DOCUMENT RESUME

ED 268 485 CS 008 374

AUTHOR Balajthy, Ernest
TITLE Expert Systems: A Challenge for the Reading Profession.
SPONS AGENCY State Univ. of New York, Geneseo. Coll. at Geneseo.
PUB DATE Apr 86
NOTE 14p.; Paper presented at the Annual Meeting of the International Reading Association (31st, Philadelphia, PA, April 13-17, 1986). Research also partially funded by the Joint Advisory Council of the New York United University Professions and State University of New York.
PUB TYPE Speeches/Conference Papers (150) -- Viewpoints (120)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Computer Assisted Instruction; Computer Managed Instruction; *Computer Software; *Expert Systems; *Reading Diagnosis; *Reading Instruction; Reading Research; Teaching Methods; Technological Advancement

ABSTRACT

The expert systems are designed to imitate the reasoning of a human expert in a content area field. Designed to be advisors, these software systems combine the content area knowledge and decision-making ability of an expert with the user's understanding and knowledge of particular circumstances. The reading diagnosis system, the RD2P System (Reading Difficulties--Diagnosis and Prescription) based on an expert system shell, guides teachers to an understanding of the possible problems underlying a student's reading difficulties and suggests possible instructional methods to solve those problems. Advantages of the expert systems are that they (1) allow an organization to place untrained staff in key decision-making positions, (2) free professionals from information processing overload so that they can provide services that only humans can offer, (3) bring the best and most expensive of expertise to bear on a problem, (4) are designed so as not to overlook remote possibilities, (5) can be easily updated as new knowledge becomes available, (6) can be used for teaching purposes, and (7) raise questions about the field of expertise and can pinpoint areas where additional research is needed. (Teacher observation data are appended.) (EL)

EXPERT SYSTEMS: A CHALLENGE FOR THE READING PROFESSION

Ernest Balajthy
Dept. of Elementary & Secondary
Education & Reading
State University of New York
at Geneseo
Geneseo, NY 14454
(o) 716-245-5259

Paper presented at the International Reading Association, Philadelphia, Pennsylvania, April, 1986.

The research reported in this paper was partially funded by the Geneseo Foundation (SUNY College at Geneseo, Geneseo, NY 14454), and by the Joint Advisory Council of the New York United University Professions and State University of New York.

While much of the research in artificial intelligence is of a theoretical nature at present, within the past ten years a variety of program systems based on AI principles have achieved a more practical status. The most obvious practical application at present is the so-called "expert system," a software system designed to imitate the reasoning of a human expert in a content area field.

What is an Expert System

Expert systems are designed as advisors. These systems combine the content area knowledge and decision-making ability of an expert with the user's understanding and knowledge of particular circumstances. A reading diagnostic expert system, for example, would contain the diagnostic knowledge and decision-making policies of one or more expert clinicians. Classroom teachers could use their knowledge of students with reading problems as the basis for a "consultation" with the expert system. The system would ask questions of the teachers to obtain information on the students' attitudes and achievement. It would then use this information to draw diagnostic and prescriptive conclusions about the students.

MYCIN is one of the most well-known of early expert systems. Designed at Stanford University, MYCIN consults with physicians to diagnose infectious diseases. It first asks questions of the user about the patient's symptoms. A complex ... m of rules about infectious diseases, their causes and cures, is used to deduce relationships and draw conclusions as to possible treatments. Other expert systems have been constructed to make decisions about spectroscopic analysis of molecular structure, mineral exploration, and vision problems.

Until recently, applications of expert system technology within the field of education have been very limited due to the cost of program design and construction. Within the past few years, however, researchers in AI have developed expert system shells which have greatly simplified the process of construction these systems. A shell program is a tool for building an expert system. Some require no knowledge of programming at all. The Insight system, for example, allows a teacher or reading specialist to use a word processor to input all information in standard English form. The program automatically converts the information into a form which is usable by the decision-making operations of the system.

How Might a Reading Diagnostic Expert System Operate?

The RD2P System (for Reading Difficulties--Diagnosis and Prescription) is based on the Insight expert system shell. The function of the program is to guide teachers to an understanding of the possible problems underlying a student's reading difficulties and to suggest possible instructional methods to solve those problems.

