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ABSTRACT

This study investigated the use of Pathfinder Associative Networks in assessing knowledge structures for people who learn information via computer-based tutorials. Graphical representations for a set of concepts were produced for participants who had completed a computer-based tutorial related to the concepts (novices) and for those who had no tutorial (naives). Thirty undergraduates were randomly assigned to be novices or naives, and 9 faculty and professional staff members volunteered to be experts. These graphs were then compared to graphical representations generated by experts. Comparing graphs revealed that the naives and novices were the most similar groups. However, the differences that occurred between the two groups were indicative of the fact that novices were becoming more similar to experts. (Author/SLD)

Running Head: ASSESSMENT OF TRAINING USING PATHFINDER

Assessment of Training Using Pathfinder Associative Networks

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Abstract

This study investigated the use of Pathfinder Associative Networks in assessing knowledge structures for people who learn information via computer-based tutorials. Graphical representations for a set of concepts were produced for participants that had completed a computer-based tutorial related to the concepts (novices) and for those that had no tutorial (naives). These graphs were then compared to graphical representations generated by experts. Comparing graphs revealed that the naives and novices were the most similar groups. However, the differences that occurred between these two groups were indicative of the fact that novices were becoming more similar to experts.

Assessment of Training Using Pathfinder Associative Networks

Currently in the Health Care field, professionals in the area of training use computer-based tutorials as one way to present new information to fieldworkers such as mental health technicians and community health educators. Following the tutorial, the fieldworker will typically complete a test, usually multiple-choice, to demonstrate that he or she has learned the material. However, it is unclear whether the fieldworkers are actually learning from these tutorials. It is possible that the fieldworker completing the tutorial passes the multiple-choice test simply because of the recency of the presentation of the material. In this case the tutorials would be testing very recent memories but not the degree to which the fieldworkers integrated the presented material. In addition, this form of assessment may not be adequate for those who lack test-taking skills or those who get anxious while taking tests. Therefore, professionals in the area of training for these fieldworkers need a better way to assess whether the material is truly learned.

An alternate method of assessing whether the material is truly learned is through assessment of how the knowledge in the tutorial is organized. It is already known that knowledge is organized as it is obtained. In fact, since the time of the ancient Greeks, it has been known that learning requires organized efforts (Walker, 1996). If we can use a quantifiable method for determining how a person organizes a particular set of concepts, we may be able to use that method for assessing how material in tutorials is learned. The Pathfinder Network Scaling Algorithm is just such a method.

Pathfinder networks are graphical representations based on similarity ratings of a set concepts in a knowledge space. Pathfinder uses the similarity ratings to create a data set called a proximity matrix. The matrix is then translated into a graph denoting similarities between

concepts as distances on the graph. The graphical representation is in the form of a model consisting of nodes and links (see Schvaneveldt, Durso, Goldsmith, Breen, Cooke, Tucker, & DeMaio, 1985 for a more detailed description). Using these graphs, we can compare knowledge structures of similar problems for people under different conditions.

Previous research indicates that Pathfinder can successfully be applied to issues in education. Gomez, Hadfield, and Housner (1996) used Pathfinder to examine knowledge obtained during a teaching methodology course in elementary mathematics. In order to further investigate the understanding of novice-expert differences in elementary math education, as well as methods for enhancing and developing conceptual and pedagogical content knowledge, the researchers assessed and compared the knowledge structures of the course instructor, teacher educators, and prospective teachers. They found that the course instructor shared a high degree of structural knowledge with other experienced teacher educators. In addition, the prospective teacher networks were similar to those of the course instructor and experienced teacher educators, suggesting that prospective teachers are gaining a more general knowledge of pedagogy.

In another study, Pathfinder was shown to be a more sensitive predictor of teaching performance than standard exams. Goldsmith, Johnson, and Acton (1991) used Pathfinder to assess students' structural knowledge of classroom learning. Students enrolled in a college course on psychological research techniques were examined to see if students with similar structures perform at a similar level on exams. Using Pathfinder they found that good students had similar knowledge structures and that poorer students have less similar knowledge structures. These findings are consistent with the notion that novices are unable to organize

information in meaningful ways, whereas the experts are able to organize information in terms of abstract relational schemata that are unavailable to novices.

Because Pathfinder was successfully used in education to assess knowledge structures, we decided to use Pathfinder to examine the knowledge structures of those who completed a tutorial on a health care related topic. The current study was designed to answer two questions: Are the tutorials actually good learning devices and can Pathfinder be used to assess this effectively? It was hypothesized that one could expect to find a positive relationship between the knowledge structures of those who have had the tutorial and that of experts in the field.

Method

Participants

Thirty undergraduate students enrolled in general psychology at a Southern university volunteered to participate. These students were given extra credit for their participation. Nine clinical and counseling experts from the psychology and counseling department and the university's counseling center also volunteered to participate.

