DOCUMENT RESUME

ED 411 644	EC 305 836
AUTHOR	Deshler, Donald; Schumaker, Jean; Fisher, Joseph
TITLE	The Effects of an Interactive Multimedia Program on Teachers' Understanding and Implementation of an Instructional Innovation.
INSTITUTION	Kansas Univ., Lawrence. Dole Center for Human Development.
SPONS AGENCY	Special Education Programs (ED/OSERS), Washington, DC.
PUB DATE	1996-00-00
NOTE	113p.
CONTRACT	H023B50025
PUB TYPE	Reports - Research (143)
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	*Disabilities; *Hypermedia; *Inservice Teacher Education; *Multimedia Instruction; Multimedia Materials; *Preservice Teacher Education; Program Effectiveness; Secondary Education; Special Education Teachers; *Teacher Workshops

ABSTRACT

The effects of an interactive multimedia program on teachers' understanding and implementation of an instructional innovation were examined. Fifty-eight preservice teachers and 10 inservice teachers participated and were randomly assigned to one of two teacher development programs. The first teacher development program, called the "Virtual Workshop," was a computer based, interactive multimedia program. The second teacher development program, called the "Actual Workshop," was a traditional, live presenter directed program. Results of the study indicate that compared to their pretest scores, the posttest scores earned by inservice and preservice teachers on the test of knowledge and understanding of the innovation significantly improved following participation in either workshop. Moreover, preservice and inservice teachers' satisfaction ratings of both workshops were favorable. Inservice teachers who participated in the workshops correctly performed a substantially greater number of the innovation's targeted behaviors after training than before training. The development cost of the Virtual Workshop was found to be nearly four times as expensive as the development cost of the Actual Workshop; however, the cost to implement the Virtual Workshop was less than the Actual Workshop. Overall, both workshops had similar, positive effects on both groups of teachers' understanding and implementation of the instructional innovation. (Contains 58 references.) (Author/CR)

Office of Special Education Programs

The Effects of an Interactive Multimedia Program on Teachers' Understanding and Implementation of an Instructional Innovation

Student Initiated Research
HO23B50025

Principal Investigators: Donald Deshler, Ph.D.
Jean Schumaker, Ph.D.

Student Investigator: Joseph Fisher, M.Ed.

Abstract

The effects of an interactive multimedia program on teachers' understanding and implementation of an instructional innovation were examined. Fifty-eight preservice teachers and 10 inservice teachers participated and were randomly assigned to one of two teacher development programs. The first teacher development program, called the Virtual Workshop, was a computer based, interactive multimedia program. The second teacher development program, called the Actual Workshop, was a traditional, live, presenter-directed program. Results of the study indicated that compared to their pretest scores, the posttest scores earned by inservice and preservice teachers on the tests of knowledge and understanding of the innovation significantly improved following participation in either the Virtual or Actual Workshops. Moreover, preservice and inservice teachers' satisfaction ratings of both the Virtual and Actual Workshops were favorable. Inservice teachers who participated in the Virtual and Actual Workshops correctly performed a substantially greater number of the innovation's targeted behaviors after training than before training. Overall, both the Virtual and Actual Workshops had similar, positive effects on both teachers' understanding and implementation of the instructional innovation. This study suggests that interactive multimedia programs like the Virtual Workshop may provide a new medium through which effective teacher development can be provided.

Table of Contents

Abstract.................... ii

Table of Contents.................... iii

List of Tables.................... iv

List of Figures.................... iv

Chapter 1: Introduction.................... 1

Chapter 2: Review of Literature.................... 5

Selection of Studies.................... 10
Hypertext Programs.................... 11
Hypermedia Programs.................... 18
Summary.................... 24

Chapter 3: Methods.................... 29

Participants.................... 29
Setting.................... 29
The Concept Mastery Routine.................... 30
Teacher Development Programs.................... 31
Measurement Instruments.................... 35
Virtual Workshop Procedures.................... 39
Actual Workshop Procedures.................... 41
Experimental Designs.................... 42

Chapter 4: Results.................... 43

Preservice Teachers.................... 43
Inservice Teachers.................... 44

Chapter 5: Discussion.................... 49

Conclusions and Relationship to Previous Research.................... 49
Limitations.................... 53
Future Research.................... 55
Teacher Development Implications.................... 56
Summary.................... 57

References.................... 58

Appendix A: Content Checklist.................... 66

Appendix B: Measures.................... 72

List of Tables

1 Preservice Teachers' Mean Percentage Scores for Pretest and Posttest Knowledge and Diagram Tests by Treatment Group

2 Inservice Teachers' Mean Percentage Scores for Pretest and Posttest Knowledge and Diagram Tests by Treatment Group

List of Figures

1 Concept Diagram

2 Virtual Workshop Computer Screen Displaying Table of Contents

3 Preservice Teacher Satisfaction Questionnaire Results

4 Inservice Teachers' #1 and #2 (Virtual Workshop Participants)

5 Inservice Teachers' #3 and #4 (Virtual Workshop Participants)

6 Inservice Teachers' #5 and #6 (Actual Workshop Participants)

7 Inservice Teachers' #7 and #8 (Actual Workshop Participants)

8 Inservice Teachers' Implementation Recording Form Results

9 Inservice Teachers' Satisfaction Questionnaire Results

Chapter 1

Introduction

The students in America's classrooms are becoming increasingly diverse (Hodgkinson, 1991). This diversity is not only ethnic, cultural, and economic, but also academic. One factor contributing to the increase in academic diversity has been the movement to include students with mild disabilities within general education classrooms for most if not all of the school day (Gartner & Lipsky, 1987; Kauffman, 1994; Will, 1986). Needless to say, appropriately addressing the educational needs of these students in general education classrooms is a challenge for teachers (Simmons et al., 1995; Zigmond et al., 1995). Although, teachers have indicated that they want to meet this challenge, they realize their need for training in effective inclusive practices (Joint Committee on Teacher Planning for Students with Disabilities, 1995).

Although inclusive practices designed to improve the achievement of students with disabilities in inclusive classes have been developed and validated (Fisher, Schumaker, & Deshler, 1995), teacher development programs have not proved successful in translating such instructional innovations into classroom practice on a broad scale (Gersten, Vaughn, Deshler, & Schiller, 1995; Malouf & Schiller, 1995). Often, these programs involve one-shot sessions (Kline, Deshler, & Schumaker, 1991), focus on practices frequently not perceived as needed by teachers (Fullan with Stiegelbauer, 1991), provide few, if any, opportunities to practice and receive feedback (Cruickshank & Metcalf, 1990), and offer little or no follow-up classroom support (Hoover & Boethel, 1991). Such *episodic* teacher development programs contrast directly with more successful *comprehensive* teacher development programs that are needs-based, participant-owned, and supported over time (Shower, Joyce, & Bennett, 1987; Schumaker & Clark, 1990). Still, comprehensive programs are more expensive than episodic programs (Korinek, Schmid, & McAdams, 1985) and may be beyond the means of today's public schools. Clearly, if general education teachers are going to more successfully address the educational needs of *all* students enrolled in academically diverse classrooms, improving teacher development programs in ways that facilitate teachers' adoption of validated inclusive practices in cost-effective ways must be found.

One emerging technology which eventually might be used to provide teacher development programs is interactive multimedia. Interactive multimedia is a term used to describe computer-based programs that provide users random access to multiple forms of media (i.e., text, graphics, audio, video, etc.) about a particular topic (e.g., Kinzie & Berdel, 1990; Marchionini, 1988). For example, when studying about semantic maps using an interactive multimedia program, a teacher might access text passages describing semantic maps, diagrams illustrating semantic maps, and video clips showing teachers using semantic maps. Moreover, the teacher would have control over which media to view, when to view them, and how many times to view each.

The availability of interactive multimedia programs for teacher development could shift the balance from less effective episodic education programs to more effective comprehensive ones. For example, a library of CD-ROM based, interactive multimedia programs on innovative practices could be provided to teachers. From this library, teachers could choose programs on those innovative practices that would fit their most pressing instructional needs. While using a chosen interactive multimedia program, teachers could practice using the innovation in a simulated lesson and receive feedback on their performance. Moreover, a teacher could review the program as frequently as desired. Such teacher-directed training would presumably enable instruction to become more individualized, in a format that is potentially less expensive than "one shot," "one-size-fits-all" programs (Schrum, 1994). The savings accrued through interactive multimedia programs could then be used to provide teachers follow-up support with consultants and/or other teachers.

Additionally, interactive multimedia programs could afford school districts the option of bringing new teachers up to speed with other staff in a relatively short period of time because the new teacher would have immediate access to the training. They would not have to wait for the next "formal" training session. Finally, because CD-ROM based, interactive multimedia programs can be distributed with great ease through the mail, professionals would have timely access to state-of-the-art instructional innovations.

These potential advantages make interactive multimedia programs an attractive form of training. Not surprisingly, numerous interactive multimedia programs for university students and professionals have been developed on a broad array of subjects including: accounting (Becker & Dwyer, 1994), art (Covey, 1990), biology (Hannaway, Shuler, Bolte, & Miller, 1992; Hutchings, Hall, & Thorogood, 1994; Jaffe & Lynch, 1989), business (Acovelli & Nowakowski, 1994), foreign language (Liu & Reed, 1995), history (Chignell & Lacy, 1988; Spoehr & Spoehr, 1994), literature (Landow, 1989), medicine (Lee, Ault, Kirk, & Comstock, 1995), and statistics (Egan et al, 1989; Harding, Lay, Moule, & Quinney, 1995; Johnson & Grover, 1993).

The surge in interactive multimedia program development for training purposes suggests that many individuals believe such programs can deliver effective instruction to adults. In fact, several methodologically sound empirical studies support this belief (D'Alessandro et al., 1993; Hudson & Holland, 1992; Lanza & Roselli, 1991; Livergood, 1994; McGrath, 1992; Patterson & Yaffe, 1993; Quade, 1993; Santer et al., 1995; Schank & Rowe, 1993; Shyu & Brown, 1992; Summers, 1991; van den Berg & Watt, 1991). Combined, these studies suggest that interactive multimedia programs are at least as effective as and sometimes more effective than traditional means of instruction. Moreover, consumer satisfaction results consistently indicate that students rate the interactive multimedia programs favorably.

Nevertheless, despite the promise these programs hold, no methodologically sound empirical studies have examined the effects of interactive multimedia programs on the professional development of classroom teachers. Moreover, except for a study by Shyu and Brown (1992) on origami, no studies have examined the effect of interactive multimedia programs on adults' ability to use what they have learned on an authentic task. If interactive multimedia programs are going to be used for teachers' professional development, studies must be conducted to determine whether such programs: a) are effective with regard to teaching preservice and inservice teachers new knowledge about innovative practices; b) are effective with regard to teaching teachers to implement innovations in their classrooms with students; and c) are efficient with regard to cost. The purpose of this study was to directly address the first two of these issues and to shed light on the third.

Chapter 2

Review of Literature

Over the past decade, professionals in the field of education have actively sought to learn how to more effectively translate research into practice on a broad scale (Lenz & Deshler, 1993; Malouf & Schiller, 1995). Their investigative efforts have substantially advanced the recognition of key factors which promote teachers' understanding and implementation of research-based practices (e.g., Gersten & Brengelman, 1996). One of these factors is comprehensive teacher development (Cruickshank & Metcalf, 1990; Fullan with Stiegelbauer, 1991; Guskey, 1986; 1994).

Much is known about how to effectively provide comprehensive teacher development (e.g., Cruickshank & Metcalf, 1990; Showers et al., 1987; Sparks, 1983; Wade, 1985), and today, validated models for such teacher development exist (e.g., Gall & Vojtek, 1994; Sparks & Loucks-Horsley, 1989). One such model for comprehensive teacher development was described by Joyce and Showers (1988). In this model, an instructional need is first targeted and teachers make a written commitment to participate fully in all aspects of a professional development program to address that need. Then teachers gain knowledge of and skill in an instructional innovation designed to meet the targeted need in a workshop. During the workshop, the theory underlying the innovation is described, demonstrations of the innovation are presented, and opportunities to practice and receive feedback using the innovation are provided. Following the workshop, teachers then participate as members of peer-coaching teams supporting one another's use of the innovation. The effectiveness of this model was tested in a study that measured teachers' ability to integrate four innovations (cooperative learning structures, inductive thinking, concept attainment, and mnemonic strategies) into their classroom practice (Showers, 1990). Results of this study indicated that following the initial workshop, participating teachers used these innovations an average of 20 times each month. Moreover, after nearly two years, 60% of the participating teachers continued to implement these innovations effectively.

A second comprehensive teacher development model, comprised of four phases, was described by Schumaker and Clark (1990). In phase one of this model, teachers, administrators, and staff developers work to identify an area of need and instructional innovations that might address that need. In phase two, teachers' commitment to learn and implement the innovation is obtained. Then, in a workshop, the philosophy behind the innovation and the innovation itself is described, a demonstration of the innovation is presented, opportunities to practice and receive feedback using the innovation are provided, and all the materials required to implement the innovation are distributed. Following the workshop, teachers meet as members of support teams to discuss implementation issues. After the initial innovation has been implemented successfully, phase three of the model is then initiated. During this phase, additional innovations are learned and integrated into a coordinated instructional program. Finally, in phase four, district policies are developed to facilitate the maintenance of this coordinated instructional program.

In a recent series of studies, aspects of this teacher development model were tested with regard to teachers' implementation of learning strategies instruction (Kline et al., 1991). Results of one study indicated that when this model was applied, all participating teachers were able to initially implement the learning strategies instruction, and 75% percent of the teachers taught the strategies throughout the school year. When aspects of the model such as providing materials, feedback, or support-team meetings, were omitted systematically, at best only half of the participating teachers implemented the learning strategies instruction. Moreover, these teachers implemented the instruction less efficiently and with significantly fewer students than teachers who participated in all components of the teacher development model.

Stallings (1989) described a third comprehensive teacher development model. In this model, teachers first work to identify an instructional need and then make a written commitment to learn and implement a new practice which address that need. Next, teachers attend small-group workshops and learn about the practice through a variety of means including explanations, models, and practice simulations. Teachers are then encouraged to integrate the practice into their classrooms and to evaluate the effects of the new practice on student learning. Once they have used the practice, teachers are observed and their performance is critiqued. Finally, teachers participate as members of support groups in which teachers report their success using the new practice, discuss problems they have experienced, develop solutions to these problems, and set new goals for professional growth.

The effectiveness of this model was examined and reported in two studies in which teachers' knowledge and implementation of a new reading program were measured (Stallings, 1989). Results of the first study indicated that after participating in the professional development model, all 47 teachers successfully implemented the reading program with regard to 26 of 31 variables. Results of the second study indicated that after participating in the model, at least 80% of the teachers in three of four participating schools implemented the program successfully. Moreover, the teachers' implementation of the reading program resulted in substantially higher student reading scores. That is, students of teachers who received training could read, on the average, half a grade level higher than students of teachers who did not receive training.

Each of these three comprehensive teacher development models has proved to be effective. Overall, these models were predicated on developing teachers' knowledge of instructional innovations and their skill in applying those innovations (Cruickshank & Metcalf, 1990). To develop teachers' knowledge and skills, these models employed many similar instructional principles which included: (a) having teachers identify a pressing instructional need; (b) having teachers make a commitment to adopt the new instructional innovation; (c) explaining the theory or rationale behind the innovation; (d) describing the innovation; (e) providing actual models and/or demonstrations of the innovation; (f) providing teachers opportunities to practice using the innovation; (g) providing teachers feedback about their use of the innovation; and (h) providing follow-up support.

Unfortunately, despite the effectiveness of comprehensive teacher development programs for helping teachers to understand and implement new practices, such programs are rarely applied (Hoover & Boethel, 1991). The reasons for such limited application are largely speculative. Possible reasons include the difficulty and the expense of arranging for qualified experts to lead a series of professional development sessions with teachers while covering instruction for students in these teachers' classes (Korinek, Schmid, & McAdams, 1985). Clearly, if the translation of research into classroom practice is going to occur on a broad scale, comprehensive teacher development programs that are widely embraced must be found.

One possible medium through which an embracable comprehensive teacher development program could be delivered is educational technology. Recent advances in computer and communications technologies have dramatically expanded teachers' opportunities to receive and to participate in professional development programs in exciting ways (Thornburg, 1992). Today, for example, first-year teachers attending Harvard University can participate in an on-line mentorship program with master teachers (Merseth, 1992); students in the School of Education at the University of

Oregon can enroll in courses offered over the Internet (Schrum, 1992); and teachers from rural school districts all over the nation can partake in workshops delivered over interactive telecommunication networks (Slaton & Lacefield, 1991).

Another recently developed computer-based technology now being used to provide professional development programs to teachers is interactive multimedia (Kinzie & Berdel, 1990; Marchionini, 1988). Interactive multimedia has great potential for developing teachers' knowledge of and skill in applying an instructional innovation, for such programs can contain many of the instructional principles present in comprehensive professional development. For example, when learning about an instructional innovation using an interactive multimedia program, teachers could view a video clip of an individual explaining the *theory* or *rationale* behind the innovation. Additionally, the innovation could be described to teachers in great detail, and they could view video clips of *demonstration* lessons performed by teachers using the innovation with students. To check their own understanding of the innovation, teachers could answer questions integrated into the program and receive immediate positive and corrective *feedback* regarding their answers. Moreover, teachers could *practice* making decisions about how to use the innovation in a scenario-based simulation. That is, teachers could read a scenario describing a lesson in which the innovation was to be used with students. At points in the scenario, teachers could respond to questions requiring them to determine how the innovation should be best used. Teachers could be given *feedback* on these responses. The flexibility of interactive multimedia programs would also allow teachers to determine the order and pace at which they learn about the innovation. Additionally, teachers could review any section of the program, at any time, as often as needed.

In recent years, numerous interactive multimedia programs have been developed for university students and professionals in a wide range of disciplines

(Acovelli & Nowakowski, 1994; Becker & Dwyer, 1994; Chignell & Lacy, 1988; Covey, 1990; Egan et al., 1989; Hannaway et al., 1992; Harding et al., 1995; Hutchings et al., 1994; Jaffe & Lynch, 1989; Johnson & Grover, 1993; Landow, 1989; Lee et al., 1995; Liu & Reed, 1995; Spoehr & Spoehr, 1994). Moreover, interactive hypermedia programs have also been developed for preservice and inservice teachers on topics such as classroom management (Overbaugh, 1994), mainstreaming (Rojewski, Gilbert, & Hoy, 1994), and measuring the behavior states of students with multiple disabilities (Bashinski, 1996).

Clearly, this surge in the development of interactive multimedia programs suggests many individuals believe such programs can effectively provide instruction to adults. However, the mere popularity of hypermedia programs is not enough to support their continued development and use. If interactive multimedia programs are to be used in the professional development of preservice and inservice teachers, the effects such programs have on adults' ability to understand and apply what is being taught must be determined. The purpose of this review is to describe and critically examine the research on existing interactive multimedia programs in light of the instructional principles found in effective teacher development programs.

Selection of Studies

The research studies included in this review were identified by searching the CD-ROM databases for the Educational Resources Information Center, Psychological Abstracts, and MedLine for the years 1980-1996. In addition, an ancestral search from the identified articles was conducted. To be selected for the review, a study had to meet the following criteria:

a) The study had to be conducted with adults. Adults were defined as individuals over the age of 18 and/or attending a post-secondary education program (i.e., university, community college, or professional workshop).

(Since few studies have been conducted on the effects of multimedia programs with teachers, the review was broadened to include any studies on adults.)

b) The study had to employ as an independent variable an interactive multimedia program. For this review, "interactive multimedia" programs were defined as learner-directed, computer-based applications, in which text, graphics, video, and/or audio segments were integrated.

c) The study had to report empirical data on the effects the interactive multimedia program on adults' knowledge and/or skill development.

d) The study had to employ an experimental design and control for the effects of extraneous variables.

Once selected, the studies were sorted into two categories of interactive multimedia: hypertext and hypermedia. Each study was then reviewed to identify the number of adults participating, the characteristics of those adults, the setting in which the study was conducted, the adequacy of the research design used, the dependent variables being measured, the outcomes for the participating adults, and the level of the participating adults' satisfaction with the interactive-multimedia program.

Each category of interactive multimedia and the studies related to it will be described. Moreover, the effectiveness of the interactive multimedia programs will be summarized with respect to how they affected adults' knowledge and/or skill development. Finally, conclusions will be drawn with regard to how well these interactive hypermedia programs match the principles of effective teacher development described above.

Hypertext Programs

Hypertext comprises one category of interactive multimedia. Originally conceived in the 1940's by Bush (Quade, 1993), hypertext provides user-driven access to *static* forms of media (i.e., text, maps, photographs, and graphic displays) related to a particular topic. These media are connected together by hypertext links, such as colored words imbedded within a passage of text. Using a mouse, these words can be "clicked." When clicked, additional information about that word appears on the computer screen. For example, if reading a passage about individualized education plans (IEPs) within a hypertext program, a teacher might click on any word from that passage which appears in blue, boldfaced print. If the teacher clicks the blue, boldfaced words, *annual goal,* sample annual goals from an actual IEP could appear on the screen for the teacher to study. If the teacher clicks the blue, boldfaced word, *committee*, the names and descriptions of those individuals required to attend an IEP meeting could also appear on the screen. Moreover, if the teacher choose to reread the passage, any previously clicked words could again be accessed for review.

