Teachers as Innovators: A Case Study of Implementing the Interactive Videodisc in a Middle School Science Program

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This study examined the effects of introducing the interactive videodisc (IVD) to two middle school science teachers and their respective classrooms. The teachers were trained by a colleague and their classrooms were observed before, during, and after the introduction of the IVD. The two experienced teachers who were novices with the IVD approached the implementation differently, underestimated the time required to introduce the innovation, and observed changes in their classrooms during the use of the IVD. Neither of them anticipated the level of independence the students developed as they worked in groups with the IVD activities.

The purpose of this study was twofold. First, to provide an extensive and detailed description of two middle school science teachers implementing Interactive Videodisc (IVD) in their sixth grade classes for the first time. Second, to interpret the data in terms of the role played by IVD as a vehicle for educational change.

Most research about IVD as a learning tool has been focused on students. Leonard’s (1995) review of the literature indicates the following benefits: (a) more extensive use of laboratory facilities and materials, (b) more efficient use of instructional time, (c) individualization of student work, (d) rapid evaluation of student response and feedback, (e) interactivity of simulations and games, enriching the educational experience, (f) access to concrete representations of abstract concepts, and (g) user interaction with phenomena normally not accessible in regular classrooms. The work of the Cognition and Technology Group at Vanderbilt (CTGV) strongly supports the use of IVD as a tool to help students develop both the confidence skills and the knowledge necessary to solve problems and to become independent thinkers and learners (Bransford, Sherwood, & Hasselbring, 1991; CTGV, 1989; Sherwood, 1984, 1988; Sherwood, Kinzer, Bransford, & Franks, 1987).

Biolo and Skrube (1980) indicate that IVD supports traditional approaches to instruction as well as encouraging alternative methods. They also report that students devote more time to tasks, maintain interest in the subject and improve self-esteem and self-efficacy while using IVD.

Ahogg (1991) proposed the use of an accepted instructional model (Figure 1) as a paradigm for the examination of variables related to the use of new technologies in the science classroom. Studies by Ebert-Zawasey (1990), Freitag (1991), Chickran (1993) and Chagas (1993) examined the instructional interaction patterns represented by this model when IVD was used in science classrooms. Freitag (1991) reported that middle school students made significant shifts in conceptual development and work-study habits while developing student-authored interactive processes. Chickran (1993) found similar shifts in student behavior with high school students who authored interactive lessons. Students, in a study by Chagas (1994), were observed to shift their focus of control and classroom interaction from teacher to the IVD and fellow students. In all these studies there was a clear shift from the traditional teacher-student interactions to the type of interaction shown in Figure 1.
Teachers as Innovators: A Case Study

Teachers are the keynotes for the success of any instructional technology, but they are commonly reluctant to change the way they teach. Because of this, computer-based technologies, IVD included, have been particularly difficult to implement in schools (CERI, 1986; Ginsburg & Zeilman, 1988; Martínez & McD, 1988; OTA, 1988; Simons, 1991). In general, teachers consider themselves poorly prepared in computer use. They indicate both dissatisfaction with undergraduate computer education programs and lack of school support (Eisid, 1991). Numerous research studies depict a variety of teacher attitudes toward computers and classroom computer use. These studies also identify teachers' perceptions and beliefs regarding new computer-based technologies. It is assumed that such attitudes and perceptions influence teacher decisions on whether to use and how to use computers (Atwater, Sinagours, Mcginnis, Hasfield, McGraw, & Issett, 1992; Dwyer, Ricks, & Sarditch, 1990, 1991; Troutman, 1991; Esoch, Riggs, and Ellis, 1991; Dorell, 1990).

However, teachers, either individually or working in groups, are developing programs involving these technologies. Little information is available about their motivations, beliefs, ideas, and the solutions they are generating from their experience. The study reported in this paper focused on the process of implementing IVD in a middle school by two science teachers (Chagas, 1993). Such a process occurred and was studied under the normal school day-to-day conditions. No ideal situations were created, and no experimental design was pre-established.

