role since one of the few roles available is that of observer-visitor. In a few studies, the participant observer was a teacher, allowing them to be true participants (Wolcott, 1988). Wolcott (1988) suggests that the role of active participant has been under-utilized in educational research. However, he warns that it can divert time and energy from the research effort. The use of a video camera to record the social scene in this study made it easier to combine the roles of teacher and participant observer.

Cochran-Smith and Lytle (1993) criticize both the quantitative (process-product) and qualitative (interpretative) paradigms for their constraint of the role of teachers in the generation of knowledge about teaching and learning in classrooms. In referring to studies in the Handbook of Research on Teaching, which they say is widely viewed as the most comprehensive synthesis of research in the field, they state, "None are written by school-based teachers themselves" (p. 7). The voice of teachers is missing from this handbook and from most research. This study is written from the perspective of a member of the social scene, a teacher, but it strives to produce the whole social scene, including the view of the student, by using the impersonal eye of the video camera to record the classroom scene.

Ethnographic researchers use many techniques (Spradley, 1980). In this study the researcher utilized participant observation as the main data-gathering device. However informal interviews and analyses of the students' projects were also used in order to develop the case study of this social scene as fully as possible. The Myers-Briggs Type Indicator was given the students in an effort to determine a relationship between personality type and the effect of the development of multimedia projects on the students or between personality type and the complexity of the student's projects.

The Myers-Briggs Type Indicator (MBTI) is an instrument based on C. J. Jung's theory of psychological types. It was developed in an attempt to make these types understandable and useful. The MBTI is based on Jung's ideas about perception and judgment, and the attitudes in which they are used in different people. It is a self-report of easily recognized reactions that identify the basic preferences of people in regard to perception and judgment and has a wide scope of practical applications (Myers & McCaulley, 1985).

The four indices of the MBTI each has two poles, producing sixteen possible types. The four preferences are: extroversion (E) or introversion (I), sensing perception(S) or intuitive perception (N), thinking judgment (T) or feeling judgment (F), and judgment (J) or perception (P). Because "people may reasonably be expected to develop greater skill with the processes they prefer to use and with the attitudes in which they prefer to use these processes" (p. 3), the MBTI can be of use in education. While all types may perform well in school, the three preferences that contribute the most to scholastic success are I, N, and J (Myers & McCaulley, 1985).

Since even the simplest social situation can involve a cluster of situations, (Spradley, 1980), the social scene, a biology classroom, was extended to include two sections of Biology I in the same school, taught by the same teacher. This provided more data and hopefully will allow the research to have more to say about the wider social scene, science classes, or at least biology classes, in general. Since the sections were divided by placing each section opposite an athletics class, the composition of the sections by gender was very uneven in both cases. One class was predominantly male because it was offered opposite girl's athletics and the other was predominantly female due to being offered opposite boy's athletics. Consideration of data from both classes allowed for inclusion of approximately equal numbers of male and female students which would be a more typical situation for biology classes, even in this school. This scheduling was not typical but was what worked best for this small school's schedule for this particular school year.

Research Participants

Students who enrolled in Biology I for the 1993-1994 school year were given the option of participating in the study. These students were in two sections. Most students were in the ninth grade, but some students from grades ten through twelve took the class. Nineteen students participated in the entire study. Four others participated but were not present for the entire study due to either entering school late or moving away during the course of the study. Four students chose not to participate. This produced a total of 23 students involved in at least part of the study out of a total of 27 biology students that year. All students in both sections of the biology class produced the multimedia reports and participated fully in the class. Those not in the study were seated where they would not appear on the video.

Research Design

In the fall of 1993, at a school orientation meeting, the researcher met with parents of students enrolled in Biology I. The proposed study was described to the parents. Following this, students were given an oral description of the study and what their part would be if they chose to participate. Students were given permission forms that had to be signed both participate. Students were given permission forms that had to be signed both by the parents and by the student. If a student failed to bring the permission form back, or if they chose not to participate, they were not included in the study.

Beginning in November, both sections of the class were videotaped. The first three weeks of the study involved videotaping the class as it was taught using traditional means. An individual project, a cell model, was assigned during this time, but was mainly an out-of-school project. Students listened to lectures, took notes, and participated in class discussion. In addition they completed group laboratory experiments, completed homework, and took tests.

When the students began work on the technology projects, some classes were held in the computer room. Students were also videotaped there. As they began to explore and learn the operating systems and software to be used, students were assigned to groups, and the groups to a kind of computer: MS-DOS-based or Macintosh. Work in the classroom continued with the students doing research, planning their projects and finishing work from the traditional unit.

At the completion of the group projects, students again studied a topic using the traditional method. Toward the end of this section of study they were assigned the individual projects and began planning them. They were again given time in the computer room to familiarize themselves with the software they were to use. As many as possible were switched from the kind of machine they had originally used to the other kind. Because the school had more MS-DOS machines than Macintoshes, not everyone could be given a different kind of machine for their individual project.

The students were given the Myers-Briggs Type Inventory. They were then given information relating to their Myers-Briggs type and its implications and wrote down their feelings regarding its correctness.

Tapes of the classes were transcribed to provide field notes. A total of 50 class periods for each section were transcribed and analyzed. Because the teacher-researcher was present during the videotaping, her memory of events helped make the transcription of the tapes easier. In turn, replaying the tapes stimulated the researcher's memory producing a detailed set of observations of the class sections.

Research Setting

A small, rural school in a county seat town in an agricultural community in the southern Great Plains was the site of this study. The school includes kindergarten through twelfth grade in a single building and has slightly less than 350 students. The population of the town is approximately 1000 people.

Research Investigator

The researcher had been a teacher at the research site for many years and had previously taught biology at the school. However the researcher had not used multimedia projects with a class previous to the pilot study. According to Spradley (1980) the highest level of participation or involvement in the social situation comes when the observer is already an ordinary participant. Many researchers have conducted research in ordinary settings in which they are members, though it may be more difficult for them to see tacit cultural rules (Spradley, 1980). Strauss and Corbin (1990) assert that professional experience is a source of theoretical sensitivity and allows a researcher to understand actions and events and do so more quickly than someone lacking knowledge of the research situation. They state, "The more professional experience, the richer the knowledge base and insight available to draw upon in the research" (p. 42). The position of ordinary participant does allow researchers to gain admittance to the social situation and to maintain rapport with the other members, which otherwise can cause many difficulties (Woolcot, 1988). The use of participant observation by teachers with their own class is one method of getting an active participant into the classroom. However, there is potential for bias that the observer must constantly guard against.

Research that uses qualitative, ethnographic methods poses a problem for researchers since they result from unique situations that cannot be reconstructed exactly. It is particularly susceptible to problems of replication, though no method can produce a study that can be replicated exactly due to changes in time, place, and human behavior. The reliability of qualitative research is increased "by recognizing and handling five major problems: researcher status position, informant choices, social situations and conditions, analytic constructs and premises, and methods of data collection and analysis" (Goetz & LeCompte, 1984, p. 214). Careful explication of these factors makes it much more likely that such a study can be replicated.

The status position of the researcher in this study was that of the teacher of the class. As a usual member of the cultural scene, she could observe less intrusively than an outsider. As a teacher she was likely to have a high degree of professional sensitivity to the classroom scene, allowing for more understanding. However, it was necessary to search carefully for the tacit knowledge possessed by all members of the social scene since it is usually taken for granted by the members of the scene. An awareness of this need and the use of the video camera helped to reveal this knowledge and limit bias.

The informants in this study included all of the participants in the study, all but four of the members of the social scene being investigated, a classroom. Classroom conditions, methods of data collection, definitions of terms, and methods of analysis are given in detail in order to improve the reliability of this study.

The internal reliability of a study using ethnographic methods is increased by including a substantial amount of raw data in the written report. The readers can then assess for themselves the appropriateness of a researcher's conclusions. It is also important for the researcher to include any negative or discrepant data as well as material that supports conclusions. The use of videotape and other equipment for data collection strengthens the reliability of results providing the camera angle, type of participant, and segments of behavior are specified (Goetz & LeCompte, 1984).

Qualitative research using ethnographic methods tends to produce high internal validity, one of its major strengths. This is due to its data collection and analysis techniques. The collection of data for long periods, conducted in natural settings, provides data that reflect participants' life experiences more accurately than that collected in contrived settings over short periods of time.

In analysis of the data collected, a researcher using ethnographic methods incorporates a process of "researcher self-monitoring, termed disciplined subjectivity (Erickson, 1973), that exposes all phases of the research activity to continual questioning and reevaluation" (Goetz &LeCompte, 1984, p. 221).

Collection of Documents

The multimedia projects created were printed and collected. Participants were given the Myers-Briggs Type Inventory and their answer sheets retained. Students wrote a personal evaluation regarding their MBTI and their feelings as to its correctness and accuracy. These were retained with the other documents.

Analysis of Data

Analysis of the data utilized a modification of Spradley's (1980) developmental research sequence. He delineates a research cycle in which the researcher answers questions, both implicit and explicit, relating to the social scene. The researcher does this by making observations of that scene while sharing in it. The three major kinds of questions used are descriptive, structural, and contrast. The researcher begins by making broad descriptive observations relating to the descriptive questions. He or she then proceeds to include more focused observations relevant to the structured questions and finally makes selective observations in an attempt to answer contrast questions. These more focused observations occur while the researcher continues to produce general descriptive observations. During or immediately following the field observations, the researcher makes field notes recording observations. These field notes are then subjected to domain analysis, taxonomic analysis, componential analysis, and theme analysis.

Domain analysis involves searching the field notes for categories of cultural meaning that include other smaller categories. There are three elements to a domain: (1) the cover term or name, (2) the included terms or smaller categories within the domain, and (3) the semantic relationship between the first two (Spradley, 1980).

In a taxonomic analysis the researcher selects several cultural domains for study. These domains and their included terms are organized to show the relationships among all the included terms in a domain as a way of revealing subsets and their relationship to the whole (Spradley, 1980).

"Componential analysis is the systematic search for the attributes (components of meaning) associated with cultural categories" (Spradley, 1980, p. 131). Key domains are examined for contrasts, beginning with notes produced from selective observations generated by contrast questions. A paradigm worksheet and a paradigm table are constructed by organizing these dimensions of contrast.

Spradley's (1980) final stage of analysis, theme analysis, involves a search for principles that recur in several domains and that serve to link cultural units. Theme analysis techniques are less well developed than the analysis at lower levels. Spradley lists several possibilities for theme analysis, including an examination of dimensions of contrast from several domains, immersion in the social scene and field notes, and production of a taxonomy of domains. In this study the researcher used the first two methods, an examination of dimensions of contrast and immersion, since the lengthy transcription of video tapes followed by analysis of the field notes produced a strong sense of reliving the classes. Finally the entire collection of field notes, notes of analysis, and collected documents were examined in a search for themes (Spradley. 1980).