Six studies examining the effects of hypertext on adults' learning have been included in this review. In one study, Livergood (1994) compared the effects of two hypertext programs and an instructional manual on 209 university students' *knowledge* of intelligent computer systems. The first hypertext program was comprised of three instructional modules. Modules one and two contained information and examples describing intelligent computer systems. Module three contained review questions students could answer about intelligent computer systems. Whether students received corrective feedback on questions they did not answer correctly is unclear. The second hypertext program was exactly like the first; however, it did not contain the third instructional module. The content contained within the instructional manual was not disclosed. Participating students were randomly assigned to one of the three instructional treatments, were given up to 45 minutes to complete their respective instructional treatment, and then completed a 20-item posttest. The nature of this posttest was not described.

The posttest scores earned by students in the three-module hypertext program were significantly higher than the scores earned by students in the other two instructional treatments. Specifically, students who participated in the three-module hypertext program earned an average posttest score of 91.71%. Students who received the two-module hypertext program earned an average posttest score of 84.37%. Students who used the instructional manual earned an average posttest score of 85.68%. Unfortunately, because a pretest was not given, the magnitude of the students' growth was not determinable.

In a similar study, Patterson and Yaffe (1993) measured and compared the effects of a hypertext program and an instructional manual on 22 social-work students' *skill* in diagnosing personality and developmental disorders. These students were randomly assigned to one of two instructional treatments. The hypertext program, called HyperAxis II, contained information describing characteristics, diagnostic information, and case studies of personality and developmental disorders. Moreover, the program contained written scenarios describing a person with an undisclosed personality or developmental disorder. From the information provided in the scenarios, students could practice making diagnoses and receive corrective feedback when errors occurred. The instructional manual contained the same information found in HyperAxis II. The instructional manual even contained the practice scenarios. However, to check the accuracy of their diagnoses, students had to look at an answer key which provided the correct answer but did not provide corrective feedback. Students in both treatments had a maximum of three hours to complete their respective treatment.

Using a pretest-posttest control-group design, participating students' skill in accurately diagnosing personality and developmental disorders was measured and compared. Results of the study revealed no significant difference between the average posttest score of 67.6% earned by students who participated in the hypermedia program and the average posttest score of 71.7% earned by students who used the instructional manual. Moreover, when compared to their pretest scores, neither group's posttest scores were significantly higher. The interscorer reliability of the tests was low, however. For example, the kappa coefficient for the pretest was .55, whereas the kappa coefficient for the posttest was .61. Thus, the accuracy of these knowledge scores is uncertain. Nevertheless, students in both treatments spent significantly less time making diagnoses on the posttest when compared to the pretest. Specifically, diagnosis time for students in the HyperAxis II program for six diagnoses fell from a pretest mean of 27.1 minutes to a posttest mean of 17.4 minutes and for students who used the instructional manual from a pretest mean of 26.5 minutes to a posttest mean of 16.4 minutes. Regarding students' satisfaction ratings of the two treatments, students who used the training manual rated their program as easier to use than students using the hypertext program. On the other hand, students who used the HyperAxis II program reported their program as more enjoyable than students who used the training manual.

The effects of hypertext programs on university students' *knowledge* were also measured and compared to the effects of computer-based tutorial programs in two recent studies conducted by Quade (1993) and Lanza and Roselli (1991). In the study conducted by Quade (1993), the hypertext program contained nine sections of information, including examples and definitions describing intellectual property law. Embedded within these sections were questions which students could answer using a mouse or the computer keyboard. When questions were answered incorrectly, corrective feedback was provided. The computer-based tutorial was comprised of the same content and questions that were provided in the hypertext program; however, the content was presented in a predetermined order.

Seventy-six undergraduate students enrolled in a business law course were randomly assigned to one of the two instructional treatments. Before and after receiving their respective instructional treatment, these students completed a pretest and posttest which contained the same 30 multiple-choice questions. Results of the study revealed no significant differences between the pretest scores and between the posttest scores earned by students in the two treatment groups. However, compared to their pretest scores, the posttest scores of students within each treatment were significantly higher. More specifically, students who participated in the hypertext program, on average, earned a pretest score of 43.50% and a posttest score of 62.73%. Students who participated in the computer-based tutorial, on average, earned a pretest score of 41.37% and a posttest score of 61.80%. Still, given that students were pretested and posttested using the same multiple-choice questions, the magnitude of these students' improvement is modest, at best.

In the study conducted by Lanza and Roselli (1991), the hypertext program described the Pascal computer language and provided students opportunities to answer multiple-choice and fill-in-the-blank questions about the language. After answering a question, students received feedback indicating whether their response was correct or incorrect. Moreover, incorrect answers were followed by another question or corrective material. The computer-based tutorial contained the same content and questions as the hypertext program; however, the tutorial was computer-directed, not user-directed like the hypermedia program. That is, the computer, not the user was in control of what content was to be presented and when it was to be presented. Additionally, the feedback provided to students in the tutorial merely indicated the correctness or incorrectness of an answer. No corrective feedback was given.

Sixty undergraduate students studying computer science were randomly assigned to either the hypertext program or the tutorial. Students were provided the same amount of time to complete their respective instructional treatment, and they completed the same 10-item posttest. The nature of the posttest questions was not disclosed, nor was the interscorer reliability for the test scores. On the posttest, students who participated in the hypertext program earned an average score of 49.67%; students who participated in the computer-based tutorial earned an average score of 53.33%. The difference between the scores earned by students in the two treatments was not statistically significant. Although the groups of students performed similarly, 76% of the students who participated in the hypertext program reported finding their program stimulating and attractive, whereas only 37% of the students rated the tutorial this way.

In a comprehensive study, McGrath (1992) examined the effects of a hypertext program, a computer-based tutorial, and an instructional manual on both university students' *knowledge* of and *skill* in calculating surface area. One hundred and three undergraduate education majors participated in the study. These participants were randomly assigned to one of the three instructional treatments. All three treatments contained identical content and practice problems on surface area. Moreover, the content and practice problems were organized into the same sections. The computer-based tutorial differed from the hypermedia program in that its sections had to be completed in a predetermined order. The instructional manual differed from the hypertext program and the computer-based tutorial in that it was in a bound, paper format.

To measure and compare the effects of each treatment, a pretest-posttest, control-group design was used. Overall, results of the study revealed no significant differences between the posttest knowledge scores earned by students in any of the three treatments. Significant differences were found with regard to the skill measure; however, because no post-hoc analyses were conducted, specifying whether the students who used the instructional manual performed significantly better than the students who participated in the hypertext program or the students who participated in the computer-based tutorial is not possible. Interestingly though, the students who used the instructional manual spent significantly more time than other groups completing the instruction. No significant differences between the students' satisfaction ratings were found; students participating in all three treatments were satisfied with the instruction they received.

Finally, van den Berg and Watt (1991) studied the effects of a hypertext program on university students' knowledge of statistics. This study was unique, because it did not compare a hypertext program to another *instructional treatment*; instead, it compared the effects of the same hypertext program under varying *instructional conditions*. The hypertext program contained hierarchically organized content about hypothesis testing. When abstract information was presented, the user could access less abstract definitions or examples to make the content more concrete. The four instructional conditions were as follows. In the first condition, called the replacement condition, students used the hypertext program in place of class lecture for a period of six weeks. In the second condition, called the supplementary condition, students used the hypertext program to supplement class lecture. In the third condition, called the competitive condition, students used the program in place of class lecture. Moreover, these students were told they were receiving their instruction in a format different from that received by their classmates. In the fourth condition, called the control condition, students did not use the hypertext program and simply attended class lectures. The content presented in the hypertext program was identical to that presented in class lectures.

For the study, 241 students were randomly assigned to one of these four instructional conditions. Initially, all the participating students first attended five weeks of class lecture and completed an exam over the content presented. Analysis of these exam scores revealed no significant differences between the groups. The four instructional conditions were then implemented. Afterward, students completed a second exam over the content presented in the four conditions. Results indicated that the scores earned by students in the control condition were significantly higher on this second exam than those earned by students in the replacement condition. No other significant differences between instructional conditions were found. Following the second exam, all participating students again attended five weeks of class lecture and completed a third exam. Analyses revealed no significant differences between the scores earned by students assigned to any of the four conditions. However, because actual scores were not reported and the level of student achievement was not revealed, the meaningfulness of student performance on each of these exams in unclear. In terms of consumer satisfaction, students in the supplementary condition rated the hypertext program the most favorably; students in the competitive condition rated their hypertext program the least favorably.

Hypermedia Programs

Hypermedia is a second type of interactive multimedia. Like hypertext, hypermedia is a computer-based program that allows user-directed access to multiple forms of static media. Additionally, however, hypermedia also allows access to *dynamic* media like audio and video segments. For example, if reading a passage about individualized education plans (IEP) within a hypermedia program, a teacher might click on the blue, boldfaced word, *negotiation*, and a video segment of a teacher and parent working to determine a child's course schedule might appear on the screen for the teacher to view. The teacher could also click the blue, boldfaced word, *invitation*, to hear an audio segment of a teacher asking parents to attend their child's IEP conference. Moreover, like in hypertext, in hypermedia any previously clicked words could again be accessed for review.

Six studies examining the effects of hypermedia on adults have met the criteria for this review. In the first study, Summers (1991) compared the effects of a hypermedia program and an instructional manual on university students' *knowledge* of pharmaceuticals. Twenty-one students participated in the study and were randomly assigned to one of the two treatments. The instructional manual contained content divided into seven sections. To provide additional information to what was presented in the manual, segments from a videotape on pharmaceuticals were shown. Beginning with section one, students read the manual, viewed excerpts from the videotape at when instructed by the manual, answered questions in the instructional manual, and checked answers using an answer key. This process was continued for the subsequent sections of the instructional manual. The hypermedia program was comprised of the same content and video segments as the instructional manual. This information was transformed into a computerized format that could be read and viewed in any order. Also, students could stop, reverse, and replay the video excerpts. When students answered questions incorrectly they received corrective feedback.

Two weeks after students completed their respective treatments, they completed a posttest. The mean posttest score of students who participated in the hypermedia program was not statistically different from the posttest score of those using the manual. Likewise, the amount of time students needed to complete each instructional treatment did not differ significantly. Still, students who participated in the hypermedia program rated their enjoyment of the hypermedia program significantly higher than students who used the instructional manual.

In two later studies, Hudson and Holland (1992) and D'Alessandro et al. (1993) measured and compared the effects of a hypermedia program and large-group lecture on university students' *knowledge* of course content. In the study conducted by Hudson and Holland (1992), the hypermedia program contained text and graphics on lighting techniques taken from the students' textbook and video excerpts from a videotape entitled, "Lighting in the Real World." The large-group lecture included the same content as the hypermedia program; however, the nature of the content was not described. Thus, whether models of effective lighting techniques and/or practice activities were provided remains unclear. During the lecture, the video excerpts were shown on a television monitor, the graphics were presented on the chalkboard, and the content was referred to in their textbook. Whether either treatment included practice activities and/or feedback was not indicated. Students in both groups received instruction on lighting techniques for no more than fifty minutes, the length of one class period.

Eighty-eight university students were randomly assigned to one of the two treatments, and a pretest-posttest control-group design was used. Results of the study revealed no statistically significant difference between the posttest knowledge scores of students in the two treatment conditions. However, compared to pretest scores, the posttest scores of students within each treatment were significantly higher. Later, when asked to rate their enjoyment of the instruction, students who participated in the large-group lecture indicated they enjoyed their lesson about the same as previous lessons. However, the students who participated in the hypermedia program indicated that they enjoyed their lesson more than previous lessons.

In the study conducted by D'Alessandro et al. (1993), the hypermedia program was divided into 10 sections containing passages of text describing respiratory diseases. Words within these passages could be clicked to access either additional text, images, video segments, audio segments, or animation. Moreover, this program contained practice test questions. Whether students received feedback after answering these questions was not explained. The large-group lecture contained content identical to the hypermedia program; however, no evidence is presented corroborating this claim. The lecture was delivered within 50 minutes.

Forty-nine staff physicians and residents in a department of radiology were randomly assigned to one of the two instructional treatments. A pretest-posttest control-group design was used. The pretest and the posttest were comprised of the same 10 questions. The type of questions used is unclear. Results indicated no statistical difference between the two groups at either pretest or posttest. However, compared to pretest scores, the posttest scores of students within each treatment group were significantly higher. For example, professionals who participated in the hypermedia program, on average, earned a pretest score of 58.8% and a posttest score of 83.2%. Professionals who attended the group lecture, on average, earned a pretest score of 53.3% and a posttest score of 82.9%. Interestingly, when considering instructional time, the professionals who attended the lecture learned the same amount of information as professionals who participated in the hypermedia program in 40% less time. Thus, the lecture was the more efficient way of teaching. In terms of consumer satisfaction, 75% of the physicians and residents rated the hypermedia program favorably, and all indicated it was easy to use. Satisfaction ratings for those professionals who attended the lecture were not reported.

In a later study, Santer et al. (1995) compared the effects of a hypermedia program to an instructional manual and a lecture on medical students' *knowledge* of respiratory diseases. In this study, two hundred sixty-seven, third- and fourth-year medical students were assigned to one of four instructional treatments. The groups of students did not significantly differ by age, sex, academic year, pediatric experience, respiratory disease knowledge, or computer proficiency. Students in the first group received a hypermedia program comprised of six discrete chapters containing text, video segments, audio segments, and diagrams. Students in the second group received a slide-based lecture. Students in the third group read a 37-page instructional manual. Except for the audio segments, the lecture and instructional manual treatments contained the same content as the hypermedia program. That is, all images, tables, and diagrams in the hypermedia program were directly abstracted and included in the lecture and text treatments, as were representative still images taken from the hypermedia program's video segments. Each treatment was completed in 60 minutes. Students in the fourth group served as a control group and received no instruction on pediatric airway diseases. This group was the only group that received a pretest on their knowledge of respiratory diseases.

Following the treatment, all students were posttested on 26 multiple-choice questions. The posttest scores of the students who participated in the hypermedia program, the lecture, and the instructional manual were significantly higher than the posttest scores earned by control-group students. The posttest scores of students who participated in the hypermedia program were significantly higher than the scores of students who attended the lecture but were not significantly higher than those earned by the students who used the instructional manual. Specifically, students who participated in the hypermedia program, on average, earned a posttest score of 63.84%. Students who attended the lecture, on average, earned a posttest score of 59.23%. Students who used the instructional manual, on average, earned a posttest score of 60.00%. Interestingly, the mean pretest score earned by control group students was 45%; their mean posttest score was 51.15%. These data suggest that the magnitude of gain attained by students in all three treatment groups was modest. Regarding consumer satisfaction, 81% of the students who participated in the hypermedia program rated it favorably, whereas fewer than 67% of the students in the other groups rated their instructional treatment favorably.

Schank and Rowe (1993) compared the effects of a hypermedia program and a computer-based tutorial on university students' *knowledge* of semiconductor manufacturing. Twenty university students were randomly assigned to receive one of the instructional treatments. Both treatments contained five sections of content describing and modeling varying aspects of the semiconductor manufacturing process. Moreover, to illustrate dynamic aspects of this process, video segments were incorporated within each section. Though both treatments contained identical content and video segments, they were structured differently. The hypermedia program allowed users to select the order in which they studied the five sections, whereas the tutorial did not. Students had a maximum of 50 minutes to complete their respective treatment.

The pretest and posttest measures given to students in both treatments were identical and were comprised of short-answer questions about semiconductors. Results revealed no significant differences between the pretest scores and between the posttest scores earned by the two groups of students. Although no within-group analyses were conducted, students in both programs did make modest gains in performance. That is, the average scores of students who participated in the hypermedia program improved from 23.20% at pretest to 40.53% at posttest. Similarly, the average scores of students who participated in the computer-based tutorial improved from 23.86% at pretest to 42.53% at posttest.

Finally, Shyu and Brown (1992) examined the effects of a hypermedia program on university students' *skill* in constructing an origami crane. This study was unique, for it was the only one to measure the effects of hypermedia on students' ability to perform a dynamic skill. In the first treatment, a computer-based tutorial, the content was presented to students in a predetermined order. More specifically, students were first presented an introduction, then a video summary of the paper folding procedure, and finally a detailed 12-step video model of the paper folding procedure. Finally, after each step was modeled, students had the option to view the video model again. However, once students proceeded to the next step, they could not view previously modeled steps. In the second treatment, a hypermedia program, students could proceeded through the content in the order of their choice. Moreover, students could review any content they wanted as often as they wanted.

Participating in the study were 52 undergraduate students enrolled in an educational psychology course. These students had indicated they had no prior experience with origami, were randomly assigned to receive either the computer-based tutorial or the hypermedia program, and were given 30 minutes to complete their respective treatment. A posttest-only control-group design was employed, and data were analyzed using t-tests. For the posttest, students were provided a piece of paper which they were to fold into a paper crane. Students' cranes were rated on a scale ranging from 0 points to 6 points. Results of the study indicated that the cranes constructed by students who participated in the hypermedia program earned significantly higher posttest ratings than those of students who participated in the computer-based tutorial. Specifically, students who participated in the hypermedia program, on average, earned a posttest rating of 4.23, whereas students who participated in the tutorial, on average, earned a posttest rating of 3.13. In terms of consumer satisfaction, students rated both instructional treatments favorably.

<u>Summary</u>

The purpose of this review has been to describe and critically examine the effects of interactive multimedia programs on adults' knowledge and skill development and to describe the principles of effective teacher development that these programs employed. Overall, this review has illustrated that few studies measuring and comparing the effectiveness of interactive multimedia on adults' professional development have been conducted. Still, much of what has been learned and described in the literature lends support for the use of interactive multimedia in professional development. For example, in all but one study (van den Berg & Watt, 1991) the results indicated that interactive multimedia programs were at least as effective as instructional manuals, lecture, and computer-based tutorials on adults' knowledge and skill development and at times proved to be even more effective (Livergood, 1994; Santer et al., 1995; Shyu & Brown, 1992). Another encouraging finding is that all four studies that analyzed the pretest and posttest scores earned by adults participating in interactive multimedia programs revealed significant improvements in their knowledge development (D'Alessandro et al., 1992; Hudson & Holland, 1992; Quade, 1993) or skill development (Patterson & Yaffe, 1993). Finally, in all nine studies reporting consumer satisfaction, interactive multimedia programs were rated favorably by adults.

Despite these promising findings, much about interactive multimedia programs remains unknown. First, much is unknown regarding the effects of interactive multimedia programs on the knowledge and skills of practicing professionals. No studies with inservice teachers have been conducted, and only one study has been conducted with preservice teachers. Moreover, the research on the effectiveness of interactive multimedia with adults has, in all but one case, been conducted exclusively with university students, individuals who are relative novices in their fields. Thus, because practicing professionals will likely be a substantially different population from the novice population, gaining a better understanding of how such programs affect these individuals is critical.

Second, the large majority of studies on interactive hypermedia have focused on adults' knowledge development even though this is only one dimension of professional development (Cruickshank & Metcalf, 1990). Knowledge is only of use if it can be readily accessed and applied to both related and novel situations. Unfortunately, few studies have examined adults' ability to apply what has been learned after using an interactive multimedia program, and these studies have primarily focused on adults' ability to apply what they have learned to paper-pencil problems (Patterson & Yaffe, 1993; McGrath, 1992). Only the study by Shyu and Brown (1992) has examined adults' ability to apply a skill (making an origami crane) in an authentic situation. However, because interactive multimedia programs are likely to be used to develop adults' skills in more sophisticated areas than folding paper cranes, more research is needed.

Third, nearly all of the studies provided limited descriptions of the interactive multimedia programs. As a result, identifying the principles of effective professional development each interactive multimedia program employed was difficult. When descriptions were provided, the principles most commonly described as part of these programs were practice activities and models. Concluding with confidence whether the presence of any one principle or combination of principles positively affected adults' knowledge and skill development is difficult. What is clear from the limited descriptions provided is that an effort has *not* been made to construct interactive multimedia programs based on known principles of effective professional development. The fact that so few principles were clearly employed may help explain why the magnitude of gain most participants in interactive multimedia programs achieved from pretest to posttest on knowledge measures was not as large as one would have hoped.

The magnitude of improvement from pretest to posttest on knowledge measures for most participating adults ranged from 17.23% to 24.40% in the studies described. This magnitude of improvement was often not enough to help the adults earn satisfactory scores (i.e., scores above 80%) on posttest knowledge measures. In only two studies did participating adults earn satisfactory posttest scores (i.e., scores above 80%). However, in one of these studies (Livergood, 1994), the magnitude of participants' improvement was impossible to ascertain because no pretest scores were reported. In the other (D'Alessandro et al., 1993), the magnitude of participants' improvement was only modest. The physicians who participated entered the study with a high level of prior knowledge of respiratory airway diseases; as a result, only modest improvement was required to earn satisfactory scores on the posttest.

If the power of interactive multimedia programs for professional development is ever going to be fully understood, new comprehensive multimedia programs integrating known principles of effective professional development must be constructed. The effects of such programs on adults' knowledge and skill development must also be measured and compared to those of other instructional treatments. Moreover, comparisons cannot be made to "strawman" treatments. To make meaningful comparisons, comprehensive interactive multimedia programs must be compared to comprehensive instructional programs.

