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ABSTRACT

Two multiple-case instructional treatments were compared to determine their relative effectiveness for helping program participants acquire, apply, and transfer complex knowledge about Assistive Technology (AT) available to help people with impaired vision. Thirty-eight college students were randomly assigned to two conditions. Both treatments presented the same information about AT in a manual and on videodisc with six case studies. Participants in treatment 1 completed activities requiring mindful analysis (in-depth and effortful) of four video-based cases and associated concepts, while in treatment 2, participants completed the same four video-based cases and an additional four text-based cases, but without mindfulness activities. On measures of knowledge, performance, and transfer, there were no statistically significant differences between mean scores for the treatment conditions. There were statistically and educationally significant differences in knowledge gain from pretest to posttest, and there was an educationally significant difference on the performance measure. In addition, there was an educationally significant treatment-by-course interaction on a measure of knowledge transfer. Students' attitudes toward the video module were positive, and they believed the cases provided useful contexts for learning about AT. (Contains 1 table, 1 figure, and 24 references.) (Author/SLD)

Effects of Combining Case-Based Instruction and Mindfulness Activities on the Acquisition, Application, and Transfer of Complex Knowledge: An Experimental Comparison of Two Multiple-Case Treatments on Videodisc

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Abstract

Two multiple-case, instructional treatments were compared to determine their relative effectiveness for helping program participants acquire, apply, and transfer complex knowledge about assistive technology (AT) that is available to help people with impaired vision. The research participants, 38 students in the Department of Special Education and Rehabilitation at Utah State University, were randomly assigned to treatments. Both treatments presented the same information about AT in a manual and on a videodisc. The videodisc contained six case studies (interviews with real people who have impaired vision) and an audiovisual database of over 100 AT devices and techniques. Treatment 1 participants completed activities requiring mindful (in-depth and effortful) analysis of four video-based cases and associated concepts while Treatment 2 participants completed the same four video-based cases and an additional four text-based cases, but without mindfulness activities.

On measures of knowledge, performance, and transfer, there were no statistically significant differences between mean scores for Treatment 1 or 2; however, there were statistically ($p < .001$) and educationally (based on effect sizes) significant differences in knowledge gain scores from pre- to posttest. There was also an educationally significant difference between treatment groups on the performance measure (two video-based cases), and there was an educationally significant Treatment by Course interaction on a measure of knowledge transfer. Survey responses revealed that participants' attitudes toward the module were positive, and that they liked working with cases on videodisc. They believed that the cases provided useful contexts for learning about AT and that the module helped them acquire and apply important information. They also indicated that they would recommend the module to other people who want to learn about the content area.

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INTRODUCTION

The widespread and increasingly popular use of case materials for instruction in various disciplines is an indication that educators generally perceive the case method as an important teaching tool (Carroll, Paine, & Ivancevich, 1972; Neider, 1981; Shoenfelt, Eastman, & Mendel, 1991). However, in five reviews of literature dealing with the use of case-based instruction (Knirk, 1991; Masoner, 1988; Smith, 1987; Sykes and Bird, 1992; Williams, 1992), a lack of empirical research on actual implementations of case teaching in several fields was noted. In Knirk's (1991) review, he specifically called attention to the fact that very few investigations have been done regarding the effects of case materials on student perception, learning, and retention. Smith (1987) pointed out a lack of research on specific methods to promote transfer of learning within the realm of case-based instruction, and in an area related to transfer, Williams (1992) indicated a lack of research on methods to help students abstract general principles through case studies. Finally, in the review of literature that was conducted for the present study, very little empirical research was found on the instructional conditions or strategies that help maximize the potential for acquisition, application, and transfer of complex knowledge through the use of case-based instructional materials.

According to Spiro and his colleagues, multiple representation of content is an important characteristic of a learning environment if transfer of complex knowledge is to occur (Spiro & Jehng, 1990; Jacobson & Spiro, 1992). Spiro and Jehng (1990) have defined transfer as learners being able to "independently apply the instructed knowledge to new situations that differ in their characteristics from those of initial learning" (p. 165). They also affirmed that the degree of structure in a content domain and the approach used to teach it have an effect on learning and transfer. For example, complex concepts in an ill-structured content domain are not adequately learned through teaching general principles. Moreover, early simplification of complex concepts may block later acquisition of their intricacies, so it is better to give small chunks of complexity than to impose artificial progression from simple to complex. As learners connect these chunks they can achieve complete rather than superficial comprehension of concepts. A multiple-case approach is one method for providing multiple representation of content in order to increase learners' potential for transferring complex knowledge to novel situations.

Salomon and Globerson (1987) have suggested that the achievement of what they call "high-road learning and transfer" requires learner mindfulness, which they define as "the volitional, metacognitively guided employment of non-automatic, usually effort demanding processes" (p. 625).

High-road learning involves "much deliberate, effortful utilization of non-automatic processes; it is a mentally demanding route to the acquisition of knowledge and skill" (Salomon & Globerson, 1987, p. 630). Learners activate non-automatic strategies such as mindful reflection, consideration of alternatives, and deep processing of information. An example would be the learning required to make good financial investments. In contrast, low-road learning depends upon "much incidental practice where skills are employed in an increasingly more automatic manner . . . . It is a mentally undemanding but practice intensive road to learning" (p. 630). An example would be learning to drive a car.

For high-road transfer to occur, the person must engage in mindful abstraction, involving the cultivation of metacognitive guidance, in which that person purposefully generalizes such things as rules, principles, labels, schematic patterns, prototypes, or categories; but he or she must genuinely comprehend those abstractions. An additional prerequisite to high-road transfer is that the high-road to learning must have been followed, that is, an individual must have mindfully acquired the knowledge to be transferred and must be mindfully seeking a solution to the problem for which the knowledge is currently required. For example, a stock broker actively employs investment principles learned in college, or actively searches his or her memory to recall previous experiences that are applicable to the current situation. Conversely, the varied practice to automaticity of low-road learning leads to low-road transfer. For example, after years of experience at driving cars, a person is able get behind the steering wheel of a large truck for the very first time and drive it reasonably well.

The road to follow (whether high or low) depends on the knowledge or skill to be learned and ultimately transferred, and both roads may be traveled simultaneously, that is, some activities involve both automatic and non-automatic processes.

In their study on cognitive flexibility, transfer of complex knowledge, and hypertext learning environments, Jacobson and Spiro (1992) acknowledged a need for further research on the problem of how to help students who prefer simplified contexts to be able to effectively use and learn from multiple knowledge representations. A potential solution may be found in the following statement by Salomon and Globerson (1987): "When mindfulness is instigated during the process of instruction it may compensate those who would not tend to be particularly mindful otherwise" (p. 632). Perhaps combining the multiple representation of content (e.g., a multiple-case approach) with activities designed to induce a state of mindfulness (e.g., exercises requiring learners to expend greater mental effort and concentration, and to think about how they performed a given task) could enhance learning and transfer, and could result in a stronger treatment effect than a multiple-case approach would have alone. However, there have been no reports of empirical studies investigating whether or not such a combination results in greater acquisition, application, and transfer of complex knowledge.