The main modification of Spradley's (1980) method employed in this research related to the time involved in transcribing the videotapes. Spradley advises a cyclic process in which the researcher makes observations, produces field notes, develops questions from these field notes, and returns to the scene to look for answers. Because the videotapes could not be transcribed each evening due to the length of time involved (usually several hours for each 50 minute class period), the researcher returned to the detailed field notes for selected and focused observations rather than returning to the classroom scene. These field notes were almost verbatim records of conversation and events in the classroom due to the ability to pause, rewind, and replay segments.

Summary

Schools are faced with a dilemma with respect to the use of technology. Hardware and software are so expensive that it is difficult to find money in school budgets to allow for their purchase. Also, the time and expense involved in training personnel tend to slow the use of technology even when it is available in the schools. Nor is the structure and organization of our schools suited to the use of technology. This calls for restructuring, at the cost of additional time and expense.

School boards and the tax-paying public have a right to expect that education dollars will be spent in the most advantageous manner by schools. For many reasons, technology has not always been used in this manner by schools. Insufficient teacher training is undoubtedly one of the major reasons. Rural schools in particular have difficulty funding and staffing appropriate uses of technology, even though it may be vital to their continued success. The use of technologies such as telecommunications, computers, robotics, fiber optics, and lasers needs to be increased to help small schools meet state and federal mandates and continue to produce quality students (Keller, 1992). The implementation of technology projects such as those in this study contribute to the growing body of evidence relating to technology use in schools and should be helpful in determining if there are benefits to technology use that warrant the acquisition of new skills by teachers and the expenditure of funds for technology. In addition, projects such as these that use technology already present in most schools should help convince those in charge of the budget that their technology dollars will be well spent.

The assessment of restructuring efforts involving technology must be an ongoing effort. The most formal assessment involves the use of standardized tests to measure student achievement. For these to be appropriate, they must be compatible with the goals of the restructuring. Even if tests can be found that satisfactorily measure the desired outcomes, sufficient time must be allowed for the plan to produce its desired results. Other assessment approaches may be needed. Assessing student attitudes provides one of these. A determination of whether the plan has increased student motivation, effort, or enthusiasm is an important indicator of success.

Student attitudes can be observed using both formal and informal techniques. Truancy rates, teacher observations, interactions between students, and teacher attitudes and behaviors all give valuable information relating to the implementation of the restructuring plan (Kinnaman, 1991). These evaluations form a significant body of information for the use of those in charge of restructuring.

The choices teachers make among alternative approaches significantly affect the attitudes, knowledge, and skills that students carry into adult life. Although every teacher and every class is different, there are enough important similarities that the detailed description of a single class involved in the use of technology may be of use to other teachers and students. The underlying assumption behind the case study method is that sites and educational programs have "stories to tell" that are useful in understanding the complexity of classroom learning (Levine, 1990, p. 467). This research is intended to help educators make informed choices that facilitate the development of the optimum learning environment for their students.

An examination of the possibilities of technology as an important factor in the restructuring of schools, especially that related to science education in rural schools, should help educators determine the efficacy of technology in the classroom and hopefully convince more schools and educators to make the commitment to change needed to fully implement technology.

Method

This observational, descriptive study explored the effectiveness of the use of technology in small rural schools with limited resources. The procedure involved the detailed description of the learning environment during differing instructional approaches relating to the integration of multimedia development in a high school biology class. Students were observed during traditional class work as well as during the production of group and individual multimedia projects. The study consisted of a qualitative examination of the students as they participated in the use of technology and acted as researcher, author, and synthesizer of biological information on specific topics. Students were given an inventory to determine their personality type and associated learning style.

Two instructional approaches were used during the course of the study. One of these involved the use of computer and video technology and one did not. In the approach using technology, the focus was on student-generated multimedia. The specific problem addressed in this study is the improvement of science education in rural schools through the use of technology and a component of restructured schools: student-generated products. Through an examination of the ways in which high school biology students with varying learning styles, attitudes, and abilities responded to the two teaching methods, themes relating to the implementation of technology in this setting were revealed.

The instructional approaches involved in the study were: 1) Students were taught using traditional methods including working cooperatively in groups for laboratory experiments, and developing projects (cell models) outside class; 2) Students worked in cooperative groups to complete multimedia projects using available technology; 3) Students worked individually to develop multimedia projects.

The individual students and student groups were given a choice of sub-topics within a general topic selected by the teacher. Students had the opportunity to make suggestions for project subjects within the general area to be considered. The videodiscs available were a determining factor in both the teacher's and the students' choices of general and specific topics. The focus was on the student functioning individually and as a member of a cooperative group while participating in the use of technology. Students authored and presented "mini-lessons" or projects and acted as an audience for other students' presentations.

Specific questions addressed by the study included the following:

1) How do the tacit rules of behavior differ between the traditional classroom setting and a setting in which multimedia projects are being produced?

2) Is personality type related to the way students respond to the use of technology in developing projects?

3) Are student-generated technology projects effective in motivating students?

4) Is it feasible for schools with limited funds and limited technology to begin implementation of technology?

The case study method was used to thoroughly examine the learning situation in this high school biology classroom. Qualitative analysis of a detailed, descriptive nature was the means of evaluation. The Myers-Briggs Type Indicator (MBTI) for the identification of personality type was given to the students in an effort to determine whether the technology projects were more effective with students having certain personality traits.

In addition, classroom proceedings were recorded (with the students' knowledge) and the video tapes were transcribed and used to analyze substantive dialogue within the classroom. The camera, fitted with a wide-angle lens, was placed in a position that allowed a view of most of the room.

It was swiveled or raised or lowered at times by students as they looked through it. During group work, the angle of the camera was adjusted periodically to show a different part of the room.

The transcripts produced from the video tapes were used to show patterns of interaction in the classroom learning situation during each section of the study. Printed copies of the multimedia projects were analyzed for content, branching, creativity, and complexity. Students wrote responses following identification and description of their Myers-Briggs Type.

During the course of the study, technology-rich and traditional methods were used. To help separate the effects of technology use from the effects of cooperative learning groups, one of the two technology-rich units involved individual projects and one involved group use of technology.

Assumptions and Limitations

The researcher assumes that the students involved in the study reacted to the treatment in a way fairly typical of high school biology students. This may or may not be true and only additional studies could help verify conclusions drawn from the results.

This study was conducted using high school biology students in a small rural school. Since the students who chose to enroll in biology and who also wished to participate in the study made up the population, there was no random selection of participants. In addition, since the hardware and software available were limited, as they are in many schools, only a few were actually used in this study.

The biggest limitation regarding this study is that restructuring with technology should involve the entire school system (David, 1991) while in this case only one class was involved.

CHAPTER IV

FINDINGS

Introduction

The major purpose of this study was to examine the tacit rules of behavior of high-school students in a biology class. These tacit rules were examined to see if there were differences between use of a traditional method with lecture, demonstration, and experiments and an alternative method in which they worked on multimedia computer projects. Spradley's (1980) developmental research method was used to analyze the data and develop "recipes" for being a student in the regular biology classroom and for being a student in the computer room. These were compared with the research in an attempt to find areas of agreement or discrepancy with a characterization of the main benefits of the computer-project method as outlined by the research.

Qualitative methods were used to examine two sections of Biology I taught by the researcher. Both sections were treated in a similar manner. In this small, rural school the class was divided into two sections through placing each section opposite athletics. Due to this scheduling, over 80 per cent of the morning students were male and over 80 per cent of the afternoon students were female. In addition there was considerable difference between a morning class held just before lunch and a class meeting the last hour in the afternoon. The school had 50-minute class periods. The morning section was shortened by five minutes on the weeks when the teacher was on hall duty and was occasionally missed for assemblies. The afternoon section was shortened by at least fifteen minutes (more for cheerleaders and band students) on many Fridays for pep assemblies.

Both sections were primarily 9th-grade students, but some 10th-grade students were in each section and one section also had an 11th-grade student. Two students switched from one section to the other during the study, three moved away, and one (a senior exchange student) entered the class after the study had begun. In each section, two individuals chose not to be included in the study. This produced nineteen students that were present for the entire study while four others took part in some portion of the study.

Description of Research Procedure:

The method of the study involved participant observation through the wide-angle lens of a video camera. The researcher, as teacher of the class, participated in the social scene and reviewed the tapes to produce field notes and develop ethnographic analyses. Students and their parents were allowed to choose whether the student was to be involved in the study. Students not in the study completed the course work, including projects, just like those in the study. However, they were seated in locations that kept them off camera and any comments they made were not included in the research data. They were assured that participation in the study or not would not affect their grades in the class.

Videotapes have some limitations in classroom research, since it proved impossible to have everyone in the study on camera all the time. However, with a wide-angle lens and a participant observer, the teacher, present in the classroom in addition to the tapes, the results may perhaps produce more detail than a participant observer alone could record. The videotape could be rewound, replayed, and paused, which made it possible to record parts of the social scene that might have been missed by an observer with pen and paper alone. The use of the camera did not allow for much observation of facial expressions which might have been useful. However, observers would have had to make themselves quite conspicuous in order to solve this problem. Whether with the use of a camera or a live observer, facing the students and carefully observing and recording their expressions would be very intrusive and would be likely to be counterproductive. The use of the stationary camera with a wide angle lens seemed to be the best solution in this classroom setting.

A second limitation that was perhaps more serious involved the failure of the microphone to pick up all conversation. It did not pick up all students' voices equally well. The teacher's voice was picked up quite well, as was that of the some of the students, but some students spoke very softly and did not project well, making it difficult to understand their comments. Distance from the microphone did not seem to be the critical factor, nor did the fact that the microphone was slightly behind and to the side of the students. An observer on the scene might well have had trouble hearing some students, since the teacher had this problem at times. It is also very difficult to write fast enough to record all conversation in a classroom discussion so having a videotape record of it is helpful.

The students showed an awareness of the presence of the camera that may have had some effect on their behavior. However due to the length of the study and the fact that the researcher assured them that the tapes would not be viewed by anyone except herself or members of her committee, this did not appear to be a very significant factor. The presence of a person in the classroom recording events would very likely have had more effect than the presence of the camera.

The videotapes produced from each class period were transcribed into longhand. The use of pause, fast forward, and reverse allowed most of the material from the tape to be successfully transcribed. Because the transcription was a lengthy process, many of the tapes could not be transcribed until after the completion of the study.

Camera placement was more difficult when the class met in the computer room since the students were scattered about a rather large room. By changing the direction of the camera occasionally, this was minimized. When the classes were working in groups, especially in the computer room, it was impossible to hear what students in each group were saying, but it was possible to hear some conversation and from the teacher's comments to reconstruct much of what was happening. In reviewing the tapes and the field notes produced from them it was at times almost as if the teacher (researcher) was reliving the events because the taped conversations and pictures brought back her memory of the circumstances and occurrences. Her impressions of each student, produced from the field notes and interactions with the students, and an analysis of their computer projects were recorded.

One area in which the video tapes seemed to be particularly useful was in examination of the body language of the students. The students were seated in rolling chairs, which allowed them to move about even when seated quietly for class discussion. The movements they made, rolling away from or up to their desk, closer to their desk partner, putting their heads on the desks, leg movements, and so on were at times indicative of not only their feeling that day but also gave hints as to their personality type.