Finally, none of the studies described in this review reported the costs associated with interactive multimedia programs and compared those costs to the costs of other programs. This is a significant limitation, for the likelihood of interactive multimedia programs being embraced will surely decrease if such programs are too expensive to produce and use. Future research studies need to describe the costs related to producing interactive multimedia programs. Once this information is available, cost benefit analyses can be conducted, and the efficiency of such programs for professional development can be illuminated.

If the translation of research into practice is going to occur on a broad scale, ways to promote cost-effective, comprehensive teacher development programs are needed. Clearly, the studies described in this review indicate interactive multimedia programs *may* help to fill this need. However, until the limitations of research studies on interactive hypermedia programs described above are addressed, determining whether such programs can provide teacher development effectively and efficiently will be difficult at best. The purpose of the following study was to address some of these limitations. For this study, two comprehensive teacher development programs were created for an innovative teaching practice. The effects of these two programs on preservice and inservice teachers' knowledge of and skill in implementing the practice were measured and compared, and the costs for developing the hypermedia program were outlined. The first program, called the Virtual Workshop, was a computer-based hypermedia program. The second program, call the Actual Workshop, was a traditional, live, presenter-directed program.

Chapter 3

Methods

Participants

Preservice Teachers. Fifty-eight university students volunteered to participate in the study. These students were recruited from a group of 59 students enrolled in an instructional methods course. Of these students, 39 were undergraduates and 19 were graduates; 22 were earning elementary teaching certificates, 34 were earning secondary teaching certificates, and 2 were seeking no certification; 44 were female and 14 were male; and 53 were white, 3 were Asian, and 2 were Hispanic. The students' ages ranged from 20 to 42 years (M = 23.86, SD = 4.33). For participating, each student received twenty-five dollars and a copy of the Concept Mastery Routine teacher's manual (Bulgren, Schumaker, & Deshler, 1993).

Inservice Teachers. Ten inservice teachers volunteered to participate in the study. Of these teachers, eight were general educators teachers (Grades 7-12), and two were special educators (Grade 7). These teachers were recruited from five schools in a suburban school district in eastern Kansas. Of these teachers, all held Bachelor's degrees and three held Master's degrees. Seven were female, and 3 were male. All were white. These teachers' ages ranged from 23 to 57 years (M= 35.80, SD = 11.18), and their years of teaching experience ranged from .50 to 24 (M= 8.80, SD = 9.77). For participating, each inservice teacher received fifty dollars and a copy of the Concept Mastery Routine teacher's manual (Bulgren et al., 1993).

Setting

Virtual Workshop. The Virtual Workshop took place in a classroom at a large midwestern university. The classroom was outfitted with 10 seats arranged in a half circle facing a large-screen television monitor that was connected to a computer. This classroom was adjacent to a Macintosh™ computer lab containing three Centris™

660s, three Quadra™ 660s, two PowerMac™ 6100s, two PowerMac™ 7100s, and one PowerMac™ 8100.

Actual Workshop. The Actual Workshop took place at the same university in a similar classroom. This classroom was outfitted with 10 seats arranged in a half circle facing an overhead projector, a projector screen, and a large-screen television monitor connected to a videotape player.

The Concept Mastery Routine

The Concept Mastery Routine (Bulgren et al., 1993) is a set of instructional procedures designed to help teachers teach academically diverse classes of students to understand and master information related to key concepts (e.g., democracy, mammal, rhombus) found in the curriculum. The routine is comprised of a three-phase instructional sequence. In phase one, called "Cue," teachers provide students an advance organizer during which they explain that a concept is going to be learned, how it is going to be learned, and how students are to participate. In phase two, called "Do," students learn about the concept by completing a Concept Diagram (see Figure 1) in partnership with the teacher. A Concept Diagram is a two-dimensional graphic device comprised of seven sections. Each section is completed with specific information about the concept. For example, sections are filled with: (a) characteristics the concept always, sometimes, and never possesses; (b) examples and nonexamples of the concept, and (c) a definition for the concept. Teachers and students complete the Concept Diagram following seven Linking Steps. The Linking Steps are procedures a teacher follows to ensure the Concept Diagram is completed accurately and in partnership with students. Once the Concept Diagram has been completed, phase three begins. In this phase, called "Review," teachers ask students questions to check their understanding of the concept and the process followed to analyze the concept.

Teacher Development Programs

Virtual Workshop. Two-teacher development programs were prepared to teach inservice and preservice teachers to use the Concept Mastery Routine. One, called the "Virtual Workshop," was a computer-based, hypermedia program created using the software programs Authorware TM (Macromedia, Inc.) and Premier TM (Adobe, Inc.). The Virtual Workshop was stored on a recordable compact disc. Organized like a book, the content for the Virtual Workshop was comprised of nearly 100 "electronic" pages. These pages were grouped into 6 chapters, and the chapters were grouped into 4 sections. The titles for these sections and chapters were listed in a table of contents that was always present along the right-hand quarter of the computer screen (see Figure 2 for the names of these sections and their related chapters.). Using a mouse, a teacher could select any section or chapter, at any time and as often as wanted, by "clicking" its title. Upon doing so, information about the selected section or chapter appeared in the presentation window -- the remaining three-quarters of the screen. This information was in the form of text, video, audio, animated graphics, or a combination of these media. For example, immediately after clicking on Chapter 2 from the table of contents, the chapter's title, "The Linking Steps," appeared in the center of the presentation window, and a narrator's voice provided an advance organizer about the chapter's contents. Following this advance organizer, the chapter's first page appeared in the presentation window. This page contained a brief passage of text describing the first Linking Step. Imbedded within this passage were several blue bold-faced words. Unlike other words, these words, called hypertext, could be "clicked" by moving the cursor to the word and pressing down once on the mouse. When clicked, additional information about that word appeared in the presentation window.

In addition to text, the page also contained a video segment showing a teacher performing the first Linking Step with students, and it could be played over and over again. To electronically control the video segments, a "remote control" was present on the computer screen. Areas on this remote control could be clicked to either play, rewind, fast forward, or pause the video segment.

To enable the learner to electronically "turn" the chapter's pages, four arrows were present in the lower-right-hand corner of the computer screen. The right-pointing arrow could be clicked to turn to the chapter's next page, while the left-pointing arrow could be clicked to turn to a previous page. The remaining arrows could be clicked to turn immediately to either the chapter's first page or last page.

Like the first page, all but the last page in Chapter 2 contained text describing a particular Linking Step, hypertext, and a video segment. The last page, designed to check teachers' understanding of Chapter 2, contained three multiple-choice questions. Each question could be answered by clicking one of three options. If a question was answered correctly, a star appeared next to the question. If a question was answered incorrectly, corrective feedback was provided, and the person was prompted to answer the question again. Once all three questions on the page were answered correctly, a checkmark appeared in the table of contents, next to the title for Chapter 2. This checkmark indicated that the chapter had been completed.

The format of each remaining section and chapter of the Virtual Workshop followed a structure similar to that in Chapter 2. However, in these sections and chapters, teachers learned about other components of the Concept Mastery Routine, practiced completing sample Concept Diagrams, studied the validation research, and examined numerous Concept Diagrams constructed by other teachers. Also, teachers practiced making decisions about the use of the Concept Mastery Routine in a scenario-based simulation. That is, participants read a scenario describing a lesson in which the routine was to be used with students. At designated points in the scenario, a multiple-choice question asking participants to decide how to apply the routine was presented. Once the question was answered correctly, participants were allowed to continue through the scenario. If participants answered the question incorrectly, corrective feedback was provided and they were allowed to attempt answering the question again.

Overall, the Virtual Workshop integrated many of the known principles of effective teacher development. For example, in the program, teachers were provided: (a) *rationales* which explained why the routine should be used; (b) a thorough description of the routine, (c) several *models* demonstrating how to use the routine in a classroom lesson; (d) the opportunity to *practice* constructing Concept Diagrams and to receive corrective *feedback*; and (e) the opportunity to *practice* answering question about how to apply the routine in a simulated lesson and to receive *feedback*. Also, as will be described latter, following the Virtual Workshop, participating inservice teachers made a *written commitment* to apply the routine.

The development of the CD-ROM containing the Virtual Workshop cost an estimated $40,800. Costs were accrued in four primary areas: hardware, software, personnel, and video production. The hardware consisted of: (a) two PowerMac™ 8500/120av ($3,500 each); (b) two 20 inch Macintosh™ monitors with speakers ($905 each); and (c) one JVC™ CD-ROM recorder ($4,000). The software consisted of: (a) one copy of Macromedia™ Authorware™ ($4,995 each); and (b) one copy of Adobe™ Primer™ ($495 each). The personnel and programming time needed for development were: (a) one programmer ($30 per hour) for 450 hours; and (b) one graphics designer ($30 per hour) for 150 hours. The video production costs were comprised of a video-production crew using one Sony™ Betacam™ recorder for three days ($1,500 per day).

Actual Workshop. The second teacher development program was called the "Actual Workshop." Unlike the Virtual Workshop, the Actual Workshop followed a more traditional format; it was done live and was presenter-directed, not user-directed. That is, the content of the Actual Workshop was presented by a live expert using a lecture format. For example, when teaching about the Linking Steps, the presenter first stated an advance organizer. Then he displayed and summarized an overhead transparency describing the first Linking Step. Next, a video segment of a teacher performing the first Linking Step was shown on a monitor. Then, in the same manner, the presenter described the remaining six Linking Steps. Finally, three multiple-choice questions were presented, and teachers answered them independently, were given the correct answers, and were asked if clarification was needed. Once the Linking Steps had been covered, the presenter proceeded to other content. Since a presenter was directing the Actual Workshop, if a teacher wanted to spend additional time reviewing the Linking Steps, he/she could not. Additionally, after learning about the Linking Steps, a teacher could not proceed to content of his/her choice. No part of the presentation was presented; however, any questions participants asked were answered.

The content covered in the Virtual Workshop was also covered in the Actual Workshop. Moreover, the content of the Actual Workshop was organized according to the Virtual Workshop's table of contents. To help ensure consistency across workshops, each page of the Virtual Workshop, including chapter questions, sample Concept Diagrams, and validation research data were downloaded and printed as overhead transparencies for the Actual Workshop. Moreover, all the video segments shown in the Virtual Workshop were integrated into the Actual Workshop. Finally, like students in the Virtual Workshop, students in the Actual Workshop practiced completing sample Concept Diagrams and practiced making decisions about how to use the routine in a scenario-based simulation.

To check content consistency across the two workshops, a content checklist (see Appendix A) was created and was completed by an independent rater for both the Virtual and Actual Workshops. The rater completed the Virtual Workshop on the computer and attended an Actual Workshop. Findings indicate that 97.6% of the content presented in the two workshops was the same.

The development cost of the Actual Workshop was an estimated $9,290. These costs were accrued in the same four areas as the Virtual Workshop: computer hardware, computer software, personnel, and video production. The computer hardware needed to produce the graphic layouts for the overhead transparencies was: (a) one PowerMac™ 6100/60 ($1,500 each); and (b) one 15 inch Macintosh™ color monitor ($395). The computer software required was Adobe™ Pagemaker™ ($395). One teacher trainer was required ($30 per hour) for 100 hours to plan the presentation and prepare overhead transparencies. The video production costs were comprised of a video-production crew using one Sony™ Betacam™ recorder for three days ($1,500 per day).

Measurement Instruments

Knowledge Test. A set of seven short-answer questions was developed to test participants' understanding of the Concept Mastery Routine (see Appendix B). These questions related to teachers' understanding of the Concept Mastery Routine's components and procedures. The instructions indicated that participants had 30 minutes to answer the questions and that only the content of each answer would be scored, not spelling, grammar, or punctuation.

To score participants' answers, evaluation guidelines specifying acceptable answers for each question were developed (see Appendix B). For five of the seven questions, participants received up to 3 points for each written answer. For Question #2, participants received up to 3 points for the answer to each of the question's three parts. For Question #3, participants received up to 2 points for the answer to each of the question's seven parts. Unacceptable answers were awarded zero points. Overall, participants could earn a maximum score of 38 points. Once a point value had been assigned to each answer, the points were totaled, divided by 38, and multiplied by one hundred, producing a percentage score. This percentage score was called the Knowledge Score.

Diagram Test. For this test, participants filled in a Concept Diagram for a familiar concept, automobile (see Appendix B). This measure was developed to test participants' knowledge of what type of information (e.g., characteristic, example, etc.) belonged in each of the Concept Diagram's sections. Participants were allowed 10 minutes to complete the twenty-six blanks on the diagram and were told that only the content of their written responses would be scored, not spelling, grammar, or punctuation.

To score participants' completed Concept Diagrams, evaluation guidelines specifying acceptable responses were developed (see Appendix B). For twenty-one of the Concept Diagram's twenty-six blanks (e.g., Always Characteristics, Nonexamples, Definition, etc.), participants received 5 points for each acceptable response. For the remaining blanks (e.g., Key Words), participants received 1 point for each acceptable response. All unacceptable responses were awarded zero points. Overall, each participant could earn a maximum of 110 points. Once a point value had been assigned to each section, the points were totaled, divided by 110, and multiplied by one hundred, producing a percentage score. This percentage score was called the Diagram Score.

Implementation Checklist. An observational checklist was developed to assess some participants' implementation of the Concept Mastery Routine during a classroom lesson (see Appendix B). The checklist was comprised of three sections which corresponded with the routine's Cue-Do-Review Sequence. Using section one, observers checked teachers' use of behaviors associated with introducing or "Cueing" the routine (e.g., gaining students' attention). Using section two, observers checked teachers' use of behaviors associated with "Doing" a Concept Diagram with students (e.g., naming the targeted concept). Using section three, observers checked teachers' use of behaviors associated with "Reviewing" the concept (e.g., asking procedural questions). A total of thirty-nine teacher behaviors were assessed. For twenty-four of these behaviors, teachers received five points per behavior when it was performed. Regarding the remaining fifteen behaviors, teachers received one point when each was performed. If any behavior was not performed, the teacher received zero points on the checklist for that behavior. Additionally, each time the teacher interacted with a student in conjunction with one of the thirty-eight behaviors, an additional point, up to twenty points in total, was awarded.

Overall, each time the Concept Mastery Routine was used, teachers could earn 155 points on the checklist. Once a point value had been assigned to each behavior on the checklist by an observer, the points were totaled, divided by 155, and multiplied by one hundred, producing a percentage score. This percentage was called the Implementation Score.

To guide observers' use of the checklist, observational guidelines were developed (see Appendix B). These guidelines objectively defined each behavior and specified how points on the checklist were to be awarded. The observers practiced scoring videotaped presentations of the routine until the observers agreed on at least 90% of their recordings on the checklist.

Implementation Recording Form. A recording form was developed to determine a teacher's willingness to implement the routine (see Appendix B). On this recording form, following training in the Concept Mastery Routine, participants were asked to identify a date by which they anticipated they would use the routine for the first time. Several weeks later, these teachers were contacted and asked if they had implemented the routine, and if so on what date. Presumably, if they were comfortable with the routine, teachers would be more likely to implement it soon after the workshop. A teacher's scores on this measure were the number of school days from training to predicted implementation and the number of school days from training to actual implementation. These scores were called the Latency of Implementation Scores. At the end of the study, the teachers were also asked how many times they had implemented the routine in their classes.

Satisfaction Questionnaire. A fourteen-item questionnaire was developed to assess participants' satisfaction with the training they received (see Appendix B). Each questionnaire item included a 7-point Likert-type scale ranging from "disagree" (1) to "agree" (7). The items were designed to determine: (a) how enjoyable participants found the training; (b) how engaged participants felt during the training; (c) how understandable participants found the content, and (d) how applicable participants found the content. Teachers' ratings for these items were called the Satisfaction Scores.

Reliability. Interscorer reliability was determined by having two scorers independently score 20% of the Knowledge Tests and Diagram Tests. Interscorer reliability for the Implementation Checklist was determined by having two observers simultaneously record information in 20% of the classroom observations of teachers' implementation of the routine. The points awarded by the two observers were compared item-by-item for each of the measures. The percentage of agreement was calculated by dividing the number of agreements by the number of disagreements and multiplying by 100. For the Knowledge Tests, the scorers agreed 1397 times out of 1444 opportunities to agree (total percentage of agreement = 96.75%). For the Diagram Tests, the scorers agreed 967 times out of 988 opportunities to agree (total percentage of agreement = 97.87%). For the Implementation Checklists, the scorers agreed 1979 times out of 2040 opportunities to agree (total percentage of agreement = 97.01%). For the Implementation Recording Form, the scorers agreed 16 times out of 16 opportunities to agree (total percentage of agreement = 100%).

Virtual Workshop Procedures

Preservice Teachers. Twenty-nine of the 58 preservice teachers were randomly assigned to the Virtual Workshop group. In groups of ten or fewer, these preservice teachers participated in a Virtual Workshop on the Concept Mastery Routine. Immediately before the Virtual Workshop, a session leader pretested the preservice teachers on the Knowledge and Diagram Tests. Participants were allowed a maximum of 30 minutes to complete the Knowledge Test and a maximum of 10 minutes to complete the Diagram Test. If participants asked about a question's answer, they were instructed to answer the question as best they could. Next, using a computer attached to a large-screen monitor, the session leader loaded the Virtual Workshop and provided a five minute demonstration of how to "page" or navigate through the computer program. Following this demonstration, the preservice teachers were escorted to an adjacent computer lab. Each preservice teacher then selected a computer on which the Virtual Workshop was loaded and began to navigate the computer program. The preservice teachers were provided a maximum of two and a half hours to navigate the entire program. The session leader remained in the lab to provide technical support (e.g., restart frozen computers, adjust computer volume, change broken CD-ROM drives). If preservice teachers had questions about content, they were told the computer program contained all the information they needed to understand the Concept Mastery Routine. Once the preservice teachers had completed the Virtual Workshop, they were administered the Knowledge Test, Diagram Test, and Satisfaction Questionnaire. Again, preservice teachers were provided a maximum of 30 minutes for the Knowledge Test, and 10 minutes for the Diagram Test. No time limit was set for the Satisfaction Questionnaire. Altogether, a total of four hours were scheduled for the preservice teachers to complete the pretests, the Virtual Workshop, and the posttests.

Inservice Teachers. Of the 10 inservice teachers, five were randomly assigned to the Virtual Workshop treatment group. These four general education teachers and one special education teacher participated in the Virtual Workshop on the Concept Mastery Routine following the same procedures as those used with preservice teachers. However, before participating, the four general education teachers were observed delivering three or more lessons in their classrooms. During these lessons, each participating teacher delivered instruction on a concept of his/her choice. The special education teacher was not observed. During each lesson, observers scored the general education teachers' presentation using the Implementation Checklist. Once the baseline data were stable or showed decreasing trends for each of these teachers, they participated the Virtual Workshop on the Concept Mastery Routine. Afterward, these four general education teachers were again observed presenting lessons in which they indicated a concept would be taught. For example, during each lesson, observers again scored the teachers' presentation using the Implementation Checklist. She teacher did not implement the routine. The special educator taught at a school with several of the participating general educators, and she wanted to learn about the routine these general educators were going to use in classes in which her mainstreamed special education students were enrolled.

Actual Workshop Procedures

Preservice Teachers. Twenty-nine preservice teachers were randomly assigned to the Actual Workshop treatment group. Like the preservice teachers assigned to the Virtual Workshop treatment group, these preservice teachers attended the Actual Workshop in groups of ten or fewer and were initially pretested on the Knowledge and Diagram Tests. Once the pretests were completed, a session leader began the Actual Workshop. Using overhead transparencies, an overhead projector, videotape segments, and a videotape player attached to a large-screen monitor, the session leader directed the Actual Workshop. Any questions asked about the Concept Mastery Routine were answered. Once all the content had been covered, all activities had been completed, and all questions had been answered, each preservice teacher was administered the Knowledge Test, Diagram Test, and Satisfaction Questionnaire. Altogether, following the same timeline as the Virtual Workshop, a total of four hours were scheduled for the completion of the pretests, the Actual Workshop, and the posttests.

Inservice Teachers. Five inservice teachers were randomly assigned to the Actual Workshop treatment group. These four general education teachers and one special education teacher participated in the Actual Workshop on the Concept Mastery Routine following the same procedures as those used with preservice teachers. Moreover, like the general education teachers in the Virtual Workshop treatment group, before and after training in the Concept Mastery Routine, these inservice teachers were observed in their classrooms presenting lessons in which they indicated a concept would be taught. Observers scored these lessons using the Implementation Checklist. Again, like the special education teacher attending the Virtual Workshop, this special education teacher taught at a school with several of the participating general educators. She wanted to learn about the routine these general educators were going to use in classes in which her mainstreamed special education students were enrolled. She did not implement the routine.

Experimental Designs

Four experimental designs were employed simultaneously during this study. A pretest-posttest control-group design (Campbell & Stanley, 1963) was used to compare the Knowledge Scores and Diagram Scores of preservice teachers participating in the Virtual and Actual Workshops and of inservice teachers in both workshops. A posttest-only control-group design (Campbell & Stanley, 1963) was used to compare the Satisfaction Scores of preservice teachers participating in the Virtual and Actual Workshops, and of inservice teachers in both workshops. To compare inservice teachers' Latency of Implementation Scores, a posttest-only control-group design was used (Campbell & Stanley, 1963). Finally, to determine the effects of the workshops on inservice teachers' Implementation Scores, a multiple-baseline across-teachers design (Baer, Wolf, & Risley, 1968) was employed and replicated two times.

