Construction and Evaluation of an Intelligent Novice Learner Microworld: Path Analyses and Learning Outcomes

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Abstract: This session showcases new multimedia materials which provide case study microworld learning environments for students preparing to work with children with behavioral disorders. These materials are being developed, researched, and nationally disseminated to teacher educators. The program used in this study *Assessment and Planning in Emotional and Behavioral Disorders,* focuses on the assessment and planning process in evaluating children's behavioral problems from a school team perspective. The presenters demonstrate the computer and videodisc components of the program, discuss its design from a cognitive science perspective, and summarize formative and summative evaluation results.

Introduction

Microworlds have been viewed as innovative learning environments which are consistent with how people learn—variables can be limited to a manageable level; structure and direction for learning can be provided; real-world problem tasks can be addressed; and learners can take control and responsibility for their own learning. Thus, a microworld learning environment supports knowledge acquisition and application from the known to the unknown (Rieber, 1992; Rieber, 1996). Debate continues about how complex the microworld environment should be to best support novice learners. Alessi (1988) recommends low fidelity in simulations for novice learners with an increase in fidelity to support transfer for more advanced learners. From a constructivist learning paradigm, however, it is recommended that complexity of the learning environment reflect the complexity expected for performance in the real world. Embedded supports and scaffolds can be provided within the microworld to assist novice learners in working within the complex environment (Honebein, Duffy, & Fishman, 1994).

From a cognitive science perspective, development of expertise is based on three important ingredients: specific knowledge, general learning strategies relevant to the specific domain area, and metacognitive skills (Bruer, 1993; Bednar, Cunningham, Duffy, & Perry, 1992). In creating a microworld problem-solving context, authentic tasks are required that enable the user to explore the environment in dynamic interaction with the context (Wilson & Cole, 1991; Young, 1993) as if he/she were really there (Honebein et al., 1994). Jacobson, Maouri, Mishra, and Kolar (1995) report that providing learner control and hypertextually-linked information is insufficient for knowledge acquisition and transfer. They recommend that modeling and scaffolding features be provided within hypermedia learning environments. Such design options enable learners to develop necessary mental models for organizing and utilizing information in problem-solving activities (Nelson & Palumbo, 1992). Internal supports facilitate flexible use of materials within a hypermedia learning environment as users gain knowledge and experience (Casey, 1996).

Theoretical Base: Cognitive Science in a Microworld Context

The content and instructional approaches within this microworld program are based on principles of cognitive science. Multiple learning opportunities are provided for users through an interactive case study approach which are closely aligned with the cognitive science perspective.

Knowledge Domain. The program includes extensive information related to special education programs, assessment procedures, placement and programming, related services, and community resources. This information provides the domain knowledge.

Contextualizing. Knowledge is applied to specific special education areas by accessing video and audio materials for observing the child and for gaining information from support personnel. The computer program provides a complete computerized database of the child's educational and treatment records. The user gains input from multiple perspectives and "looks in" on a case conference in a multidisciplinary setting. The process of contextualizing facilitates the development of general learning strategies in a specific competency area.

Metacognitive Skills. Users must evaluate and apply information as they carry out assessment and planning activities. Examples are provided within the program to guide the user. The program has embedded notetaking tools to aid the user in organizing and accessing case information. Higher level, metacognitive thinking skills are enhanced through synthesis, comparison, and reflective thinking required in the on-line problem-solving activities.

Because the program is designed as hypertext with the information and media linked through buttons, users are able to determine their own learning paths through the materials. All main components of the program can be accessed through the main menu and sub-menu structure, and material can be reviewed in any desired sequence. Because learning is viewed as constructed by the individual, from the known to the unknown, and through contextualized interaction in the microworld, the multimedia program should meet the needs of novices as well as experienced teachers who may have extensive knowledge but limited experience with this population of youngsters.