The Myers-Briggs Type Indicator was given to the students but no causal relationship between Myers-Briggs personality type and the effect of multimedia production was found.

Description of the Research Setting:

The site of the study was a small rural school, located in a town with a population of about 1000. The town is part of a farming community in the center of the United States. The school population at the time of the study was less than 350 students in grades kindergarten through 12. The school is contained in a single one-story building. The facilities are relatively modern and in very good condition, providing an appropriate learning atmosphere. The school has been a member of a large regional accrediting association for many years, which is unusual for schools of this size in the area.

Until recently the school was relatively affluent, in part due to local moneys from a large industrial plant at the edge of town. In an effort to equalize per student expenditure across the state, the state has been sending less and less money to this school. The school population has dropped along with the population of the town and surrounding rural area as a result of the economic difficulties of farmers. Many farmers have gone out of business as have many related businesses. The combination of less state aid, fewer students, state-mandated salary increases for teachers, and other expenditures required by the state have changed the school from one with sufficient funds to one that is cutting teachers and programs and struggling to survive.

The biology room is part of a two-room addition to the building constructed within the last 10 years. At the same time the room used as the computer room was remodeled. Because of this recent addition, storage facilities and safety provisions are well provided for.

The biology room has 12 two-person laboratory tables. They are the correct height for seated work and have book slots above each chair well and a single cabinet between the chair wells. They do not have sinks, but two large sinks are located in cabinets at the front and back of the room. Two other sinks are available in the biology storage room and the project room, both of which open off of the biology room. A short hallway connects with the chemistry room and with the small science office and with a chemistry storage area between the biology and chemistry rooms. The project room also opens into the chemistry room.

The biology room had colorful, door sized biology posters attached to three of the doors. Large south windows and an east window were lined with hanging baskets of plants, and the shelves below them supported numerous plants of varied types. A small marine aquarium was maintained near the east window. It usually contained three or four marine invertebrates and one or two small marine fish. A terrarium under the hanging baskets contained plants and small lizards. A large, shallow, fish bowl near the back sink contained a flat rock and a salamander. A cage containing a pair of zebra finches was on the cabinet at the front next to the chalkboard. The west wall of the room is covered with two bulletin boards, one large and one small. The small one was used for the display of weekly bulletins, monthly calendars, and lunch menus. The larger bulletin board had plant and animal pictures relating to a biological theme.

The biology room has a glass-fronted microscope cabinet, a coat closet, glass-fronted display shelves, and bookshelves covering most of the remaining wall space. Some of these shelves contain preserved specimens of various types. A life-sized human torso model stands on a table that runs across about one-third of the front of the room. Other models or laboratory equipment for use that day also were placed on it. The table was designed for the placement of computers, but the school had been unable to purchase them due to lack of funds. Students were allowed to get up and look at the displays and examine the specimens when they were given study time or had finished tests and other assignments. They also had a chance to read wildlife magazines stacked on shelves at the back of the room.

To allow students a better chance to observe the organisms, and to help them develop responsible attitudes relating to organisms, they cared for them in pairs according to a schedule assigned by the teacher. The marine aquarium was cared for by another class, but the other organisms were cared for by Biology I students. Though the marine aquarium was not their responsibility, they were allowed to observe the animals and on occasion were given food for them so that they could observe the feeding behavior. Some students really liked caring for the organisms, especially the animals, and others were rather reluctant, but all participated. The truly squeamish were allowed to have someone help them feed mealworms to the lizards and salamander, but this was unusual. The use of tweezers to put a little distance between the student and the mealworm satisfied the sensibilities of most students. The student aides were assigned for a week at a time and were rotated so that students had different partners each time they were assigned the duties.

Every three weeks, students in the biology room drew a number and moved to the associated seat. This made it likely that each student would be paired with most of the other students at one time or other during the year. These desk partners were normally the groups used for laboratory activities, but if more than two in a group were needed, the teacher usually specified how they were to divide up. Thus, students were accustomed to being assigned to groups, whether randomly or by the teacher, even before their work on the group computer projects. In the computer room students were allowed to select their own desks, since they were at the computers most of the time. The computers were assigned on most occasions, though at times a student arriving early could select which specific computer they wished to use as long as it was the kind (MS-DOS or Macintosh) they had been assigned to.

The computer room is a large rectangular room that was once the school's cafeteria. It has been remodeled, but because of its cement floors has electrical outlets only along the two long walls. Old movable laboratory tables have been placed along the south and west walls and extended into the center of the room to hold the computers. Extension cords and power strips are used to connect these to the power supply.

At the beginning of the 1993-1994 school year, three computer tables were purchased and placed on the north wall of the room. Because of the problem with chalk dust near the computers, the chalk board that was there was covered with a dry marker board. This room also has space for twelve student chair/desk combinations, a teacher's desk, a round table, a laboratory demonstration table, and a large storage cabinet. It has a large walk-in closet used for the storage of physics equipment and computer software and supplies. There is a large bulletin board on the east wall which held a computer science display during the study. This room has three doors, one leading directly into the chemistry room and two (on the long north wall) leading to an east-west hallway. This connects with a north-south hallway that leads to the biology room.

The distance between the computer and biology rooms is significant since the videodisc player, books and magazines used to develop the projects, and the students, moved back and forth between rooms. Generally the students were told ahead of time to meet in the computer room, but on occasion they went to the computer room after finishing a test or some other activity.

The biology room and the computer room are separated by only one room, but the computer room opens onto a different hallway, so while the distance is not great, the biology room and computer rooms are some distance apart.

While science supplies were provided, there had been a shortage of money in recent years which made the purchase of computers and other technology difficult. In the 1992-93 school year a $9,000 grant allowed the purchase of three new computers and software. One of these was placed in the business room, and the other two were placed in the computer room. An older Macintosh machine was removed from the business room and placed in the computer room at the same time. At the beginning of the school year 1993-94, five new computers were purchased. These eight machines were the computers used by the students in the study. The other eleven machines present in the computer room could not be used with the software available due to their age and lack of memory.

The computers used included two Macintosh LC520s, one Macintosh LC, two 386-based IBM computers and three 486-based personal computers. The software used was presentation software that allowed videodisc control. One version was used for the Macintosh machines, another for the MS-DOS machines. The teacher typed up detailed directions for each type of machine, since they were not all set up the same way. This allowed the students to begin work on their own even though there were differences in startup procedures as well as in software.

The videodisc player and the television used with it are mounted in a large rolling cabinet that is normally stored in the chemistry room. It was usually brought through the door connecting the rooms but even this involved moving chairs and desks to roll the large cabinet between them. This often had to be done between classes since both teachers used the machine frequently. Rolling the cabinet around, attaching the proper cable, connecting it to the computer, loading the proper disc, and attempting to provide each group and individual student sufficient access to the videodisc machine was one of the teacher's biggest problems during the computer projects. Luckily, most of their preparation could be done with the videodisc player standing alone. Only the final check to see if their videodisc buttons worked correctly and the viewing of the presentation by other members of the class required the player to actually be connected to the computer.

Description of the Research Participants

Nineteen students in grades 9 through 11 participated in the entire study. Four others participated but were not present for the full time encompassed by the study. These students are described briefly in student profiles. Few of them had much computer experience, and many of them had no keyboarding skills. Several students were enrolled in typing and so had begun to develop some keyboarding ability before the projects were begun. The groups for the first computer project were assigned with keyboarding skill in mind, so that each group had one person with at least some keyboarding experience.

Collected Data

Student profiles were developed using field notes, the researcher's observations, and the student's projects. The two students that switched sections at semester, Ken and Bill, both fit in very well with both sections of the class, but if anything were more popular in the afternoon class. At this time they were only males in the class because Abe and John had moved away. Perhaps it lends a little cachet to be the only males in a class of girls. The two girls in the morning class seemed to have the same advantage. They were popular desk partners and seemed to get along well with the rest of the class.

Student Profiles

Morning Section

Kip's Profile. Kip is a bright, quick, vocal student who often dominated the discussion. His quick answers were not always correct, but they often were. However, many of these answers lacked depth. His memory is quite good, but he did not show an inclination for much deep thought. That will probably come later, as he appeared to be a very capable student. He is very restless and was always in motion. He obviously likes science and was enrolled in two science classes, which is unusual, especially for a ninth-grade student. He liked labs and was interested in the animals in the room. He did well but was not overly motivated by grades. He was fast with almost everything, even a bit hasty at times, and should probably have slowed down a little. He exhibited a great deal of interest and ingenuity in the production of both the group and the individual projects. He was grouped with David and a student not in the study for the group projects and the group worked very independently with little help from the teacher. When the students were given a day in the computer room to explore the software preparatory to beginning the individual projects, he immediately began working on his project, which he had been planning in his head. Though he is a quick, restless individual, Kip tended to show a great deal of active involvement regardless of the teaching method. As he commented, he just likes science.

Brent's Profile. Brent is a pleasant, well-liked student in the ninth grade. Most students would consider him fun to be with. He studied a minimal amount and though he didn't always know answers, he was not at all shy but would take a chance and volunteer at times. He was not usually well-prepared and was somewhat mischievous, but basically mannerly. He was always quite interested in the video camera and liked to fiddle with it at the beginning of the hour or whenever he had a chance to be up and moving around. He seemed to be interested in aiming it at other students and messing around for fun but didn't really seem self-conscious about being seen on the tape himself. He sometimes phrased answers in familiar or mundane terms, showing an understanding of concepts while lacking mastery of the terminology. He thus appeared to have more understanding than vocabulary.

Lee's Profile. Lee is an extremely quiet young man who was in the ninth grade. He is very intelligent and is very interested in science. He was taking two science classes and had attended academic summer camps. He was well-liked though he did not seem to have any particular pals in the class. The other students listened when he did have a comment. He was not yet very articulate considering his obvious knowledge and intelligence. He studied, was always well-prepared, and did quite well on tests. He has a good sense of humor and occasionally made funny comments. He likes and knows about computers and was anxious to get one, which he did toward the end of the year. He seldom initiated a conversation but he showed the teacher his score in science on a standardized test he has taken and made a comment about the very difficult biology test the class took for a national contest. His family appeared very supportive. He rarely volunteered anything in class, but when he did speak, whether called on or volunteered, he was almost always right. He speaks rather softly and his voice was difficult to pick up on tape. He worked quite independently both in the classroom and in the computer room and did not help others too much, though he obviously could have. He seemed very involved in the computer projects.

Bill's Profile. Bill is a very friendly and outgoing student who was in the 10th grade. He speaks with a drawl and had just recently moved to this state. He was a very conscientious student and put out a lot of effort. He acted interested in what was going on and frequently checked on the animals in the room. He got along well with everyone and was very polite. He didn't seem to have any close friends in the class. Despite previous experience on computers, Bill seemed to have trouble with the projects.