Chapter 4

Results

Preservice Teachers

Listed in Table 1 are the mean percentage scores and standard deviations summarizing the pretest and posttest performances of preservice teachers from both treatment groups on the Knowledge and Diagram Tests. To compare the differences between these pretest and posttest scores within each treatment group, t-tests were performed and indicated that: (a) the posttest scores of preservice teachers who participated in the Virtual Workshop were significantly higher than their pretest scores on the Knowledge Test [t (28) = 15.35, $p < 0.00$] and the Diagram Test [t (28) = 37.99, $p < 0.00$]; and (b) the posttest scores of preservice teachers who participated in the Actual Workshop were significantly higher than their pretest scores on the Knowledge Test [t (28) = 17.05, $p < 0.00$] and the Diagram Test [t (28) = 38.70, $p < 0.00$].

To determine whether the two training methods had differential effects on the preservice teachers' performance, analyses of covariance (ANCOVA) were employed using the preservice teachers' posttest scores as the dependent variable and their pretest scores as the covariate. These analyses revealed no statistically significant difference between the posttest scores that preservice teachers in the Virtual and Actual Workshops earned on the Knowledge Test [F (1, 55) = 0.44, $p < 0.51$] or the Diagram Test [F (1, 55) = 0.00, $p < 0.98$].

Figure 3 depicts the results from the Satisfaction Questionnaire distributed to all preservice teachers who participated. Overall, preservice teachers rated both the Virtual and Actual Workshops favorably. Across all fourteen Likert-scale items, mean Satisfaction Scores ranged from 5.10 to 6.14 for preservice teachers participating in the Virtual Workshop and from 4.93 to 6.66 for preservice teachers participating in the Actual Workshop. To illuminate differences between the mean Satisfaction Scores of each treatment group for each item, analyses of variance (ANOVA) were performed. These analyses indicated that teachers who participated in the Actual Workshop rated questionnaire items #1 [F (1, 56) = 8.38, $p < 0.01$], #5 [F (1, 56) = 5.09, $p < 0.03$], and #9 [F (1, 56) = 5.72, $p < 0.02$] significantly higher than preservice teachers who participated in the Virtual Workshop. Interestingly, each of these three items pertained to how well the preservice teachers thought they understood the content presented. The remaining questionnaire items, which related to how applicable participants found the content, how enjoyable they found the training, and how engaging they found the training, were rated similarly by preservice teachers from both groups.

Inservice Teachers

Listed in Table 2 are the mean percentage scores and standard deviations summarizing the pretest and posttest performances of inservice teachers from both treatment groups on the Knowledge and Diagram Tests. The differences between these pretest and posttest scores within each treatment group were compared using Wilcoxon Signed Ranks Tests. These analyses indicated: (a) the posttest scores of inservice teachers who participated in the Virtual Workshop were significantly higher than their pretest scores on the Knowledge Test [$z = 2.19$, $p < 0.04$] and on the Diagram Test [$z = 2.19$, $p < 0.04$]; and (b) the posttest scores of inservice teachers who participated in the Actual Workshop were significantly higher than their pretest scores on the Knowledge Test [$z = 2.21$, $p < 0.04$] and on the Diagram Test [$z = 1.80$, $p < 0.04$].

Though both treatments produced significant improvement, to identify possible differential effects of the two training methods on inservice teachers' Knowledge and Diagram Scores, Kruskal-Wallis One-Way Analyses of Variance by

Ranks (KWANOVA) were used. These analyses revealed no significant differences between the pretest scores of teachers participating in the Virtual and Actual Workshops on the Knowledge Test [$\underline{X}^2$ (1, $\underline{N}$ = 10) = 0.05, $\underline{p} < 0.83$] and the Diagram Test [$\underline{X}^2$ (1, $\underline{N}$ = 10) = 2.53, $\underline{p} < 0.11$], or between the posttest scores of these same teachers on the Knowledge Test [$\underline{X}^2$ (1, $\underline{N}$ = 10) = 0.18, $\underline{p} < 0.67$] and the Diagram Test [$\underline{X}^2$ (1, $\underline{N}$ = 10) = 2.22, $\underline{p} < 0.14$]. Interestingly, the pretest Diagram Scores of inservice teachers who participated in the Actual Workshop were 32.95 percentage points higher than those of the inservice teachers who participated in the Virtual Workshop. Given these different levels of prior knowledge, one would assume the Actual Workshop teachers would also score higher than Virtual Workshop teachers at posttest. However, on average, the inservice teachers who participated in the Virtual Workshop actually scored higher than teachers who participated in the Actual Workshop on the Diagram Posttest.

Eight of the inservice teachers were observed in their classrooms teaching concepts to their students. Figures 4, 5, 6, and 7 show the performance of these teachers as recorded on the Implementation Checklist. In these figures, each teacher's performances before participating in a workshop (i.e., during baseline) are shown to the left of the solid vertical line and their performances after participating in workshop (i.e., after training) are shown to the right of this line. The performances of teachers who participated in the Virtual Workshop are shown in Figures 4 and 5, whereas the performances of teachers who participated in the Actual Workshop are shown in Figures 6 and 7.

As illustrated in these two figures, during baseline, the percentage of points earned on the Implementation Checklist by teachers who participated in the Virtual Workshop ranged from 0% to 31.60% ($\underline{M}$ = 12.45%, $\underline{SD}$ = 9.15); the percentage of points earned by teachers who participated in the Actual Workshop ranged from

3.20% to 38.06% (M = 19.03%, SD = 11.82). The scores earned during baseline by teachers in both treatments were compared using the KWANOVA . Results revealed no significant differences between the groups' scores [X^2 (1, N = 8) = 3.43, p = 0.06].

After training, the percentage of points earned on the Implementation Checklist by teachers who participated in the Virtual Workshop ranged from 73% to 92.25% (M = 84.68%, SD = 5.54) (See Figures 5 and 6). Moreover, 10 of the 12 lessons presented by teachers after training exceeded the arbitrary mastery level of 80%. Visual examination of scored Implementation Checklists suggested that the teachers rarely reviewed what had been learned with their students. These teachers also did not regularly help students discuss the characteristics possessed by examples of the targeted concept. Moreover, after the first time teachers used the routine, they rarely explained to students how the routine would help them learn and how they were to participate when it was used.

The percentage of points earned on the Implementation Checklist after training by teachers who participated in the Actual Workshop ranged from 58.70% to 100% (M = 78.25%, SD = 13.27) (See Figures 6 and 7). Of the 12 lessons presented by these teachers after training, five exceeded the mastery level of 80%. Visual examination of the Implementation Checklists suggested that, like teachers who participated in the Virtual Workshop, these teachers also rarely reviewed with their students what had been learned. Moreover, these teachers also did not regularly help students to discuss the characteristics possessed by examples of the targeted concept. One teacher who participated in the Actual Workshop lost some points on the Implementation Checklist because he did not always fill in the example and nonexample sections of the Concept Diagram; rather, he stated the examples and nonexamples aloud. On other occasions, teachers did not earn points because they did not provide students an adequate number of characteristics or examples of the targeted concept.

The KWANOVA was used to compare the scores earned after training by teachers in the two treatment groups. No statistically significant differences between the groups' scores were revealed [$\underline{X}^2$ (1, $\underline{N}$ = 8) = 1.62, $\underline{p}$ = 0. 23].

Immediately after training, the eight inservice teachers predicted a date on which they would first implement the routine. Later, they reported the date on which they actually implemented the routine. The results are depicted in Figure 8 and indicate that teachers who participated in the Actual Workshop predicted they would implement the Concept Mastery Routine in fewer days than teachers who participated in the Virtual Workshop. Teachers who participated in the Actual Workshop predicted they would implement the routine after an average of 8.25 school days ($\underline{SD}$ = 2.63), whereas teachers who participated in the Virtual Workshop predicted they would implement the routine after an average of 17 school days ($\underline{SD}$ = 8.60). Despite the variation among these predictions, a KWANOVA revealed that these differences were not statistically significant [$\underline{X}^2$ (1, $\underline{N}$ = 8) = 2.55, $\underline{p}$ = 0.11].

With regard to actual implementation, the teachers who participated in the Actual Workshop implemented the routine sooner than teachers who participated in the Virtual Workshop. On average, they implemented the routine after 19.50 days ($\underline{SD}$ = 16.09), whereas teachers who participated in the Virtual Workshop implemented the routine after an average of 29 school days ($\underline{SD}$ = 7.79). Again, however, the KWANOVA revealed that these differences were not statistically significant [$\underline{X}^2$ (1, $\underline{N}$ = 8) = 0.75, $\underline{p}$ = 0.39]. Interestingly, for both groups, the number of days between the dates teachers predicted they would implement and actually implemented the routine were very similar. That is, teachers who participated in the Actual Workshop, on average, implemented the routine 11.25 school days ($\underline{SD}$ =

15.71) after the date they had predicted, whereas teachers who participated in the Virtual Workshop, on average, implemented the routine 12 school days (SD = 11.75) after the date they had predicted.

Depicted in Figure 9 are the results from the Satisfaction Questionnaire for participating inservice teachers. Overall, like the preservice teachers, the inservice teachers rated both the Virtual and Actual Workshops favorably. In fact, the mean Satisfaction Scores of the inservice teachers were even higher than those of the preservice teachers. Across all fourteen Likert-scale items, mean Satisfaction Scores ranged from 5.50 to 7.00 for inservice teachers who participated in the Virtual Workshop and the Actual Workshop. Analysis of the teachers' mean Satisfaction Scores using the KWANOVA revealed no significant differences between the two groups on any item. Thus, what was most notable about these findings was how similarly teachers participating in the two workshops rated each item.

Chapter 5

Discussion

Conclusions and Relationship to Previous Research

The purpose of this project was to develop an interactive multimedia program and to examine: a) its effects on preservice and inservice teachers' knowledge of an instructional innovation; b) its effects on inservice teachers' skill in implementing the innovation in their classrooms with students; and c) to outline the costs associated with its development.

Several conclusions can be drawn from the results of this research effort. First, compared to their pretest scores, the posttest scores preservice and inservice teachers earned on the Knowledge and Diagram Tests significantly improved following participation in either the Virtual or Actual Workshops. Unfortunately, the magnitude of their improvement on the Knowledge Test was not as large as might be desired. That is, despite improving an average of at least 45 percentage points from pretest to posttest, preservice and inservice teachers' posttest scores on the Knowledge Test still averaged from only 49.09% to 63.68%. The instruction, models, practice, and feedback these teachers received did impact their knowledge about the innovation, but the teachers' recall of information related to the Concept Mastery Routine was approximately 40% incomplete or inaccurate after training. Nevertheless, this magnitude of gain on the Knowledge Test was considerably higher than the magnitude of gain reported by other investigators utilizing interactive multimedia programs (Lanza & Roselli, 1991; Quade, 1993; Santer et al., 1995; Schank & Rowe, 1993).

The magnitude of the effects of both workshops on preservice and inservice teachers' performance on the Diagram Test, on the other hand, was socially significant. Overall, the teachers' average scores ranged from 84.14% to 93.63%. For this test, participating teachers were provided a blank Concept Diagram and asked to complete it for the targeted concept "automobile." The graphic structure of the blank Concept Diagram was designed to prompt the entry of specific content related to the targeted concept. Thus, because of the prompts the Concept Diagram provided, this test may have not been as difficult as a Knowledge Test which required complete recall. Nevertheless, given that teachers improved, on average, at least 45 percentage points, this finding indicates that the instruction, practice, and feedback these teacher received led them to construct highly accurately Concept Diagrams.

Second, both the Virtual Workshop and the Actual Workshop had similar effects on the scores earned by preservice and inservice teachers on the Knowledge and Diagram Tests. Thus, for these two measures, the Virtual and Actual Workshops appear to be interchangeable. Interestingly, other studies comparing the effects of user-directed interactive multimedia programs to computer-directed tutorials (D'Alessando et al., 1992; Hudson & Holland, 1992) and teacher-directed lectures (Lanza & Roselli, 1991; Quade, 1993; Santer et al., 1995; Schank & Rowe, 1992) have also contained similar findings.

Third, an analysis of the scores from the actual implementation of this innovation suggests that inservice teachers who participated in the Virtual Workshop and those who participated in the Actual Workshop performed a substantially greater number of the Concept Mastery Routine's targeted behaviors after training than before training. Moreover, these findings also suggest that, on average, inservice teachers who participated in the Virtual Workshop performed the Concept Mastery Routine in a manner similar to those teachers who participated in the Actual Workshop. This finding is important, for other studies have not measured the effect of an interactive multimedia program on adults' ability to apply a sophisticated skill in an authentic setting like a classroom. Still, despite the marked improvement of both groups with regard to teaching concepts, room remained for all participating teachers to use the routine more completely. For example, inservice teachers who participated in the Virtual Workshop rarely reviewed what had been learned with their students, did not regularly discuss what characteristics, examples, and nonexamples of the targeted concept possessed, and often failed to explain to students how the routine would help them to learn.

Interestingly, a previous study that measured teachers' ability to implement the Concept Mastery Routine following a workshop format similar to the Actual Workshop revealed that, on their first try, participating teachers could implement the routine nearly perfectly (Bulgren, Schumaker, & Deshler, 1988). This workshop differed from the Actual and Virtual Workshops in one important way: before trying the routine with students, participating teachers first taught a practice lesson to other teachers and received corrective feedback on their performance. During the Virtual and Actual Workshops in this study, teachers answered questions in a scenario-based simulation only; they did not have an opportunity to actually practice the routine in a live simulation activity.

Fourth, although the inservice teachers in both groups performed similarly on the Knowledge Test, the Diagram Test, and the Implementation Checklist, some variation existed between their predicted and actual dates of implementation on the Implementation Recording Form. Though these differences were not statistically significant, they do suggest that inservice teachers who participated in the Actual Workshop were more comfortable with their understanding of the Concept Mastery Routine than teachers who participated in the Virtual Workshop.

Fifth, preservice and inservice teachers' satisfaction ratings of the Virtual and Actual Workshops were favorable. The fact that preservice and inservice teachers rated the Virtual Workshop favorably was not surprising. Interactive multimedia programs are typically well-liked by their users. What was surprising, however, was how favorably preservice and inservice teachers rated the Actual Workshop. In three previous studies in which the consumer satisfaction ratings of adults who participated in group lectures and adults who participated in interactive multimedia programs were compared, the adults who experienced the multimedia programs rated their enjoyment of the interactive multimedia programs substantially higher than those who participated in lecture (Hudson & Holland, 1992; D'Alessandro et al., 1992; Santer et al., 1995). Interestingly, preservice teachers who participated in the Actual Workshop had significantly higher ratings on questionnaire items pertaining to how well they understood the content presented than preservice teachers who participated in the Virtual Workshop. This finding corroborates the finding that Actual Workshop participants predicted that they would use the Routine sooner than Virtual Workshop participants. Such findings may be cause for concern because if Virtual Workshop participants walk away from a session feeling uncomfortable about using an innovation, they may never use it. Since both groups of inservice teachers understood that the researchers would be visiting their classrooms to observe their implementation of the Routine, whether or not they would have actually implemented it in their classrooms if visitors had not been coming to observe is unknown.

Finally, the development cost of the Virtual Workshop was nearly four times as expensive as the development cost of the Actual Workshop. Still, though the development cost of the Virtual Workshop was greater, the cost to implement this workshop with teachers is less than the cost to implementation the Actual Workshop. That is, each time the Actual Workshop is implemented, $250 for the half-day presenter and $30 for each participating teacher's half-day substitute needs to be spent. Thus, the cost for 100 teachers to attend an Actual Workshop would be $3,250. However, to implement the Virtual Workshop with one teacher could cost as little as

$2.50, the price of one compact disc with postage. Thus, training for 100 teachers could cost only $250.00. Conceivably, if the number of teachers trained was increased, the cost to develop and implement the Virtual Workshop *could* be similar to or even less than the cost to develop and implement the Actual Workshop.

This research has both replicated and extended the literature on interactive multimedia. First, it has replicated existing research by: (a) demonstrating the effects of an interactive multimedia program on preservice and inservice teachers' *knowledge* of an instructional innovation; and (b) comparing their satisfaction with the interactive multimedia program and a traditional professional development program. Second, this study has extended existing research by measuring the effects of an interactive multimedia program on inservice teachers' *skill* in applying an instructional innovation in authentic classroom situations. In previous studies participants only applied what they had learned to paper-pencil tasks (Patterson & Yaffe, 1993; McGrath, 1992) or simple procedural tasks like folding paper cranes (Shyu & Brown, 1991). This study has provided evidence that inservice teachers can, on average, apply a complex instructional innovation in their own classrooms with 84.68% accuracy after completing an interactive multimedia program. Finally, this study has shed light on the cost associated with interactive multimedia programs. Though a comprehensive cost-benefit analysis is not feasible at this time, the information regarding costs provides some guidance about the potential use of interactive multimedia programs for teacher development in the future.

<u>Limitations</u>

Despite these encouraging findings, this study is limited in several ways. First, only the inservice teachers were observed implementing the Concept Mastery Routine with students. Whether preservice teachers could correctly implement the routine in an authentic setting at levels similar to the inservice teachers remains unknown.

Second, in most cases, inservice teachers who participated in either of the two workshops were, in most cases, observed using the routine only three times. Although the inservice teacher's scores on the Implementation Checklist were consistent, whether this level of consistency would be maintained over a semester or school year is unknown. Moreover, whether participating teachers would continue to use the Concept Mastery Routine is unclear. For example, one teacher indicated that he had used the routine with 12 different concepts during a three-month period, whereas another teacher implemented the routine only two times in this same period of time. Though this second teacher used the routine adequately, she was uncomfortable using it with her students and chose to not use the routine again.

Third, all of the teachers were given a pretest prior to participating in either the Virtual or Actual Workshop. This pretest may have sensitized teachers to particular content. As a result of being sensitized, their performance on the posttests and in the classroom may have been affected. Neither the Virtual or Actual Workshop may have similar effects with another group of preservice or inservice teachers if those teachers are not first given a pretest.

Fourth, the only instructional innovation taught to the participating preservice and inservice teachers through the Virtual Workshop was the Concept Mastery Routine. Thus, the effects of the Virtual Workshop on these teachers' performance may have resulted from the novelty of this approach. Whether these same teachers would benefit as much from participating in a second or third Virtual Workshop on other instructional innovations is unknown. Whether teachers can learn about other instructional innovations through this method is also unknown.

Finally, all of the participants in this study were volunteers. These teachers may not be representative of the general population of preservice and inservice teachers. Neither the Virtual or Actual Workshops may have similar effects with another group of preservice or inservice teachers if those teachers are required to participate.

Future Research

Additional research is needed before the Virtual Workshop for the Concept Mastery Routine can be used confidently in teacher development programs. Clearly, given the low posttest Knowledge Scores of inservice teachers who completed the Virtual Workshop, studies need to be conducted to examine how to improve the understanding and recall of critical content presented in interactive multimedia programs. Secondly, studies should also be conducted to identify methods for improving the ability of teachers who have completed the Virtual Workshop to implement the Concept Mastery Routine more precisely. Although the teachers in the study did apply the Concept Mastery Routine with over 80% accuracy, in an earlier study (Bulgren et al., 1988) teachers who completed a traditional workshop implemented the routine nearly perfectly with students on their first try. This traditional workshop differed from the Virtual Workshop in that participating teachers taught a practice lesson to one another and received corrective feedback on their instruction. Perhaps by following up the Virtual Workshop with a similar combination of practice and feedback, teachers participating in the Virtual Workshop could apply the routine nearly perfectly with students on their first try, too.

Once improvements to the Virtual Workshop are made, long-term studies in which teachers learn a series of instructional innovations using such an interactive multimedia program should be conducted. Such studies would allow investigators to determine whether the novelty of interactive multimedia impacts teachers' professional development. Moreover, such a study would enable investigators to determine whether teachers can sustain the application of newly learned innovations over time. In conjunction with this research, a cost-benefit analysis could also be conducted. This analysis would more accurately reflect the true costs associated with developing and using interactive multimedia programs like the Virtual Workshop. That is, after the first interactive multimedia program was developed, subsequent programs would be less expensive to produce because the computer programmers would be trained and no additional computer equipment would need to be purchased. Thus, through the development of several interactive multimedia programs, a more accurate price for each program could be calculated.

Teacher Development Implications

Since the findings suggest that the Virtual Workshop can effectively advance both preservice and inservice teachers' knowledge of and skill in implementing a complex instructional routine in their classrooms with students and are satisfied with the instruction, this medium may have great impact on the field of teacher education. For example, at the preservice level, interactive multimedia programs could be used in place of lectures given in methods courses. That is, education students could learn about different instructional methods at home or at a computer lab. Moreover, this instruction would provide a degree of depth and breadth not possible in the limited time of most university courses. In turn, course time could be used to provide preservice teachers a setting in which to practice and receive corrective feedback about an innovation learned from an interactive multimedia program. At the inservice level, teachers could choose to learn about cutting-edge innovations which they are interested in learning, rather than attending traditional workshops about methods administrators think they should know. These teachers could also learn about cutting-edge innovations from the very best the field of education has to offer, and do so according to their own schedule. Moreover, districts could potentially provide teachers such professional development opportunities at a cost that is less per teacher than existing professional development models.