Objectives

The research described in this paper was part of two federally funded projects (see Note at end), the purpose of which was to design, develop, and field test videodisc-based, instructional modules to teach vocational rehabilitation counselors, special educators, and medical professionals about assistive technology (AT) for people with disabilities. The module used in this research was about AT available to help people with impaired vision on the job and in their daily lives. The objective of the main field test for this module (hereafter referred to as the Vision Module) was to investigate the effects of combining mindfulness activities with a multiple case approach to determine if the combination would produce higher participant achievement on knowledge tests about impaired vision and AT, better performance on tests of recommending AT, and greater knowledge transfer to novel cases than instruction using a multiple-case approach alone.

PROCEDURES

Instructional Treatment and Field Tests

Description of the Vision Module

The Vision Module has two components: a manual and a videodisc. The manual contains the following: (a) information about the module and suggestions for using it effectively; (b) a brief introduction and explanation of how to begin; (c) terminology related to vision impairment; (d) general information about assistive devices, techniques, services, and organizations for people with impaired vision; (e) important considerations in the process of recommending and acquiring AT for a person with a disability; (f) case analysis activities (including four text-based cases); and (g) detailed descriptions of all the devices and techniques shown in the audiovisual database of AT on the videodisc. The videodisc contains the following: (a) an introduction to the module and a presentation of the module goals, (b) six video-based case studies, (c) two simulations of vision impairment and of how AT can help, and (d) an audiovisual database with over 100 examples of assistive devices and techniques that are available for people who have impaired vision. The instructional sequence of the module requires the user to switch back and forth between the videodisc and the manual. To help participants find their way through the materials and know what to do next at a given point, the manual has instruction boxes at the bottom of each page, and the videodisc has navigational menus and icons which are displayed on the television screen.

The video-based case studies consist of initial interviews with real people who have impaired vision (three with low vision and three with total blindness), supplementary case information in the manual, an answer sheet for making recommendations of AT, and a follow-up interview. The initial interview and the supplementary case information provide personal details for the participants to use in making recommendations of AT for the specific circumstances of the individual in each case. In the process of working on a case, participants may refer as often as needed to the initial interview, the audiovisual database of AT, or to the manual. After completing recommendations of AT for a case, participants view the follow-up interview to receive feedback about the AT that the person in the case actually uses or would like to use. When participants' recommendations of AT differ from the summary of AT at the end of the follow-up interview, their answers are not necessarily wrong. After such differences are discovered, participants are expected to critically analyze their own recommendations and either defend or revise items in their list. In addition, participants may engage in analytical activities that require them to reflect upon, compare, and contrast concepts and critical attributes of different case studies and of AT associated with those case studies.

The text-based case problems begin with one or two paragraphs about a fictional person with impaired vision (two with low vision and two with total blindness), focusing on his or her interests, wants, and needs for education, employment, recreation, and so forth. Just as with the video-based cases, participants make a list of AT recommendations for the person in the case. After completing the list, they turn to a page containing possible responses (which were suggested by the module developer) as feedback on their responses. Participants should analyze their own recommendations, not in terms of right or wrong, but to reconsider the appropriateness of their recommendations for the situation of the person in the case; then, they may either defend or revise specific items in their list.

The reason for the variety of cases in the Vision Module was to provide opportunities for participants to think about different people with different levels of impaired vision as well as

different needs and interests; thus, the cases give a context (and hopefully increase participants' interest) to learn about AT for people with impaired vision.

Because the intended audience for the Vision Module consists of literate adults with varied levels of experience in the content area, it was designed for a straightforward, sequential presentation as well as for random-access information gathering. It was also designed for instructor-guided use with groups of people or for self-directed learning by individuals seeking specific information and/or problem-solving practice in the content area.

Field Tests

Three field tests were conducted during the development of the Vision Module. Information gathered from the first two field tests were used to revise the module in preparation for the main field test (the data source for the present study). As previously indicated, the purpose of the main field test was to evaluate two different instructional strategies. This was accomplished by randomly assigning participants to either of two treatment groups and comparing their scores on various measures.

Treatments

The Vision Module, as described earlier, was modified to create two versions with different instructional strategies. The videodisc component was the same for both treatments, but the manuals were different. Both versions of the manual contained the same details and information about AT and had the same general goals and instructional objectives; however, three sections in the two versions contained activities that required the participants in each treatment group to perform different mental processes.

In the manual for Treatment 1, the review activities at the end of Section 2 (Terminology of Vision) and Section 4 (Recommending and Acquiring AT) consisted of instructions to identify key concepts, and to reflect upon, analyze, and attempt to commit those concepts to memory.

The manual for Treatment 2 also had review activities in the aforementioned sections, but the instructions were simply to go over the preceding material again before continuing with the module: No specific method for review was suggested.

The major difference between the treatments was in Section 5 (Case Analysis Activities). In this section, both treatment groups did four of the six cases on the videodisc (two of the six were used as performance posttests). For each of these cases, the participants were required to identify needs and problems for the person in the case, recommend AT to meet those needs, and justify their recommendations. The difference between treatments in this section was in the amount of analysis of the video-based case and in the total number of cases completed by each group. In Treatment 1, the participants were required to analyze their recommendations of AT and their decision-making process after receiving feedback on the four video-based practice cases; they were also required to reflect upon, compare, and contrast critical attributes of the different cases and general concepts related to AT. The group receiving Treatment 2 did not have these analysis activities, but instead completed a set of four text-based cases, in addition to the four video-based cases, for more practice at identifying needs and recommending AT. The Treatment 1 group did not have text-based cases. Consequently, participants in Treatment 1 had a more intense instructional experience with fewer cases than participants in Treatment 2.

Population and Sample

The target populations for the present investigation were Rehabilitation (Rehab) students at the graduate level (master's degree) and Special Education (SPED) students at the undergraduate level (juniors and seniors). The accessible population consisted of students who were taking courses in the Department of Special Education and Rehabilitation at Utah State University. Two instructors in this department reviewed the Vision Module and agreed to include it as a required assignment for their students. Of the 38 students in the research sample, 14 were enrolled in a graduate course for Rehab majors titled *Psycho-Social Aspects of Disability* and 24 were enrolled in an undergraduate course for SPED majors titled *Assistive and Adaptive Technology for Persons with Disabilities.*

Research Design

A pretest-posttest, control group design (Campbell & Stanley, 1963) was used in this research; however, the control group received a comparison treatment instead of no treatment. The sample was stratified on course enrollment, and students were randomly assigned to either Treatment 1 or 2. This design method helps control for most threats to internal and external validity as described by Campbell and Stanley (1963). Potentially, the main threat to external validity for this research design was a pretest by treatment interaction. This threat would be greatest if the experimental treatment provided specific information that was part of the pretest, and if the comparison group received no treatment or one that may not have provided all of the relevant information that the experimental group received. In the present study, however, all of the information referred to in the pretest was provided in both treatments. Therefore, any pretest sensitization that may have occurred should be evenly distributed across both treatment groups.

At least two factors may have had an effect on the generalizability of findings from the current investigation: lack of random selection and small sample size. However, participant data were collected on such personological variables as major, level in college, scores on the Need for Cognition Scale, gender, age, and prior experience with this content area. Analyses were conducted to determine correlations among personological and dependent variables.