METHODS

The study was framed in a qualitative case study methodology with the following major characteristics (Merriam, 1991):

- it was partialistic because it was focused on a particular situation or phenomenon: two science teachers implementing IVD for the first time;
- it was descriptive because the research results were organized in a complete and literal description of the process under study;
- it was heuristic, or interpretive, because it brought new explanations, generated new hypotheses and meanings;
- it was inductive because its purpose was to discover new relationships and concepts or to build theoretical categories rather than to test predetermined hypotheses;
- it was naturalistic because the researcher focused on natural behaviors and situations. No pre-established, controlled experimental settings or treatments were created;
- it was primarily concerned with processes rather than outcomes or products;
- it involved fieldwork because the researcher was present in the setting where the process under study was naturally occurring; and
- the researcher was the primary instrument for data collection and analysis.

Data collection procedures involved semi-structured interviews, participant observation, document analysis, and two questionnaires investigating both teachers and students background knowledge about computers and computer-based technologies. The formal interviews followed the semi-structured dialogue model, as described by Spradley (1979), and consisted of a set of opinion/attitude, knowledge, feelings, and experiences/behavior questions. They were tape recorded and verbatim transcriptions were made for analysis. Notes were taken of the informal conversations that place throughout the study. Observations were conducted either during the classes or at IVD stations. They were mainly centered on the teachers' practices, the interactions between students (both teachers and students) and the subjects' approaches to IVD. Preliminary notes were taken during each session. These notes constituted the raw data for the full notes which were developed as a narrative of each class. Document analysis provided complementary information about the community, the school, and the science curriculum. Several procedures were performed in order to enhance the study's reliability and validity. The selection of these techniques was primarily based on Merriam's review (Merriam, 1991).

SUBJECTS

The study focused on two middle school science teachers Andrew and Peter who decided to implement IVD in their classes. They collaborated with a colleague John, also a science teacher in the school, who trained them in the technology. This expert teacher had extensive experience using IVD in the classroom.

Peter was an experienced teacher who had been teaching middle school science in the Laketown school system for 22 years. He used the computer for his own personal work, mainly word processing. Sometimes, students analyzed data from lab assignments using spreadsheets. At the beginning of the study, Peter had no experience with IVD or similar technol-
Lake School’s particular characteristics partially explained two contradictory facts observed during the study. First, Lake School’s ethos in valuing innovation and supporting students’ use of computer-based technologies explained the teachers’ motivations to spontaneously engage in the introduction of this innovation despite the energy and effort that such a process involves. Second, the school’s lack of a coherent basis on which to ground the use of computer-based technologies in science education partially explained the decrease of enthusiasm toward the innovation showed by the two teachers throughout the semester. Consequently, the innovation had limited use in their classes.

At the beginning of the study, the teachers’ motivations to try IVD were not clear. Peter was an established teacher who had mastered the methodology that he had developed throughout his teaching experience of twenty years. Several times he admitted his tendency to disregard audio-visuals as a support for his classes. Although he recognized the increasing impact that computers had on society and in education as a useful tool to improve performance, he had raised feelings about the role played by these machines in education. He was particularly critical of the playful side of the computer, which encourages students to approach it more as a toy than as a tool. Although an experienced teacher in the school, Andrew was teaching both science and mathematics for the first time. He referred to the additional time he needed in order to study the content and to handle strategies with which he was not comfortable.

Why did Peter engage in using IVD despite his successful teaching methodology and his general dislike for modern instructional technologies? Why did Andrew engage in using IVD despite some of his difficulties teaching science? These were questions that became more and more pertinent throughout the study and led to the analysis of the Lake School ethos. The results of this analysis showed that the School valued innovation and the use of computer-based technologies by both teachers and students. Computers were the rule and not the exception. They were part of the day-to-day life of the school. The majority of students had computers at home and had several years experience in their use. Such familiarity with the computer was observed by the teachers who were struggling to develop their own competency in computer use.

Olson (1984) describes the expressive teaching acts that “convey messages about how the teacher wishes to be seen by his or her students” (p. 30). Generalizing this notion to the wider context of the school, the motivations of the two teachers in the study can be explained in the light of the school’s ethos. We see then that, through this project, both teachers were able to convey the positive image of the innovative and computer-user teacher which was valued by the members of the school’s community.
Despite his experience as a science teacher, Peter had the least preparation concerning the instructional use of computer-based technologies. Several times he compared himself to both John and Andrew in order to emphasize his lack of expertise. The project would enable him not only to establish an image among the science teachers as an innovative and computer-based teacher but also to learn the technology within the school day schedule. Personally, he was curious in knowing how IVD worked in the classroom in order to develop an opinion about its educational worth. His position was clear. Though the project aimed to find experience-based arguments for either his acceptance or rejection of IVD.