Summary

The results of this study indicate that compared to their pretest scores, the posttest scores earned by inservice and preservice teachers on the Knowledge and Diagram Tests significantly improved following participation in either the Virtual or Actual Workshops. Moreover, preservice and inservice teachers' satisfaction ratings of both the Virtual and Actual Workshops were favorable. Inservice teachers who participated in the Virtual Workshop and Actual Workshops correctly performed a substantially greater number of the innovation's targeted behaviors after training than before training. Overall, both the Virtual and Actual Workshops had similar, positive effects on both teachers understanding and implementation of the instructional innovation. This study suggests interactive multimedia programs like the Virtual Workshop may provide a new medium through which effective teacher development can be provided. Potentially, this medium could provide general education teachers, who teach academically diverse classes of students, the training in inclusive practices they testify they need.

References

Acovelli, M., & Nowakowski, A. (1994). The business practices course: Self-study learning reengineered. Educational Technology, 54, 21-27.

Bashinski, S. M. (1996). Interactive multimedia technology as an instructional tool for teachers of students with profound or multiple disabilities. Unpublished doctoral dissertation, University of Kansas, Lawrence.

Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. Journal of Applied Behavior Analysis, 1, 91-97.

Becker, D. A., & Dwyer, M. M. (1994). Using hypermedia to provide learner control. Journal of Educational Multimedia and Hypermedia, 3(2), 155-172.

Bulgren, J. A., Deshler, D. D., & Schumaker, J. B. (1993). The Concept Mastery Routine. Lawrence, KS: Edge Enterprises.

Bulgren, J. A., Schumaker, J. B., & Deshler, D. D. (1988). Effectiveness of a concept teaching routine in enhancing the performance of LD students in secondary-level mainstream classes. Learning Disabilities Quarterly, 11(1), 3-17.

Campbell, D. T., & Stanley, J. C. (1963). Experimental and quasi-experimental designs for research. Dallas, TX: Houghton Mifflin.

Chignell, M. H., & Lacy, R. M. (1988). Project Jefferson: Integrating research and instruction. Academic Computing, 3(2), 12-17, 41-45.

Covey, P. K. (1990). Art or forgery? The strange case of Han Van Meegeren a videodisc for aesthetics and art history. Journal of Computing in Higher Education, 2(1), 3-31.

Cruickshank, D. R., & Metcalf, K. K. (1990). Training within teacher preparation. In W. R. Houston (ED.), Handbook of research on teacher education (pp. 469-497). New York: Macmillan.

D'Alessandro, M. P., Galvin, J. R., Erkonsen, W. E., Albanese, M. A., Michaelsen, V. E., Huntley, J. S., McBurney, R. M., & Easley, G. (1993). The instructional effectiveness of a radiology multimedia textbook (hyperlung) versus standard lecture. Investigative Radiology, 28(7), 643-648.

Egan, D. E., Remde, J. R., Gomez, L. M., Landauer, T. K., Eberhardt, J., & Lochbaum, C. C. (1989). Formative design-evaluation of superbook. Transactions on Information Systems, 7(1), 30-57.

Fisher, J. B., Schumaker, J. B., & Deshler, D. D. (1995). Searching for validated inclusive practices: A review of the literature. Focus on Exceptional Children, 28(4), 1-20.

Fullan, M. G., with Stiegelbauer, S. (1991). The new meaning of educational change (2nd ed.). New York: Teachers College Press.

Gall, M. D., & Vojtek, R. O. (1994). Planning for effective staff development: Six research-based models. Eugene, OR: ERIC Clearinghouse on Educational Management, University of Oregon.

Gartner, A., & Lipsky, D. K. (1987). Beyond special education: Toward a quality system for all students. Harvard Educational Review, 57, 367-395.

Gersten, R., & Brengelman, S. U. (1996). The quest to translate research into classroom practice: The emerging knowledge base. Remedial and Special Education, 17(2), 67-74.

Gersten, R., Vaughn, S., Deshler, D. D., & Schiller, E. P. (1995, July). What we know (and still don't know) about utilizing research findings to improve practice: Implications for special education. Paper presented at the annual project directors meeting of the US. Department of Education, Office of Special Education, Washington, DC.

Guskey, T. R. (1994). Results-oriented professional development: In search of an optimal mix of effective practices. Journal of Staff Development, 15(4), 42-50.

Guskey, T. R. (1986). Staff development and the process of teacher change. Educational Researcher, 15(5), 5-12.

Hannaway, D. B., Shuler, P. E., Bolte, J. P., & Miller, M. J. (1992). Development and evaluation of LEGUME ID: A toolbook multimedia module. Journal of Natural Resources and Life Science Education, 21(1), 57-61.

Harding, R. D., Lay, S. W., Moule, H., & Quinney, D. A. (1995). Multimedia interactive mathematics courseware: The mathematics experience within the renaissance project. Computers and Education, 24(1), 1-23.

Hodgkinson, H. (1991). Reform versus reality. Phi Delta Kappan, 73(1), 8-16.

Hoover, W. A., Boethel, M. (1991). Staff development in the southwest's rural/small schools. Rural Educator, 12(2), 9-13.

Hudson, T. J., & Holland, S. D. (1992). Interactive multimedia instruction in video production classes. Journalism Educator, 47(3), 18-26.

Hutchings, G. A., Hall, A., & Thorogood, P. (1994). Experiences with hypermedia in undergraduate education. Computers and Education, 22(1), 39-44.

Jaffe, C. C., & Lynch, P. J. (1989). Hypermedia for education in the life sciences. Academic Computing, 4, 10-13, 52-57, 73.

Johnson, C. W., & Grover, P. A. (1993). Hypertutor therapy for interactive instruction. Educational Technology, 33 (1), 5-16.

Joint Committee on Teachers Planning for Students with Disabilities. (1995). Planning for academic diversity in America's classrooms: Windows on reality, research, change, and practice. Lawrence: The University of Kansas Center for Research on Learning.

Joyce, B., & Showers, B. (1988). Student achievement through staff development. New York: Longman.

Kauffman, J. M. (1994). Places of change: Special education's power and identity in an era of educational reform. Journal of Learning Disabilities, 27(10), 610-618.

Kinzie, M. B., & Berdel, R. L. (1990). Design and use of hypermedia systems. Education Technology Research and Development, 38(3), 61-68.

Kline, F. M., Deshler, D. D., & Schumaker, J. B. (1992). Implementing learning strategy instruction in class settings: A research perspective. In M. Pressley, K. R. Harris, & J. T. Guthrie (Eds.), Promoting academic competence and literacy in school (pp. 361-406). San Diego, CA: Academic Press.

Korinek, L., Schmid, R., & McAdams, M. (1985). Inservice types and best practices. Journal of Research and Development in Education, 18, 33-38.

Landow, G. P. (1989). Hypertext in literacy education, criticism, and scholarship. Computers and the Humanities, 23, 173-198.

Lanza, A., & Roselli, T. (1991). Effects of the hypertextual approach versus the structured approach on students' achievement. Journal of Computer-Based Instruction, 18(2), 48-50.

Lee, W., Ault, H., Kirk, J. S., & Comstock, C. H. (1995). Interactive multimedia for prenatal ultrasound training. Obsentrics and Gynecology, 85(1), 135-140.

Lenz, B. K., & Deshler, D. D. (1993). Ethical issues related to translating research in learning disabilities into practice. In S. Vaughn & C. S. Bos (Eds.), Research issues in learning disabilities: Theory, Methodology, Assessment, and Ethics. (pp. 329-347). New York: Springer-Verlag.

Liu, M., & Reed, W. M. (1995), The effect of hypermedia assisted instruction on second language learning. Journal of Educational Computing Research, 12(2), 159-175.

Livergood, N. D. (1993). A study of the effectiveness of a multimedia intelligent tutoring system. Journal of educational technology systems, 22(4), 337-344.

Malouf, D. B., & Schiller, E. P. (1995). Practice and research in special education. Exceptional Children, 61(5), 414-424.

Marchionini, G. (1988). Hypermedia and learning: Freedom and chaos. Educational Technology, 28(11), 8-12.

McGrath, D. (1992). Hypertext, CAI, paper, or program control: Do learners benefit from choices? Journal of Research on Computing Education, 24(4), 513-532.

Merseth, K. K. (1992). First aid for first-year teachers. Phi Delta Kappan, 73(9), 678-683.

Overbaugh, R. C. (1994). An example of software development and authoring with hypercard: Creating an interactive video simulation for teaching basic principles of classroom management to pre-service teachers. Computers in the Schools, 10(3/4), 313-338.

Patterson D. A., & Yaffe, J. (1993). Using computer-assisted instruction to teach Axis-II of the DSM-III-R to social work students. Research on social work practice, 3(3), 343-357.

Quade, A. M. (1993, January). An assessment of the effectiveness of a hypertext instructional delivery system when compared to a traditional CAI tutorial. Paper presented at the Convention of the Association for Educational Communications and Technology, New Orleans, LA.

Rojewski, J. W., Gilbert, J. P., & Hoy, C. A. (1994). Effects of a hypertext computer program on academic performance in a special education course for nonmajors. Teacher Education and Special Education, 17(4), 249-259.

Santer, D. M., Michaelsen, V. E., Erkonsen, W. E., Winter, R. J., Woodhead, J. C., Gilmer, J. S., D'Alessandro, M. P., & Galvin, J. R. (1995). A comparison of educational interventions: Multimedia textbook, standard lecture, and printed textbook, Archives of Pediatric and Adolescent Medicine, 149, 297-302.

Schumaker, J. B., & Clark, F. L. (1990). Achieving implementation of strategy instruction through effective inservice education. Teacher education and special education, 13(2), 105-116.

Schank, P. K., & Rowe, L. A. (1993). The design and assessment of a hypermedia course on semiconductor manufacturing. Journal of educational multimedia and hypermedia, 2(3), 299-320.

Schrum, L. (1992). Professional development in the information age: An online experience. Educational Technology, 32(12), 49-53.

Showers, B. (1990). Aiming for superior classroom instruction for all children: A comprehensive staff development model. Remedial and Special Education, 11(3), 35-39.

Showers, B., Joyce, B., & Bennett, B. (1987). Synthesis of research on staff development: A framework for future study and a state-of-the-art analysis. Educational Leadership, 45(3), 77-87.

Shyu H. Y. & Brown, S. W. (1992). Learner control versus program control in interactive videodisc instruction: What are the effects in procedural learning. International Journal of Instructional Media, 19(2), 85-96.

Simmons, D. C., Fuchs, L. S., Fuchs, D., Mathes, P., & Hodge, J. P. (1995). Effects of explicit teaching and peer tutoring on the reading achievement of learningdisabled and low-performing students in regular classrooms. The Elementary School Journal, 95(5), 387-408.

Slaton , D. B., & Lacefield, W. E. (1991). Use of an interactive telecommunications network to deliver inservice education. Journal of Special Education Technology, 11(2), 65-74.

Sparks, G. M. (1983). Synthesis of research on staff development for effective teaching. Educational Leadership, 41(3), 65-72.

Sparks, D., & Loucks-Horsley, S. (1989). Five models of staff development of teachers. Journal of Staff Development, 10(4), 40-57.

Spoehr, K. T., & Spoehr, L W. (1994). Learning to think historically. Educational Psychologist, 29(2), 71-77.

Stallings, J. A. (1989, March). School achievement effects and staff development: What are some critical factors? Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Summers, J. A. (1990). Effect of interactivity upon student achievement, completion intervals, and affective perceptions, Journal of Educational Technology Systems, 19(1), 53-57.

Thornburg, D. (1992). Edutrends. San Carlos, CA: Starsong.

van den Berg, S., & Watt, J. H. (1991). Effects of educational setting on student responses to structured hypertext. Journal of Computer-Based Instruction, 18(4), 118-124.

Wade, R. K. (1984). What makes a difference in inservice teacher education? A meta-analysis of research. Educational Leadership, 42(4), 48-54.

Will, M. C. (1986). Educating children with learning problems: A shared responsibility. Exceptional Children, 52, 411-415.

Zigmond, N., Jenkins, J., Fuchs, L., Deno, S., Fuchs, D., Baker, J. N., Jenkins, L., & Couthino, M. (1995). Special education in restructured schools: Findings from three multi-year studies. Phi Delta Kappan, 76, 531-540.

Appendix A

Content Checklist

Content Checklist for the Virtual and Actual Workshops

A. Introduction

Challenges Teachers Face:
- ❑ Large volume of content to teach
- ❑ Limited amount of instructional time
- ❑ High expectations for student achievement
- ❑ Cultural diversity among students
- ❑ Academic diversity among students

The Concept Mastery Routine:
- ❑ Specify a concept students will learn about
- ❑ Place that concept within a larger framework
- ❑ Explore students' prior knowledge
- ❑ Specify characteristics of the concept
- ❑ Analyze examples and nonexamples of the concept

B. Overview

Advance Organizer:
- ❑ The three parts of the Concept Mastery Routine (CMR) will be described
- ❑ Model lessons of the CMR being used with student will be reviewed

Part One: The Concept Diagram

Advance Organizer:
- ❑ The Concept Diagram (CD) is a graphic device
- ❑ The CD has seven sections

CD Section 1:
- ❑ Targeted Concept Name (TCN) defined
- ❑ TCN written in smaller rectangle
- ❑ Example TCN (rhombus) provided

CD Section 2:
- ❑ Overall Concept Name (OCN) defined
- ❑ OCN written in larger rectangle
- ❑ Example OCN (quadrilaterals) provided

CD Section 3:
- ❑ Key Words defined
- ❑ Key Words written in large vertical rectangle
- ❑ Example Key Words for rhombus provided

CD Section 4:
- ❑ Define Characteristics
- ❑ Characteristics written on solid, wavy, and dashed lines
- ❑ Example Characteristics for rhombus provided

CD Section 5:
- ❑ Examples and Nonexamples defined
- ❑ Examples and Nonexamples written in ovals
- ❑ Sample Examples and Nonexamples for rhombus provided

CD Section 6:
- ❑ Testing Ground Defined
- ❑ Testing Ground items written between Examples and Nonexamples
- ❑ Sample Testing Ground items provided

CD Section 7:
- ❑ Concept Definition defined
- ❑ Concept Definition written in bottom rectangle
- ❑ Example Definition for Rhombus provided

CD Summary:
- ❑ Graphic Device
- ❑ Seven Sections
- ❑ Draft created before used
- ❑ Constructed following linking steps

CD Questions:
- ❑ Examples of the Targeted Concept must possess what?
- ❑ Key Words are words a teacher or student associates with what?
- ❑ The Concept Definition is a sentence that contains what?

<u>Part Two: The Linking Steps</u>

Advance Organizer:
- ❑ Linking Steps (LS) followed to fill-in the CD
- ❑ There are seven LS
- ❑ Together, that first letter from each LS spells CONCEPT

LS 1:
- ❑ Action of Offering the TCN described
- ❑ CD Section 1 filled
- ❑ Video model provided

LS 2:
- ❑ Action of Offering OCN described
- ❑ CD Section 2 filled
- ❑ Video model provided

LS 3:
- ❑ Action of Noting Key Words described
- ❑ CD Section 3 filled
- ❑ Video model provided

LS 4:

- ❑ Action of Classifying Characteristics described
- ❑ CD Section 4 filled
- ❑ Video model provided

LS 5:

- ❑ Action of Exploring Examples and Nonexamples described
- ❑ CD Section 5 filled
- ❑ Video model provided

LS 6:

- ❑ Action of Practicing with a New Example described
- ❑ CD Section 6 filled
- ❑ Video model provided

LS 7:

- ❑ Action of Tying Down a Definition described
- ❑ CD Section 7 filled
- ❑ Video model provided

LS Summary:

- ❑ LS used to involve students in construction of CD
- ❑ CD must be constructed with student input
- ❑ Seven LS
- ❑ Mnemonic CONCEPT
- ❑ Order of steps may be changed

LS Questions:

- ❑ After brainstorming Key Words the teacher and students should do what?
- ❑ When determining if an item is an Example the student should do what?
- ❑ The purpose of the LS is what?

<u>Part Three: The Cue-Do-Review Sequence</u>

Advance Organizer:

- ❑ The Cue-Do-Review Sequence (CDR) are the three phases of instruction a teacher follows when using the CMR

Phase One:

- ❑ Purpose of the Cue explained
- ❑ Three parts of Cue described
- ❑ Video model shown

Phase Two:

- ❑ Do defined as the performance of the LS

Phase Three:

- ❑ Purpose of the Review explained
- ❑ Two types of Review questions described

❑ Video model shown

Phase Summary:

❑ The CDR are the three phases of instruction a teacher follows when using the CMR

❑ Cue performed to gain students attention

❑ Do performed to complete CD with students using LS

❑ Review performed to check understanding

Phase Questions:

❑ The purpose of the Cue phase of the sequence is what?

❑ To complete the DO phase of the sequence the teacher does what?

❑ During the Review phase of the sequence the teacher asks what?

C. Instructional Guidelines

<u>Practice: Getting Ready!</u>

Advance Organizer:

❑ Opportunity to practice constructing a concept diagram will be provided

Select Content for the CMR:

❑ Use the CMR to teach concepts important for future learning

❑ Consider the concepts abstractness, organization, relevance, interest, and complexity

Decide When to Use the Routine:

❑ The CD must be constructed in partnership with students

❑ Students need prior knowledge of the concept to participate in the CMR

❑ Consider if students have adequate knowledge

❑ Give students needed prior knowledge before using CMR

Construct a Draft:

❑ Construct a draft CD before using the CMR

❑ Constructing a draft will help you communicate more clearly

❑ Students provided opportunity to construct a draft and get needed clues and answers to complete draft

<u>Practice: Using the Routine</u>

Advance Organizer:

❑ Opportunity to use the CMR in a simulated lesson will be provided

Complete Simulation:

❑ Students provided opportunity to read simulated lesson, answer questions, and receive needed clues and answers to complete simulation

D. Research Findings

Concept Acquisition:

❑ Students score significantly better on concept acquisition tests

- ❑ Students with and without learning disabilities made similar gains

Unit Tests:
- ❑ Students scored significantly better on unit tests
- ❑ Gains for student with and without disabilities were moderate
- ❑ The percentage of student who passed unit tests also increased

Note Taking:
- ❑ Students recorded more items teachers mentioned in notes
- ❑ Teachers wrote more information on the board

Successful Teachers:
- ❑ Attended a four-hour workshop
- ❑ Discussed using the routine with colleagues
- ❑ Spent time preparing to use the routine
- ❑ Taught students how to understand the routine
- ❑ Used the routine regularly

E. Library

History:
- ❑ Civil War
- ❑ Democracy
- ❑ Monopoly

English:
- ❑ Story
- ❑ Nonfiction

Math:
- ❑ Fraction
- ❑ Prism
- ❑ Square

Science:
- ❑ Organism
- ❑ Herbivore

Appendix B

Measures

Number: ____

Knowledge Test

The Concept Mastery Routine

University of Kansas
Center for Research on Learning

Name: ______________________________ Date: ____________

Directions: In the 30 minute time limit, responded to each of the statements below. Number and record your responses on the paper provided. Please note, only the content of your responses will be scored (not spelling, grammar, punctuation, etc.)

1. Briefly describe the purpose of the Concept Mastery Routine.
2. Briefly describe each phase of the Cue-Do-Review Sequence.
3. List and explain the Linking Steps of the Concept Mastery Routine.
4. List the three ways characteristics of a concept are classified in the Concept Mastery Routine.
5. List the elements present in a good definition for a concept.
6. Describe criteria to be considered when selecting concepts to be taught using the Concept Mastery Routine.
7. Describe what a teacher should do to prepare to use the Concept Mastery Routine with students.