Data Collection Instruments

The following eight separate instruments were used to gather data from and about the participants: (1) Research Participant Information Sheet; (2) Pre-Treatment Knowledge Assessment; (3) Need for Cognition Scale (short form developed by Cacioppo, Petty, and Kao, 1984); (4) Time Log and Treatment Completion Checklists; (5) Vision Module Evaluation Form; (6) Post-Treatment Knowledge Assessment; (7) Post-Treatment Performance Assessment; and (8) Vision Module Post-Treatment Survey. Instruments 2, 6, and 7 were scored by three expert raters, content specialists in the area of Rehab and SPED, who also provided expert review of the Pre- and Post-Treatment Knowledge Assessments, the Post-Treatment Performance Assessment, and the associated scoring protocols for each of these instruments before they were used. The project director (the second author of this paper) reviewed the Research Participant Information Sheet, the Time Log and Treatment Completion Checklists, the Vision Module Evaluation Form, and the Vision Module Post-Treatment Survey before they were used to collect data. The Need for Cognition Scale (which will be discussed later in this section) has undergone numerous validation studies. Following are descriptions of the instruments in the preceding list.

Research Participant Information Sheet

On the Research Participant Information Sheet, demographic data, such as gender, age, major, and prior experience with the content area, were requested from each subject at the first class meeting for the investigation.

Pre-Treatment Knowledge Assessment

The Pre-Treatment Knowledge Assessment was administered to all participants at their first class meeting for the study. This instrument measured the participants' knowledge of (a) vision-related terminology, (b) functional needs of people who have impaired vision and AT available to meet those needs, and (c) considerations in the process of recommending and acquiring AT for a person with a disability. In the present study, participants had 20 minutes to complete the test. An answer key and protocol for scoring the three sections of this test were used by three raters to assist them in judging the acceptability of participant responses. The resulting score was an average of the scores awarded by the three raters, who were trained using test data and copies of the actual test forms from the second field study.

Test reliability and interrater agreement were calculated using data from the present study to determine the internal consistency of each dependent measure. Because the items in the Pre-Treatment Knowledge Assessment and all other dependent measures were scored dichotomously, the Kuder-Richardson 21 (K-R 21) formula could be used to calculate reliability. The resulting reliability coefficient of .82 indicated that the internal consistency of the test was good.

Interrater agreement was calculated by (a) determining the percentage of agreement on each item and for each section of the test for each participant, (b) averaging the agreement on each section for all of the participants, and then (c) averaging the agreement for the three sections of the test for the entire sample. The agreement among the three raters on the Pre-Treatment Knowledge Assessment was as follows: Section 1 = 100%; Section 2 = 97.08%; Section 3 = 86.15%; and Total Test = 94.41%. The reason for such high levels of agreement was due to the fact that discrepancies were brought to the attention of the raters, who had complete freedom to independently change or retain any score that they had given on any item.

Need for Cognition Scale

The Need for Cognition Scale (NCS) measures an individual's inclination to engage in cognitively demanding tasks, such as organizing, abstracting, and evaluating information (Cacioppo & Petty, 1982), which Salomon and Globerson (1987) interpreted to be the same as an inclination toward mindfulness. A high need for cognition suggests that a person has a tendency to engage in mindfulness while a low need indicates that the individual avoids situations that require mindfulness. This does not mean that people who have a low need for cognition are incapable of mindfulness, but rather that they do not enjoy cognitively demanding activities. Salomon and Globerson (1987) made the point that students who actually become mindful as a result of instructional procedures are likely to be those who are already inclined to be more mindful; however, they also suggested that mindfulness-inducing activities may compensate students who would not be particularly mindful otherwise. Thus, the participants' need for cognition could be an important moderating variable for the present study, and although the epistemic learning preference (ELP) instrument used by Jacobson and Spiro (1992) measures a similar construct, the NCS was selected for use in this research because it has already undergone numerous validation studies (Cacioppo & Petty, 1982; Cacioppo, Petty, & Kao, 1984; Cacioppo,

Petty, Kao, & Rodriguez, 1986), whereas the ELP was still being developed. The short form of the NCS, which was used in the present study, consists of 18 items. Its reliability coefficient (which was a maximized Cronbach's alpha) was reported as .90 by Cacioppo et al. (1984).

Time Logs and Treatment Completion Checklists

The treatment supervisors used checklists to record the date of treatment, the starting and ending times (to calculate the duration of the instructional period), and the completion of the entire treatment for each participant (verifying that all instructional activities had been done).

Vision Module Evaluation Forms

The Vision Module Evaluation Forms were completed by the participants immediately after they had finished all of the activities in the module. These forms were used to assess participants' perceptions of and/or attitudes toward the module and its various subsections. Most of the items had been used in previous field tests and were revised for the present study. Because there were two treatments, two versions of the evaluation were developed so that participants could evaluate specific aspects of the treatment that they received.

Post-Treatment Knowledge Assessment

The Post-Treatment Knowledge Assessment was the same as the Pre-Treatment Knowledge Assessment. In the week following the last day of treatment, this test was administered to both treatment groups at the same time during their respective classes. Just as with the pretest, participants had 20 minutes to complete it. The Knowledge Assessment was given before the Performance Assessment because the participants were allowed to use their manuals as a reference on the Performance Assessment. The cause for concern was that the manuals contain all of the information necessary to answer the questions on the Knowledge Assessment. As with the pretest, the score for an individual participant on the Knowledge Assessment was the average of the scores given by the three raters, who used a scoring protocol.

Interrater agreement was calculated; and the agreement among the three raters on the Post-Treatment Knowledge Assessment was as follows: Section 1 = 100%; Section 2 = 96.98%; Section 3 = 85.93%; and Total Test = 94.30%.

Post-Treatment Performance Assessment

This part of the posttest consisted of two video-based cases (one of a man who is totally blind and the other of a woman with low vision), which were used to determine participants' ability to identify functional needs of the person in each case (i.e., activities that the person needs or wants to do), to recommend AT to meet those needs, and to demonstrate an understanding of the conceptual relationship between functional needs and specific AT by justifying their recommendations. The responses to this assessment were rated by the three raters, who followed scoring guidelines in a protocol that was developed for this module as a method of rating each participant's recommendations of AT. As a part of the protocol, the raters received relevant case information, including a list of the AT that the person in each case actually uses or would like to use. The raters were trained to use the instrument with answer sheets from the second field test.

The raters also used a scoring protocol to assist them in identifying and counting examples of transfer in the AT recommendations made by each participant. As mentioned earlier,

transfer in this report is defined as a participant being able to apply certain knowledge gained from the Vision Module to solving new case studies. Two types of transfer were measured: (a) Strategy Transfer (TotST), which indicates that a participant used a verb form to express a functional activity in the process of recommending AT (e.g., *getting* around or *playing* baseball, in contrast to *transportation* or *recreation*); and (b) Knowledge Transfer (TotKT), which indicates that a participant recommended an AT device or technique that was not shown in the audiovisual database or discussed in the manual, but that is conceptually related to the AT that was demonstrated in the module.

As with the other measures, the scores for the Performance Assessment, Strategy Transfer, and Knowledge Transfer were averages of the scores given by the three raters.