Ken's Profile. Ken, a 10th-grade student, took responsibility for setting up, starting, stopping, and putting away the video camera under his own initiative. Although the teacher was somewhat reluctant at first to allow him to do this, he was very good at it and very careful with the equipment. Sometimes the teacher had the equipment set up and ready to go when he entered, and he seemed almost disappointed. It took considerable time to take the camera apart and put it in its case to be taken home each night so that the tapes could be copied, but he voluntarily remained after class and took care of it. He was usually the last one out of the classroom even before video taping began. He had his project ready well ahead of time and spent considerable extra time before and after school working on both his individual project and on his group project. He gave other students a great deal of help at the computers and seemed to enjoy the chance to help them. While his previous computer experience had been mainly playing computer games on an aunt's computer, he caught on quickly, typed well, and had little difficulty with the software. He liked to tease and make jokes in a low-key way, but was always cooperative. He never caused a disturbance or trouble of any sort. He said he was "hooked on" computer games but at that time had no access to a computer except at school. He had very good rapport with the teacher and got along well with other students. Ken was a student that showed much more interest and confidence during the projects than during the traditional section of the study. He did not seem to understand concepts discussed in the traditional manner and once commented that he kept quiet in class because he "didn't know what he was talking about." He was obviously motivated by the use of technology. He worked on a Macintosh during the group projects and was switched to an MS-DOS machines for his individual project. At first he had trouble with the change, but a little later he commented, "Me and the IBM are gettin' along great now."

Marty's Profile. Marty was a very friendly and popular ninth-grade student. He usually worked hard at his lessons, but biology was difficult for him. He is particularly good-looking and was quite friendly with the girls in the class. Sometimes he didn't understand how to do things and others helped him without drawing attention to it. He was very interested in the classroom animals and was concerned about or interested in the camera. He was quite aware of where it was pointed and liked to adjust it. He showed more concern for his appearance on camera than many of the others. He has a very supportive family as was typical for most of the students.

Fred's Profile. Fred, an 11th-grade student, was very quiet. He often looked at the animals or through the camera. He seldom asked questions or made comments and almost never volunteered anything. He avoided answering questions and science seemed difficult for him. He is a good athlete and well-liked. He was perhaps not so much shy as afraid of appearing foolish. At times he could be very funny. Fred showed more interest in the projects than in the traditional lessons. He made arrangements to come in after school to work on his project even though he could not come until rather late in the afternoon, after sports practices were over.

David's Profile. David seemed very mature for a ninth-grade student. He is athletic and popular. He has lots of common sense and is intelligent but probably didn't study much. He completed his assignments, though they often appeared hurriedly done, and paid attention during class. He often showed signs of restlessness, tiredness, or boredom. However, he answered questions indicating attention to the lesson. He may be bothered by inactivity, since he is very fond of sports. He is quite polite and has a good sense of humor. He whistled and hummed in the computer room, though he did it quietly enough not to cause a disturbance. The teacher used him as a "barometer" of class feeling. When he appeared restless or bored, it was time for a change of activity. He and Kip especially seemed to pride themselves on working independently in the computer room and asked for help only when absolutely necessary.

Carl's Profile. Carl was a senior exchange student from an East European country. He entered the study late but was eager to participate. His English was very difficult to understand even in class but especially so on tape. He came a few weeks after the study had begun. He was very agreeable and wanted to take part, but had a great deal of trouble picking a topic. Though he had trouble with spoken English, he read it fairly well. He could not type, which slowed his work at the computer even more. He was not prepared on time, but came in outside of class and successfully completed his project. He was present only for the individual projects.

Travis's Profile. Travis is a bright young man, but is deliberate of speech and movement and has to work to make good grades. He was in the ninth grade and involved in numerous activities including sports. He is a good athlete and was also very serious and conscientious about his class work but sometimes got behind because of his natural pace and the number of things he was involved in. He was very aware of what he viewed as his shortcomings; and appeared to have a lot of responsibility at home.

Susie's Profile. Susie was very popular ninth-grade student involved in many activities. She made good grades although she said she didn't always understand concepts. She was motivated to get good grades and do well. She could be quite funny and frequently volunteered to help with whatever needed to be done. She chose to do her individual project outside of class so that she could use the software she liked best. She helped others with their projects during class, used the videodisc to select pictures, and worked on her project at her desk. She was extremely well-organized and well-prepared. She had trouble deciding on a topic for her individual project and also had difficulty coming up with an idea for her cell model. She spent a good deal of time helping others with the software, which she learned for the first time during the group projects.

Deena's Profile. Deena is friendly, outgoing, and very considerate of others. She studied hard and did well although she said science was difficult for her. She was very responsible, interested in the animals in the room, and volunteered to help whenever anything needed to be done. She seemed to have more confidence in her work at the computer than when in the classroom. She was in the ninth grade.

Afternoon Section

Abe's Profile. Abe was a 10th-grade student new to this school. He got along well with other students and completed most assignments, but probably didn't study much. He usually participated during class. He moved away before the end of the first semester and did not complete a project.

John's Profile. John was also a 10th-grade student new to this school. He was friendly and occasionally a clown. He was interested in the animals and spent a lot of time watching them. He moved away before the end of the first semester and did not complete a project.

Anne's Profile. Anne was a 10th-grade student who was quite vocal and assertive. She asked lots of questions. She studied only as much as she needed to in order to get the grade she wanted. She could be disruptive at times, but at other times was very helpful. She was a definite leader of one group within the section. Typical comments from her include: "When's our next test," "I don't get it," "I don't understand," and "Hold on." Despite the tone of these comments, she made good grades, perhaps as a result of vocalizing her problems in understanding and drawing attention to them. In general she understood fairly well, at least when it was time for a test. She is quite outspoken, as she mentioned, but is fun and likable also. She had trouble with the software at times and let everyone know when she had a question or needed help, as in the classroom. She seemed frustrated by the amount of time required to produce the projects.

Michele's Profile. Michele, a ninth-grade student, didn't appear particularly interested in science though she did fairly well when she studied. At times she seemed to have trouble understanding concepts. She generally completed assignments but possibly didn't study consistently. She would laugh and giggle with Anne at times. She wasn't much more interested in spending time developing computer projects than she was in ordinary classroom work.

Leah's Profile. Leah was in the 10th grade, was quite popular and a good student. She often volunteered answers. She has a good personality and is friendly and helpful. Though she seemed to be a very logical thinker she was not secure with computers. She felt she was not good with them. Lack of exposure to them was a possible reason for her feelings. She was well-organized, quick to catch on, and showed insight into the behavior of other students. She showed a lot of maturity. She volunteered to help care for the plants and animals when someone was gone and couldn't take their turn.

Tava's Profile. Tava was belligerent at times but was usually cooperative. She was outspoken and said that she didn't understand science. However, she turned in most assignments, was quite interested in the animals, and participated actively in the class. She was in the ninth grade. She moved away during the study, after finishing the group project.

Hanna's Profile. Hanna, a 10th-grade student, said the class was too hard for her but that she liked it. She didn't always have assignments done.

She requested a front-row seat in place of the seat she drew, saying that she paid attention better when she was at the front. The teacher allowed her to move temporarily to an unused seat at the front table at the side of the room a few days later when she said she could not see the chalkboard. The new seat was very near the board where no one normally sat. She was very helpful and on her own initiative often took roll, filling out the attendance slips and putting them outside the door for the teacher. She helped care for the birds and the other plants and animals when one of the student aides was absent, ran errands for the teacher, helped hand out papers and equipment for experiments, and otherwise expedited classroom activities. She often reminded the teacher when it was time for the aides to do their work. She said she couldn't do the work in biology, that it was too hard, but she acted as if she enjoyed the class much of the time. She talked of dropping the class at the semester, but did not. Typical comments include: "Can I ask where we are?", "I don't have this," "I didn't get it down," and "Are you having fun giving us all this work". She says in the computer room, "I'm stupid", although the teacher assures her that she is not at all stupid.

Patrice's Profile. Patrice is a 10th-grade student who missed school often. She sometimes didn't turn in assignments. She is very bright and often answered questions that no one else could, though usually they were general information and not specifically related to biology. She did not appear to study and indicated that she did not like biology nor science in general. She often did not seem to be paying attention during class. She exhibited a number of mannerisms that led the teacher to think she was bored. She seemed to particularly enjoy the computer work, although she came in after class one day and requested a change of group. When that was denied, she seemed to work well with her group, though she probably dominated it, perhaps doing more than her share of the work. This emphasized her interest in the projects since she sometimes didn't do regular classroom assignments at all. She also was actively involved in her individual project.

Morgan's Profile. Morgan was a bright, highly motivated, serious ninth-grade student. She did not volunteer as much as she might have and tended to be quiet during class, possibly due to the influence of the tenth-grade students. Perhaps she didn't want to appear to know too much, which they would probably have derided. She loved working with computers and helped others a great deal during both the individual projects and the group projects. She spent almost the entire class period helping others on one occasion when the teacher was ill (though present for this last hour class). She did not know that the teacher was ill, but just took it upon herself to help those that needed help. She was very disgusted after one day at the computer when she felt that she accomplished very little. She wanted to come in and work the next morning before school because she always liked to feel that she was a little ahead on her assignments. She didn't want to be behind, even though with justification. She particularly liked the salamander in the biology room and thought it cute. She said working with computers was fun and she produced a very long individual project.

Meri's Profile. Meri, a ninth-grade student, did not like biology. She thought it hard. She was very quiet during class and seldom gave answers, even when called on. She was well-liked and very friendly. She sometimes talked a little during labs or when working on projects, but she didn't seem to feel secure asking or answering questions relating to the information covered. Biology seemed difficult for her though she completed the assignments and was in general a good average student. She showed more active participation and animation during the group computer projects than at any other time in the biology class.

Sheri's Profile. Sheri was in the ninth grade. She is very quiet and reserved though she did rather well on most tests. When she gave answers they were extremely difficult to hear because of her soft voice. She appeared rather shy, but got along well in groups. She seemed to be mainly shy of answering when the whole class was listening.

Project Complexity

The students' computer projects were rated by the researcher. A rating method was devised using the number of screens as an estimate of the length of the project, the approximate difficulty of the subject matter, whether the project was linear or branched in nature, and the appearance of the screens. The minimum number of screens required for the project was seven. The project was given one point if it was seven or eight screens long, two points if it was nine or ten screens long, and three points if it was more than ten screens long. The project length ranged from seven to twenty screens in length, with the average length being 10.5 screens. One project in each section was considerably longer than the others. These projects were nineteen and twenty screens long.

The difficulty of the topic was given a rating of one, two, or three, with three being the most difficult. The project was given one point for a linear plan (like the sequential pages of a book), and two points for a more complex branched hypertext design. Decoration of the screen and careful arrangement of the buttons, pictures, and fields was added in for either one or two points, with two points given for those that were more complex. This made a possible score of ten as an estimate of the project's overall complexity. This information for each student is summarized in Table 1.

Cultural Themes

As schools are organized today, at least for a large segment of the student population, making an acceptable grade is a recurrent theme. Their success in doing so gives them both intrinsic and extrinsic rewards including increased status with their peers, their parents, and the community. If they don't succeed they may reject grades along with other school values, or substitute of other values in place of these.