Studies of problem-solving processes of novice and expert teachers' efforts with classroom discipline suggest that expert teachers use heuristics and strategies in solving problems more so than novice teachers and that their reflections are more comprehensive and detailed (Swanson, O'Connor, & Cooney, 1990). Expert teachers emphasize problem identification and data acquisition techniques in prioritizing problems and solutions, while novice teachers are more concerned for problem solution. Expert teachers will be more likely to use new information and details in solving problems and generate qualitatively superior solutions. By enabling users of this program to access the information bases for knowledge development; to situate the cases in authentic scenarios; and by providing aids through examples, embedded structure, and notetaking tools; the multimedia program is likely to be equally effective for both novice and experienced teachers.

Thus, the program is built from real cases with real-world complexity provided through multiple observations of the children in differing situations, complete case records over time, and input from significant adults. Sufficient procedural and information supports are provided within the program to guide the user through the proper steps of assessing and planning for each case study youngster. By operationalizing the principles of cognitive science in the design of the multimedia microworld, it is anticipated that learners will gain knowledge and skills to engage in successful problem solving in assessment and planning procedures for youngsters with emotional and behavioral disorders.

Description of the Interactive Training Program

The program, *Assessment and Planning in Emotional and Behavioral Disorders,* focuses on: (a) ecological assessment and observation of children across settings, (b) philosophical orientations to types and uses of assessment information, (c) the continuum of program placements and support services, and (d) integrated resource planning. Assessment and planning activities are carried out using two interactive case studies, *Jimmy* and *Joyce.* Additional classroom video scenes on the backside of the laserdisc provide extensive practice in a variety of observational procedures: (a) event recording, (b) duration, (c) latency, (d) interval, (e) time sampling, and (f) A-B-C functional analysis of behavioral sequences. Figure 1 displays the purposes, support material, and program activities associated with each of the major modules within each program, *Jimmy* and *Joyce.*

Module	Purpose	Videodisc	Program Activities
Meet Jimmy Scenario	Situate problem solving in realistic assessment scenario.	• Video of Jimmy with description of behavioral concerns.	• Overall challenge to seek information for planning. • Overview steps in the assessment process.
Procedural Information	Provide information necessary to make eligibility decision and recommend placement and goals.		• Definitions and state labels. • Assessment procedures and instruments. • Placement options. • School and agency services
Student Records	Provide background and assessment information for Jimmy.		• Developmental/medical. • Vision/hearing. • Social/school history. • Standard test results. • Anecdotal records.
Assessment Activities	Engage the user in gathering and using assessment information necessary for a referral.	• Videos of Jimmy in variety of classroom, testing, and interview situations. • Interview with principal.	• Write interview questions for Jimmy. • Write interview questions for principal. • Get parent input. • Write eligibility referral.
Planning Process	Engage the user in determining eligibility and placement planning.	• Videos and audio clips from Jimmy's clinic conference with team members.	• Determine eligibility. • Recommend placement. • Write goals, activities, and support plans.
Take Notes Read Notes	Provide a personalized note-taking tool on pull-down menu.		• Take and read notes made while exploring the program.

Figure 1: Activities in the Program for *Jimmy*

The Case Studies

The interactive program contains case study vignettes of two students, *Jimmy* and *Joyce*. Following is a brief description of each student for which the user carries out referral, assessment, and planning activities.

Jimmy. Jimmy is eight years old and referred for evaluation of aggressive, destructive behavior in the home, social withdrawal, and possible suicide attempts. The school reports that he does not socialize with other children and rarely talks to others at school. When Jimmy speaks, he whispers with one word responses or covers his mouth. Previous assistance has included visits to the school counselor, speech therapy, Chapter One reading, and outpatient and inpatient clinic evaluation and family counseling.

Joyce. Joyce is a 15-year old girl placed in a residential setting by court order. In the past she has run away, experienced difficulties in school, exhibited aggression towards others, and has threatened suicide. In a structured setting she is able to handle the freedom and responsibility that comes in an "open campus" program. Previous efforts, including hospitalization, have not resulted in successful efforts to serve Joyce in a public school setting. These difficulties may be related to her family and home situation.