Formula K-R 21 was used to calculate the following reliability coefficients for the preceding measures: .85 on the Post-Treatment Performance Assessment, .84 on Strategy Transfer, and .74 on Knowledge Transfer.

Interrater agreement was calculated in a similar manner as on the Pre- and Post-Treatment Knowledge Assessments. The agreement among the three raters on the Post-Treatment Performance Assessment was 99.62%, and was 99.35% for Strategy Transfer and 97.47% for Knowledge Transfer.

Vision Module Post-Treatment Survey

The Vision Module Post-Treatment Survey was completed by the participants at the time of debriefing (several days after the posttests were administered). Its purpose was to collect data regarding the potential for treatment diffusion in the research and to gather additional information about the attitudes of the participants toward the module.

Field Test Procedures

At the first meeting with the research participants, they received ID numbers to write on all of their research materials (to help ensure anonymity), and they completed the Research Participant Information Sheet, the Pre-Treatment Knowledge Assessment, and the Need for Cognition Scale. Approximately 1 week later, participants were permitted to begin the treatment. Four workstations (consisting of a videodisc player, a videodisc, a television monitor, a set of headphones, and a remote control unit for the videodisc player) were set up in a conference room where participants could work without being disturbed. A treatment supervisor distributed the printed materials, kept a record of the time that each participant spent on the instruction, and verified that each participant had completed all of the activities in the module by looking through the manual to see if the work was done and checking off each part on a checklist. Immediately after completing the treatment, each participant was asked to respond to the Vision Module Evaluation Form. In order to help avoid a potential internal-validity threat of treatment diffusion, participants were asked not to discuss the module with anyone until after the posttreatment assessments had been administered.

During the week following the last day of treatment, the posttests were administered to both treatment groups at the same time in their respective classes. The participants repeated the same assessment of knowledge that was used for the pretest, but they were not informed of this fact before they actually began taking that part of the posttest. This procedure was intended to help reduce the likelihood of pretest sensitization to better reveal how much factual information the participants had learned from the module. After that, they completed the Post-Treatment Performance Assessment, in which they watched two cases from the videodisc and referred to

printed supplementary case information. With this information, they were to identify the functional needs of the person in the case, recommend AT to meet those needs, and justify their recommendations. They also had their own manuals (from the treatment phase of the field test), which they were able to use as a reference for their work so that they did not have to remember the names of over 100 different AT devices and techniques. A part of this performance test was intended to reveal examples of transfer, in terms of concepts and strategies that were embedded in the practice cases completed during the treatment.

Variables

Independent Variables

1. Treatment group membership.

2. Course enrollment (the stratification variable).

Dependent Variables

1. Scores on the Post-Treatment Knowledge Assessment, consisting of subscores for (a) Knowledge of terminology related to vision impairment, (b) Knowledge of functional needs of people with impaired vision and AT available to meet those needs, and (c) Knowledge of considerations in recommending and acquiring AT for a person with a disability.

2. Scores on the Post-Treatment Performance Assessment (performance at recommending AT for the two people in the two video-based test cases).

3. Scores on Strategy Transfer and Knowledge Transfer (from the preceding two video-based case studies).

Additional Variables

1. Scores on the Pre-Treatment Knowledge Assessment.

2. Scores on the Need for Cognition Scale.

3. Duration of the Instructional Period (elapsed time from initiation to completion of the treatment).

4. Duration of the Instructional Hiatus (elapsed time from completion of the treatment to initiation of the posttest).

5. Scores on measures of attitude toward the module.

6. Prior experience with this content area (familiarity with disability in general and with vision impairment in particular).

Data Analysis

Estimates of both statistical and educational significance were calculated in this investigation. Even though statistical significance provides no information about the importance of observed differences between mean scores or relationships between variables, it does provide information about chance occurrences being a threat to the internal validity of the research. Whenever possible, exact probability levels (p) for statistical analyses have been stated in this paper. These p values tell the researcher and other interested persons about the likelihood of obtaining differences or relationships of the magnitude observed in the long run with repeated same-size sampling, and given that the null hypothesis is true. Regarding the importance of observed differences, estimates of educational significance provide information about the magnitude of differences between mean scores and relationships that are independent of sample size and in a standardized form. In this study, standardized mean differences and correlation coefficients were used to calculate educational significance.

Because there was no untreated control group, the standard deviation (*SD*) used to calculate standardized mean difference effect sizes (ES) *between* groups on the posttest measures was derived by pooling the standard deviations from the pretests of the two comparison groups. The same procedure was used for posttest-only measures by pooling the standard deviations of the posttests of the two groups. For consistency, the mean difference between groups was always derived by subtracting the Treatment 2 mean from the Treatment 1 mean, or the Course 2 mean from the Course 1 mean.

In calculating effect sizes to show the magnitude of the mean gain from pre- to posttest *within* groups, a formula for deriving a standard deviation for raw gain scores was used, and the pretest mean was subtracted from the posttest mean in order to obtain the mean difference.

Standards for determining when an effect size is educationally significant are rather arbitrary because few guidelines are available. Cohen (1988) has suggested that 0.20 is a small effect, 0.50 is a medium effect, and 0.80 is a large effect. In a book prepared for the Joint Dissemination Review Panel, Tallmadge (1977) considered an effect size of 0.25 to be significant for achievement tests; however, the panel did not distinguish between the use of this standard for analyzing pre- to posttest gains or for analyzing group differences. In the present investigation, an *ES* of 0.25 is regarded as insufficient, particularly for judging the significance of a pre- to posttest gain; therefore, the following standards were set for judging educational significance: (a) for a pre- to posttest gain, the criterion is $ES \geq 1.00$; (b) for differences between groups, the criterion is $ES \geq 0.50$; and (c) for correlation coefficients, the criterion is $r \geq .50$.

The criterion for statistical significance in this study is the traditionally accepted $p \leq .05$.

In order to analyze the gain within groups from pretest to posttest for each section of the Knowledge Assessment, a t test for paired samples was performed on the data from each section and for the total test, and effect sizes were calculated.

A two-way analysis of covariance (ANCOVA) was used to test the statistical significance of the differences between the adjusted posttest scores of the groups and to determine if there was a statistically significant interaction between the two factors (i.e., Treatment Group and Course Enrollment). The covariates used for adjusting means were the pretest scores on the Knowledge Assessment and the scores on the NCS. Two-way analysis of variance (ANOVA) procedures were also performed on the same data used for ANCOVA. The reason for conducting ANOVA will be discussed in the Results section.

Pearson product-moment correlation coefficients were calculated to determine the direction and magnitude of relationships among the following variables: (a) participants' posttest scores and their scores on the Need for Cognition Scale; (b) posttest scores and the duration of

the instructional period, that is, the elapsed time (in hours) from initiation to completion of either treatment; and (c) posttest scores and the duration of the instructional hiatus, that is, the elapsed time (in hours) from completion of the treatment to initiation of the posttest.

Finally, in order to reveal participants' perceptions of or attitudes toward the various features of the materials they used, frequency counts were performed on their responses to the items on the Vision Module Evaluation Form and the Vision Module Post-Treatment Survey. Descriptive statistics were calculated for the responses to each item, and student comments associated with each item were compiled.