During analysis of the data 70 categories of cultural meaning, or domains (Spradley, 1980) were recognized. Of these, 31 related to grades in one way or another. Figure 1 illustrates the relationships proposed. There appears to be a critical reciprocal relationship between the kind of student one is and the grade one makes. The kind of student they are affects their grade and their grade affects the kind of student they are in that particular situation and at that specific time. It was evident that many, perhaps most, of the students were more concerned with their grade than with the content of the lessons.

The keeping of records is a typical human behavior. Most of these records in a school relate to grades. The nine different types of grade reports making up one domain certainly indicate that grades are important to someone. All of these grade reports but one were written. Several of these written reports are kept at least during the school year and sometimes longer. Three, grade books, grade cards, and green sheets, are kept indefinitely, with the green sheets stored in the vault to form a permanent record. Along with cumulative folders for each student, all three are kept in the vault once the year ends. It is common to make several copies of important information, and to keep it in a safe place. By inference, grade records are important papers, or at least they are treated that way by school authorities. It is evident that students concern for grades, an important theme revealed by domain analysis, may be justified considering the number of places they are recorded.

Students at times may feel they are trapped between two conflicting authorities. On one hand there is the authority of the teacher, who is in a way their opponent, making the achievement of good grades more difficult, at least in their view. On the other hand is the authority of their parents, most of whom expect, perhaps even demand, that they make good grades. Students may feel considerable tension, especially when their peers have yet other expectations of them, as they may have themselves. Spending the time and effort necessary to make good grades in a difficult course may make it almost impossible to go out with the "guys" or on dates, practice for and play a sport, and hold down a job. Many students try to do just this, especially in a small school. The status that athletic prowess, a nice car or pickup, and a full social calendar provide is very attractive to a teenager.

Student Behavior in the Biology Room

Students entering the biology room during the traditional teaching method followed one of two routines. They either went immediately and sat in their assigned seats, meanwhile visiting with each other and the teacher, or they went immediately to check on one or more of the animals or look at the displays, usually the aide list, lunch menu, or calendar. They normally took their seats just before the bell rang either way. If they didn't they were reminded by the teacher. More time was spent on "housekeeping" tasks in the biology room than in the computer room. The class didn't really begin until the teacher had taken roll, collected papers, and answered questions relating to homework, scheduling, and other matters.

The students had a more passive role from the time they entered the biology room. Much of the time they were observers. This quickly became apparent as the researcher transcribed the video tapes. In tapes of the biology room during the traditional teaching sections of the study, there were at times many pages of transcribed material that was almost entirely the teacher speaking. Even during class discussions the teacher did most of the talking. The students listened, asked occasional questions, and took notes. Even when they were involved in experimenting or other activities, much of the time they were essentially following her instructions, asking her questions about what to do and how to do it.

Student Behavior in the Computer Room

In the computer room students came in and asked to go immediately to the computer, or at times to the videodisc player. They knew that the teacher had a schedule to insure that they all would get equal time, but if they went quickly they might get to work at the computer the first half of the hour rather than the last. They also got their choice of the machines within the type they were using. If they came in one or two at a time the teacher allowed them to do this. If a whole group came in at once, she had them be seated at the desks and then sent them to the computer one at a time as she consulted her list.

In the computer room they often began work as soon as they entered. They went directly to a computer and started in. The teacher took roll and carried out other tasks as they worked. However, especially at first, they spent quite a lot time waiting on the teacher for help.

Since most of the students had little computer experience, and none of them had experience with the software used, there were many questions and students needed lots of help. They soon began to help each other and did not hesitate to ask for help from students that they normally did not socialize with. This was consistent with the "instant community" reported by Riskin (1990, p. 11) as a characteristic of students working on multimedia projects.

When students were working at the computer they seemed to have a graduated method of attacking problems. They tried repeatedly to fix the problem themselves (as evidenced by repeated beeps or error messages), then they asked one or more of their classmates, and finally they asked the teacher if the problem was not resolved. They acted as if they hated to relinquish control of the computer, or of their project, by asking the teacher for help.

In the first days in the computer room the teacher was so busy helping them and so many of them needed help that they were forced to fall back on themselves and their classmates if they didn't want a long wait. Later on however, on some occasions the teacher was seated at the desk or table working and they did not ask her except as a last resort. Some students, especially those that seemed to feel the most insecure with computer use called the teacher over immediately and repeatedly and resorted to the help of classmates only when the teacher was not available. It almost seemed a matter of pride to the others not to have to ask for very much help from the teacher. Those that really felt that they "didn't have a clue" didn't show this reluctance.

There was some evidence of this reluctance to ask the teacher even in the biology room, especially during laboratory activities. They would confer with other students or groups of students about what to do and avoid asking the teacher if they could. This may relate to grades and seeing the teacher as an authority figure that will judge them lacking in preparation or understanding if they need to ask questions.

However, students weren't expected to know about the computers or software and problems with them did not reflect a lack of study nor were they graded on anything except the final product. Their reliance upon themselves and their peers was much more prevalent in the computer room, and resulted in much more independent students. Of course they asked the teacher many questions in both situations, but there was a definite reluctance, at least on the part of some students, to do so unless it was necessary. The theme that emerged from these observations could be stated in the following way. In this student culture it was best to work independently, but getting help from peers was almost as good.

Students received feedback from the teacher throughout the project. Unlike the test-day anxiety and attendant comments and last-minute cramming and agonizing, the computer projects made it not only natural but vital that the teacher give the student continuing advice and help. Rather than "gambling" on a good test grade (as some students see it), and not knowing anything about their grade until after it is finished, they have the opportunity to get an idea of their success or failure as they go along and can adjust their expenditure of effort. One evidence for this was that students almost always called the teacher over to examine their drawings. This seemed to be the area in which most of them felt the least secure. The teacher's comments helped them decide whether to continue to work on the drawing. start over, or to save the current version and begin on something else. This continual feedback seemed to contribute to the students' general satisfaction with their computer projects as compared to their tests or to other projects such as the cell models.

To a certain extent this opportunity for feedback may be true of many projects, but it was uniquely so with these projects due to the scarcity of the equipment. None of the students had a computer with the necessary software, much less a videodisc player, at home and those at school were used by other classes, not only during the day but also before and after school. Therefore their work had to be completed at school, with much of it done in class due to the demand for the computers before and after school as well as the fact that many of the students were involved in extra-curricular activities both before and after school. Nonetheless many of them did find time to work on the projects before and after school. In fact, one student negotiated with the teacher to complete all of her individual project outside of class so that she could use the software that she preferred.

Grouping has been typical of laboratory work in the sciences in part due to limitations of space and equipment. The scarcity of computers and other equipment for the production of multimedia also will often force the use of groups. The use of groups for initial projects or for students with very little computer experience, as in this study, seems to be the most desirable situation. From the teacher's point of view, the use of groups is much more efficient as well as likely to encourage cooperative learning, especially if the groups are assigned with care. However many of the students preferred the individual projects. This seemed to be in part because they liked the hands-on time at the computer even though several of them had little or no keyboarding experience prior to the study. Even when they were working on individual projects, students helped each other a great deal. Because the teacher was often busy with other students they came to rely on each other for help, especially with computer operation and software questions. These interchanges undoubtedly constituted learning for the students involved, whether the learning was specifically related to biology or not.

A recurrent theme in the biology classroom was related to test anxiety. Students asked many more questions on the day before a test than on other days. On the day of a test some students vocalized their fears while others made few comments but showed evidence of stress by their body language. For example, toward the end of one test David scooted his chair back and put his head down briefly with his forehead touching the edge of the desk. Then he sat up and looked at the test again. Later, after some students had already turned in their tests, he again rested his head on the edge of the desk looking down at the floor. The teacher said “You’ve got about six or seven minutes to finish up your test if you’re still on it.” Some students were working on a description of their cell models and the teacher was handing back papers. David handed in his test and then went to the teacher’s desk and got the calculator she kept in the top drawer. He sat down and began to figure his grade. It wasn’t difficult to see that he was concerned about his test grade and what it might do to his cumulative grade.

In some cases, students retained their tests for an inordinate length of time, not really appearing to work on them, but as if they had forgotten something or were hoping for inspiration. Only a few students showed any degree of confidence with respect to tests. Test day appeared to be a stressful occasion for almost all of them. The following field notes were taken from the day of a test over respiration, fermentation, and enzyme action.

> Michele asks, "Is there going to be bonus?" The teacher does not answer but says, "Close your notebooks and put everything away." Anne says, "I'm gonna cry!" Several students comment and then Anne adds, "I wish I was smart." Michele asks, "Is there special ed for biology?" The teacher responds, "Well, I think all you guys need is a special study hall, not special ed." Hanna retorts, "Well, I need special ed." Leah says to the others, "Well, if you guys tried - ." The teacher says, "Did I warn you or not?" (that the class was difficult) Anne says, "You warned me last year and I got out." The teacher says, "Well, I really thought you sophomores should stay in this year." She begins handing out the tests, and has Michele help her. After they look at the test briefly, Michele says, "This is hard!" and Anne says "I think it looks awful." Several other students make inaudible comments. Morgan says "I think it looks easy."

Even though stress levels appeared lower during their work on projects there were definite time pressures and this undoubtedly caused stress in some individuals. For example, one student said on the last full day of work on the projects, "Man, we gotta get this done today!" Time pressures were made more severe by the number of computers available and the number of different students using them. Students that were absent from class needed to make up their work before or after school, as well as those students who felt they needed more time than that in class to complete their projects.

Scheduling problems can be expected in situations where there is scarce equipment and high usage and can in one respect be a measure of the success of the various uses of the equipment. Popularity does not equal effectiveness, however, and other aspects must also be considered.

When working on computer projects, successful completion requires considerable help from the teacher. For example a member of one group, after struggling to get some aspect of the software to behave the way they wanted it to said, "Mrs. T, I give up!" Most people who work with computers have at some time or other felt like this. After teacher intervention a member of the group said, "Oh, it did it! It worked!" Another group reported, "We couldn't do it. It messed up." While students should be allowed to maintain ownership of their projects, most needed help to achieve what they wanted on their projects. The teacher tried to make her intervention as unobtrusive as possible, helping them fulfill their plan but not destroying their creativity and control over the result.

Chapter V

Introduction

A detailed study of the learning situation in this biology class during students' development of technology products and during traditional study has produced insight into the use of student-produced multimedia. This chapter contains a summary of the study followed by conclusions and recommendations for further research. These were developed using ethnographic methods and a case study approach.

Summary of the Study

This study involved in-depth case studies of two sections of a biology class in a small, rural school. These class sections were described through the use of ethnographic methods with a video camera acting as "the eye of the observer." The videotapes were transcribed to produce field notes that were then examined and thoroughly analyzed in an effort to understand this complex social scene. The focus of the study was to delineate the behaviors characterizing these students during traditional learning activities and during the development of computer multimedia projects and compare the two.

Purpose

The purpose of this research was to examine a learning situation to discover as much as possible of the underlying meaning to the participants. The learning situation was a high school biology class. Two sections of the class were studied during both traditional instruction and during the development of computer projects incorporating videodisc control. Technology is becoming a very important educational tool, and its effect on students must be determined. Because of the complexity of the issue, it was felt that a qualitative study might produce more insight than a quantitative study. While a study such as this may never produce definitive, reproducible, and generalizable results, it may well be the best possible way to treat such a complex issue, at least at this time. At the very least it may help generate testable hypotheses for use in future research.

