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Final Report

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A Conference on "Diagnostic Monitoring of
Skill and Knowledge Acquisition"

Norman Frederiksen
Educational Testing Service

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| 19. ABSTRACT (Continue on reverse if necessary and identify by block number) Much of the research in cognitive science has been concerned with identifying and describing the information-processing skills and knowledge that are involved in problem solving and in acquiring an understanding of an area of expertise. In applying this knowledge to the management of instruction, it would seem desirable to devise ways of monitoring change in cognitive skills by collecting information about levels of development of automatic processing of basic procedures, the nature of the students' knowledge structures, and the adequacy of his/her problem-solving control strategies. Conventional psychometric methods fail to yield such diagnostic information. The purpose of this project was to call attention to the need for diagnostic monitoring of skill and knowledge acquisition during the instructional process and to provide some examples of methods for obtaining such information. A conference was organized to discuss the implications of cognitive science for the assessment of learning, with the expectation that the presentations would be revised and extended for publication in book form. Twenty-six authors and coauthors contributed 15 | | | | | |
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chapters, and 4 discussants have so far contributed commentaries to sets of chapters (a fifth commentary will probably be added). A manuscript containing an introduction, the 15 chapters, and four commentaries has been sent to the publisher for publication under the title "Diagnostic Monitoring of Skill and Knowledge Acquisition." The publication date is expected to be sometime in the fall of 1989.

Final Report

Grant No. N00014-85-G-0217

A Conference on "Diagnostic Monitoring of
Skill and Knowledge Acquisition"

Norman Frederiksen

Educational Testing Service



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The purpose of this project was to encourage cognitive scientists to consider the implications of their research for assessment as well as for instruction. Conventional methods of assessment are not adequate for two reasons: (a) since the score on a conventional test is based on the number of correct answers to a set of items that vary widely in difficulty and in content, it is not possible to obtain such qualitative information as a student's problem-solving procedures or the nature of his/her mental model of a domain; and (b) the items of conventional tests tend to emphasize factual and algorithmic knowledge rather than understanding.

It was proposed that a conference be held at which leading cognitive scientists would address the question of how their work could be adapted to assessing various aspects of performance during learning, such as level of automatization of basic procedures, incomplete or erroneous knowledge structures, and inadequate regulatory control strategies. The conference was thus intended to call attention to the need for diagnostic monitoring of skill and knowledge acquisition during the instructional process and to provide examples of assessment methods that grow out of cognitive research.

When the project was funded in the fall of 1985, Michael Shafto was designated Scientific Officer, and arrangements were made for Robert Glaser and Alan Lesgold to serve as advisors to the project. Our first task was to decide on who should be invited to participate in the conference. After a meeting at LRDC and after allowing several weeks for consideration, a selection was made of those who should be invited to present papers or serve as discussants. Almost all of those invited agreed to participate.

Since the research of most of the presenters was concerned with learning rather than assessment, we felt that a special effort was needed to orient them toward applications of their work toward diagnosis of sources of error and misconceptions, and thus to develop a shared point of view with regard to the purpose of the conference. Therefore a planning meeting was held at LRDC in November 1985 at which the theme of the conference was discussed and each participant was given an opportunity to reflect and report on the implications of his or her research for assessment. The goal was to achieve a well-integrated set of presentations and eventually chapters for publication in book form.

The conference was held at the Henry Chauncey Conference Center at ETS on July 17, 18, and 19, 1986. A copy of the program is attached. The conference was attended by approximately 65 people, including not only cognitive scientists but also educators, educational researchers, and psychometricians.

At the time of the conference, a contract for publication of the proceedings by Lawrence Erlbaum Associates was agreed to. The four editors are N. Frederiksen, R. Glaser, A. Lesgold, and M. G. Shafto. The MS was sent to the publisher in late November, 1988. Copies of the title page and the table of contents are appended. The MS is complete except for one commentary, which may yet arrive in time to be included in the volume. If all of the corrected proofs are returned to the publisher promptly, the publication date should be in the late fall of 1989.