RESULTS

Alternative Analysis of Dependent Variables

During the initial phases of this investigation, the plan for seeking an answer to several of the research questions involved conducting a two-way ANCOVA on the dependent variables with Treatment Group and Course Enrollment as the two factors. The covariates for ANCOVA on the Post-Treatment Knowledge Assessment (TotKPst) were the scores from (a) the Pre-Treatment Knowledge Assessment (TotKPre) and (b) the Need for Cognition Scale (NCS). Both covariates, as pretreatment measures, were used to adjust posttest means to compensate for initial, pretreatment differences. The covariate for ANCOVA on the Post-Treatment Performance Assessment (TotPrf) as well as on Strategy Transfer (TotST) and Knowledge Transfer (TotKT) consisted of the scores from the NCS.

ANCOVA was performed on TotKPst, TotPrf, TotST, and TotKT, but no statistically significant differences were found between treatment groups. Also, the correlations of these dependent variables with the covariates were low. Furthermore, when a two-way ANOVA was performed on each of the dependent variables (with Treatment Group and Course Enrollment as the factors), the results were essentially the same as with ANCOVA; that is to say, there were no statistically significant differences between treatments on the total posttest measures; therefore, for the sake of simplicity, the ANOVA instead of ANCOVA results were used.

Personological Details about the Sample

In the process of randomly assigning participants to treatment groups, a relative balance of variables, such as Gender and Age, across treatment groups happened completely by chance. However, an error was made during the compilation of treatment materials into folders: Course 2 originally had 12 participants in both treatment groups, but 1 participant who had been assigned to do Treatment 1 accidentally received and completed the materials for Treatment 2. This was the reason for the unequal treatment group sizes within Course 2.

Gender, Level (graduate vs. undergraduate), and Age were correlated with prior experience variables, such as work experience with people who have disabilities (DisWrk), experience with people who have impaired vision, and experience with AT for people with impaired vision. The only statistically significant correlation was between Level and DisWrk ($r = -.41$, $p < .05$, two-tailed); however, the square of the correlation coefficient ($r^2 = .17$) indicated that only 17% of the variance in DisWrk can be explained by Level. The negative direction of the correlation suggests that the undergraduates in the sample reported more actual work experience with people who have disabilities than the graduate students.

Because the NCS reveals an important characteristic of the participants in the sample, it will be discussed here as a personological variable. The means on the NCS for Course 1 (gradu-

ates, $M = 66.43$, $SD = 6.68$, $N = 14$) were greater than for Course 2 (undergraduates, $M = 61.54$, $SD = 8.81$, $N = 24$). Thus, a two-way ANOVA was performed on the NCS data with Treatment Group and Course Enrollment as the two factors; but the results indicated that the differences between means for treatment groups and for courses, and the interactions between Treatment Group and Course Enrollment on the NCS, were not statistically significant at the .05 level.

Answers to the Research Questions

1. As a result of using either version of the module, is there a statistically and/or educationally significant increase in the participants' knowledge (from pretest to posttest) about AT?

In order to determine the statistical significance of the differences in gain from pretest to posttest for the combined groups ($N = 38$), a t test for paired samples was performed on the pretest and posttest means of the Knowledge Assessment. In addition, effect sizes were calculated to provide an estimate of the educational significance of the differences between pretest and posttest means. Descriptive statistics are reported in Table 1.

With regard to combined groups, the result was a mean gain of 13.54 points, $t\,(37) = 11.33$, $p < .001$, two-tailed, $ES = 2.33$. Thus, the answer to Question 1 is yes, participants did increase their knowledge of AT. The increase is statistically significant beyond the .001 level, but more importantly, it has educational significance as indicated by the magnitude of the effect sizes: The average participant advanced more than two standard deviation units on the total test.

Table 1

Descriptive Statistics on the Total Pre- and Post-Treatment Knowledge Assessments

Groups	*N*	Pretest *M* (*SD*)	Posttest *M* (*SD*)	Gain *M* (*SD*)	*ES* Within Groups Pre to Post	*ES* Between Groups Post Only
Treatment 1: More Analysis	18	18.39 (7.18)	31.15 (4.23)	12.76 (6.93)	2.34	-0.08
Treatment 2: More Cases	20	17.48 (6.95)	31.73 (4.03)	14.25 (7.86)	2.30	
Course 1: Graduate	14	19.86 (8.86)	32.31 (5.29)	12.45 (9.73)	1.63	0.20
Course 2: Undergraduate	24	16.78 (5.51)	30.96 (3.21)	14.18 (5.72)	3.15	
Combined Groups	38	17.91 (6.98)	31.45 (4.08)	13.54 (7.37)	2.33	

Note. 40 points were possible on the Knowledge Pretest and Posttest.

2. Is there a statistically and/or educationally significant difference between the mean scores on the knowledge posttest of the groups receiving Treatment 1 or 2?

A two-way ANOVA was performed on TotKPst with Treatment Group and Course Enrollment as the factors, but there were no statistically significant differences for either main effect or the interaction. The effect sizes between the treatment groups, as well as between the courses, on this variable were also quite low (see Table 1). Thus, the answer to Question 2 is no; however, when the three subsections of the Post-Treatment Knowledge Assessment were analyzed using the same ANOVA procedure as with the total test, a statistically and educationally significant difference between the scores of participants in Courses 1 and 2 was revealed on the Terminology subsection (KPst1): $F(1,34) = 5.348$, $p = .027$, two-tailed, $ES = 0.94$. The average participants in Course 1 (graduates) scored almost one standard deviation unit above the average participants in Course 2 (undergraduates).

In an effort to gather additional information about differences between courses, the following statistically significant correlations were discovered between the NCS and the Terminology subsections of the pre- and posttest: NCS with KPre1, $r = .45$, $p < .01$, two-tailed, $r^2 = .20$; and NCS with KPst1, $r = .47$, $p < .01$, two-tailed, $r^2 = .22$. Furthermore, the correlation between KPre1 and KPst1 is statistically significant (KPre1 with KPst1, $r = .54$, $p < .01$, two-tailed, $r^2 = .29$).

For KPst1, Course Enrollment appears to be an important moderating variable. As noted earlier in this section, there were initial (although statistically insignificant) differences between Courses 1 and 2 on the NCS. Given the statistical and educational significance of the difference between the means of Courses 1 and 2 on KPst1, and the statistical significance of the correlations for NCS, KPre1, and KPst1, ANCOVA procedures were performed on KPst1 to adjust for pretreatment differences between the courses. However, once the means for Courses 1 and 2 were adjusted using KPre1 and NCS scores as covariates, the statistical significance of the difference between courses was no longer present: $F(1,32) = 0.71$, $p = .406$. This result suggests that the difference between courses on KPst1 may be accounted for by pretreatment differences among the participants in the two courses.

3. Is there a statistically and/or educationally significant difference between the mean scores on the performance posttest of the groups receiving Treatment 1 or 2?

The Post-Treatment Performance Assessment (TotPrf) consisted of two case studies presented on the videodisc, supplementary case information on paper (which was in the same format as for the video-based practice cases during treatment), and answer sheets for each case study. No pretest of performance was administered.