Evaluation Guidelines for the Knowledge Test

1. **Briefly describe the purpose of the Concept Mastery Routine.** (3 points possible)

   1 Point - teach/ master/ understand

   1 Point - concepts/ big ideas

   1 Point - diverse/ academically diverse/ heterogeneous learners

2. **Briefly describe each phase of the Cue-Do-Review Sequence.** (9 points possible)

   a. Cue:

      1 Point - explain that a Concept Diagram or the Concept Mastery Routine is going to be used

      1 Point - explain how the diagram or routine will help students learn

      1 Point - explain how students are to participate while the routine is used

   b. Do:

      1 Point - follow the Linking Steps

      1 Point - complete Concept Diagram

      1 Point - interact with students

   c. Review:

      1 Point - ask students questions

      1 Point - procedural and factual questions

      1 Point - check/ confirm/ determine student understanding

3. **List and explain the Linking Steps of the Concept Mastery Routine.** (14 points possible)

   a. Step 1

      1 Point - Convey Targeted Concept Name

      1 Point - name the concept to be learned

   b. Step 2

1 Point - Offer Overall Concept Name

1 Point - name a larger/ broader concept which subsumes targeted concept

c. Step 3

1 Point - Note Key Words

1 Point - brainstorm/ elicit words related to targeted concept

d. Step 4

1 Point - Classify Characteristics

1 Point - identify always, sometimes, and never characteristics

e. Step 5

1 Point - Explore Examples

1 Point - identify examples and nonexamples

f. Step 6

1 Point - Practice with Examples

1 Point - practice with a new example/ nonexample

g. Step 7

1 Point - Tie Down a Definition

1 Point - define the concept

4. **List the three ways characteristics of a concept are classified in the Concept Mastery Routine.** (3 points possible)

1 Point - always characteristics

1 Point - sometimes characteristics

1 Point - never characteristics

5. **List the elements present in a good definition for a concept.** (3 points possible)

1 Point - contain the targeted concept name

1 Point - contain the overall concept name

1 Point - contain the always characteristics

6. **Describe criteria to be considered when selecting concepts to be taught using the Concept Mastery Routine.** (3 points possible)

   1 Point - important for future learning/ foundational/ assumptions

   1 Point - abstractness of concept

   1 Point - relevance of concept

   1 Point - student's interest in concept

   1 Point - complexity of concept

7. **Describe what a teacher should do to prepare to use the Concept Mastery Routine with students.** (3 points possible)

   1 Point - teacher must select concept to be taught using routine

   1 Point - students must have prior knowledge of the concept

   1 Point - teacher must prepare a draft concept diagram

Diagram Test

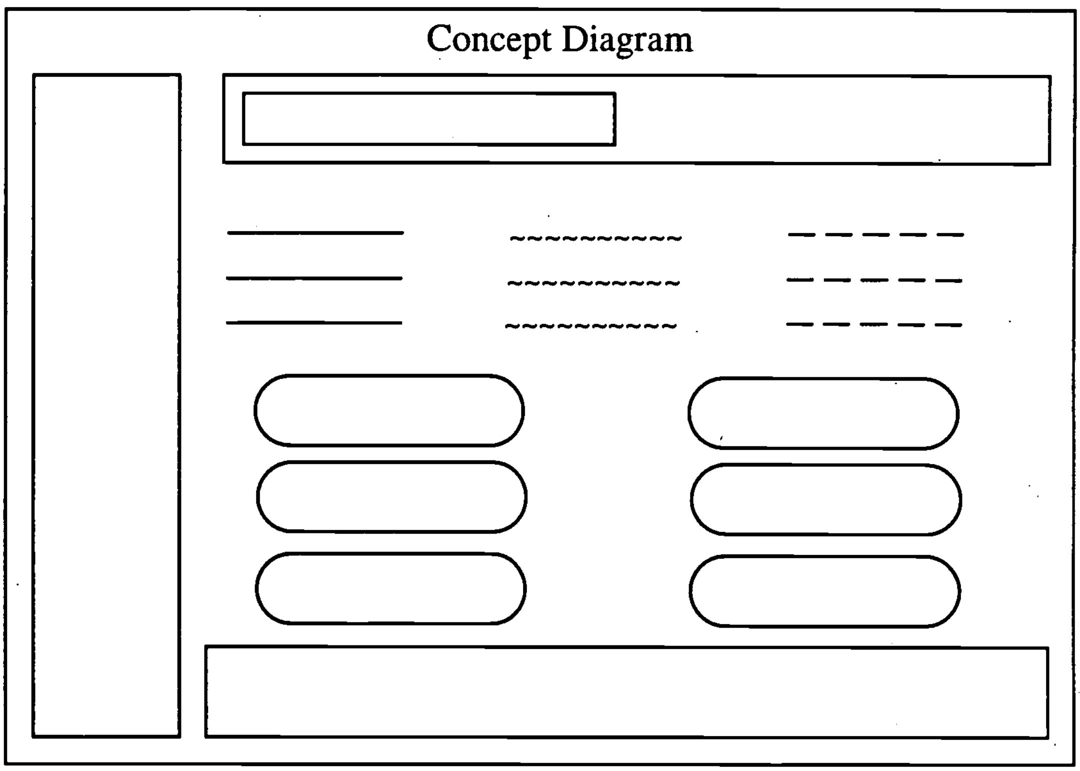
Number: ________

The Concept Mastery Routine

University of Kansas
Center for Research on Learning

Name: ______________________________ Date: ________

Directions: In the 10-minute time limit, complete the Concept Diagram for the targeted concept, automobile. Please note, only the content of your responces will be scored (not spelling,grammar, punctuation, etc.)



Evaluation Guidelines for the Diagram Test

1. **Evaluate Targeted Concept Name:** 5 points possible

The Targeted Concept Name is a commonly accepted generic term for a class or category into which events, ideas, or objects can be grouped.

a. Score 5 points if written in the rectangle 1 is a relevant word or phrase naming a the targeted concept - automobile.

b. Score 0 points if written in rectangle 1 is not a meaningful word or phrase naming the targeted concept- automobile.

2. **Evaluate Overall Concept Name:** 5 points possible

The Overall Concept Name specifies a category or class into which the Targeted Concept Name and similar concepts can be grouped.

a. Score 5 points if written in rectangle 2 is a relevant word or phrase naming an overall concept for automobile.

Examples: Modes of Transportation
Inventions
Motorized Vehicles

b. Score 0 points if written in rectangle 2 is not a relevant word or phrase naming an overall concept for automobile.

Example: Motorcycles

3. **Note Key Words:** 5 points possible

Key words are words or phrases associated with the Targeted Concept Name. The Key Words for a Targeted Concept can be characteristics, examples, nonexamples, or other related concepts.

a. Score 1 point for each word or phrase associated with automobile written in rectangle 3 of the concept diagram.

Examples: Model T
engine
Boeing 747 (nonexample)

b. Score 0 points for each non-meaningful word or phrase written in rectangle 3 of the concept diagram.

Examples: diagnostic questions

4. **Evaluate Always Characteristics:** 15 points possible

Always Characteristics are qualities that all examples of the concept automobile must possess.

a. Score 5 (up to a total of 15) points for each of the first three always characteristics written on the solid lines of the concept diagram.

Examples: have a motor
have tires

b. Score 0 points for each inappropriate always characteristic.

Examples: have 4 doors
are green

5. **Evaluate Sometimes Characteristics:** 15 points possible

Sometimes Characteristics are qualities which may be present in some but not all examples of the concept automobile.

a. Score 5 (up to a total of 15) points for each of the first three sometimes characteristics written on the wavy lines of the concept diagram.

Examples: have a hatchback
have air conditioning

b. Score 0 points for each non-appropriate sometimes characteristic.

Example: have motors

6. **Evaluate Never Characteristics:** 15 points possible

Never Characteristics are qualities not found in any examples of the concept automobile.

a. Score 5 (up to a total of 15) points for each of the first three never characteristics written on the broken lines.

Examples: have wings
have only 2 wheels

b. Score 0 points for each non-appropriate Never Characteristic.

7. **Evaluate Examples**

Examples are instances that posses all of the Always Characteristics and none of the Never Characteristics.

a. Score 5 (up to a total of 15) points for each of the first three examples written in the solid ovals if each possesses all of the Always and none of the Never Characteristics.

Examples: truck
Nash Rambler

b. Score 0 points for each example which is an invalid illustration of the concept because it lacks one of the always present or possesses one of the never present characteristics.

Examples: horse

8. **Evaluate Nonexamples**

Nonexamples are instances that possess one or more of the Never Characteristics or lack one or more of the Always Characteristics.

a. Score 5 (up to a total of 15) points for each of the first three nonexamples written in the broken ovals if each lacks one or more Always Characteristics or possesses one or more Never Characteristics.

Examples: bicycle
Sherman Tank

b. Score 0 points for a non-example which does not lack one or more of the Always or Never Characteristics.

Examples: Model T Ford
'57 Chevy

9. **Examine New Example:** Maximum of 5 points

Practicing with a new example is an instance in which either an example or nonexample for the Targeted Concept is written in the testing ground of the concept diagram.

a. Score 5 (up to a total of 5) points if an example or nonexample of the Targeted Concept is written in the testing ground.

Examples: lawn tractor
Jeep CJ-6

b. Score 0 points if a nonmeaningful example or nonexample for the Targeted Concept is written in the testing ground.

10. **Examine Definition:** Maximum of 15 points

The definition for the Targeted Concept must be a complete sentence that includes the name of the Targeted Concept, the name of the Overall Concept, and all of the Always Characteristics. Moreover, it must be written for students to see.

a. Score 5 points if the definition written in rectangle 7 includes the Targeted Concept name .

Example: Automobile

b. Score 5 points if the definition written in rectangle 7 includes the Overall Concept name.

Example: Mode of Transportation

c. Score 5 points if the definition written in rectangle 7 includes all of the Always Characteristics.

Example: has a motor
has tires
carries passengers

Implementation Checklist

Concept Mastery Routine

Date: ________ Teacher: ________ Class: ____________ Observer: ______________

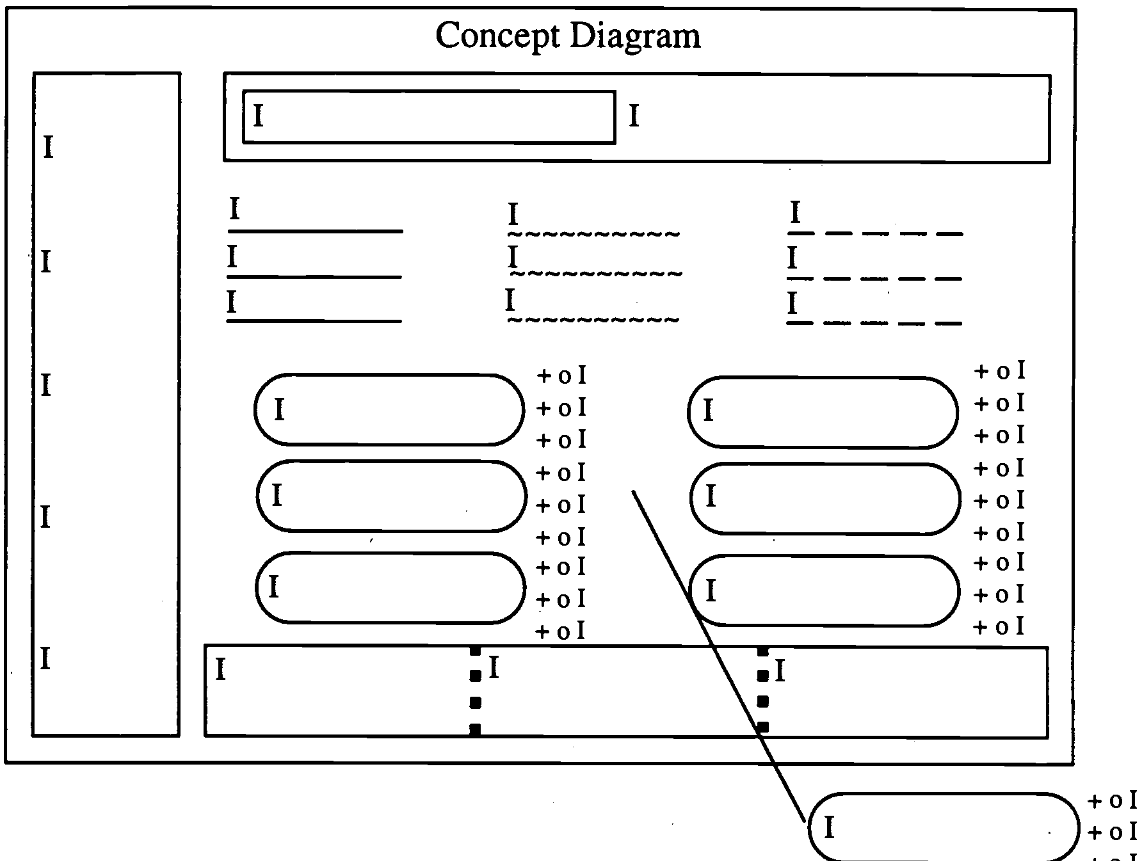
CUE:

_____Names process to be used to learn information

_____Explains how process will help students learn

_____Specifies what students need to do to participate in the process

DO:



REVIEW:

I ? ______________________________

I ? ______________________________

I ? ______________________________

I ? ______________________________

I ? ______________________________

Evaluation Guidelines for the Implementation Checklist

A. Cue

1. **Provide Advance Organizer:** 15 points possible

An Advance Organizer is a statement naming the process to be used to learn information, explaining how the process will help students learn, and specifying what students need to do to participate in the process.

a. Score 5 points if the teacher names a specific process (i.e., Concept Mastery Routine, Concept Diagram, Cooperative Learning) will be used to teacher a concept.

b. Score 5 points if the teacher explains how the process will improve students learning of a concept.

c. Score 5 points if the teacher specifies the students role in the process.

c. Examples:

- Teacher says, "Today I am going to teach using a Concept Diagram. This process will help clarify your understanding of a concept we have been studying. You are to participate in the lesson by sharing what you know about the concept and taking note on the concept diagram."

- Teacher says, "In order to help you better understand the concept of a rhombus, I will review the past week's notes using the Concept Mastery Routine. While reviewing, you will need to share what you remember about rhombi and help place that information into the Concept Diagram."

B. Do

1. **Convey the Targeted Concept Name:** 5 points possible

The Targeted Concept Name is a commonly accepted generic term for a class or category into which events, ideas, or objects can be grouped.

a. Score 5 points if the concept is appropriate and specifies a commonly accepted generic term for a class or category into which events, ideas, or objects can be grouped. The Targeted Concept Name must be written on the chalkboard or overhead for students to see.

b. Examples:

- Teacher says, "Today we are going to study the rhombus," and writes the word "rhombus" on the board.

- Teacher says, "Let's consider amphibians," and writes the word "amphibians" on the overhead.

2. **Offer the Overall Concept Name:** 5 points possible

The Overall Concept Name specifies a category or class into which the Targeted Concept Name and similar concepts can be grouped.

a. Score 5 points if the overall concept is appropriate and specifies a category or class into which the Targeted Concept Name and similar concepts can be grouped. The Overall Concept Name must be written on the board or overhead for students to see.

b. Examples:

- Teacher says, "The rhombus is a type of geometric figure," and writes the word "geometric figure" on the board.

- Teacher says, "Amphibians are a type of vertebrate," and writes "vertebrate" on the board.

3. **Note Key Words:** Maximum of 5 points possible

Key words are words or phrases students associate with the Targeted Concept Name. The Key Words for a Targeted Concept can be characteristics, examples, nonexamples, or other related concepts.

a. Score 1 point for each meaningful word or phrase shared by a students and written on the board associated with the Targeted Concept.

b. Examples:

- For the Targeted Concept amphibians, a student says, "frogs," and the teacher writes "frogs" on the board.

- For the Targeted Concept of rhombus, a students says, "four sides," and the teacher writes four sides on the board.

4. **Classify the Always, Sometimes, and Never Characteristics:** Maximum of 45 points.

Always Characteristics are qualities that all examples of the concept must possess. Sometimes Characteristics are qualities which may be present in some but not all examples of the concept. Never Characteristics are qualities not found in any examples of the concept.

a. Score 5 (up to a total of 15) points for each appropriate characteristic written on the board labeled as always present.

b. Examples:

- Always Characteristic for a rhombus - Teacher say, "Yes, has four sides is an Always characteristic," and writes "has four sides" on the board with an identification of being an Always Characteristic."

- Always Characteristic for an amphibian - Teacher says, "Yes, are cold-blooded is an Always Characteristic of an amphibian," and on writes "are cold-blooded" on the board with an identification of it being an Always Characteristic..

c. Score 5 (up to a total of 15) points for each appropriate characteristic written on the board and labeled as <u>sometimes</u> present.

d. Examples:

- Sometimes Characteristic for a rhombus - Teacher says, "can have four equal angles is a Sometimes Characteristic of rhombi," and writes "four equal angles" on the board noting it is a Sometimes Characteristic..

- Sometimes Characteristic for a amphibian - Teacher says, "have 4 legs is another Sometimes Characteristic," and writes "have 4 legs" on the board identifying it as a Sometimes Characteristic.

e. Score 5 (up to a total of 15) points for each appropriate characteristic written on the board and labeled as <u>never</u> present.

f. Examples:

- Never Characteristic for a rhombus - Student says, "two unparallel sides is a Never Characteristic," and the teacher writes "2 unparallel sides" on the board noting it as a Never Characteristic.

- Never Characteristic for an amphibian - Teachers says, "warm-blooded, " and on writes it on the board under the header Never Characteristic.

5. **Explore Examples and Nonexamples:** Maximum of 30 points.

Examples are instances that posses all of the Always Characteristics and none of the Never Characteristics. Nonexamples are instances that possess one or more of the Never Characteristics or lack one or more of the Always Characteristics.

a. Score 5 (up to a total of 15) points for each example if the example possesses all of the Always, none of the Never Characteristics, and is written on the board.

b. Examples:

- Example of a rhombus - a square.

- Example of an amphibian - a frog.

c. Score 5 (up to a total of 15) points for a nonexample if the nonexample lacks one or more Always Characteristics, or possesses one or more Never Characteristics, and is written on the board.

d. Examples:

- Nonexample of a rhombus - a triangle.

- Nonexample of an amphibian - a bird.

6. **Practice with a New Example:** Maximum of 5 points

Practicing with a new example is an instance in which the teacher tells students the name of either an example or nonexample for the Targeted Concept and provides students (without teacher support) the opportunity determine which of the two it is.

a. Score 5 (up to a total of 5) points if the teacher provides students an example or nonexample of the Targeted Concept, time to determine which of the two it is, and writes the example or nonexample on the board.

b. Examples:

- Teacher says, "Students, determine for yourself whether a snake is an example of an amphibian or not."

- Teacher says, "I am going to test your understanding of the concept. Is a diamond an example or nonexample of a rhombus? Be ready to tell me in two minutes!"

7. **Explore and Practice Example Links:** Maximum of 5 points

Links are when the teacher, using either an example or nonexample (during either the Explore Examples or Practice with New Examples step), says or prompts students to say whether an example or nonexample does or does not possess an Always or a Never Characteristic of the Targeted Concept.

a. Score 1 point for each link the teacher makes between a characteristic and an example or nonexample.

b. Examples:

- The teacher asks, "Is a square a rhombi?", and a student replies, "A square has four sides and that is an always characteristic for rhombi."

- The teacher says, "A bird is warm-blooded, this is a never characteristic for amphibians."

c. Score 1 additional point for each link the teacher highlights using a symbol such as a + or an 0, a star, or an underline.

d. Examples:

- For the example "square", the teachers places a + next to the always characteristic - has four sides. (has four sides +)

- For the nonexample "bird", the teacher places a 0 next to the always characteristic for amphibians - is cold-blooded.(is cold-blooded 0)

8. **Tie Down a Definition:** Maximum of 15 points

The definition for the Targeted Concept must be a complete sentence that includes the name of the Targeted Concept, the name of the Overall Concept, and all of the Always Characteristics. Moreover, it must be written for students to see.

a. Score 5 points if the Targeted Concept name is included in the definition.

b. Score 5 points if the Overall Concept name is included in the definition.

c. Score 5 points if all of the Always Characteristics are included in the definition.

C. **Review**

1. **Checks Student Understanding:** 5 points possible.

The review comes at the end of a lesson. During the review, the teacher checks students understanding by asking questions about either what was learned or how it was learned.

a. Score 1 point (up to a total of 5 points) for each question the teacher asks students about what was learned or how it was learned.

b. Examples:

- Teacher says, "Today we learned about what?"

- Teacher says, "What is another example of the concept we did not discuss today?"

- Teacher says, "In what way do you suppose organizing information in a graphic format helps us understand this idea better?"

- Teachers says, "If you were teaching a group of younger students this idea, would you relate it to a bigger idea the students may be familiar with? Why?"

D. **Interactions**

An interaction is observed each time the teacher obtains a piece of verbal information about the targeted concept for the concept diagram or for the review.

a. Score 1 point (up to a total of 20 points) each time the teacher interacts with student in obtaining information related to the concept.

b. Examples:

- Teacher asks, "Is this characteristic Always, Sometimes, or Never present for this concept?" and a students provides an answer.

- Teacher asks, "What would be a good definition?" and a student provides one.

Implementation Recording Form

Concept Mastery Routine

Name	ID#	Date of Training?	Anticipated date of implementation?	Actual date of implementation?	Number of times used?

Satisfaction Questionnaire

Concept Mastery Routine

Name: ______________________________ Date: __________

Please rate today's program by circling the appropriate number.