Andrew was experienced using computer-based technologies although he had never used IVD and he was teaching science for the first time. This project was the opportunity for him to use his particular computer skills in order to reinforce his image among the science teachers. Moreover, it was an opportunity for him to personalize his teaching which he was mostly based on Peter's teaching methods.

In summary, three context levels were identified that may have influenced both teachers' motivations. The first level involved the teachers' personal expectations concerning the impact of the technology on their practices. The second level involved the teachers' perceptions of their own image among science faculty. Finally, the third level involved the teachers' perceptions of the school's ethos.

Both teachers' enthusiasm decreased substantially during the implementation phase. They kept delaying the beginning of the training period as well as the use of the technology in the classroom. Consequently, the actual classroom use of IVD was reduced to a period of one week in the middle of the Spring semester for the following reasons:

1. When the two IVD stations became available, Peter and Andrew had to deal with the following issues that required both time and decision-making: To learn how IVD works, to decide which IVD tools to use, to select the most adequate program according to students' age and awareness of computer-based technologies, to decide the best way to use the program with the class in order to integrate IVD, and to organize the classroom so that each IVD station could be accessed by all the students. All these issues required more attention than the teachers initially predicted. Their perception of this extra time investment made the initial plan less attractive.

2. Despite their different experiences with computers, both teachers were IVD novices. At the beginning of the study, Peter admitted not having any previous idea about the value of IVD as an instructional tool. Andrew had a limited repertoire concerning the use of IVD in science classes. Therefore, these teachers did not have a theoretical basis for IVD that they could use as counterpoint for their increasing questioning of the project's worth.

3. There was the uncertainty that the introduction of any innovation brings to the person who is doing it. Literature about the processes of innovation and change considers this aspect a relevant reason for the participants' resistance in adopting an innovation (Rogers, 1983; Dreyer, Ringstaff, & Sandholtz, 1990; Fullan, 1994).

4. Peter and Andrew had increasing difficulty in finding the time to dedicate to the IVD project because they were engaged in several on-going and special activities which were deemed as obligations. Although students at Lake School were expected to develop basic computer skills enabling them to prepare for high school, the use of computer-based technologies as a tool for learning science was considered less important.

The understanding of the forces of constancy and change that characterize how innovation occurs in schools (Cuban, 1986) involves the understanding of the context within which teachers work. In this case, the influence of Lake School's culture on the process of introducing IVD was obvious. The innovative and computer-experienced status of the school allowed both teachers to engage in innovative practices. On the contrary, the school's ethos not valuing the use of computers in the teaching-learning process of science obstructed implementation of the innovation.

Teachers spontaneously engaged in an innovative project with the purpose of enriching their common practices.

Results showed that both teachers implemented the IVD for the purpose of enlarging their repertoire of teaching strategies. IVD was approached as an additional source of interesting activities with the power to engage students in learning. Both teachers were basically concerned with recognizing familiar aspects in the program that could be used as anchors for their usual practices. During the study, they never addressed the issue of change inherent to the introduction of the innovation. As a matter of fact, their enthusiasm diminished when they realized that the introduction of IVD would require more classroom attention than those they had predicted.

IVD's qualities include (a) promoting new interaction patterns between students, teacher and IVD; (b) encouraging students' confidence building demonstrated by their initiative in using IVD outside the regular class schedule; and (c) providing learning environments where problem solving and cooperative learning skills were promoted, were vaguely perceived by both teachers. Despite ample evidence that these qualities were at work in their classrooms, they did not integrate such qualities in their teaching repertoire.
Working with IVD developed new interactions between teacher and students.

Teacher to student, student to teacher, and two-way student to student interactions, changed both qualitatively and quantitatively when IVD was introduced in the classroom. Student to teacher interactions increased while teacher to student interactions decreased. Interactions between students increased substantially. When working with IVD, students engaged in new complex interactions in order to clarify colleagues' questions, make uncertainties clear and understandable to others, test hypotheses together, discuss results, and make predictions. Teachers acted differently within this context. They left IVD working groups alone most of the time with only occasional checks on students' work. During these short visits at the IVD station, teachers attempted to understand events by asking students for explanations. Sometimes students took the initiative to explain the decision made related to the program. A spontaneous framework of interactions was not observed in the regular lab station work in which the conventional teacher to student interaction was predominant. At the IVD station students engaged in a diversity of interactions that were not observed at the other student lab stations.