Materials

Tutorial. The computer-based tutorial that students in the training condition received is part of a multi-modal self-instruction program series on mental illnesses and behavior disorders for people who have mental retardation (Poindexter, 1997). An individual tutorial on the topic of schizophrenia and other psychotic disorders was used for this study. The program provides the material in small blocks. After each block the participants answer questions about what they just read. If they answer correctly they move to the next block. If they answer incorrectly the program takes them back to the block to review the material again.

Rating task. All participants, regardless of condition, rated concepts from the tutorial for similarity using Pathfinder. Pathfinder pairs concepts together and prompts the participant to decide how similar the two concepts are on a scale of one (not similar) to nine (very similar). The participants rated all possible pairwise comparisons of concepts.

Distractor task. The control group did not receive the tutorial. Instead, they completed a distractor task consisting of five puzzle mazes. The students' task was to trace a continuous line from the top left corner to the bottom right corner of the same maze without crossing any lines in the maze.

Procedure

Before the experiment began, concepts for the rating task were selected by asking five people to complete the tutorial and record what they believed were key concepts. Then they were asked to rank those concepts in order of importance. The 13 concepts that all people agreed upon were selected to be used for the rating task (see Appendix).

For the experiment, student participants were randomly assigned to one of two conditions. In the Experimental condition (novice), participants first navigated through the tutorial, then when finished rated the concepts for similarity. In the Control condition (naïve), participants first completed the maze task, and then completed the rating task. Faculty and professional staff members (expert) completed the rating task only.

Results and Discussion

Graphical Representation

The similarity scores for each individual were averaged among all members per condition before applying the Pathfinder algorithm to the ratings. Figures 1 through 3 show the Pathfinder graphs for each condition.

Central Tendency

Pathfinder graphs can be assessed in terms identifying focal nodes. Focal nodes are nodes of central tendency (see Dayton, Durso, & Shepard, 1990 for a detailed explanation of focal nodes). There are three ways to determine central tendency. First, we can identify central tendency in terms of the highest degree node, defined as the node that has the greatest number of links to it. Second, we can describe central tendency by the median node, which is the node with the smallest average distance to all other nodes. Third, we measure central tendency with the center node defined as the smallest maximum distance to any other node. Each type of central tendency and the corresponding nodes for all three nodes are represented in Table 1.

Table 1 suggests that naïve participants believe that the central concept for this set of concepts is medication. Expert graphs, on the other hand, tend towards psychosis as a central concept. Novice central tendency is different than both the naïve participants and the experts. In contrast to naïve participants, novices have viewed the tutorial and realize that medication is not central to the set of concepts. However, novices still have not formed a representation similar to the experts. This is evident in the fact that depression appears to be more central than psychosis.

Network Similarity

Comparison among conditions can also be made via similarity scores. Similarity scores are calculated by dividing the number of shared links between two graphs by the total number of links for those two graphs. In essence, this number represents the amount of overlap for the graphs in question. The network similarity score for the naive condition compared to novice condition was .444. The network similarity score for the naïve condition compared to the expert condition was .136. The network similarity score for the novice condition compared to the expert was .19.

These similarity scores suggest that novices and naives are very similar in their structure of knowledge, yet novices are more similar to experts than naives. This type of finding should not be surprising. Surely, after one exposure to a set of information, we would not expect novices to be equal to experts in how the set of knowledge is organized. What is encouraging is that the novice is slightly closer to the expert score than the naïve score when compared to the expert score, suggesting that some learning did occur.

General Discussion

In response to the earlier question, are individuals learning, the response is "yes". However, it may be difficult to determine from this study that fieldworkers would benefit from this tutorial because fieldworkers may have some previous knowledge about the topic in the tutorial, unlike the students enrolled in general psychology.

In terms of our other question, the usefulness of Pathfinder as a tool to assess learning, we believe we have demonstrated Pathfinder to be an effective method. Our findings suggest that Pathfinder detects the change in knowledge structures that even a small amount of training will produce.

One possible use of Pathfinder that we have not addressed in this study involves using Pathfinder to track changes in knowledge organization as knowledge is accrued. We know from the current study that some learning has occurred after the first tutorial, but we do not know the course of development of expertise over a longer period of time in terms of how knowledge is organized. One way to test this would be to ask psychology majors to complete the ratings task on psychology concepts as freshman and then test them periodically until they reach their final degree level. We should be able to see changes in knowledge structures as expertise is developed, giving us insight to the process of becoming an expert.

Another question that we have not addressed in this study is whether the knowledge structure created by the tutorial remains the same over time. For example, we know that if we train someone on a body of knowledge and then test them using the multiple-choice format immediately after study, the test scores are high. If we test again later, say six months, the test scores are significantly lower due to forgetting. However, it is possible that when facts cannot be recalled, the knowledge is still represented in the same way. If so, then Pathfinder graphs generated immediately after studying a body of knowledge should be comparatively the same as graphs generated six months later by the same person. If not, then how we think about forgetting (loss of information) could change dramatically. Forgetting would have to be redefined as loss of information *and* loss of organizational structure. The use of Pathfinder Networks as an assessment tool will allow us to answer these and other questions.