		Disagree						Agree
1.	I believe that I will remember everything covered today.	1	2	3	4	5	6	7
2.	The training session kept me focused on the content throughout.	1	2	3	4	5	6	7
3.	I am very confident that I will soon use the routine learned today.	1	2	3	4	5	6	7
4.	This training session made me very enthusiastic about the content covered.	1	2	3	4	5	6	7
5.	It will be very easy to summarize for other what this routine is all about	1	2	3	4	5	6	7
6.	It was easy to concentrate on the content of this presentation.	1	2	3	4	5	6	7
7.	I plan to implement the routine very soon.	1	2	3	4	5	6	7
8.	I had a lot of fun during this presentation.	1	2	3	4	5	6	7
9.	I clearly understand everything that was presented today.	1	2	3	4	5	6	7
10.	The training session was engaging throughout.	1	2	3	4	5	6	7
11.	I am looking forward to incorporating this routine into the teaching that I am already doing	1	2	3	4	5	6	7
12.	This session was very enjoyable for me.	1	2	3	4	5	6	7
13.	This training session was superior to other training sessions I have attended.	1	2	3	4	5	6	7
14.	Overall, I was highly satisfied with this training session.	1	2	3	4	5	6	7

15. Please make additional comments about the training session on the back of this sheet.

Table 1

Preservice Teachers' Mean Percentage Scores for Pretest and Posttest Knowledge and Diagram Tests by Treatment Group

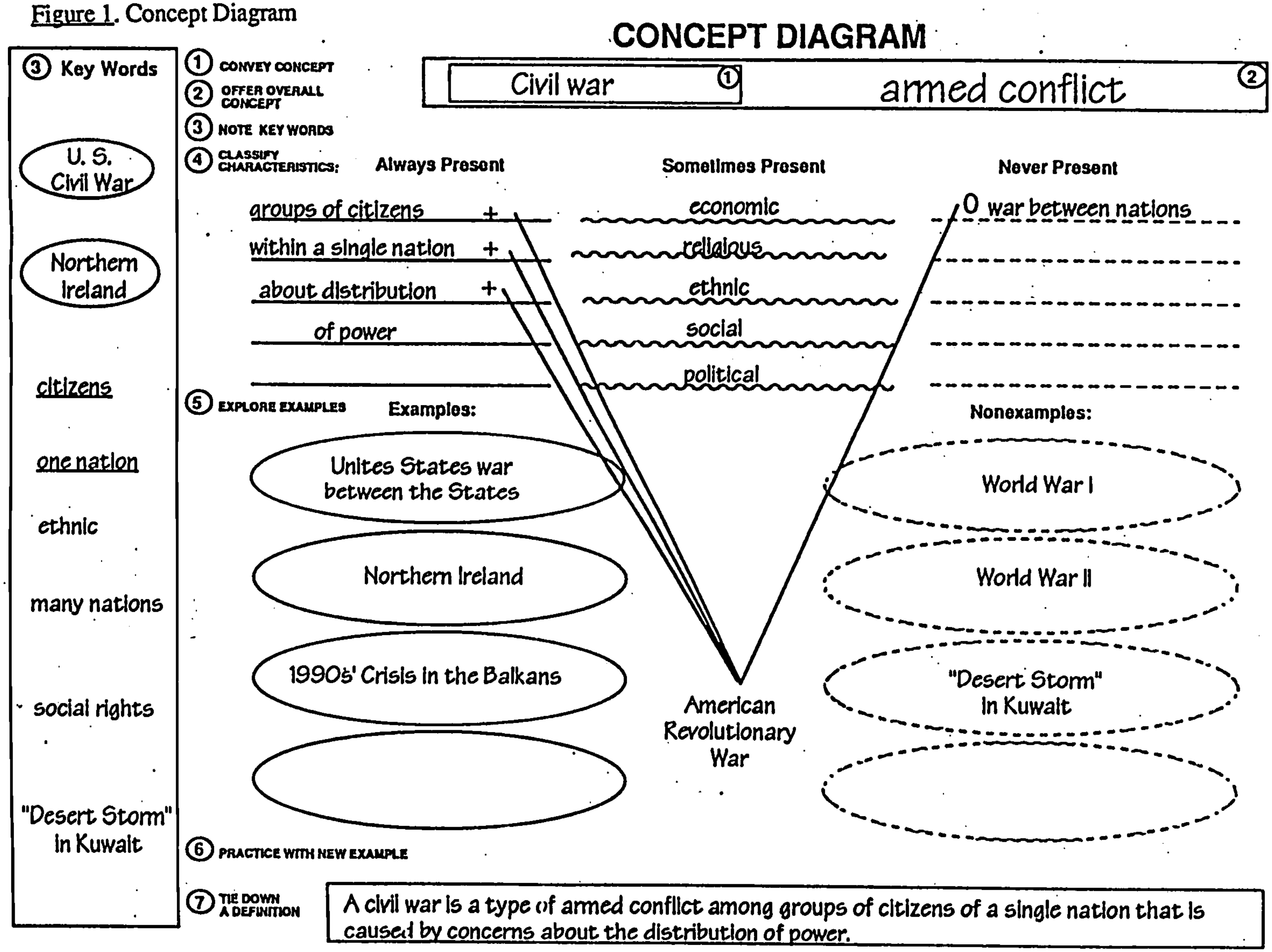
	Knowledge Scores		Diagram Scores	
Treatment Group	Pretest	Posttest	Pretest	Posttest
Virtual Workshop				
M	.90%	49.09%	10.03%	84.76%
SD	.67	6.46	7.47	10.92
Actual Workshop				
M	2.30%	53.99%	8.30%	84.14%
SD	.90	6.31	6.69	11.44

Table 2

Inservice Teachers' Mean Percentage Scores for Pretest and Posttest Knowledge and Diagram Tests by Treatment Group

	Knowledge Scores		Diagram Scores	
Treatment Group	Pretest	Posttest	Pretest	Posttest
Virtual Workshop				
M	5.26%	63.68%	11.81%	93.63%
SD	1.23	4.15	16.05	10.95
Actual Workshop				
M	6.32%	60.00%	39.09%	85.45%
SD	1.82	3.56	38.18	7.42

Figure 1. Concept Diagram



97

BEST COPY AVAILABLE

98

Figure 2. Virtual Workshop Computer Screen Displaying Table of Contents

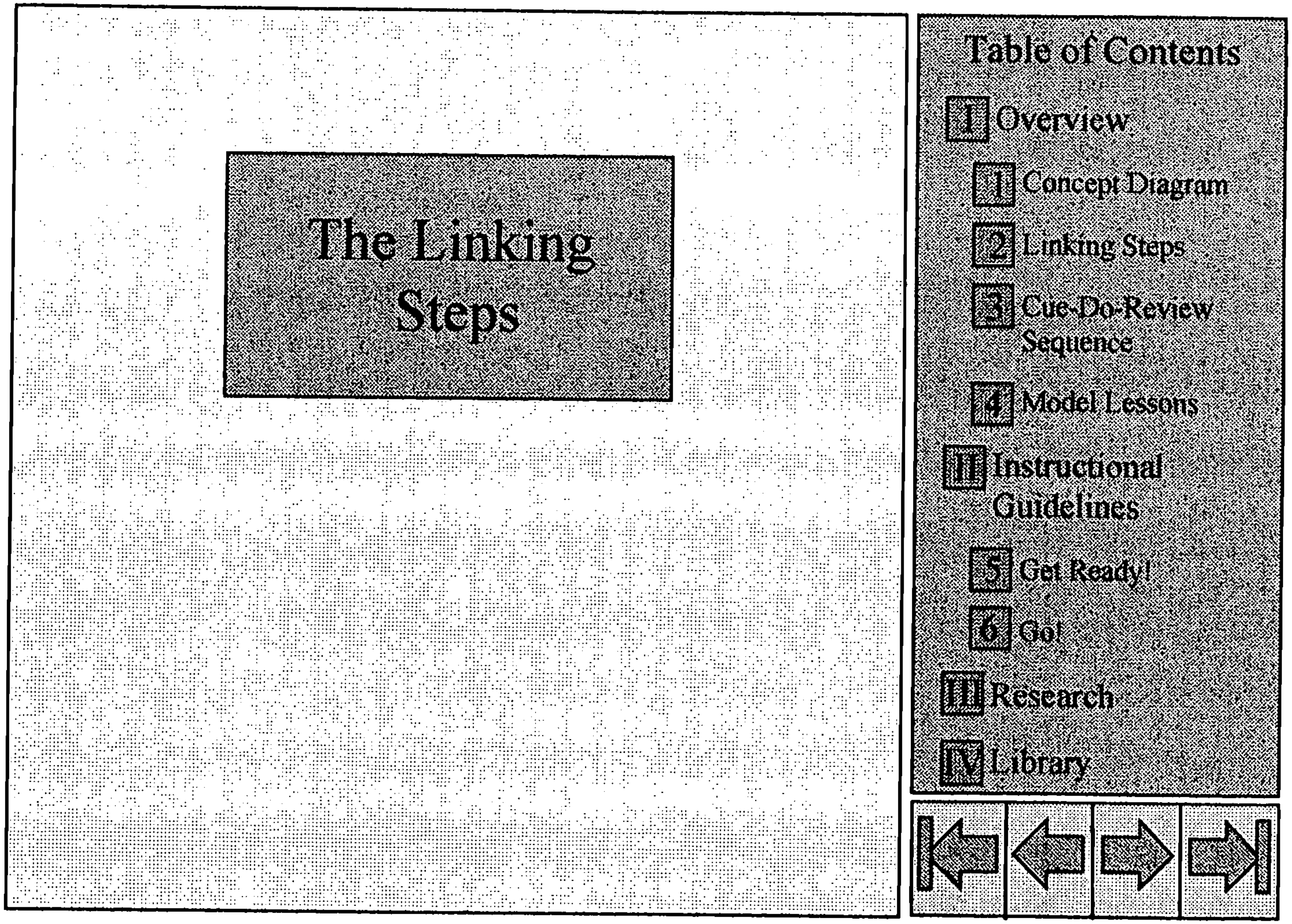
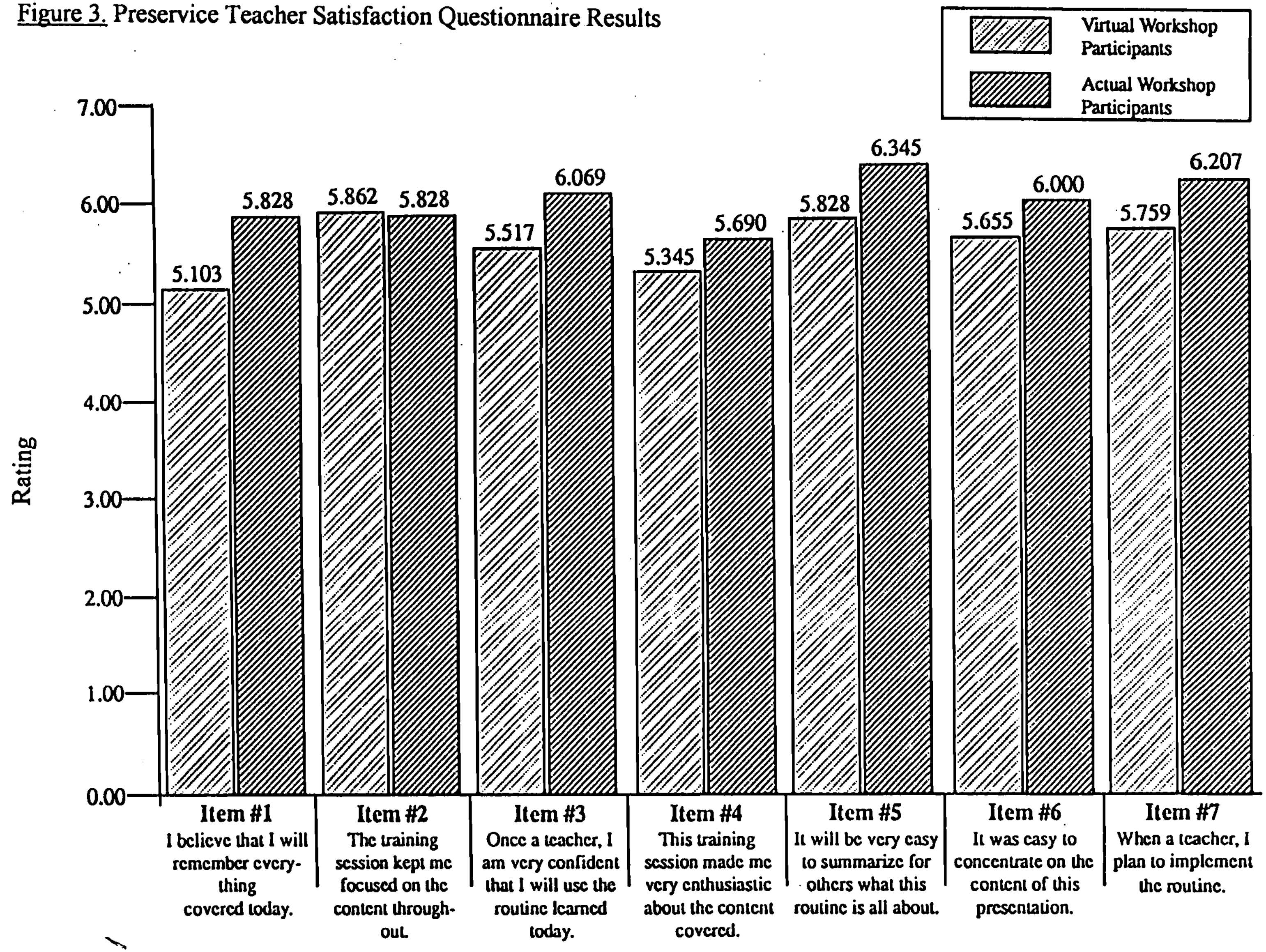


Figure 3. Preservice Teacher Satisfaction Questionnaire Results



101

BEST COPY AVAILABLE

102

Figure 3. Preservice Teacher Satisfaction Questionnaire Results (con't)

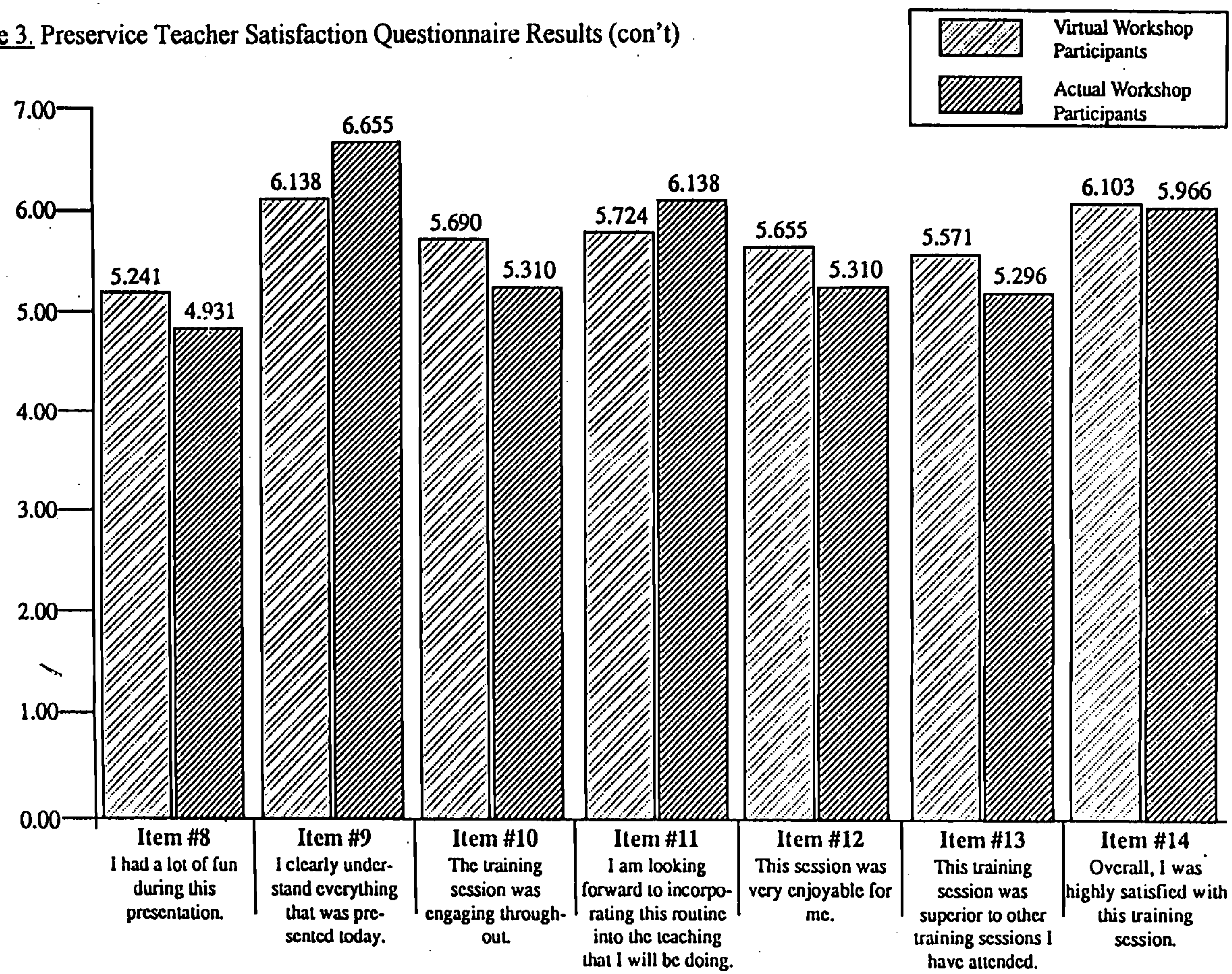


Figure 4. Inservice Teachers' #1 and #2 (Virtual Workshop Participants)

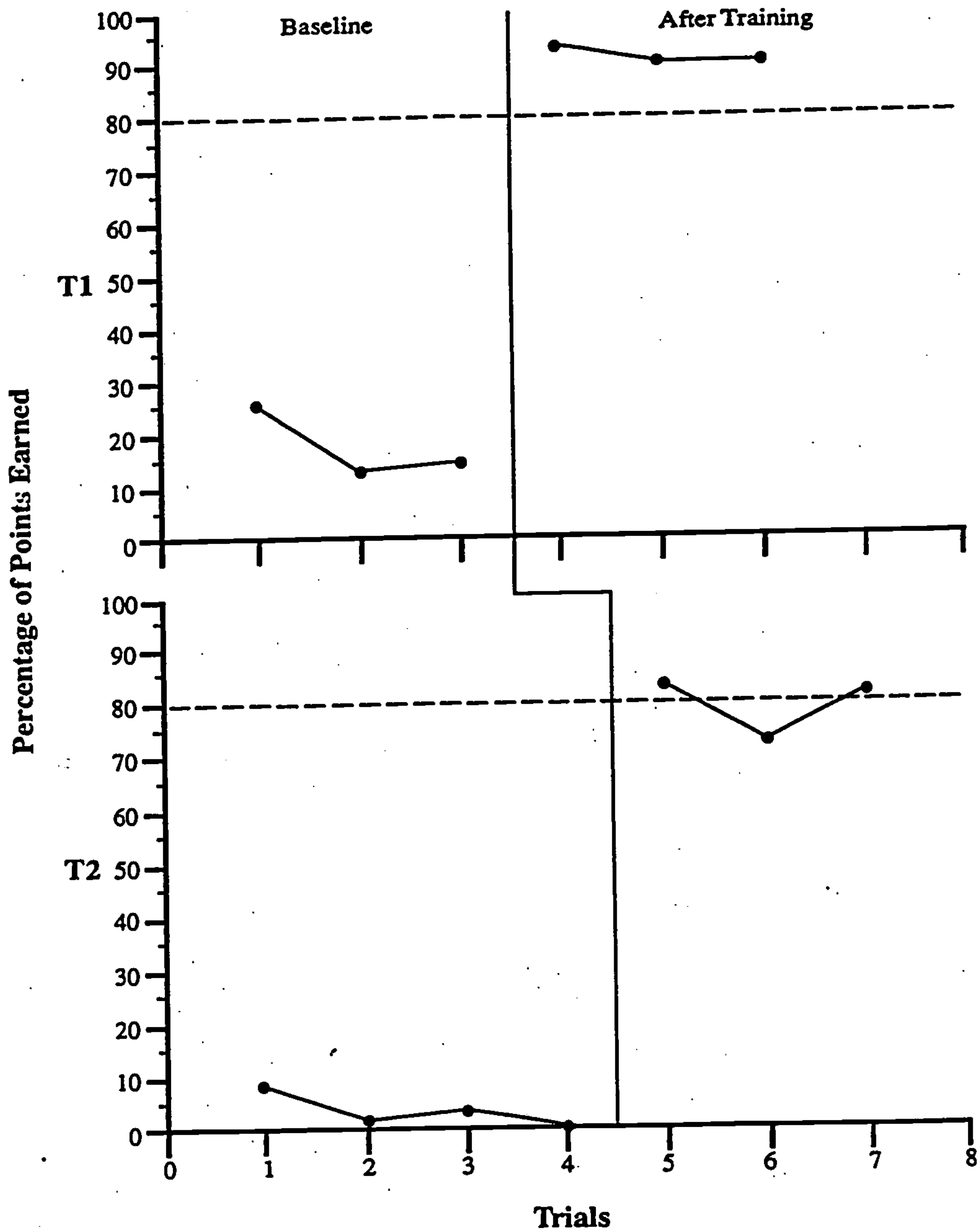


Figure 5. Inservice Teachers' #3 and #4 (Virtual Workshop Participants)