There appears to be a direct relationship between the way the teacher "sets the stage" for the activity and students' engagement in the activity.

Peter considered the IVD activity as part of a wider range of activities. He did not consider a specific strategy in order for the students to work with the IVD. He gave a brief introduction in the beginning and asked the students at the end of the period if they were finished.

Andrew organized a "cooperative learning activity" (using his words) in which the students completed a hand-out at the end of the activity. There was a total score comprised of individual and group scores assigned individually to each of the students. For example, a group of three had to complete a sequence of six card 8 games—three individually, and three as a group. A 100% score corresponded to all trials correct.

Most students in Andrew's class were able to successfully complete the game while in Peter's classes a great number were not able to accomplish it.

Students took the initiative in order to have more access over IVD.

After experiencing IVD, students started coming into Peter's classroom during lunch and study periods in order to play with the device. This event surprised Peter who commented that "this never happened before." The motivation which led students to take each initiative is not clear and should be the object of further research; however, their behavior demonstrates that the new learning experience provided by IVD enabled students to get more control over the device and consequently over their learning. In fact, having access to the machine in out-of-class periods gave students more time to grasp the aspects involved in the video-disc program.

IVD widens the range of activities that teachers can use in order to reach both old and new goals.

IVD was not used as a substitute for any established strategy. It worked as a source of situations that other instructional technologies were unable to provide. The video-disc program involved a problem-solving situation in which students interpreted and selected data from different media: Text, graphics, drawings, animation, still pictures, and motion pictures. Student activity at the IVD station was different from activity observed at other stations in the classroom. In Andrew's class, some students were performing paper and pencil tasks while others were working at the IVD station. Peter designed different lab activities to run simultaneously with the IVD activity. These labs had an experimental component that students performed according to instructions written in a hand-out. At the IVD station students showed more control over their task. In spite of their teacher's recommendations on how to approach the program, they were free to use any strategy to discover the best way to find the solutions. Similar problem-solving situations were not observed in the labs stations.

In addition, students working with IVD showed more control over their learning pace. Students were allowed to ask for additional time in order to finish their task if they decided that they were still unable to solve the problem satisfactorily. In fact, most students in each group showed a sense of their own understanding. They were able to recognize that "something was not making sense" and that they needed to struggle more in order to completely understand the problem.

There was a collaborative effort within each IVD group. Students communicated doubts, findings, concerns, and insights among themselves. More able students spontaneously helped colleagues who had difficulties verbalizing their doubts. Through such processes, assumptions and ideas were confronted. Such a rich and complex collaboration was not observed at the regular lab stations.

During IVD implementation, both teachers considered it difficult to orchestrate simultaneous tasks performed at different stations. The new classroom organization was adequate considering the scarce IVD resources; however, it required teachers to design several tasks, equally interesting, and lasting approximately the same time. Moreover, teachers had to move constantly from one station to another to assist students. Andrew considered this situation particularly difficult and suggested the installation of another IVD station in his class.
Teachers used content issues almost exclusively for assessing IVD as an instructional tool.

During the periods in which both Peter and Andrew learned the basics of IVD and began planning its integration in the science program, they only addressed issues related to content. They seldom referred to the skills that IVD use could provide students. When asked to indicate IVD's advantages and disadvantages at the end of their experience, both referred to content as a relevant constraint for implementing the technology. In addition, they never suggested giving up any part of their science curriculum content in order to integrate the new IVD program material. Using Cuban's (1986) terminology such concerns regarding content is a factor for constancy, leading to the use of the innovation in a conservative framework.

Lack of time was the constraint to innovation that teachers mentioned most often.

Lack of time was frequently mentioned. All the science teachers in the school referred to it in order to justify the delay and limited use of computer-based technologies in their respective classes. The study's participants started invoking time as an obstacle for their project as soon as the demands brought by IVD integration became apparent. Requirements regarding training and planning exceeded both teachers' expectations even though the time commitment was clearly defined at the onset of the project.