Screen Examples

Users have access to materials typically found in a youngster's school file and medical record in this infobase. Each entry includes the source of information and date of the report to allow users to re-construct the child's history over time, across different settings and to examine different views of the reporters. Figure 2 displays a sample of one page from Jimmy's Student Records in the clinical information section. This page contains a scanned image of a writing sample by Jimmy along with its transcription, source, and date.

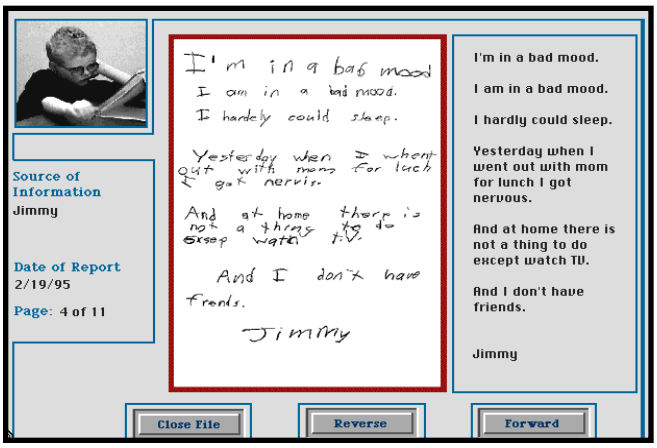

Figure 2. Sample Screen from School Records

In the planning process component, users are engaged in the multiple steps of the formal assessment and planning process used in education to identify children in need of special education services. Users draw upon procedural knowledge and case specific information to determine eligibility, recommend a placement, and write goals and objectives for the student. Figure 3 displays one screen from the Determine Eligibility activities. For each criteria, the user decides whether the student meets or does not meet the criteria and provides documentation for that decision.

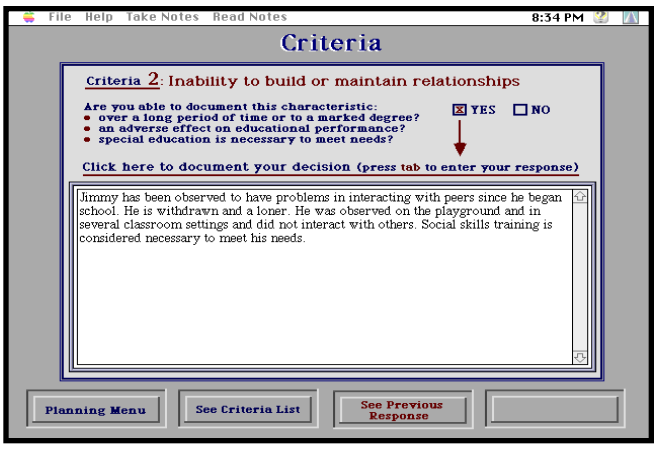

Figure 3. Sample Screen from Determine Eligibility

Development

The software programs to run the case study programs and the observation practices were created using *Authorware Professional* (Macromedia, 1992) by a small design and development team. Software development involved creating the screen interfaces with original graphics, authoring the program logic to deliver the information and problem-solving activities, computerizing the children's records, writing the extensive procedural information base, developing electronic notetaking and report-writing tools, developing the observation feedback routines using specialized variables, and creating data collection systems within the software. The video and audio segments placed on the videodisc were selected from original source material filmed in authentic educational settings for expressed use in this project. Preparation of the videodisc involved editing the raw source material, preparing a master videotape, and conversion to laserdisc by a commercial production company.

Field Testing

Fourteen graduate students enrolled in a methods course in behavioral disorders used the case study program, *Jimmy*, as an integrated course requirement. Some students were enrolled as preservice teachers while others were already teaching but returning to graduate school to work on additional special education certifications. Prior to enrollment in the present course, all students had completed introductory coursework in special education, assessment, and behavior management. Thus, the participants had considerable prior knowledge related to the content of the program. The program provided them an opportunity to apply their prior knowledge to the specialized area of behavioral disorders.

Because the course was taught in a three-week summer format, there were time limitations for class sessions and work time in the computer lab. The content of the program was a good match to the coursework, but due to time demands, the instructor was unable to provide direct instruction in all areas of the knowledge base included in the computer program. Each participant was expected to work independently through the case study. The instructor required students to take electronic notes through the program, to access all instructional components on the videodisc and computer program, and complete all assessment and planning activities within the program.