A two-way ANOVA was conducted on TotPrf with Treatment Group and Course Enrollment as the two factors. The results showed no statistically significant mean score differences. However, the average participant in Treatment 1 scored over half a standard deviation unit ($ES = 0.52$) above the average participant in Treatment 2, so the answer to Question 3 is no with respect to statistical significance, but perhaps yes for educational significance. The correlation between the NCS and TotPrf was not statistically significant ($r = .26$, *ns*, two-tailed, $r^2 = .07$); therefore, that particular relationship accounts for little variance. Also, the mean difference between Treatment 1 and 2 is only 1.55 points, so the real difference in actual points was not very great.

4. Are there statistically and/or educationally significant differences between the mean scores on the measures of transfer of the groups receiving Treatment 1 or 2?

As previously discussed, transfer in this report is defined as participants being able to apply certain knowledge that they have gained from the Vision Module to solving new case studies. Two types of transfer were measured: (a) Strategy Transfer (TotST), which indicates the use of verbs to express functional activities in the process of recommending AT, and (b) Knowledge Transfer (TotKT), which indicates the recommendation of AT not shown in the audiovisual database or discussed in the manual, but that has a conceptual relationship with AT demonstrated in the module.

For TotST, a two-way ANOVA was performed. The result showed no statistically or educationally significant difference between treatment group means. However, there were statistically ($p = .025$) and educationally significant ($ES = -0.77$) differences between Courses 1 and 2: $F(1,34) = 5.496$, $p = .025$, two-tailed, $ES = -0.77$. The average participants in Course 2 were over three fourths of a standard deviation unit above the average participants in Course 1.

For TotKT, a two-way ANOVA was also performed with the result of no statistically or educationally significant difference between the mean scores of treatment groups or courses.

The following are some of the responses that the raters judged as examples of Knowledge Transfer based on the guidelines of the scoring protocol. They were (a) a beeping signal beacon to mark a golf hole, (b) a beeping golf ball, (c) a sighted golf guide, (d) signal beacons on the sides of a swimming pool, (e) a sighted swim guide, (f) a sighted skydiving guide, (g) a sighted guide for camping and fishing, and (g) a beeping bobber to signal when a fish bites. Most of these recommendations of AT on the posttest cases were made by more than one participant in an effort to respond to the stated needs of the person in the case. The basis for citing these as examples of transfer is that they have a conceptual relationship to devices and techniques that were demonstrated in the audiovisual database of AT on the videodisc, but none of the preceding devices or techniques were themselves demonstrated. Whether or not these examples actually exist does not negate them as potential examples of knowledge transfer, especially in terms of creativity (i.e., recommending a solution that was not suggested in the instructional materials). However, it must be acknowledged that these are examples of "near" transfer because they have a close conceptual relationship to the AT that was demonstrated.

5. Are there statistically and/or educationally significant interactions between the factors of Treatment Group and Course Enrollment on the posttest measures?

In the two-way ANOVAs conducted on posttest measures (i.e., TotKPst, KPst1, TotPrf, TotST, and TotKT), no statistically significant interactions were evident between Treatment Group and Course Enrollment. However, in terms of educational significance, there was a fairly obvious interaction between the two factors on Knowledge Transfer (TotKT). The participants in Treatment 2 of Course 1 had a substantially higher mean score than any other subgroup. The graph in Figure 1 displays the non-orthogonal interaction between the two factors.

In order to calculate effect sizes between the Treatment 2-Course 1 mean and the means of the other subgroups, the standard deviations for all of the subgroups were pooled together. The results indicated that the average Treatment 2-Course 1 participants were more than one standard deviation unit ($ES = 1.05$) ahead of the average Treatment 1-Course 1 participants. They were almost two thirds of a standard deviation unit ($ES = 0.63$) ahead of the average Treatment 2-Course 2 participants; and more than half a standard deviation unit ($ES = 0.59$) ahead of the average Treatment 1-Course 2 participants.

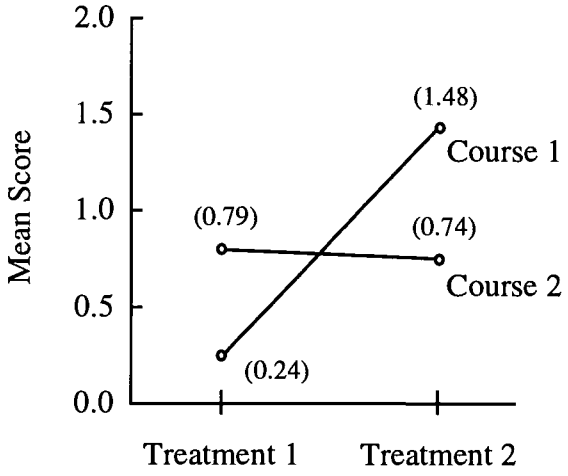

Figure 1. Treatment by Course Interaction on Knowledge Transfer.

6. What is the direction and magnitude of the relationship between participants' posttest scores and their scores on the Need for Cognition Scale?

The only statistically significant correlation was between NCS and TotKPst ($r = .38$, $p < .05$, two-tailed, $r^2 = .14$). This relationship suggests that participants with high NCS scores also have high scores on TotKPst. As was previously mentioned, there were statistically significant results when the NCS was correlated with KPre1 and KPst1, which were the Terminology subsections of the Pre- and Post-Treatment Knowledge Assessments (NCS with KPre1, $r = .45$, $p < .01$, two-tailed, $r^2 = .20$; and NCS with KPst1, $r = .47$, $p < .01$, two-tailed, $r^2 = .22$). Correlations of NCS scores with KPst2 ($r = .07$) and KPst3 ($r = .17$) were not statistically significant.

7. What is the direction and magnitude of the relationship between the posttest scores and the duration of the instructional period (DIP), that is, the elapsed time (in hours) from initiation to completion of either treatment?

All of the coefficients were quite low, and none were statistically or educationally significant, indicating that there was no important relationship between posttest scores and DIP.

8. What is the direction and magnitude of the relationship between the posttest scores and the duration of the instructional hiatus (DIH), that is, the elapsed time (in hours) from completion of the treatment to initiation of the posttest?

The only statistically significant correlation was DIH with TotST ($r = -.36$, $p < .05$, two-tailed, $r^2 = .13$), which indicates that DIH has an inverse relationship with Strategy Transfer scores (i.e., a shorter hiatus was related to higher scores on TotST).

9. What are participants' perceptions of or attitudes toward the various features of the materials they used?

On the whole, the attitude of the participants toward the various parts of the module was quite positive. All of the mean responses to statements regarding specific parts of the module were above 4.00 (4 = Agree; 5 = Strongly Agree), indicating general agreement with the statements of the evaluation items for those features of the materials.

One unique feature of the Vision Module was that it presented a case study at the beginning in order to provide a context for learning about AT and to give the participants a reason to care about AT. All participants agreed (68% strongly agreed and 32% agreed) with a statement about liking this feature; and their written comments were generally in favor of case-based instruction.

In a related item, participants were asked to indicate their preference for studying all of the content material first, before doing a case study. Strong agreement with the statement indicates a preference for studying content materials first while strong disagreement suggests a preference for starting with a case study. The responses of the 38 participants were mixed across the scale, but 34% were in general agreement with doing content first and 45% were in general disagreement with the statement.

