

**Designing Effective Multimedia Programs to Enhance Teacher
Problem Solving Skills and Cognitive Flexibility**

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Abstract: Multimedia case studies are becoming more common in teacher education. This paper discusses the design of multimedia case study materials from cognitive flexibility theory and reports the results of the use of these materials in graduate education courses in two national field test sites. Findings and discussion are based on analysis of on-line user records, embedded computer-generated reports, and qualitative interviews from the two sites. Results include changes in perspectives, responses to design features of hypermedia-based case studies, and suggestions for implementation.

Introduction

Teacher education involves the development of knowledge, skills, and applications. The weakest link in preservice teacher education is the translation of knowledge and skills taught in methods classes to performance skills in the classroom (Rule & Salzberg 1988). Multimedia simulations afford an intermediary step for applying knowledge and skills through classroom-anchored scenarios. In simulations, learners must seek information, modify preexisting concepts, and utilize knowledge and skills in new ways.

Interactive videodisc technology has several characteristics which make it a powerful training tool. The videodisc has a large storage capacity for video, audio, text and graphics which can be linked to a computer program for instruction. When the materials stored on the videodisc are controlled through a computer program, these instructional materials can be accessed in an immediate and nonlinear fashion. In this way, the instructional process is dynamic, delivered efficiently, and individualized by learner input through the computer (Fitzgerald 1995).

Theoretical Framework

The constructivist view of learning asserts that knowledge is internal to the individual and constructed through interactions with the environment and through negotiations of meaning with others. Learning occurs when new materials are integrated within an individual's preexisting knowledge structure. Knowledge comes from experiencing problems in diverse contexts, sharing multiple perspectives, scaffolding, and cognitive apprenticeships (Nelson 1994). Hypermedia-based instruction must go beyond simply representing associations (knowledge representation); it must stimulate cognitive processing to construct meaning from those associations (knowledge construction). Key tenets in constructivism include personal experience, active exploration, multiple

perspectives, and cooperative learning activities for communication and collaboration. A major problem in designing hypermedia instructional systems is to avoid merely presenting information, but rather, to foster learning through the interface design and interactive problem solving activities.

The design for this interactive videodisc program is based on *Cognitive Flexibility Theory*, one of the constructivist theories which emphasizes the real-world complexity and ill-structuredness of knowledge. "Cognitive flexibility" involves the *selective* use of knowledge to *adaptively fit* the needs of understanding and decision making in a particular situation; the potential adaptive *knowledge assembly* depends upon the availability of a full representation of complexity to draw upon. "Ill-structuredness" means that many concepts (interacting contextually) are pertinent to a specific case, but that their patterns of combination are inconsistent across case applications of the same nominal type (Spiro, Coulson, Feltovich, & Anderson 1988). The instructional approach utilized in this program strives to develop cognitive flexibility to enable the learner to construct knowledge based on complex and irregular situations. It focuses on the construction of knowledge structures and the use of that knowledge structure in problem solving.

A major difference in cognitive flexibility theory from traditional constructivist theory is the change in emphasis *from* developing a knowledge structure based on intact preexisting knowledge *to* flexible adaption of preexisting knowledge to fit needs of a new situation (Spiro, Feltovich, Jacobson, & Coulson 1991b). Such is the case in understanding and assisting children with emotional and behavioral disorders. While central concepts related to the child and situation must be considered, each case involves clinical and ecological differences which must be viewed, interpreted, and responded to differently from multiple perspectives. While the concepts and views of the problem may be well-structured—albeit different based on various theoretical perspectives—the use of those concepts and views in problem solving will be substantially ill-structured, leading to diverse solutions.

Instruction in ill-structured domains is different from instruction in well-structured domains where knowledge may be taught in compartmentalized units and later integrated. In ill-structured domains, instruction must focus on general principles and knowledge interconnectedness across a wide scope of cases or examples. Multiple representations are required to enable preexisting knowledge to be assembled flexibly on a case-by-case basis. Through this process, adaptive knowledge is developed and flexible knowledge structures are acquired. By drawing upon preexisting knowledge with cognitive flexibility, the learner is able to transform that knowledge and act upon a particular case (Spiro, Feltovich, Jacobson, & Coulson 1991a).