When a teacher consults with RD2P, the program begins by asking a series of questions about the student. Some deal with observed classroom behaviors and performance (see Figures 1 and 2). Others deal with student achievement on standardized and informal tests (see Figures 3 and 4). Some responses, such as a low score on phonetic analysis, may lead to a detailed series of questions such as that is Figure 4 to provide more in-depth information on that issue.

An expert system typically has two major components, an inference engine and a knowledge base. The inference engine is the part of the system that operates on the knowledge base, carrying out inferencing procedures according to a prescribed hierarchical sequence. In expert system shells such as Insight, the inference engine is provided. System designers need only concern themselves with construction of the knowledge base.

The knowledge base is composed of several types of information, structured according to a rule system. In a reading diagnostic system, this knowledge base contains the actual information necessary to draw diagnostic and prescriptive conclusions. The information is simple to "program" into the knowledge base. In Insight, the information is typed into the computer using a standard word processor, according to a system of rules known as production rules. Figure 5 presents a simplification of one such rule from the RD2P system.

The rule deals with a diagnosis of comprehension ability of a student as being at the developmental level, that is, of not requiring any correction by the classroom teacher or reading specialist. The rule commands the inference engine to check the

Stanford Diagnostic Comprehension Subtest Score to determine whether it is at or above the student's actual grade level. If so, and if that subtest score is also at or above the student's reading potential (as indicated by an aptitude test), then the student is diagnosed as being developmental in comprehension. If either of the two IF statements are not true, another production rule will be activated, leading to another diagnosis.

The expert system shell provides a simple-to-understand format for construction of the production rules. No programming knowledge is necessary. All rules are typed in standard English, though certain basic patterns (such as the RULE--IF--THEN pattern in Figure 5) must be followed.

Each production rule can lead to another production rule further within the knowledge base. For example, a conclusion that a reader is remedial in comprehension might lead to the system's offering the teacher the option of obtaining prescriptive suggestions for techniques and materials to use to remediate comprehension at that student's grade level. The conclusion will also lead to additional questions about comprehension subskill achievement, as the system attempts to discover the causes of the comprehension deficiencies. The teacher's answers to these questions might lead to further diagnoses, such as conclusions that the student is deficient in finding main ideas or in integrating prior knowledge with material being read.

One of the great advantages arising from artificial intelligence research in decision-making has to do with certainty and uncertainty. That is, when a human expert draws a

BEST COPY AVAILABLE

conclusion, it is rarely an all-or-nothing affair. There is usually some degree of confidence associated with it. For example, in the conclusion that a student has no comprehension difficulties, the conclusion will be far more sure if the student scored several grades above his expectancy score than if he scored at his expectancy.

Expert systems make provision for varying levels of confidence in the decisions made, such as in the comprehension conclusions or in the teacher observations in Figures 1 and 2. The use of uncertain knowledge in reasoning, called fuzzy knowledge by artificial intelligence experts, is one of the truly innovative developments of AI research.

Confidence levels in the Insight system, for example, are stated using the term CONFIDENCE in conjunction with the rule's concluding statement (see Figure 5). The use of the term CONFIDENCE requires a numerical value between 0 and 100. 0 signifies that the conclusion is completely false and 100 that it is completely true. A confidence of 75 might signify "probably true," 50 might signify "unsure," and 25 "probably false." The inference engine uses mathematical formulas to keep track of the confidence levels of its conclusions. A combination of one conclusion with a 70% confidence value and another, dependent on the truth of the first, with an 80% confidence value, leads to a final conclusion with a 56% confidence level.

What are the Advantages of Expert Systems?

1. An expert systems allows an organization to place untrained staff in key decision-making positions. Due to the enormous complexity of the educational process, teachers often must make decisions in areas about which they have received little or no training. Is a student suffering from an emotional problem? Does a student have a specific learning deficit? Are there reading skills which the student lacks? Does a special education student need extra kinds of help?

A teacher could use an expert system to deal with each of these issues. The system could be designed to obtain information from the teacher, structure the teacher's thinking about the problem, and provide specific ideas for solution of any problems diagnosed.