Research Participants

Biology students at a small, rural school were given the option of participation or non-participation in the study. Four members of the two class sections chose not to participate. Twenty-three class members did participate, although 4 of those were present for only part of the study.. The class work and projects for those in the study and those not in the study were identical, but those not in the study were seated in such a way that they did not show up on the videotape.

Data Collection

Field notes produced by the transcription of videotapes of the class were subjected to ethnographic analysis using techniques detailed by Spradley in Participant Observation (1980). Profiles of each student were developed as part of the case study for each section. These profiles consist of a description developed by the teacher/researcher from the field notes and from personal contact with the students.

Summary of the Findings

An overriding concern for grades was evidenced by the numerous comments related to grades, the many questions on the day before a test, the anxious comment on test days, and the number of grade reports of various kinds received by students and their parents. The test anxiety exhibited by many of the students was a major component of their concern for grades.

This concern for grades was lessened during the production of computer projects as students had continual feedback from the teacher relating to their project. If there was a problem, they could fix it. There was less anxiety, even with the considerable time pressures involved and the fears of some of them that they were "not good with computers." This theme was not found in the survey of the literature and would be a good area of investigation for future studies.

Despite the fears of some students relating to computer use, as shown by their comments, the computer projects seemed to motivate the students. They asked to go to the computer room and work on their projects even on days when they were scheduled to remain in the classroom. Many of them made comments relating to the effects they were producing on screen that indicated their approval. Comments such as "Oh, it did it! It worked!" and "Oh, cool!" indicated the motivating effect of the technology. This evidence relating to motivation supported the findings of other researchers (Bransford, et al, 1989)

Students were much more actively involved when working on the computer projects. During the traditional work in the biology classroom almost everything depended on the teacher. Most of the information came from the teacher, or was at least distilled through her viewpoint. Students passively received the information and some of them processed it, but they were not always actively involved. Even when experimenting, they were highly dependent upon the teacher's plans and arrangements.

When working on the computer projects, students were in charge, even when they needed considerable technical help from the teacher. They planned and executed the project themselves. This theme agreed with reports in the literature (National Foundation for the Improvement of Education, 1991, Farley, 1993, Pearlman, 1989) relating this effect of technology project use.

During the time spent developing the computer projects, the students were in general more independent, relying on the teacher for help only when absolutely necessary. This increased their responsibility for their own learning.

Conclusion

Students working on multimedia computer projects in high school biology showed less anxiety over grades, more active, independent learning and increased motivation. The same students when studying biology in a traditional way exhibited considerable grade and test anxiety, were passive learners, and were very dependent upon the teacher.

Computer projects give a teacher the opportunity to incorporate the novelty of multimedia and students' concern for grades into a more active role in their own learning. These projects provide an opportunity for much cross-curricular learning, where the students develop and use skills in a more natural way. They are one way to develop students who are actively involved in their own learning and provide them with a way to use what they learn in many classes to create meaningful products.

In our efforts to improve science education it is important to develop positive attitudes toward science. We need scientifically literate citizens, but science is not as highly valued as in the past and many students have negative attitudes toward it. Large amounts of information are readily available on compact disc and on-line, but students must learn what to do with it, how to limit and organize it to make sense of it. Multimedia computer projects allow educators a useful and motivating way to begin the process of restructuring education.

Recommendations For Further Study

- Study examining the importance of active involvement to learning.
- Study investigating whether long-term retention of material is affected by degree of involvement.

- Study considering whether the use of projects lessens anxiety over grades.
- Study comparing the scope and depth of learning using technology projects and the traditional method.
- Study exploring possible correlation between MBTI types and success in biology.
- Study looking for correlation between MBTI types and success with computer projects.
- Study considering the effect of lessening anxiety on learning.

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APPENDIXES

APPENDIX A

DOMAINS

Semantic Relationship: Is a Kind of

Domain 1

Cover term: Student

Included terms:

Grade-conscious (worrier)
Questioner
Articulate
Informed
Inarticulate
Responder
Passive
Note-taker
Soft-voiced
Inattentive
Insecure
Gifted
Preoccupied
Clown
Aide
Independent
Self-sufficient
Dependent
Helpers (help other students or the teacher

Domain 2

Cover term: Question

Included terms:

Challenging
Rhetorical
Related to topic of study
About classroom animals
About the teacher's research
About grading, assignments, and tests
About school activities in general

Domain 3

Cover term: Topic

Included terms:

General
Science
Biology
Lesson

Domain 4

Cover term: Answers

Included terms:

Forced
Volunteer
Very soft
Authoritative
Tentative
Elicited
Inaudible
Choice/selection
Non-responsive (answer not related to question)
Reluctant
Given by teacher

Domain 5

Cover term: Teacher response

Included terms:

Affirming
Challenging
Questioning
Leading
Repudiating (Refuting)
Informative
Negating
Non-responsive
Validating
Reinforcing

Domain 6

Cover term: Student comment

Included terms:

Complimentary
Admiring
Deprecatory
Disparaging
Non sequiturs
Humorous

Domain 7

Cover term: Student interchange

Included terms

Verification (Didn't she say...)
Purely social
Flirting

Gossip
Plans for social activities
Related to assignments
Antagonistic
Teasing
Arguments
Discussion of school activities
Quasi-social
Extra-curricular

<u>Domain 8</u>
<u>Cover term: Grade</u>
<u>Included terms</u>:
Good
Bad
Acceptable

<u>Domain 9</u>
<u>Cover Term: project</u>
<u>Included terms</u>:
Cell models
Group computer projects
Individual computer projects

<u>Domain 10</u>
<u>Cover term: Study topic</u>
<u>Included terms</u>:
Genetics
Enzyme action
Photosynthesis

<u>Domain 11</u>
<u>Cover term: Homework</u>
<u>Included Terms</u>:
Cell model project
Chapter questions
Vocabulary
Reading
Studying for tests

<u>Domain 12</u>
<u>Cover term: book</u>
<u>Included terms</u>:
Biology text
Science reference books from the classroom and library

Encyclopedias
Dictionaries

Domain 13
Cover term: Undesirable behavior
Included terms:
Popping gum
Talking out at inappropriate times
Visiting instead of working
Wasting time
Laughing and giggling excessively

Domain 14
Cover term: Group
Included terms:
Gender
Age
Friends
Socioeconomic classes
Town/rural
Athletic teams
Academically oriented
Honor roll students
Religious denomination
Work-related (work at grocery store, mini-mart, and so on)
Parents' company or occupation
Behavior ("trouble-makers" / "good kids")
Cheerleaders
Play cast

Domain 15
Cover term: Desk
Included terms:
Lab table/desks
Individual desks
Computer tables

Domain 16
Cover term: Disciplinary Action
Included terms:
Oral reprimand
Part of dictionary page to copy (or mention of)
Threaten to take a point off
Give pop quiz, save them for a few days (suggesting they may be thrown away if the behavior(most of class talking

after bell) doesn't recur -

<u>Domain 17</u>
<u>Cover term: Assignment</u>
<u>Included terms</u>:
Cross-word puzzles
Definitions
Lab questions
Make-up
Population studies
Reading
Projects
Worksheets
Essay questions

<u>Domain 18</u>
<u>Cover term: Background noise</u>
<u>Included terms</u>:
Announcements
Zebra finches
Printers
Noise from gym
Talking and laughing in gym hall
Audio from the television attached to the videodisc player when students preview segments for their projects
Squeaky chairs
Students repeatedly opening and shutting cabinet doors on Lab table desks in the Biology Room
Error sounds from the computers (beep, and so on)
Baby finches begging for food

<u>Domain 19</u>
<u>Cover term: Model</u>
<u>Included terms</u>:
Cell
Enzyme
Paper karyotypes
Mitosis
DNA
Meiosis
Protein synthesis

<u>Domain 20</u>
<u>Cover term: Chemical</u>
<u>Included terms</u>:

Iodine
Pancreatin

Domain 21
Cover term: test
Included terms:
Chapter
Topic
9-weeks
Semester
Chemical

Domain 22
Cover term: quiz
Included terms:
Pop
Announced
Non-graded
Open notes

Domain 23
Cover term: Notebook
Included terms:
Neat
Organized
Disorganized, sloppy, torn up
Incomplete
Loose sheets
Legible

Domain 24
Cover term: Grade report
Included terms:
Graded papers
Graded tests
Grade sheets in notebooks
Grade print-outs
5-week letters
Grade cards
Green sheets
Grade folders
Parent-Teacher conferences

Domain 25

Cover term: notes

Included terms:

Complete
Incomplete
Neat
Legible
Illegible
Organized
Dated

Domain 26

Cover term: Laboratory equipment used

Included terms:

Lamps
Ring stands and rings
Clamps
Graduated pipettes and bulbs
Beakers
Stirring rods

Domain 27

Cover term: Distraction/interruption

Included terms:

Bird noise
Gym noise
Playground noise
Office aides with notes for the teacher or students
Computer Science II student with questions for the teacher
Secretary, librarian with questions about software or computer room orders
Announcements over the intercom
Students leaving in the middle of the hour for appointments or illness
Loud error messages from the computers (especially Macintoshes, on which students could change the sound produced)

Domain 28

Cover term: Comment before a test

Included terms:

"Oh, man!"
"I think I'm gonna cry."
"Is there Special Ed biology?"
"I think it's easy."
"If you guys would just try!"

"I wish I was smart."
"Oh, don't do that to us!" (essay questions)
"Please don't torture us!" (essay questions)

Domain 29
Cover term: excuse
Included terms:
"It's at home."
Blame the teacher (for errors in notes, etc. Example: "You messed me up.")
"It's in my locker."
"I didn't hear you."

Domain 30
Cover term: Mistake or problem in the computer room
Included terms:
Choosing to print by accident
Clicking on videodisc button when not attached to videodisc player
Asking for help from a student on a different kind of computer
Hanging up the machine so that it must be restarted
Not having project written on paper, or on time, or with them
Stacked or hidden buttons and fields
Incorrect order of cards or pages
Hardware failure (Example: mouse not working)
Button links
Saving on hard drive by mistake and then not having the program on their disk when they must use a different machine
Having several versions of a project, only one of which is the final correct one
Difficulty selecting a topic for the project
Varied and limited hardware (especially the one videodisc player)
Students from other classes coming in (without previous notice) to use computer and laser printer for last minute changes in basketball program for the office
Having the videodisc player available in the computer room,
Non-typists
Spaces in file names
Finishing in time to get out of class promptly (Having one class just before lunch and the other the last period of the day helped alleviate this problem.)
Hall duty and after-school detention make it difficult for the teacher to supervise students that needed to work on projects before or after school
Typographical or spelling errors in the program language

Failure to get the video driver in the stack
Absenteeism
Procrastination
Time pressures
Wear and tear on videodisc books

<u>Domain 31</u>
<u>Cover term: Problem in the biology classroom</u>
<u>Included terms</u>:
Water running on cabinets or floors when plants are over-watered
Terrarium plants watered too much
Birds not given enough food or water
Cabinet around birds not cleaned up
Beakers and test tubes not washed up
Lack of time
Escaping animals (birds, lizards)
Late assignments
Absenteeism

<u>Domain 32</u>
<u>Cover Term: Problem in group work</u>
<u>Included Terms</u>:
Not wishing to work with other members of the group
Not getting along with other members of the group
Staying with the group (Some like to "group hop")
One or more members not doing their share
One or more members not bringing their share on time

<u>Domain 33</u>
<u>Cover term: Social role played by students</u>
<u>Included terms</u>:
Facilitator - expediter
Echoer or reinforcer
Organizer (Anne says, "When is our next test?)
Classifier ("What is this?)
Comic ("It sounds like a golf tournament." - referring to PGAL)
Distracter (Makes irrelevant comments: "I cry when I cut onions.")
Delayer ("Let me think.")
Chorus (Several students respond with the same answer or comment at the same time.)
Informant (Answers questions.)
Helper (Helps others find what they need.)
Assistant (Helps the teacher take role, hands out papers, runs

errands)
Shocker ("My friend has a lizard and he kisses it.")