The Multimedia Program: Multiple Perspectives in Behavior Disorders

Description

The purpose of *Perspectives on Emotional and Behavioral Disorders* is to enhance problem solving skills of teachers who work with children with behavioral disorders. Each of the three cases includes an opening challenge scenario and supportive information presented via software controlling a Level III interactive videodisc. The case materials allow users to explore and practice the processes involved in serving such children by (1) observing children in a variety of situations; (2) "interviewing" their teachers and parents; (3) seeking information; (4) comparing and contrasting multiple theoretical views; (5) hearing "experts" discuss the cases; and (6) engaging in problem solving and planning activities.

Through the interactive case study approach, the learner is expected to develop a *cognitively flexible* understanding of the complex, multiple theories and approaches used in formulating intervention programs for students with emotional and behavioral disorders. The *real life* situations provide a micro-world for exploration. Each case study student represents a different severity level, e.g., mild to severe in regular classrooms and special settings. Within its *hypermedia structure*, user control is provided through the main menu and perpetually-active pull-down menus. The video and audio materials are linked to choices made via the computer program so that they may be accessed in different sequences and ways under learner control.

Once the learner enters his or her name, the *Case Explorer* screen appears on the monitor and the user starts exploring the case study materials. A variety of video, audio, and text-based activities are provided.

- The opening *Scenario* depicts a school administrator addressing two teachers regarding a youngster who is having difficulties in school and home settings.
- The administrator asks the teachers to *Get Information* by observing the student, talking with others with knowledge in the field, reviewing background information on the child, and then meeting back with questions regarding the child's needs. This video-based scenario establishes the need to go through a problem solving process to consider a range of options and to synthesize information.
- The videodisc contains a database of information regarding the students in *Student Records* and substantial support material in *Fact Sheets* and *Theoretical Perspectives*.
- Users are able to view children in multiple classroom situations through *Observation* segments.
- Special terminology is hot-linked to a *Glossary*.
- A second audio track placed on the videodisc provides dialogue about the youngsters by *Experts* in the field of behavioral disorders. Photographs of the experts appear on the computer screen to provide a visual image of the speaker while the audio sound track is played.
- The program includes note-taking tools in *My Notes* for users to record observations, thoughts, and questions. These can be accessed by the user, either on screen in *Read My Notes* or through a printed hard copy; these notes provide an opportunity to document the user's progress through the program.
- Users write their own questions in *Prepare to Meet* to be discussed in a simulated case conference *Attend Meeting*.
- Users check the accuracy of the information gained through the *Quiz* option.
- When finished exploring the case materials, the user enters answers to the challenge questions in *Make My Report*.
- The notes, the amount of time the program is used, scores on the quiz, questions prepared for the meeting, report answers, and the user path through the computer program are all recorded on a floppy disk. These files can be used by the instructor to monitor each user's progress and to make instructional adjustments.

Implementation

The program was field tested in graduate courses in behavioral disorders at two locations. Data collected for analysis included on-line user records, on-line student reports, instructional material artifacts, and semi-structured qualitative interviews with users.

Site I

In a Mid-Atlantic state, the program was integrated into an on-campus course with nine graduate students. To obtain course credit, all students were required to complete the case studies on all three children featured in the program. Users worked independently in the computer lab on the case studies. No direct instructor supervision was provided but computer lab assistants and the instructor were available if help was needed. Following case exploration, class discussion groups were held during class time to simulate a planning conference for each child. Students submitted their floppy disks containing usage data and computer-generated reports; the instructor provided feedback on submitted work.

Site II

In a Midwest state, the program was set up at a juvenile detention center school for eight practicing teachers enrolled in an off-campus course. The materials were provided as an independent work station activity; these users were instructed to explore the materials to prepare for class discussion of the children. Following a brief demonstration of the program and equipment, users worked on their own time at the work station during after-work hours. No instructor or troubleshooting assistance were available. Users submitted their floppy disks containing usage data and computer-generated reports to the instructor for the purpose of evaluating the materials; no grade contingencies or instructor feedback were attached to the user records.