2. Johns (1982) noted that as many reading research studies were carried out in the decade from 1971 to 1980 as in all other decades combined since the beginning of reading research in the 1880's. Despite the tremendously increased knowledge base, however, teacher training remains much the same. Most teachers in the field have received only a minimum of training in the area of reading, and even well-trained reading specialists have trouble keeping up with developments.

Roger Schank, Director of the Artificial Intelligence Program at Yale, has suggested that AI has the potential of releasing human beings from the burdens of these overwhelming technical demands. Expert systems can free professionals from this information processing overload so that they can provide services that only humans can offer (1984).

3. An expert system can bring the best and most expensive of expertise to bear on a problem. Imagine, for example, an expert system which combined the diagnostic perspectives of several nationally-known reading experts. Such a system might well be designed to analyze a problem from a variety of viewpoints, offering the teacher-user several alternatives, each based on a different model of the reading process or a different philosophy of instruction.

4. Expert systems can be designed so as not to overlook remote possibilities. Neurological research on such topics as "deep dyslexia", for example, is not well-known to most reading specialists. Only a very small percentage of the population of students with reading problems may be affected by such lesser known problems. A comprehensive diagnostic system can be prepared to recognize such cases.

5. A properly designed expert system can be easily updated as new knowledge becomes available. Updates within the production rule knowledge base of an expert system are far easier to make than in traditionally programmed software.

6. Expert systems can be used for teaching purposes. Imagine, for example, a reading specialist being trained in diagnosis. A reading diagnostic expert system could be used as a teaching device, especially if the system can clearly explain its decisions and arrange simulated diagnostic experiences for the learner. <u>Insight</u>, as well as most other systems, provides a detailed report on the reasoning processes it uses to draw

conclusions.

7. Finally, and perhaps most importantly, the construction of an expert system within the reading field may be an important experience for the field itself. Too often, .elds of expertise within education suffer from a lack of comprehensive organization. Thinking can be sloppy. Ideas and relationships between those ideas have not been carefully formulated. Research has not been closely analyzed.

The construction of an expert system--or of competing expert systems--must necessarily raise questions about the field of expertise. What are the ultimate goals of the diagnostic process? What are the logical substages involved in achievement of the final diagnosis? What actual evidence does the field have for the components of the knowledge network within the expert system?

One immediate outcome of the construction of such a system would be the pinpointing of areas wh e additional research is needed. An expert system project would benefit greatly from being paired with empirical research in these areas. Certainly the construction of the reading field's first expert system will raise more questions than it answers, but the ultimate outcome would be to greatly strengthen the field in its understanding of its own fundamental structure.

REFERENCES

Johns, Jerry L. "Research in Reading: A Century of Inquiry." In Samuel Weintraub, Helen K. Smith, Guss P. Plessas, Nancy L. Roser, Walter R. Hill, and Michael W. Kibby (Eds.), Summary of Investigations Related to Reading, July 1, 1980, to June 30, 1981. Newark, Del.: International Reading Association, 1982.

Schank, Roger C. The Cognitive Computer. Reading, Mass.: Addison-Wesley, 1984.

Insight

Level 5 Research, Inc.

4980 S. A1A, Melbourne Beach, FL 32951

Figure 1. Teacher observational data

The student has difficulty pronouncing unfamiliar words during oral reading.

(Type the correct number, then press RETURN.)

1. I am confident this statement is true.
2. This statement is possibly true.
3. I am not sure that this statement is true.
4. This statement is possibly false.
5. I am confident this statement is false.

(For information on identification of word recognition problems, press Function Key 4.)

Figure 2: Teacher Observational Data

The student is demonstrating a poor attitude toward reading.

(Type the correct number, then press RETURN.)

1. I am confident this statement is true.
2. This statement is possibly true.
3. I am not sure that this statement is true.
4. This statement is possibly false.
5. I am confident this statement is false.

(For information on identification of attitude problems, press Function Key 4.)

Figure 5: Production Rule

RULE Developmental Diagnosis--Comprehension

IF Stanford Diagnostic Comprehension Subtest Grade Equivalent Score >= Grade Level

AND Stanford Diagnostic Comprehension Subtest Grade Equivalent Score >= Reading Potential

THEN The student is developmental in comprehension

CONFIDENCE 85