Most participants believed that the Vision Module helped them understand more about common functional needs among people with impaired vision, the variety of AT available for people with impaired vision, and considerations in the process of recommending and acquiring AT for a person with a disability. Furthermore, when asked if they would recommend the Vision Module to others who want to learn about AT for people with impaired vision, 68% strongly agreed and 32% agreed that they would recommend it.

Most of the participants had positive attitudes toward the activities in the version of the module they completed.

Although the Vision Module was designed for use by individuals or by groups, for this investigation, the two versions of the module were administered as individual rather than group treatments. Out of the 38 respondents, 53% indicated that they preferred working alone, 34% would have preferred working with a partner or group, and 13% felt that either individual or group work would be acceptable.

DISCUSSION

The development of case materials on videodisc can be expensive, so one area of concern that came immediately to mind was the number of cases required for learners to gain the maximum instructional benefit. Specifically, we needed to know if a few cases with intensive analysis would be as good or better than several cases with less intensive analysis. That notion became the basis for the two comparison treatments in the study.

All of the prior reviews of literature referred to in this dissertation called for more research on actual implementations of the case method. Some other recommendations for research were to conduct it in the context of developing case materials (Sykes & Bird, 1992), and to study variations of the case method to determine their effects on such things as learning and transfer (Knirk, 1991; Smith, 1987; Sykes & Bird; Williams, 1992). The present investigation was based on an actual implementation of two variations of case-based instruction to determine their effects on acquisition, application, and transfer of complex knowledge, thus contributing to the research called for by these reviewers.

Interpretation of the Results

Treatments and Courses

Both versions of the Vision Module were multiple-case interventions, and even though an attempt was made to provide instructional strategies to induce a greater degree of mindfulness among the participants of Treatment 1, as it turned out, the instructional difference between the two comparison treatments was relatively minor, which may explain the lack of statistically significant differences between the treatment groups on the dependent measures. The pretreatment difference between courses on the NCS was one condition that may have had an influence on the dependent variables; however, at least one other condition that has not been discussed in detail may have had an impact. Winter quarter of 1994 began in early January, but at that time, the two versions of the manuals were still being prepared for the main field test, which began in February. Thus, the students had already completed several weeks of their respective courses by the time they studied the Vision Module. As stated in the Procedures section, the undergraduate-level course (Course 2) dealt specifically with assistive technology, while the graduate-level course (Course 1) focused on psychosocial aspects of disability. Because of the focus of the undergraduate course on assistive technology, those participants may have been more prepared for the intervention than the graduate students. Nevertheless, the pretest scores on the Knowledge Assessment showed no statistically significant differences among any of the groups on knowledge about AT for people with impaired vision, and the only educationally significant difference was in favor of the graduate students on the terminology subsection ($ES = 0.94$).

Knowledge Acquisition

In comparing the two treatments to determine if one was more effective than the other for knowledge acquisition, the differences between posttest means of the treatment groups on the Knowledge Assessment (TotKPst) were neither statistically nor educationally significant. This lack of significance suggests that the strength of the two treatments for fostering the acquisition of the factual information in the module was about the same. However, both versions (Treatments 1 and 2) of the module were effective for knowledge acquisition as demonstrated by the participants' statistically and educationally significant gains from pre- to posttest on the Knowledge Assessment. Furthermore, their responses and comments on the evaluation form were positive indications that they believed the module helped them learn important information and that having to make recommendations of AT for people in the case studies motivated them to concentrate more on learning about AT. Even though there is evidence that some forms or implementations of case-based instruction may not be effective for knowledge acquisition (Argyris, 1980; Smith, 1987; Sykes & Bird, 1992), there is as much or more evidence suggesting that it is effective for that objective (Bocker, 1987; Burford, Ingenito, & Williams, 1990; Carroll et al., 1972; Neider, 1981; Shoenfelt et al., 1991), which supports the findings from this study.

In the comparison of the two courses, there was a statistically and educationally significant difference between the posttest means on the Terminology subsection (KPst1) of the Knowledge Assessment; however, based on the analysis described in the previous section, the difference can be accounted for by initial differences on the NCS and the pretest. The statistically significant and positive correlation between the NCS and KPst1 scores indicates that participants with high scores on the NCS also had high scores on KPst1. Given the fact that the participants in Course 1 (the graduate level class) had higher NCS scores than participants in Course 2, it is likely that the difference between the courses on KPst1 can be attributed to the

differences on the NCS. One interpretation is that graduate students would typically have a higher need for cognition and greater experience at knowledge acquisition than undergraduates.

Knowledge Application

The Performance Assessment (consisting of two video-based cases) was only administered as a posttest. Although there were no statistically significant differences between the mean scores of the two treatment groups (or the two courses) on the Performance Assessment (TotPrf), there was an educationally significant difference ($ES = 0.52$) in favor of Treatment 1.

The participants in Treatment 1 were required to analyze their recommendations of AT, to compare and contrast the four video-based cases, and to analyze conceptual relationships of different AT devices and techniques. The participants in Treatment 2 completed four text-based cases in addition to the video-based cases, but they received no analysis activities. For participants in Treatment 1, the more intensive examination and mindful abstraction of cases and concepts may have given them an understanding of appropriate matching of AT to particular functional needs of people with impaired vision, and consequently an advantage in the application of knowledge about AT on the posttest cases. Such an application of knowledge would be a good example of high-road transfer and the role that mindfulness plays; that is to say, mindful abstraction of knowledge is a prerequisite for high-road transfer to occur (Salomon & Perkins, 1989). Previous literature reviews and research also support the finding that case-based instruction is effective for knowledge application (Bocker, 1987; Masoner, 1988; Smith, 1987).

Knowledge Transfer and Strategy Transfer

Based on the criteria set in the Procedures section for educational and statistical significance, there was no significant difference between treatment groups on Knowledge Transfer (TotKT); and although the interaction between Treatment Group and Course Enrollment on TotKT was not statistically significant, it was educationally significant. The participants in Treatment 2 of Course 1 scored substantially higher than the participants in any of the other subgroups. This difference may be related to the slightly higher NCS scores for Course 1 in combination with having practiced with a variety of cases from Treatment 2. This hypothesis is supported by the research of Jacobson and Spiro (1992), in which they found that given the same multiple-case treatment, participants who had an affinity for working with complexity performed better on a measure of transfer than subjects who preferred simplified contexts. The difference among the subgroups could also be related to age and experience of the participants in combination with the treatment, or any of several variables both measured and unmeasured in this study.

As with Knowledge Transfer, there was no significant difference between treatments on Strategy Transfer, but the small difference between treatment groups favored the participants in Treatment 1. Several of the activities in Treatment 1 suggested, but did not require, the use of verbs in thinking about functional activities. The use of verb forms (e.g., *playing golf* or *golfing* as opposed to *sports* or *recreation*) for stating functional activities is desirable in that it may help focus the participants' attention on the specific actions that a person with impaired vision may want or need to accomplish. This strategy may be useful in thinking about the appropriateness of certain AT devices or techniques for the particular circumstances of the person in the case. However, the actual occurrence of Strategy Transfer (i.e., the use of verbs in specifying functional activities for a posttest case) in this investigation was difficult to determine because some (or most) of the participants may have a general tendency to use verb forms in this way. Such a tendency would confound any between-group differences that may have resulted from other

participants who actually transferred the use of verbs as a general strategy for thinking about functions.