Results

User Records

Data collection routines were included in the software which appended archival user records onto a student floppy disk. Data collected for each user included date, usage time, and on-line responses to question prompts.

Patterns of Use

Significant differences were found between the two sites in on-line usage time. In *Site I* where the program was fully integrated into the graduate course, the average time of use equalled 5.04 (standard deviation = 1.80) hours for the first case study; 4.24 (standard deviation = 1.91) hours for the second case study; and 4.06 (standard deviation = 1.23) for the third case study. In *Site II* where users were asked to explore the materials independently as time permitted, the users spent approximately 45 minutes on one case study; only one user recorded 6 hours of usage.

Perspectives Changing

The on-line reports written by users in *Site I* were analyzed using a scoring rubric. Scores from the first case study were compared to scores for the third case study in order to measure change. All reports were scored blind by two raters; inter-rater reliability equalled 72% based on 17 disagreements and 43 agreements; only one disagreement was more than one point different. All differences were resolved prior to data analysis.

A "personal perspectives" score was given based on responses to the on-line question prompts: *What is your perspective of this child's needs and how do you support this position?* On the "personal perspectives" comparison, no significant difference was found between scores for the first case and the third case. Using a paired t-test analysis, the mean difference equalled 0.2 on a five-point scale (score=2.0 pre compared to 2.2 post; $p=.55$). These moderate scores revealed that respondents select only one or two perspectives for the basis of their opinion and did not show much change in personal perspectives.

A "team synthesis" score was given based on responses to the question prompts: *Who would you like to be on the team for this child and what views do your team members share?* A significant difference was found on the "team synthesis" comparison between scores for the first case and the third case. The difference equalled 1.6 on a five-point scale (score=2.9 pre compared to 4.5 post; $p=.002$). The higher scores for a "team synthesis" revealed an awareness that multiple team members are needed to meet children's needs, that these team member's represent multiple professions, and that common agreement exists which goes beyond the beliefs of individual team members.

Qualitative Interviews

Two-and-one-half months following course completion, semi-structured interviews were completed with all students from *Site I* and six of the eight students from *Site II*. The purpose of the interviews was to evaluate the students' perceptions of the software and its use in the course. The interview included the following prompts:

- (1) Tell me something about your feelings when first using these materials; what were your initial reactions?
- (2) Did you have any problems using the materials as assigned?
- (3) How did your impressions of the materials change towards the end?
- (4) Could you reflect on what you learned from your experiences with this program?
- (5) Do you have any advice for the instructor for implementing these materials?

A phenomenological approach was used to analyze the data (Glesne & Peshkin 1992). The interviews were transcribed and read multiple times. Four of the interviews were read in group sessions by the researchers. Notes were taken during the reading of the transcripts about possible themes and idea units. The second author segmented the transcripts into idea units and these units were sorted into categories. The idea units and categories were independently applied to three interview transcripts; discrepancies were resolved and the remaining interviews were subsequently segmented and sorted by the second author. Analysis of the data produced four themes.

The Program Was a Good Way to Learn

Most participants expressed enthusiastic praise for the use of the program to learn about children with behavioral disorders. The praise ranged from the very general to the very specific. For example, one said, "I thought it was excellent. I've never seen anything like that before in any of the classes I've been in...I think it will be helpful for most students to go through it." The videos of the children were valued as opportunities to observe specific behaviors in an informed way. The voices of the experts, giving insight into the children's behavior from different theoretical perspectives, were highly regarded by all. The note-taking feature, the planning meeting, and the quiz were all singled out for praise. Participants also regarded the hypermedia aspects of the program highly. They felt that the ability to interact actively with the different media of the program was beneficial. Most of them found that they enjoyed the ability to choose their own path through the materials, the individualization, and the learner control.