Domain 34
Cover term: Social role played by the teacher
Included terms:
Disciplinarian
Friend
Confidant
Authority figure

Domain 35
Cover term: Student Record
Included terms:
Grade book
Grade card
Grade sheets
Grade folders
Test folders
Notebooks
Projects
Principal's notebook on disciplinary action
Attendance record in office
Permanent records in office
Standardized test results in counselor's files and permanent record

Domain 36
Cover term: Paperwork for teacher
Included terms:
Assignments to grade
Tests to grade
Makeup slips
Grade cards
Grade sheets
Grade folders

Semantic Relationship: is a way to:

Domain 1
Cover term: Teach
Included terms:
Give notes (Lecture)
Write on the chalkboard

Ask questions
Discuss
Summarize
List (in order)
Give hints (to answers of questions)
Amplify student answers
Examine the book together
Make drawings on the board
Give illustrations
Reword concepts
Relate to familiar experiences
Review games
Demonstrate
Model the desired skills or problem-solving techniques

Domain 2
Cover term: Learn
Included terms:
Listen
Write in notebook
Ask questions
Complete laboratory activities in lab manual
Complete laboratory activities suggested by the teacher
Make physical models
Keep notebooks including notes, definitions, graded papers and grade sheet
Read textbook
Discuss lab results with members of group
Memorize
Make observations (especially during lab work)
Explore (computer programs, videodiscs, books)
Experiment
Look up and organize information into a report or project
Hear and repeat information orally (as in oral review or games)

Domain 3
Cover term: Avoid ridicule
Included terms:
Speak softly
Stay home (frequent absences)
Keep quiet
Make deprecating statements

Domain 4
Cover term: Pass time

Included terms:

Pass notes
Bite fingernails
Put head down on desk
Look around
Sit quietly
Check aide list
Visit
Stand with hands in pockets
Look at birds, animals, or aquarium
Look at lunch menu
Lean against corner of desk
Stand swinging book gently back and forth
Look at bulletin board
Walk around looking at computer screens

Domain 5
Cover term: Avoid answering

Included terms:

Wait silently
Say "I don't know."
Look down
Talk very softly
Say "Let me think."

Domain 6
Cover term: Induce students to study

Included terms:

Tests
Quizzes
Grades
Grade print-outs
Grade reports to parents

Domain 7
Cover term: Get the teacher's attention

Included terms:

Raise hand
Call teacher's name
Begin talking
Ask the teacher to come over

Domain 8
Cover Term: Maintain order

Included terms:

Oral reprimand
Copying part of a page from a dictionary

Domain 9
Cover term: Show detachment, disinterest, fatigue, boredom,
Included terms:
Sit back relaxing in chair
Lay across the desk
Look at clock
Sit back and fold arms
Fail to write when others are writing down notes
Look around toward windows
Comb hair with fingers
Read a book
Look at the floor

Domain 10
Cover term: Show boredom or restlessness
Included Terms:
Rolling chair forward and back
Looking at floor
Laying head on desk
Frequently volunteer to help the teacher

Domain 11
Cover term: Get help
Included terms:
Say "I don't understand."
Ask a member of another group
Discuss the problem with members of your group
Ask the teacher to come over
Look at classmate's drawing
Go to another group
Ask someone in your group
Ask the teacher
Use a classmate's notes
A classmate shows you what is being discussed
A classmate explains (rephrases) what the teacher has said
Look in notes
Look in book

Domain 12
Cover term: Get attention
Included terms:
Tell about something gross (kissing lizard)

Act silly (fake ballet move as handing out papers)

Domain 13

Cover term: Avoid disciplinary action

Included terms:

Talk briefly and go back to work (several times)
Say "I'm sorry. I knew better than that."

Domain 14

Cover term: Concentrate (during tests)

Included terms:

Roll back and put forehead down on desk

Domain 15

Cover term: Elicit answers

Included terms:

Give part of the answer
Have students look in their notes or their books
Have students tell what they know about a related topic
Refer to previous lessons
Rephrase question as a true-false or yes or no question

Domain 16

Cover term: Get comfortable

Included terms:

Remove letter jacket
Look around (As when a new student is getting familiar with the school.)
Stretch

Domain 17

Cover term: Show that student knows little information on test

Included terms:

Push hair back repeatedly
Look up and around repeatedly
Turn in the test quickly
Turn in the test very late, after sitting for a long while

Domain 18

Cover term: Release nervous energy

Included terms:

Bounce leg up and down
Roll chair back and then forward

Domain 19

Cover term: Get comfortable

Included terms:

Stretch
Twist head as if to pop neck
Move about discreetly
Roll chair back

Domain 20
Cover term: Lower others' expectations of you

Included terms:

Announce that you don't know it, don't have it, can't get it, and so on

Domain 21
Cover term: Evaluate student learning

Included terms:

Check assignments
Check tests
Check notebooks
Maintain test folders
Check projects
Record class participation
Record grade for oral answers

Domain 22
Cover term: Feel

Included terms:

nervous
confident
insecure
frustrated
scared
bored
restless
happy
excited
sad
involved
left-out
secure

Semantic Relationship: Is a reason for

Domain 1

<u>Cover term: Hyperactive behavior</u>

<u>Included terms</u>:

Spirit Day (Basketball Homecoming)
Pep Assembly

<u>Domain 2</u>

<u>Cover term: Time pressure</u>

<u>Included terms</u>:

Procrastination
Worry

<u>Domain 3</u>

<u>Cover term: Giggling</u>

<u>Included terms</u>:

Any unusual event
Old cell models falling apart
Comments relating to lizards mating
Nothing at all (Just teen-age high spirits)
Getting cell model from the trash
Student stands and dusts off seat
Teacher dropping chalk and it breaks
Any slightly humorous remark
Student almost tipping over in chair (happens easily with rolling, swiveling chairs
Student calling teacher by another teacher's name
Teacher drawing very large picture on chalkboard when someone says they cannot see
Teacher getting insect net to capture baby bird that escaped from cage
They want to know who over-watered their plants and find out it was the teacher
Their drawings on the computer screen
Different pronunciations of words
Finding out that they must make a drawing as part of their computer projects
Almost anything

<u>Domain 4</u>

<u>Cover term: Laughing</u>

<u>Included Terms</u>:

Teacher telling birds to be quiet and they do (at least temporarily)
Teacher's drawing on chalkboard (bird)
Teacher's reference to <u>their</u> drawing ability
Sounds they made and recorded
Teacher's comments ("Jack is just dying to help you." - answer question)

Student saying "Oh, I guess we do have that." after saying teacher didn't give something to them

Watching another student feeding mealworms to the salamander (It lunges at the food and the student pulls his or her hand back quickly.)

Domain 5

Cover Term: Missing class

Included terms:

Pep assemblies
Hall duty
Holidays
Health seminars
Motivational assemblies
Illness
Dental appointments
School-sponsored activities
Going to court

Domain 6

Cover term: Confusion and disruption

Included terms:

Computer Science II student coming in to ask teacher for help
Anyone entering classroom and distracting teacher's attention
Not knowing what to do (or how to do it - as in saving documents after the bell rings when first in computer room)
Noise from the gym
Printer noise (in the Computer Room)
Spirit Day (Basketball Homecoming)
Swivel chairs tipping over or almost doing so
Baby finches begging for food

Semantic Relationship: is a stage in

Domain 1

Cover term: Class

Included terms:

Visiting, looking at plants and animals, displays
Sharpening pencils
Taking role
Filling out make-up slips
Answering/asking initial questions (relating to assignments, the work planned for the day, relating to scheduling,

holidays, events)
Introducing the day's work
Getting out notebooks and equipment
Discussion
Lab work or assignments
Closing comments
Assignment of homework
Putting notebooks and equipment away
Taking care of plants and animals
Putting on jackets, closing and gathering books
Leaving the room when the bell rings
Remaining behind to ask questions, relate problems, or visit

Domain 2
Cover term: Study of a topic
Included terms:
Introduction by teacher
Reading assignments
Vocabulary study
Demonstrations
Modeling
Experimenting
Lecturing

Domain 3
Cover term: Making a cell model
Included terms:
Study the chapter in the text on cells
Examine sample cell models from previous years
Find out the teacher's requirements for the model
Find pictures and descriptions
Read and examine the pictures and descriptions
Formulate and write down plan
Turn in plan for approval
Revise plan if necessary incorporating the teacher's suggestions
Find out how much the model will count toward your grade when it is due
Gather materials
Put model together and label it
Take model to class (while keeping it in good shape)
Look at classmate's models
Tell about failures, problems
Getting help from parents

Domain 4

Cover Term: Completing a project

Included Terms:

- Get rules
- Examine possibilities
- Choose topic
- Do research
- Plan project
- Write or make project
- Select videodisc pictures
- Make buttons, fields
- Enter information into computer
- Make drawings
- Test results
- Print copy
- Display to class

Domain: 5

Cover Term: Preparing for a test

Included Terms:

- Finding out what the test covers
- Going over notes
- Studying textbook
- Reviewing with someone
- Comparing notes with other students
- Asking teacher about test (length, type)
- Worrying

Domain: 6

Cover Term: Learning to use computers

Included Terms:

- Learning how to turn it on
- Learning how to get into the program
- Learning how to use the program
- Learning how to save and shut down
- Learning how to print
- Learning how to save on floppy disks

Domain 7

Cover Term: Completing an assignment

Included Terms:

- Getting the assignment explained
- Writing the assignment down
- Getting out paper
- Working on the assignment
- Putting name and other information on the assignment]

Turning in the assignment

Domain 8
Cover Term: Taking a test
Included Terms:
Getting the test handed out
Getting directions
Putting name on test
Answering questions
Going back over test
Reflecting on doubtful answers
Asking questions
Turning in the test
Looking up answers

Semantic Relationship: is a part of:

Domain 1
Cover term: Biology classroom
Included terms:
Bookshelves
Preserved specimen display
Glass display cases
Terrarium
Bird cage
Salamander Bowl
Marine aquarium
Teacher's demonstration table/desk
Bulletin board
Door panel posters
Cell models
Pencil sharpener
Biology storage area
Project storage area