The difference between courses on the mean scores for Strategy Transfer was both statistically and educationally significant in favor of participants in Course 2, all of whom were undergraduates majoring in Special Education (SPED). Perhaps SPED majors are more accustomed to thinking in terms of action verbs about the people they serve, but this notion is purely conjecture. A factor that may have confounded this variable was that the Knowledge Assessment had instructions for the Functional Activities/AT subsection (on both the pretest and posttest) suggesting the use of verbs for describing functions; thus, the Knowledge Assessment may have served as part of the instructional treatment on this strategy for all of the participants. This circumstance would usually be a threat to external validity, but the testing instruments are considered to be part of the instructional module.

With transfer defined as a learner independently applying knowledge to new situations with characteristics that are different from the initial learning situation (Spiro & Jehng, 1990), we can say that Knowledge Transfer occurred during this investigation. The concept of Strategy Transfer, on the other hand, was added to determine if there were any differences between groups in their use of verbs as a strategy for analyzing functional needs of people with impaired vision (specifically the people depicted in the two case studies of the Post-Treatment Performance Assessment); however, the measure of Strategy Transfer did not discriminate between groups. The measurement of Strategy Transfer as the use of verbs did not have a strong conceptual base, or established criteria for achievement; thus, we cannot conclude that it occurred.

To the extent that participants in this study achieved Knowledge Transfer, this research adds support to the notion that case-based instruction promotes transfer. Prior research also supports the idea that case-based instruction is effective for promoting transfer (Jacobson & Spiro, 1992; Williams, 1992).

Attitude and Motivation

The majority of research participants expressed enthusiasm for using case-based instruction, especially when it presents interviews with real people in a video-based format. Several participants stated that it made the learning experience more interesting to have real people to think about in the process of learning about the AT available to help meet the needs of people with impaired vision. Moreover, most of the participants (92%) believed that having to make specific recommendations of AT for people with impaired vision motivated them to concentrate more on learning about AT. Earlier reviews and primary research also support the motivational benefits of case-based instruction (Beckman, 1972; Bocker, 1987; Burford et al., 1990; Carroll et al., 1972; Kleinfeld, 1991; Neider, 1981; Shoenfelt et al., 1991).

Research Conclusions

One of the goals of this research was to investigate instructional conditions within the case method that would help maximize learning and transfer. The two main conditions consisted of (a) activities designed to induce a state of mindfulness in the learners by way of intensive analysis of a few video-based case studies, and (b) text-based cases in addition to the video-based cases. Both treatments involved the use of a multiple-case approach. In general, the instructional differences between treatments were insufficient in strength to produce statistically or educationally significant differences on the dependent measures. However, given the magnitude of gains in participants' knowledge scores, the lack of significant differences between

treatment groups may in itself be significant. If multiple representation of content is important for the transfer of complex knowledge, the implication may be that completing a few cases with in-depth analysis is just as effective as completing several cases with less intensive analysis. At the very least, we may conclude that for participants with similar characteristics to the sample in this research and in a similar environment, a multiple-case instructional approach can be effective for knowledge acquisition in the content area covered by the Vision Module.

The NCS was used in this investigation as a measure of a person's tendency toward mindfulness; however, it provides no information about whether or not a person was mindful during the treatment or the tests. It is likely that both instructional treatments induced a state of mindfulness in all of the participants, to a greater or lesser degree, including those who do not have a high need for cognition and thus tend to avoid cognitively demanding tasks. As was previously mentioned, the differences in the NCS means may be explained by the fact that 12 out of 14 participants in Course 2 were graduate students. One would expect that most people who continue on to graduate school would have a greater inclination to engage in cognitively demanding tasks than the average college student who does not plan on postgraduate studies. Such inclinations and preferences are measured by the NCS.

Correlation coefficients that were calculated between the NCS and each of the dependent variables revealed a small relationship with the Knowledge Assessment (TotKPst), but more particularly with the Terminology subsection and with the Performance Assessment. This suggests that participants with a tendency toward a high need for cognition also tended to score higher on these two measures. Need for cognition, or the trait of mindfulness, is an important variable for research dealing with learning and transfer (Salomon & Globerson, 1987; Salomon & Perkins, 1989), but as it was used in this investigation, it did not help reveal the influence of activities designed to induce a state of mindfulness.

Although the participants did learn from the materials, both treatments were more or less equivalent for helping them achieve an understanding of information in the module. The mindfulness-inducing activities were probably not strong enough to produce a greater degree of mindfulness in the participants of Treatment 1 than naturally occurred in the participants of Treatment 2. Thus, in both treatment groups, participants' mindfulness was probably increased during treatment and testing. Regarding mindfulness and transfer, beyond the statement that instances of "near" transfer were detected during this study, no firm conclusions can be made on the cause of those occurrences.

Most participants had a positive attitude toward the activities and case studies in the version of the Vision Module they completed, and the majority of participants from both treatment groups liked the activities specific to their treatment. One of the main advantages of case-based instruction is the positive attitude that students have toward it and the motivation that it seems to generate to learn about the particular content area.

Recommendations

From the formative evaluation of the module, we found evidence to suggest that in the design and development of case materials, a video format is advisable (if at all possible) because of the potential for embedding data within the presentation of a case and because participants seem to be more interested in video-based rather than text-based cases. Participant motivation is a critical factor in the effectiveness of training materials.

Presentation of a case at the beginning of instruction, rather than waiting until all of the associated concepts have been taught, is a design feature that needs more investigation; however, the context that it provides and the potential for motivating the learners are both important

reasons to consider its implementation in an instructional module. If this approach is used, the participants need to understand early on that the cases are trial-and-error exercises, and that making mistakes is acceptable and even expected.

From the empirical results of this study, the strongest recommendation that can be made is that when case-based instruction is implemented, it should provide multiple cases for the participants to work with. This recommendation is supported by the substantial gain scores of all the groups on the Knowledge Assessment, the participant evaluation data, and by previous research and theory (Jacobson & Spiro, 1992; Spiro, Feltovich, Jacobson, & Coulson, 1991; Spiro & Jehng, 1990; Sykes & Bird, 1992; Williams, 1992).

In this study, the *trait* of mindfulness was measured as a personological variable before the treatment. In future research on case-based instruction, learning, and transfer, it would be useful to develop a way to measure participants' *state* of mindfulness during treatment, testing, and transfer situations.

The relationship of mindfulness to the learning and transfer of complex knowledge needs further investigation. Instructional treatments that induce a state of mindfulness in learners need to be developed and studied, but those treatments need to be much stronger than the ones that were presented to the participants in Treatment 1 of this investigation. It would also be useful to conduct more research on the idea of combining a multiple-case approach with mindfulness activities.

Finally, the retention, application, and transfer of complex knowledge from the case-based instructional environment to the job environment needs to be studied in order to determine whether a case approach provides any real benefit to learners in preparing for actual problem-solving situations.

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