DOCUMENT RESUME

ED 091 440 TM 003 654

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TITLE	Applications of Ordering Theory Analysis in the Formative Evaluation of Instruction for Retarded Children.
PUB DATE	[Apr 74]
NOTE	4p.; Paper presented at the Annual Meeting of the American Educational Research Association (59th, Chicago, Illinois, April 1974)
EDRS PRICE	MF-$0.75 HC-$1.50 PLUS POSTAGE
DESCRIPTORS	Criterion Referenced Tests; Educable Mentally Handicapped; *Evaluation Techniques; *Formative Evaluation; Instructional Improvement; Instructional Programs; Item Analysis; Test Construction
IDENTIFIERS	*Ordering Theory Analysis

ABSTRACT

Four applications of ordering theory analysis in the formative evaluation of an instructional program which is being developed for retarded children are described. Data from the pilot-testing of this program demonstrated two uses of ordering theory directly related to the formative evaluation of instruction: the testing of hypothesized relationships between concepts and the revision of the instruction based partly on the hierarchies which were determined among items. In addition, ordering theory analysis is used in the construction of both diagnostic-placement tests and criterion-referenced tests. Attention is given to the educational significance of these applications in reference to the products developed, as well as the dissemination of ordering theory as a tool for formative evaluators. (Author/RC)

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Applications of Ordering Theory Analysis in the Formative Evaluation of Instruction for Retarded Children

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The objective of this paper is to describe four applications of ordering theory analysis used in the formative evaluation of an instructional program, including: a) the testing of hypothesized relationships between concepts, b) the revision of the instruction based partly on the hierarchies which were determined among items, c) the development of a diagnostic placement test, and d) the development of an efficient criterion referenced test.

Airasian and Bart (1970) introduced tree theory as an alternative measurement model. Subsequently it was renamed "ordering theory" so that it would more closely mirror its Boolean algebraic framework. Ordering theory provides a means of identifying the logical relationships among items, and "has as its primary intent either the testing of hypothesized hierarchies among items or the determination of hierarchies among items" (Bart & Krus, 1971, p. 1). Bart and Krus conclude their paper by stating that a major practical use of ordering theory would be to analyze test data "so that rich perspective, directive, and diagnostic information can be provided for the teacher and other test users" (p. 13). The intent of the present paper is to describe several such uses in the formative evaluation of the Money, Measurement and Time Program (Taylor, Thurlow, & Turnure, 1973) which is being developed for educable mentally retarded (EMR) children.

Ordering theory analysis is being used in the evaluation of all instruction from this program, but only data from the Money Unit is presented in this summary. This unit was pilot tested in three EMR classes, with the mean chronological age of the 36 children in these classes being 8, and the mean IQ 71. These children were given a 55 item pre-test, which included items to test each of the objectives of the unit. Portions of this test were given during instruction and the complete test was again given after all instruction in the unit was complete. Of the 55 items in the complete test, 24 relate to the identification, labeling, physical characteristics, and relative value of the individual coins (i.e., penny, nickel, dime, quarter, and half-dollar) and the generic "coins." The ordering theory analysis of these 24 items was supplemented by a traditional item-analysis, and these two analyses on the pre- and post-test provide the data source for the present paper.

As Bart and Krus have discussed, the problem of a statistical test for a prerequisite relationship between two items is unsolved. The alternative to statistical tests is the tolerance level technique, which is the primary procedure used to indicate whether a hypothesized prerequisite relationship between two items is accepted or rejected. However, it is necessary to set low tolerance levels (of errors) to insure that maximally rigorous results are identified and that weaker or even spurious relationships are not selected. In the present analyses, .03 was set as the tolerance level which meant that if more than one of the 36 subjects had a pattern which conflicted with a given prerequisite relationship, that relationship was rejected.