Each student used a floppy disk to store his or her records and work products; these were submitted to the course instructor. Case study requirements were included in grading for the course, with completion of all assigned activities the basis for the grade. The instructor reviewed all records and written products and provided individual feedback for each student following completion of *Jimmy*. Feedback was designed to provide encouragement and dialog with each participant; it was not evaluative.

Formative Evaluation

To summarize the formative evaluative findings, participants were satisfied with the quality and usefulness of the interactive case study materials. Users valued the opportunity to "see" children in naturalistic situations, gain information from support personnel and case records, and practice the steps of the assessment process. In spite of the fact that the materials were used in a short time frame in a three-week summer class, participants felt their learning was substantial and they had only a few logistical complaints about access to the computer lab and time to complete the program's activities. These findings are particularly encouraging given that the learners had extensive prior knowledge related to the content of the program and varying levels of experience with the use of multimedia as a tool for professional learning.

Summative Evaluation

Measures and Descriptive Data

Data were gathered using self-report instruments on two demographic variables to serve as independent variables: (1) prior computer experience and (2) prior teaching experience in special education. Path analysis data were collected from records stored on user floppy disks. Data collected from the audit trail included (1) total engagement time spent in the case study *Jimmy*, (2) total time spent in the program choices, and (3) electronic responses to all on-line problem-solving activities included within the case study.

Independent Variables

1. Prior Computer Experience with Computers. Data were gathered using a self-report instrument on prior experience with computers and hypermedia learning environments. Based on a scale where users rated their experience from 0 = "no knowledge" to 9 = "expert knowledge" on 9 categories of computer applications (total score possible = 81).

2. Prior Teaching Experience**.** Years of experience as teachers in regular and special education classrooms were solicited from self-report questionnaires.

3. EngagementTime. The total time each user worked on the case study *Jimmy* based on audit trail data stored on the users' disks.

4. Proportions of Time in Program Components**.** Proportion of usage time spent within each type of component in the microworld (knowledge domain, contextualized, multiple perspectives, problem-solving tasks) for *Jimmy*. The audit trail data were taken from user disks and segmented for component analysis.

Dependent Variable

Learning Outcome Score**.** The responses of the users were taken from on-line records produced through their interaction with the program. These responses were then scored using rubrics which defined the accuracy and quality of desired user responses. Scoring of six activities yielded a maximum score = 35 derived as follows:

Points	Activity	Criteria
3	• Interview questions for child	• Three questions that request new information and relate to educational programming
3	• Interview questions for the child's school principal	• Three questions that request new information and relate to educational programming
3	• Summary of prior school modifications	• Three specific modifications made in school services prior to child's referral
4	• Identification of needs for for further assessment	• Two remaining assessment needs with a plan for securing that information
10	• Determination of the child's eligibility for services based on definitional criteria	• Correct determination whether child meets each of five criteria with specific supporting documentation for each criteria
12	• Educational goals written for child which are matched to problems identified in case	• Three goals, each with four action parts: (1) statement of behavior to be performed, (2) educational activity to develop behavior, (3) related services to support goal, and (4) agency services to support goal.

Results

Outcome Scores

The mean outcome score = 27.9, standard deviation = 4.9, and range = 19 to 35.

Relationships Between Learning Outcomes and Independent Variables

Simple regressions were run to evaluate whether outcomes of hypermedia-based instruction were related to the independent variables examined in this study. Table 1 presents the regression results for the independent variables.

	r	*F*-value	*p*
Prior Computer Experience	.124	.188	.6722
Prior Teaching Experience	.087	.091	.7680
On-line Engagement Time	.619	7.435	.0184 *
Proportion: Domain Knowledge	.030	.011	.9187
Proportion: Contextualizing	-.029	.010	.9221
Proportion: Multiple Perspectives	.424	2.626	.1311
Proportion: Problem-solving Tasks	.008	.092	.7664

Table 1. Relationship Between Independent Variables and Learning Outcomes

Prior Computer Experience

The mean prior computer experience score = 30.5, standard deviation = 18.18, and range = 2 to 61. No significant relationships were found to indicate prior computer experience with computers was related to differing levels of learning outcomes based on scoring of on-line reports.