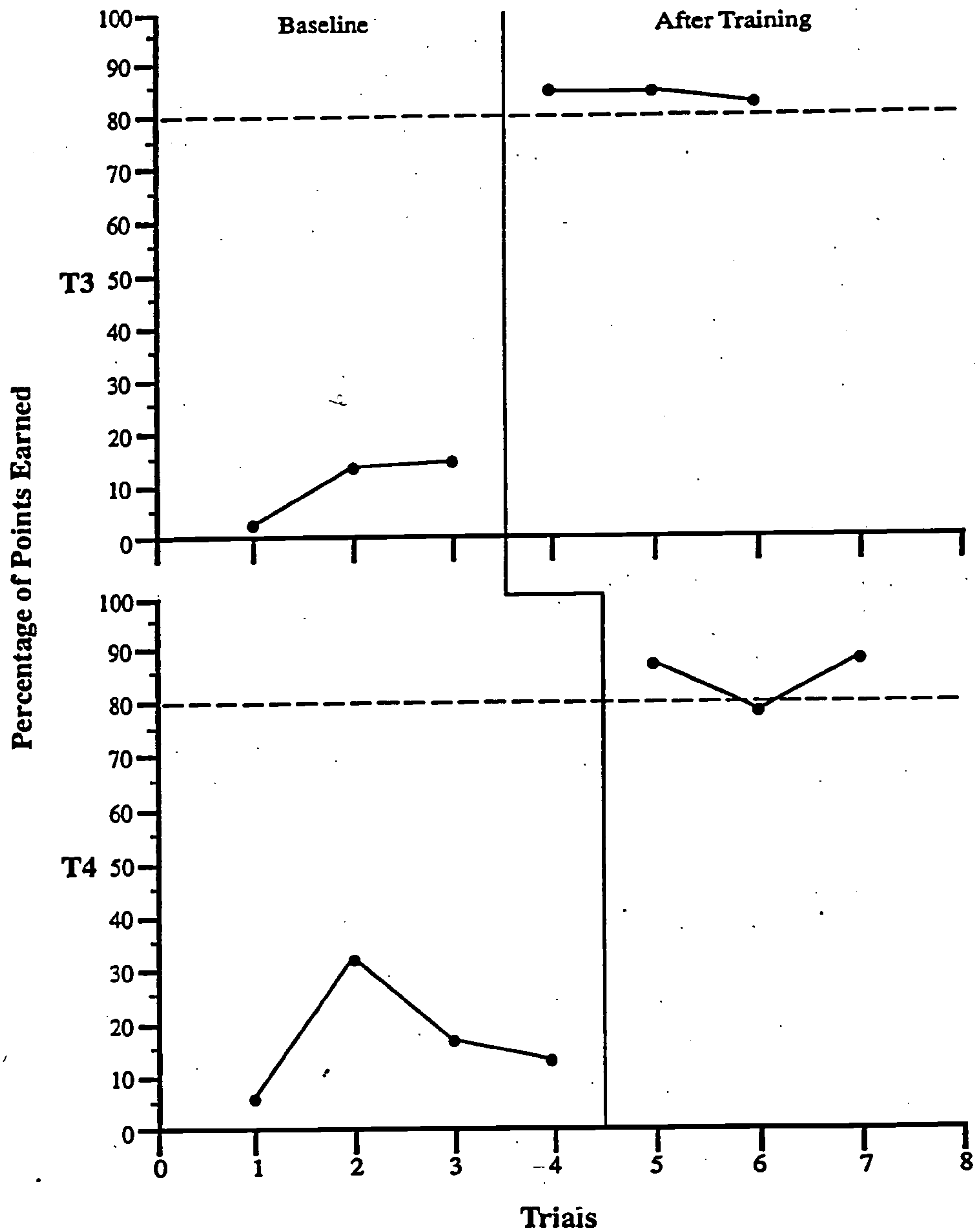


Figure 6. Inservice Teachers' #5 and #6 (Actual Workshop Participants)

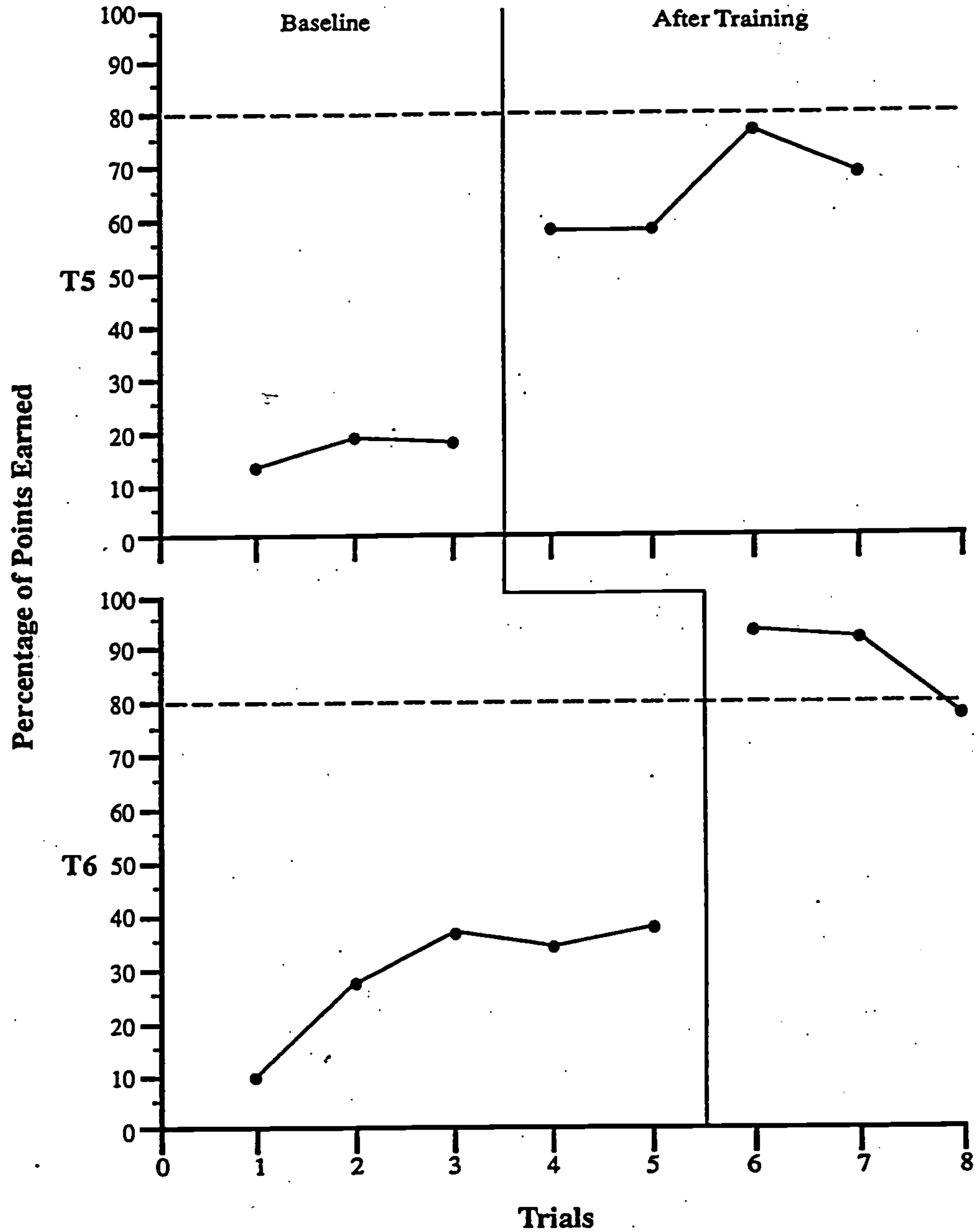


Figure 7. Inservice Teachers' #7 and #8 (Actual Workshop Participants)

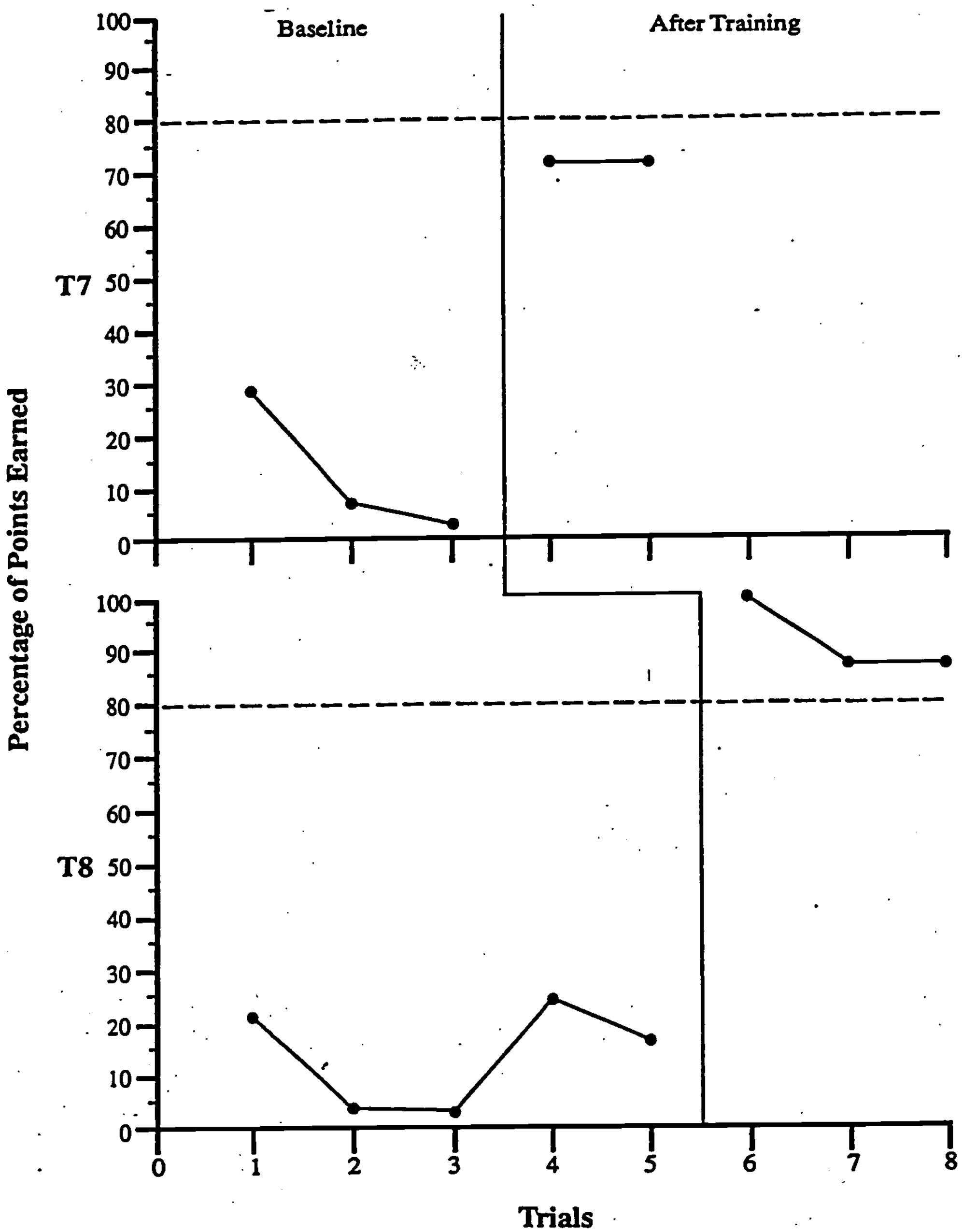


Figure 8. Inservice Teachers' Implementation Questionnaire Results

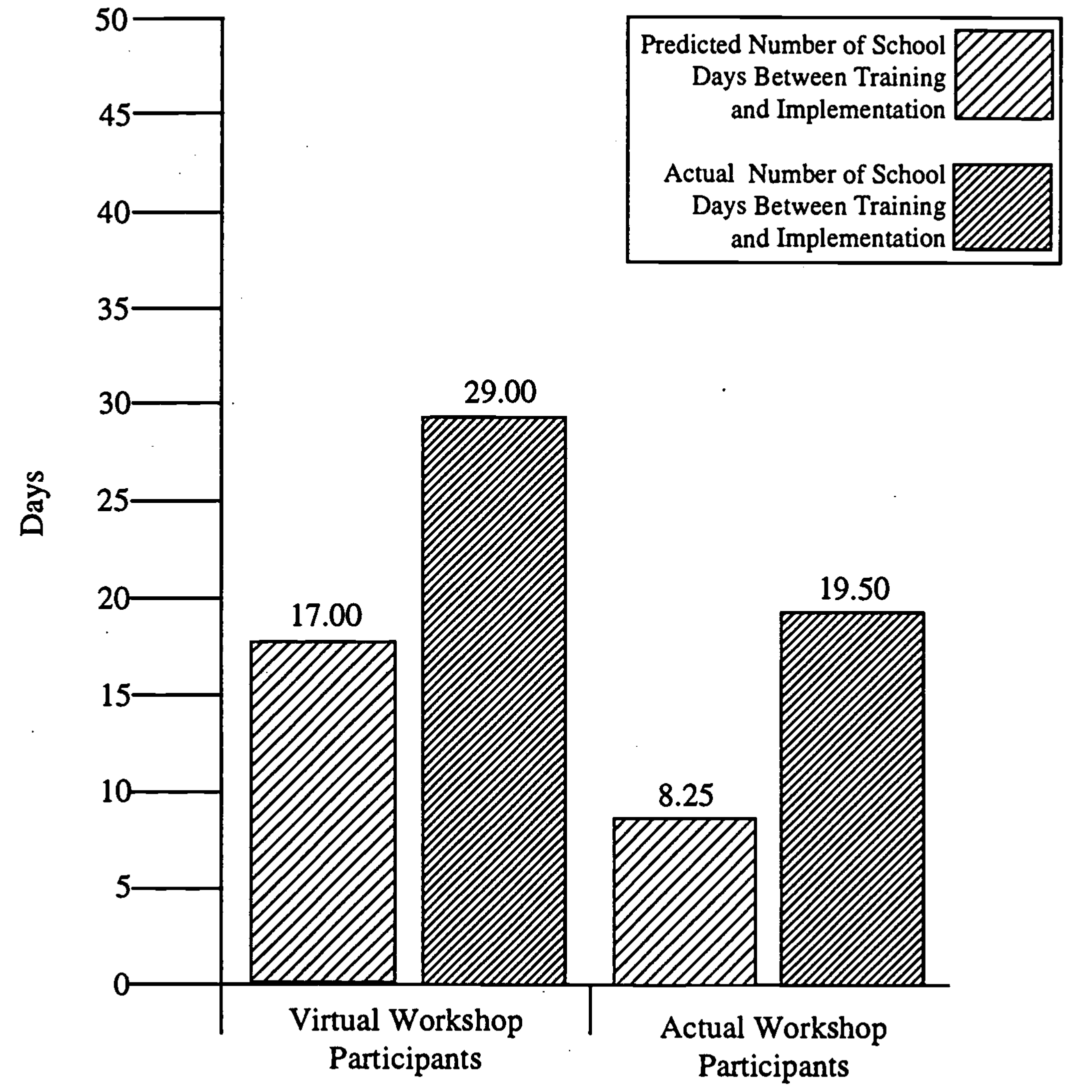


Figure 9. Inservice Teacher Satisfaction Questionnaire Results

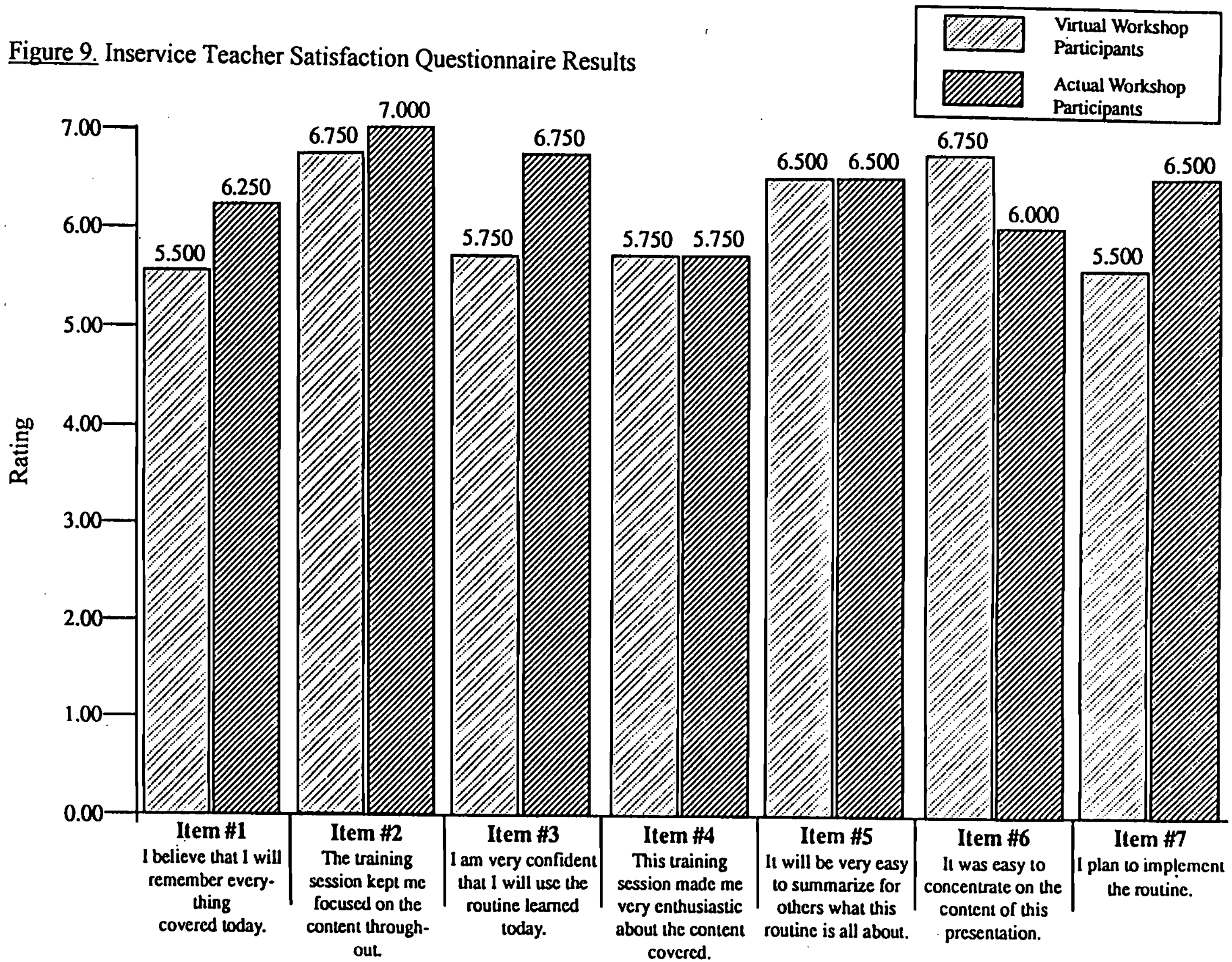
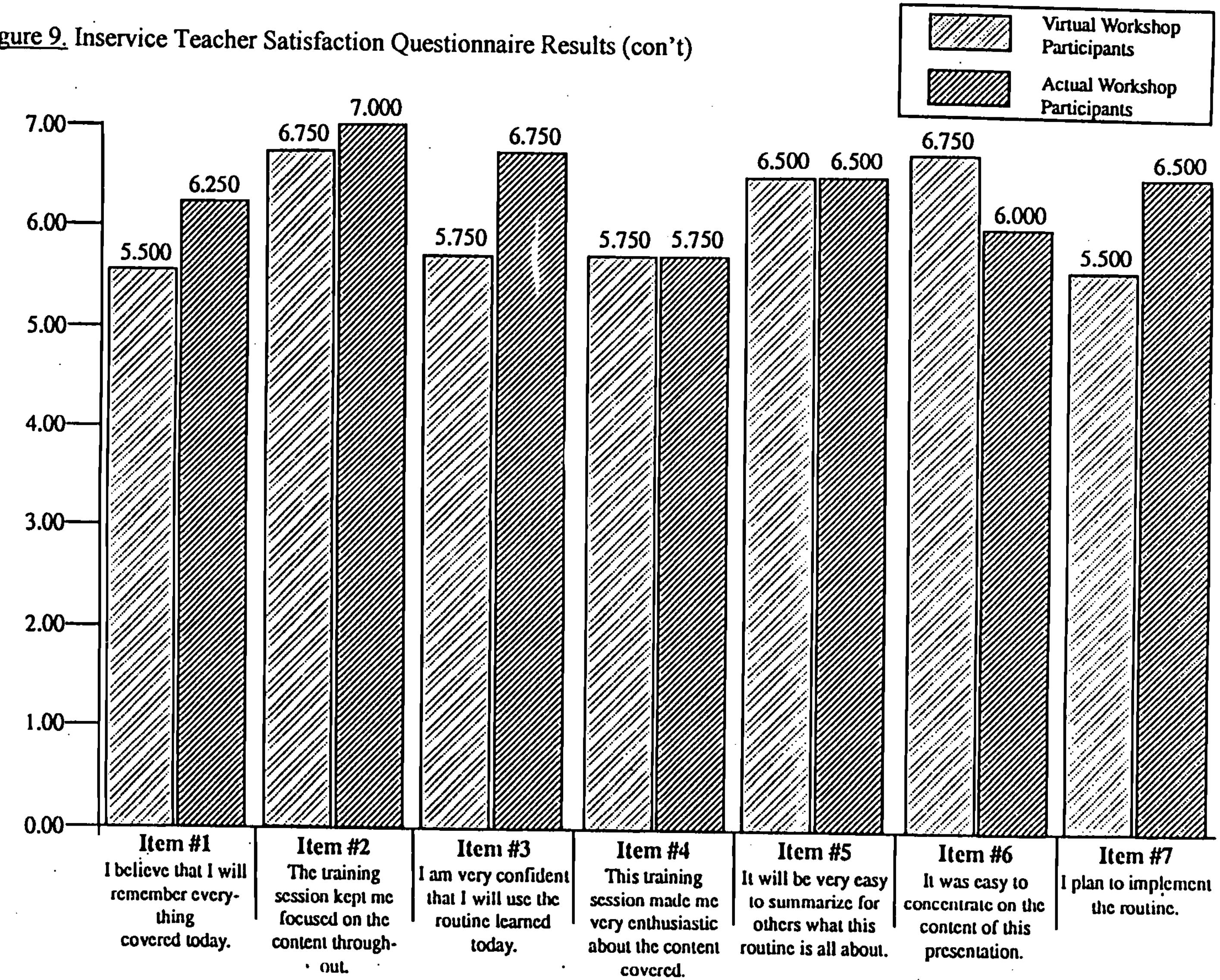


Figure 9. Inservice Teacher Satisfaction Questionnaire Results (con't)



112

113

EC 305836

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

ERIC®

NOTICE

REPRODUCTION BASIS

☐ This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☑ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").