Comparisons were made to learning through this program and learning through traditional forms of instruction. The program was generally viewed as more meaningful and more interesting than text. It was seen as an aid to visualization and it made the abstract theories presented in the text easier to understand through concrete examples. When comparing it to lecture, discussion, or classroom observations; it was considered superior for allowing you to "go at your own pace" and to "go over what you might have missed." Participants regarded the program as a good preparation for teaching. As one stated, "I feel like I can do better in the classroom now as a teacher. I feel like I have had hands-on experience doing an assessment. I feel like I can write up a report better. It is actually like you're in the classroom—you're right there—you are doing the observation."

Users Experience a Variety of Problems

The use of level III interactive videodisc technology was a new experience for all participants. At both sites, they experienced some problems using the software and equipment. Most frequently cited problems were loading and getting into the program, problems with using the note-taking part of the program, and problems with access and scheduling of the videodisc equipment.

Several students at *Site I* found that access to the computer labs in terms of their schedule or their travel time was problematic. The further their distance from the campus, the greater the problem. In *Site II*, participants often attributed their problems to their own lack of computer experience or knowledge. One difference between sites was the perception of the locus of the problem. If notes were lost from the user's disk in *Site I*, these participants attributed their problems to the program or the disk, while at *Site II*, participants often attributed their problems to their own lack of computer experience or knowledge as expressed by one, "At times it was terribly frustrating—again, it was just my ineptibility with the computer."

Anxiety and Frustration During Initial Program Use

Most participants said they felt stressed while beginning to use the technology. At *Site I*, they expressed fear of failure and fear of being overwhelmed by the demands on their time. All participants in *Site I* made the transition to feelings of comfort and confidence, as voiced by one, "I was indifferent and worried or anxious in the beginning that it was something over my head. But at the end I was very competent—or I felt very confident. The more experience I got the better."

At *Site II* participants initially expressed frustration at being unsuccessful at their first attempts to using the program. Here there were many more expressions of fear of using computers and frustration during computer use, as expressed by one, "I'm not a real computer literate anyhow, and the first night I went to work by myself it took me...35 minutes just to get into the program. I was real frustrated with it—terribly frustrated with it." This frustration frequently continued with further computer use; problems cited were navigating the program, note-taking, and confusions over the instructor's requirements for using the program. *Site II* participants expressed as much frustration at the end of their time using the program as at the beginning.

Users Give Advice for Solving Problems

The most common suggestions included to make the key words easier to identify by providing a list of key words and to provide additional assistance or training to those who have little computer experience. Suggestions on modifying the software included to provide case studies on older students, to make it easier to navigate the program, to speed up the program, and to provide more background on the students. Suggestions for instructor implementation included giving specific directions on operating the program and having someone available during program use to answer questions and solve problems.

Discussion

The results indicated that graduate students were positive about learning through interactive case studies. Users found the materials and interactive learning experiences worthwhile, valued the hypermedia design, and felt the materials were more meaningful than traditional forms of instruction involving textbooks, lectures, discussions, and classroom observations. A content analysis of reports written by the users indicated they did not alter their personal perspectives about meeting the needs of behaviorally disordered students, but did reveal a significant change in their understanding and synthesis of multiple perspectives and team roles.

As examination of the data concerning problems using interactive videodisc technology found differences between the two sites. At *Site I*, participants characterized their problems as minor and felt the instructor resolved difficulties quickly. These users experienced some initial anxiety when using the materials but developed confidence with further program use. At *Site II*, the participants experienced frustrations using the software and never felt a sense of competence using the program. Records indicated these users spent inadequate time on the case studies and failed to complete the on-line activities. They attributed problems to the lack of on-site technical support, confusion over requirements, and their own lack of computer skills.

Further research is needed to evaluate the impact of instructor skills to teach with new technologies, technical support, equipment availability, prior computer knowledge and experience of users, and user anxiety and persistence. Multimedia case studies have the potential to provide a bridge between knowledge acquisition and application, but their effectiveness will be severely restricted by ineffective methods of implementation and inadequate support for new users.

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