Prior Teaching Experience

The mean years of teaching experience = 3.29, standard deviation = 1.05, and range = 0 to 11. No significant relationships were found to indicate prior teaching experience was related to differing levels of learning outcomes based on scoring of on-line reports.

On-line Engagement Time

The mean engagement time = 5.09 hours, standard deviation = 1.9, and range = 2.52 to 8.75. A significant relationship was found between the engagement time using the program and learning outcomes based on scoring of on-line reports. The results showed a positive relationship between greater engagement time and higher outcome scores.

Proportions of Usage Time in the Components of the Program

The proportion of time the users spent in each of the components of the program are: (1) domain knowledge = 8.14%; *SD* = 3.69; (2) contextualizing = 40.85; *SD* = 11.48; (3) multiple perspectives = 9.69; *SD* = 2.55; and (4) problem-solving activities = 41.05; *SD* = 9.80. No significant relationships were found between the proportions of usage time within the components of the program and learning outcomes.

Patterns of Use

Audit trail records were examined for differences in path sequences through the hypermedia program based on graphical analysis procedures (Misanchuk & Schwier, 1992). Records were examined for eight users across the spectrum of outcome scores, from low to high. Patterns revealed that most users explored the case-specific components prior to beginning the problem-solving activities. Once engaged in problem solving they re-visited the components extensively to solicit new information, recall case specifics, or gather additional perspectives from the informants. Electronic notes were not extensively used. Most users accessed the optional scaffolds to display the eligibility criteria list and to view a model of an educational goal.

Figure 1 (see next page) displays the paths through the program for the two users who scored at the mean on the outcome score. While engagement time, number of steps taken in the program, proportions of time in the components, and outcome scores were nearly identical for these two users, their path sequences showed remarkable differences. These graphical displays illustrate different nonlinear uses of the program by two users with similar backgrounds.

Limitations and Discussion

The findings from this study must be considered preliminary due to the limitations. First of all, the materials were implemented in an intensive summer course; the short period of time may not have allowed differences of usage to fully emerge. Second, the users were all graduate students who had considerable prior knowledge related to the content in the program; their usage of the program and outcomes may not be representative of learners who are undergraduate students or users without substantial prior knowledge in the field.

When used with graduate students with considerable prior knowledge, the findings from this study support the assertion that hypermedia *is* good for instruction. These adult learners who utilized the complex hypermedia program demonstrated that they *could* and *would* customize their use of the program. Differences among the learners were documented by four variables—prior computer experience, prior teaching experience, engagement time using the program, and proportions of time in the program components. It appeared that the hypermedia program provided equally effective instruction for learners regardless of their differences. The only variable relating to learning outcomes was engagement time with the program. Users spending more time with the program demonstrated higher scores on the problem-solving activities.

Results did not support discussions in the literature of differences between novice and expert teachers in their use of strategies in solving problems. Differences in prior teaching experience did not differentiate the proportions of time users accessed the components. Further, prior teaching experience did not relate to the scores on the problem-solving activities. One explanation for these findings may be that the group, as a whole, performed as experts due to their high level of prior domain knowledge. An alternate explanation is that the hypermedia program is sufficiently robust to ameliorate differences among users based on prior knowledge and teaching experience.

The cognitive science design of this hypermedia program provided users a flexible learning environment for exploration and problem solving. Users accessed all components—knowledge domain, contextualizing, multiple perspectives, and problem-solving activities—in nonlinear ways. Audit path analyses revealed that users sought information in different ways—in orienting themselves to the case study, in seeking detailed case information, and in re-visiting previously explored components for additional ideas or reviewing prior information. In summary, users with differing learning profiles and usage patterns were equally successful in case-based problem solving. These conclusions may be limited to a robust hypermedia intervention with adult learners with high levels of prior knowledge.

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