It became obvious, early in the study, that both teachers as well as the expert teacher had limited time to dedicate to this project because they were involved in several school activities in addition to classroom teaching. Since these activities were generally framed in narrow deadlines, teachers had to continuously change from one subject to another in order to solve problems that needed immediate attention. Such demands led them to develop work styles characterized by being immediate and practical. It was immediate, because decision-making was done rapidly, "on the spot," in answer to problems. It was practical, because teachers were continuously doing something using a framework of knowledge built from experience. As a consequence, there was little time to meet, discuss and reflect upon the implications of IVD integration as well as to practice the IVD program and to plan classes accordingly.

DISCUSSION AND SUGGESTIONS FOR FUTURE RESEARCH

This case study was limited to the documentation of the first attempt to innovate science teaching through the introduction of IVD in the science classroom. Long-term, longitudinal studies, following holistic qualitative methodologies are needed in order to systematize information about spontaneous innovative projects involving computer-based technologies. In many ways, the results of this case study were consistent with research reports from different theoretical and methodological trends. This fact suggests that patterns of classroom participants' behavior can emerge from the comparative analysis of research results. Long-term, qualitative case studies would help understand the framework of relationships that characterize school culture.

Three levels affecting teacher decision making were found in this study—school culture, science teachers' subculture and personal. The first two levels emphasize the relevance of the school context for any innovation to have an impact on teaching and learning. Therefore, research should focus on schools which have different ethos regarding both innovation and computer-based education, and which have different approaches about the use of computer-based technologies in science learning. The purpose of such studies would be to understand how such characteristics differently affect teacher decision making as well as the success of innovative projects.

Time was a relevant parameter identified in this study. Frick (1991) describes innovative time approaches attempted in several U.S. schools. Such approaches have been developed with the purpose to expand time available for students to learn at their own pace. However, it is important to create realistic options with the purpose to expand time available for teachers to dedicate to their own projects. This study's results suggested that there is a relationship between the school working climate and the degree of teacher involvement in new experiences leading to a change in their practices. Such relationships should be investigated with more detail in future research.

After the use of IVD by the two case study teachers a shift in their classroom climate was observed. Now patterns with more focus on student-student and student-teacher interactions emerged in the classrooms in which the interactions had previously been teacher dominated. These results are consistent with data from recent research that is centered on how the classroom structure changes with the introduction of computer-based technologies. Such research is also based on cultural constructivist theoretical principles (Creeba, 1991; Mehan, 1989; Scott, Cole, & Engel, 1993).
Based on the interactions identified in this study, further research should focus on how both teacher and student roles shift while working with IVD.

Lack of information concerning the qualities of IVD as a tool for learning science was a factor which led the case study teachers to question their project. During the training phase, they expressed the need for more basic information about IVD that they could use in order to justify their efforts. Information involving a framework of variables is necessary in order to provide teachers with the knowledge on which to base their decisions concerning how to use IVD, when to use it and with whom to use it.

References


The Cognition and Technology Group at Vanderbilt (1992). Anchored instruc-

...tution and its relationship to situated cognition. Educational Researcher, 19(6), 1-10.


Government Printing Office.
Olson, J. (1988). Schoolworlds, microworlds, computers, & the culture of
the classroom. Toronto: Pergamon Press.
tural constructivist perspective. In G. Grant (Ed.), Review of research
in education (Vol. 18) (pp. 191-251). Washington, DC: AERA.
No. 84.2.2). Nashville, TN: George Peabody College for Teachers.
(ERIC Document Reproduction Service No. ED 262 753).
Sherwood, R. (1989). Optical technologies: Current status and possible di-
rections for science instruction. In J. Ellis (Ed.), 1988 ABT yearbook:
Information technology and science education (pp. 35-58). Columbus,
OH: SMEAC Information Reference Center.
Some benefits of creating macro-contexts for science instruction: Initial
Glynn, R.H. Yeany, & B.K. Britton (Eds.), The psychology of learning
science. (pp. 241-257). Hilldale, NJ: Lawrence Erlbaum Associates,
Publishers.
hart and Winston.
Troutman, A. (1991, February). Attitudes toward personal use of comput-
ers and school use of computers. Paper presented at the annual meet-
ing of the Eastern Educational Research Association, Boston, MA.

Note

1. Fictional names were given to the subjects and the school.