The raw data from the pre-test were subjected to ordering theory analysis to determine the hierarchical relationships among the items. These existing hierarchical relationships were then compared with the hypothesized relationships upon which the instruction was developed. The most important relationship hypothesized was that most, if not all, of the 20 items relating to the identification, labeling, physical characteristics, and relative value of the individual coins were prerequisites to ordering the 5 coins, as to their relative value. Figure 1 presents an ordering diagram of the items which were found to be prerequisite to ordering the coins. As can be inferred from this figure, 10 of the 20 items on the individual coins were found to be prerequisites to the coin ordering item. Several other hypothesized relations were confirmed by the ordering theory analysis and no reversals of hypothesized relations were found.

The second reason for the use of ordering theory analyses was to provide qualitative data to be used in the revision of the instruction. Since this revision was based on nine other data sources, in addition to these hierarchical relationships, the exact input from the ordering theory analysis is difficult to describe in this summary. However, two important revisions were made largely on the basis of the hierarchical relationships which were determined by ordering theory.

The third reason for the use of ordering theory analyses was to assist in the development of diagnostic placement tests. The analyses of the pre-test data were used to develop these placement tests. For example, the item at the top of the ordering-diagram in Figure 1 provides an excellent indication of whether the child has obtained most of the instructional objectives. Indeed, if a subject is correct on this item and three other selected test items, the ordering theory analysis would predict correct performance on all 24 items with 97% certainty. Furthermore, if the subject missed one or more of these specified items, it would be possible to select items that were lower on these branches of the ordering hierarchy, and in this way determine where the child should be placed in the instructional unit. The specific items for the diagnostic placement test are now being selected so as to be consistent with the revised instruction and objectives of the Money Unit.

The final reason for the use of ordering theory was to provide qualitative data to aid in the development of criterion referenced tests. This use is an important one since these criterion referenced tests are to be administered by classroom teachers, and excessively long, repetitious, or difficult to administer tests would at best be a burden to the classroom teacher. However, a short test, the results of which are easy to interpret, would provide a help to the teacher, as well as substantially increasing the probability of obtaining meaningful, valid evaluation data. Since the effectiveness of ordering theory analysis increases as the number of test items is decreased, it is seen as being very appropriate for the development of efficient criterion-referenced tests (Airasian & Bart, 1971).

The educational significance of the present application of ordering theory can be in part evaluated by examining the effectiveness and usability of the resulting instructional units and tests. However, the most important contribution of this paper seems to us to be that it describes several applications of ordering theory which could make this type of analysis a valuable tool in formative evaluation and test construction. It would seem that the qualitative data base provided by the ordering theory analyses, and the strong conceptual appeal of the hierarchy approach to instruction (cf., Gagne, 1970) make further investigation of the educational applications of ordering theory a high priority for this and other R&D projects.

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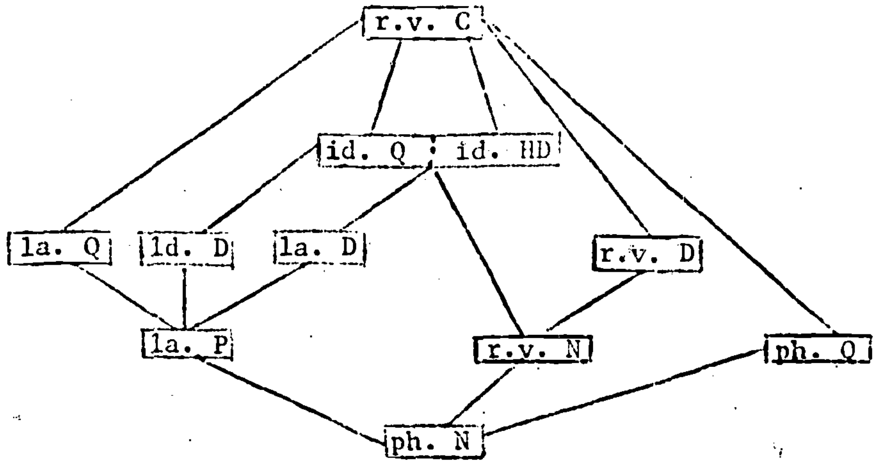

Figure 1

Key

id. = identification	P = Penny
la. = label	N = Nickel
ph. = physical characteristics	D = Dime
r.v. = relative value	Q = Quarter
	HD = Half-Dollar
	C = Coins