Domain 2
Cover term: A class period
Included terms:
Coming in and looking around
Getting settled
Waiting for the teacher to begin class
Taking roll
Explanations about missing students
Getting help with homework

Turning in assignments
Opening books and notebooks
Beginning the day's activities
Listening to the teacher
Making notes
Getting out supplies and equipment
Conducting lab
Putting away supplies and equipment
Cleaning up
Getting a homework assignment
Discussing the assignment and how to do it
Working on the assignment
Caring for the plants and animals
Putting away books and notebooks
Chatting while waiting for the bell
Putting on jackets, rings and so on
Leaving when the bell rings

Domain 3
Cover term: Government entities
Included terms:
State government entities
Schools
Schools in the United States
Schools belonging to the same accrediting association
Schools in this state
Rural schools
Small schools
One-building schools

Domain 4
Cover term: This school
Included terms:
This high school
Classes under this teacher
Science classes in this school
Afternoon classes
Morning classes
Classes under this teacher this year
Biology classes in this school
1993-94 classes at this school
1993-94 biology classes at this school
1993-94 Biology I classes at this school

APPENDIX B

TAXONOMY

DOMAIN:

Student

1. active/involved
    - 1.1 articulate
        - 1.11 questioner
        - 1.12 responder
    - 1.2 clown
    - 1.3 note-taker
    - 1.4 aide
    - 1.5 informed
    - 1.6 grade-conscious

2. passive/uninvolved
    - 2.1 preoccupied
    - 2.2 soft-voiced
    - 2.3 inarticulate
    - 2.4 inattentive
    - 2.5 insecure

3. gifted
4. struggling

DOMAIN

answers

1. secure
    - 1.1 volunteer
    - 1.2 authoritative
    - 1.3 given by teacher
2. insecure
    - 2.1 forced
    - 2.2 very soft
    - 2.3 tentative
    - 2.4 elicited
    - 2.5 inaudible
    - 2.6 choice/selection

DOMAIN:

responses

1. positive
    - 1.1 affirming
    - 1.2 informative
    - 1.3 questioning
    - 1.4 leading
    - 1.5 validating
    - 1.6 reinforcing

2. negative
    2.1 challenging
    2.2 refuting/repudiating
    2.3 negating
    2.4 non-responsive

<u>DOMAIN:</u>

student comments

1. positive
    1.1 complimentary
    1.2 admiring
2. negative
    1.1 deprecatory
    1.2 disparaging
3. non sequiturs
4. humorous

<u>DOMAIN</u>

student interchanges

1. related to biology
    1.1 related to assignments
    1.2 explanations of subject matter
    1.3 help with skills (computer, lab)
    1.4 verification
        1.11 of assignments
        1.12 of their results in lab
    1.5 consultation
        1.11 concerning lab results
            ("What did you get?")
        1.12 relating to questions of assignments
            ("What did you put for ...")
2. purely social
    1.1 flirting
    1.2 gossip
    1.3 plans for social activities
3. antagonistic
4. teasing
5. arguments
6. quasi-social
    1.1 discussion of school activities

<u>DOMAIN:</u>

Background noises

1. unavoidable/appropriate

1.1 printers
1.2 announcements over the intercom
1.3 audio from videodisc or computer
1.4 zebra finches
2. avoidable/inappropriate
2.2 noise from gym
2.3 talking and laughing in gym hall

<u>DOMAIN:</u>

tests

1. scheduled by school
    1.1 nine weeks
    1.2 semester
2. scheduled by teacher
    2.1 topic
    2.2 chapter
3. chemical (used in lab work)

<u>DOMAIN:</u>

notebooks

1. satisfactory
    1.1 neat
    1.2 organized
    1.3 legible
2. unsatisfactory
    2.1 disorganized
    2.2 sloppy
    2.3 torn up
    2.4 incomplete
    2.5 loose sheets

<u>DOMAIN:</u>

grade reports

1. Maintained by the teacher
    1.1 grade book (turned in at end of year)
    1.2 computer grade print-outs
    1.3 graded tests (kept in a folder for each student)
2. maintained by the student
    2.1 graded papers (in notebook)
    2.2 grade sheets (in notebook)
3. timing determined by the school (scheduled and or maintained by the school)
    3.1 5-week letters (copies kept in office)
    3.2 grade cards (final card turned in to office)
    3.3 green sheets (permanent record)

3.4 grade folders (in office)
3.5 parent-teacher conferences

DOMAIN:
distractions/interruptions
1. teacher-related
    1.1 Computer Science student with questions for the teacher
    1.2 librarian or secretary with computer-related questions
    1.3 office aides with notes for the teacher
2. student-related
    2.1 office aides with notes for the students
    2.2 announcements over the intercom
    2.3 students leaving in the middle of the hour for illness or appointments
3. background noise
    3.1 birds
    3.2 gym noise
    3.3 playground noise

DOMAIN:
computer room problems
1. hardware related
    1.1 asking for help from a student on a different kind of computer
    1.2 mouse not working
    1.3 saving on hard drive by mistake and then not having their program on their disk to load when using another machine
    1.4 only one videodisc player
    1.5 not enough computers
    1.6 too many kinds and models of computers
    1.7 students from other classes coming in (without previous notice) to use a computer and the laser printer to make last-minute changes in a basketball program -only 1 laser printer in the school
    1.8 Having the video disc player available in the computer room (another teacher uses it in the chemistry room and this teacher uses it in the biology room at times and moving it about is very time-consuming)
2. software related
    2.1 choosing "print" by accident
    2.2 hanging up the machine by clicking on a videodisk button when the videodisk player is not attached to the computer

2.3 "hanging" the machine
2.4 button links
2.5 stacked (hidden) buttons and fields
2.6 order of cards or pages
2.7 having several versions of a project, only one of which is the final correct one and getting them confused
2.8 having spaces in file names

3. student related
    3.1 lack of preparedness
        3.11 not having project written on time
        3.12 not having written project with them
    3.2 difficulty selecting a topic
    3.3 lack of keyboarding skills
4. time constraints
    4.1 getting everything saved and put away in time to get out of class promptly (having a one class right before lunch and the other the last hour of the day helped make this less of a problem)
    4.2 hall duty and after-school detention made it difficult for the teacher to supervise students that needed to work on projects before or after school

<u>DOMAIN:</u>

problems in the classroom

1. messes
    1.1 water running on the cabinets or the floor when plants are over-watered
    1.2 cabinet around birds not cleaned up
    1.3 beakers and test tubes not washed up (usually due to lack of time)
2. carelessness
    2.1 terrarium plants standing in water
    2.2 birds not given enough food or water
    2.3 escaping animals (birds, lizards)

APPENDIX C

COMPONENTIAL ANALYSIS

COMPONENTIAL ANALYSIS

Domain	Ways to teach	Mainly auditory	Mainly visual
	Dimensions of contrast:		
	Included terms:		
Present:	lecture	+	-
	write on chalkboard	-	+
	demonstrate	-	+
	model	-	+
	amplify	+	-
	hint	+	-
Organize:	summarize	+	-
	list in order		
Explain/Illustrate	examine book	-	+
	make drawings	-	+
	illustrate	-	+
	reword	+	-
Reinforce	relate to experience	+	-
	use review games	+	-

Domain	Kind of student	Verbal	Inform. Giver	Grade Conscious
	Dimensions of contrast			
Involved	articulate	+	+	+
	questioner	+	-	+
	responder	+	+	+
	clown	-	-	-
	note-taker			+
	aide	+	-	
	informed	U	+	+
Passive	preoccupied	-	-	S
	soft-voiced	-	N	
	inarticulate	-	S	S
	inattentive	-	-	N
	insecure	S		+
	struggling	S	N	U
-	gifted	S	U	S

+ ~ Yes, U ~ Usually, S ~ Sometimes, N ~ Not often, - ~ No

APPENDIX D

TABLE 1

TABLE 1

PROJECT COMPLEXITY

Student (Morning)	Group Project	Individual Project	Student (Afternoon)	Group Project	Individual Project
Kip	7	8	Anne	6	6
Brent	10	6	Michele	5	6
Lee	10	10	Leah	6	8
Marty	9	5	Hanna	5	5
Fred	7	7	Ken	7	8
David	7	8	Bill	4	6
Carl*	*	7	Patrice	7	9
Travis	4	6	Morgan	9	10
Susie	9	8	Meri	9	5
Deena	10	8	Sheri	9	5
			Tava*	9	*

* Present for only part of the study

APPENDIX E

FIGURE 1

FIGURE 1

DOMAINS RELATED TO GRADES

Way to teach
Way to learn
Way to elicit answers
Way to motivate student to study

↑

Grade <--> Kind of student --------> Kind of:
- Question
- Answer
- Teacher response
- Student comments
- Student interchange
- Need for disciplinary actions

Kind of tests
- Kind of notebook
- Kind of project
- Homework quality
- Notes
- Undesirable behavior

Way to:
- Get help
- Concentrate
- Get comfortable
- Pass time

Grade ↓

Kind of student ↓

Usefulness of models
Effect of distractions
Effect of background noise
Comments before test
Grade report ----> Kind of excuses
Way to avoid ridicule
Way to delay or avoid answering
Way to release nervous energy
Way to get attention

APPENDIX F

IRB FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH

Date: 04-23-93 **IRB#:** ED-93-075

Proposal Title: A QUALITATIVE STUDY OF THE USE OF TECHNOLOGY AS A RESTRUCTURING AGENT IN A BIOLOGY CLASS IN A RURAL SCHOOL

Principal Investigator(s): Bruce Petty, Carolyn Hildinger

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

APPROVAL STATUS SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL. ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

MODIFICATIONS RECEIVED AND APPROVED

Signature: Maria L. Tilley **Date: April 23, 1993**
Chair of Institutional Review Board

VITA

Carolyn Elson Hildinger

Candidate for the Degree of
Doctor of Education

Thesis: A QUALITATIVE STUDY: STUDENT PRODUCTION OF MULTIMEDIA PROJECTS IN HIGH SCHOOL BIOLOGY - USING TECHNOLOGY IN A SMALL, RURAL SCHOOL

Major Field: Curriculum and Instruction Education

Biographical:

Personal Data: Born in Enid, Oklahoma, August 13, 1943, the daughter of Kenneth C. and Dorothy E. Elson. Married to Donald L. Hildinger. Mother of D. Barry Hildinger, and Brian L. Hildinger.

Education: Graduated from Nash High School, Nash, Oklahoma in May 1961; received Bachelor of Science in Natural Science Education from Northwestern State University in 1968; Master of Education from Northwestern State University in 1973; completed requirements for the Doctor of Education Degree at Oklahoma State University in December 1996.

Professional Experience: Classroom Science Teacher - Carmen-Dacoma High School 1968-1970; Classroom Science, Mathematics, and Computer Science Teacher - Medford High School 1970 - 1996.

Professional and Academic Memberships: The Honor Society of Phi Kappa Phi, National Science Teachers Association, International Society for Technology in Education