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Table 1.

Central Tendency Nodes by Level of Expertise

	Central Tendency Nodes		
Level of Expertise	Highest Degree	Center	Median
Naïve	Medication	Medication	Medication
Novice	Depression Medication	Depression Medication Psychosis	Depression
Expert	Psychosis	Catatonic Behavior Affective Flattening	Psychosis

Appendix

Psychosis

Delusions

Hallucinations

Mental Retardation

Disorganization

Catatonic Behaviors

Depression

Diagnostic Overshadowing

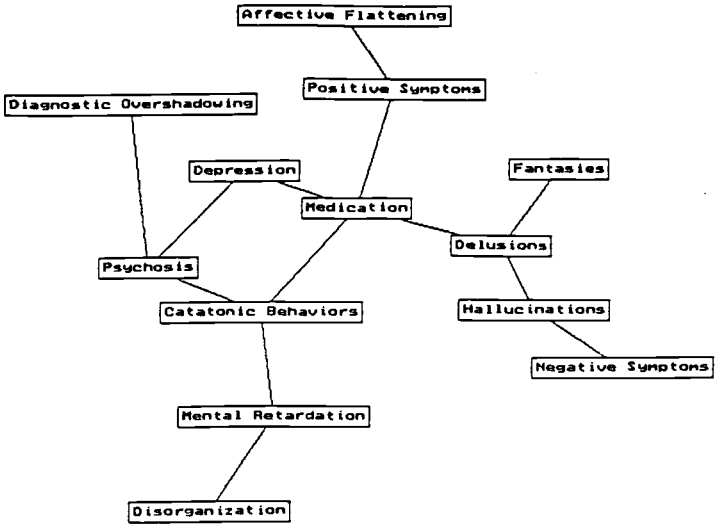
Negative Symptoms

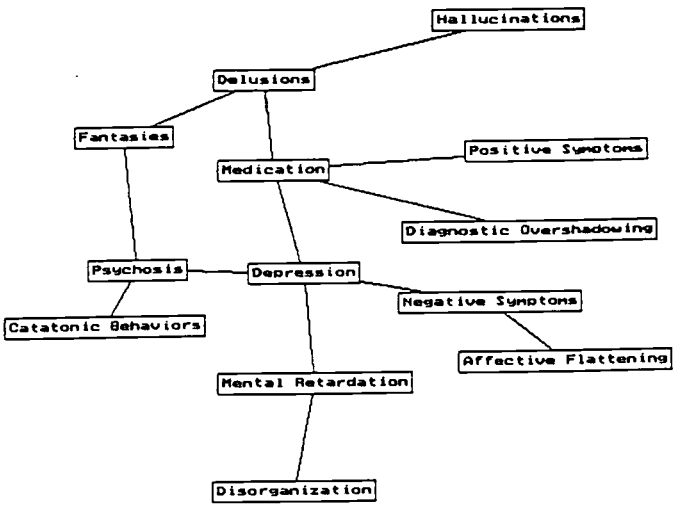
Fantasies

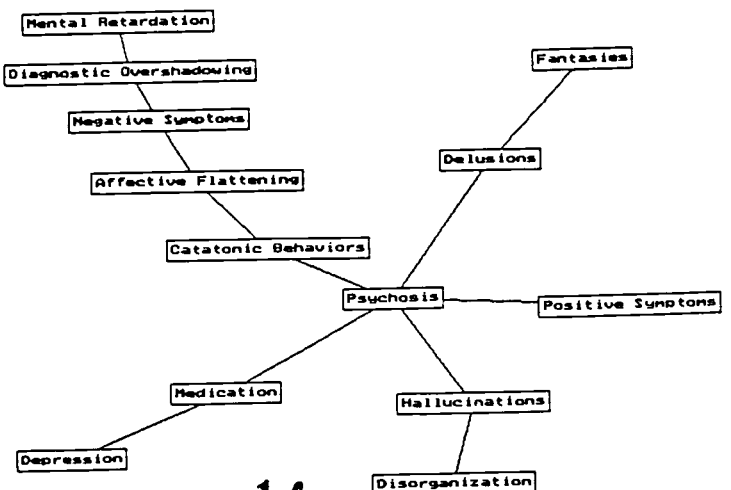
Medication

Affective Flattening

Positive Symptoms


Affective Flattening
Positive Symptoms
Diagnostic Overshadowing
Depression
Fantasies
Medication
Delusions
Psychosis
Catatonic Behaviors
Hallucinations
Negative Symptoms
Mental Retardation
Disorganization


Hallucinations
Delusions
Fantasies
Positive Symptoms
Medication
Diagnostic Overshadowing
Psychosis
Depression
Negative Symptoms
Catatonic Behaviors
Affective Flattening
Mental Retardation
Disorganization


Mental Retardation
Diagnostic Overshadowing
Fantasies
Negative Symptoms
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