PROGRAM

Conference on
Diagnostic Monitoring of Skill and Knowledge Acquisition

Thursday, July 17

| | | |
|-------|---|--|
| 9:00 | Gregory Anrig | Opening Remarks |
| | C. Victor Bunderson, Chairman | |
| 9:10 | John R. Anderson | Analysis of Student Performance with the LISP Tutor |
| 9:50 | | Discussion |
| 10:00 | John Frederiksen and Barbara White | Intelligent Tutors as Intelligent Testers |
| 10:40 | | Discussion |
| 10:50 | | BREAK |
| 11:05 | David Kieras | The Role of Cognitive Simulation Models in Advanced Training and Assessment Technology |
| 11:45 | | Discussion |
| 11:55 | Allan Collins (discussant) | |
| 12:20 | | General discussion |
| 12:30 | | LUNCH |
| | William C. Ward Chairman | |
| 1:30 | James Reggia | The Role of Diagnostic Reasoning Models in Assessment and Adaptive Instruction |
| 2:10 | | Discussion |
| 2:20 | Pat Langley, Stellan Ohlsson, & James Wogulis | Rules and Principles in Automated Cognitive Diagnosis |
| 3:00 | | Discussion |
| 3:10 | | BREAK |
| 3:25 | Stellan Ohlsson | Intensive vs. Extensive Cognitive Diagnosis: A Case Study and Its Implications |
| 4:05 | | Discussion |
| 4:15 | James D. Hollan (discussant) | |
| 4:40 | | General Discussion |
| 5:00 | | ADJOURN |

Friday, July 18

Roy O. Freedle, Chairman

| | | |
|-------|---------------------------------------|--|
| 9:00 | Harry S. Pople and Cynthia S. Gadd | Evidence from Internal Medicine Teaching Rounds of the Multiple Roles of Diagnosis in the Transmission and Testing of Medical Expertise |
| 9:40 | | Discussion |
| 9:50 | Ann Brown and Joseph C. Campione | Guided Learning and Transfer: Implications for Assessment |
| 10:30 | | Discussion |
| 10:40 | | BREAK |
| 11:00 | Carl Frederiksen | Evaluating Prior Knowledge and Its Use in Comprehension, Knowledge Integration, Production, and Problem Solving |
| 11:40 | | Discussion |
| 11:50 | George A. Miller (discussant) | |
| 12:15 | | General discussion |
| 12:35 | | LUNCH |
| | Henry I. Braun, Chairman | |
| 1:30 | Sandra P. Marshall | Selecting Good Diagnostic Items |
| 2:10 | | Discussion |
| 2:20 | Susan Embretson | Psychometric Methods for Diagnosing Processing at Different Performance Levels |
| 3:00 | | Discussion |
| 3:10 | | BREAK |
| 3:30 | Kikumi Tatsuoka | Toward an Integration of Item-Response Theory and Cognitive Error Diagnoses |
| 4:10 | | Discussion |
| 4:20 | Robert Linn (discussant) | |
| 4:45 | | General discussion |
| 5:00 | | ADJOURN |

Saturday, July 19

Walter Emmerich, Chairman

9:00 Robert S. Siegler Diagnostic Monitoring of Strategy Choice
Procedures

9:40 Discussion

9:50 Mary S. Riley Diagnosing Levels of Competence in
Knowledge-Rich Domains

10:30 Discussion

10:40 BREAK

11:00 Sherrie Gott (discussant)

11:25 General discussion

11:45 LUNCH

Garlie A. Forehand, Chairman

12:45 Walter Schneider and Wesley Regian Assessment Procedures for Predicting and
Optimizing Skill Acquisition in
Extended Training

1:25 Discussion

1:35 Alan Lesgold Cognitive Task Analysis Approaches to
Testing

2:15 Discussion

2:25 BREAK

2:45 Judith Orasanu (discussant)

3:10 General discussion

3:30 Robert Glaser The Final Word

4:00 ADJOURN

DIAGNOSTIC MONITORING OF SKILL AND KNOWLEDGE ACQUISITION

Edited by

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