ABSTRACT

This represents the latest in a series of efforts, on-going since 1965, to update and revise a listing of continuously received literature which pertains to the Taxonomy. (TL)
TAXONOMY OF EDUCATIONAL OBJECTIVES: COGNITIVE DOMAIN

AN ANNOTATED BIBLIOGRAPHY

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Taxonomy of Educational Objectives: Cognitive Domain

An Annotated Bibliography

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PREFACE

At the 1965 meeting of the American Educational Research Association a small group of individuals met for the purpose of discussing various research activities pertaining to the Taxonomy of Educational Objectives Handbook 1. Cognitive Domain. The participants in this meeting, chaired by David Krathwohl, included the authors of the Taxonomy and approximately fifteen scholars who had either utilized the Taxonomy in their work or had conducted research on the Taxonomy. There was agreement at the meeting that there existed a definite need for communication among persons working with the Taxonomy.

As a first step toward meeting this need, John M. Gordon and I started systematically to search for publications and unpublished reports in order to compile a list of references for dissemination to interested researchers. As this task proceeded it seemed logical to provide a short description of each report so that a prospective user could decide whether or not the reported study would be relevant for his purposes. The result of the first effort at information retrieval was two documents: "Validation and Uses of the Taxonomy of Educational Objectives: Cognitive Domain, A Select and Annotated Bibliography" and "In Progress Studies and Utilization of the Taxonomy." Both of these documents were mimeographed reports and were disseminated during the month of February 1966. The documents were sent to all persons contributing references to the participants of the 1965 meeting, and in answer to any individual requests received during 1966. The response to this first effort was extremely rewarding both in terms of the number of requests and the favorable unsolicited comments.

Another meeting of the Taxonomy group was held during the February 1966, AERA session. At this time it was heartily recommended that the bibliographies were prepared and disseminated. These
included the studies and in-progress reports that had come to my attention since the original documents were compiled.

With the help of Nancy Jordan Unks, a graduate student in Educational Research, the collection and abstraction process continued. In June, 1967 an annotated bibliography prepared by Nancy Unks and myself was published as Working Paper 13 of the Learning Research and Development Center, University of Pittsburgh.

Following the publication of Working Paper 13 there were many helpful suggestions for yet a further revision. Abstracts and original research reports pertaining to the Taxonomy continued to be received, and these combined with references appearing in Dissertation Abstracts and the Education Index form the basis for the latest updating of the Taxonomy bibliography. Assistance with this 1970 version was provided by Carol Wildemann, a graduate student in Educational Research. As the research dealing with the Taxonomy increases it is inevitable that some relevant studies will have been overlooked in our abstracting process. We apologize and would hope that nevertheless this document will be of value to those interested in the cognitive domain of the Taxonomy.

Richard C. Cox
March, 1970
ANNOTATED BIBLIOGRAPHY

The following series of pamphlets was developed at the direction of the Alberta Department of Education to encourage teachers to use the Taxonomy in the statement of instructional objectives and construction of classroom tests. In each booklet the Taxonomy is outlined and sample objectives and test items relevant to the specific subject area are presented.


The Taxonomy was used to classify objectives of Social Studies. Tests were then designed to measure these objectives and an attempt was made to use correlational techniques, including factor analysis, to establish some of the properties claimed for the Taxonomy. It was found that sub-tests of items from the same test correlated more highly and were more alike in factor structure than sub-tests of items from different tests which had the same taxonomic classification. Thus the hierarchical structure of the Taxonomy was neither supported nor denied.


This working paper examines the emerging trend of theory development and evaluation in the area of secondary education curriculum. After a short review of both the cognitive and affective Taxonomies as meaningful tools in curriculum work, the authors conclude that there is a need for a systematic analysis of the capacity aspects of the Knowledge category for certain purposes.
Anderson, June S. A comparative study of chemical educational material study and traditional chemistry in terms of students' ability to use selected cognitive processes. Dissertation Abstracts, 1965, 25, 5147.

The investigation was designed to determine whether student's abilities to use selected cognitive processes were developed to a different extent when CHEM study, as opposed to traditional chemistry, was the mode of instruction. The selected cognitive processes were the first four categories of the Taxonomy and multiple choice tests based on these levels were constructed. Factor analyses included in the study tend to support the hierarchical nature of the Taxonomy.


Discussion centers around the importance of formulating behavioral objectives for an elementary school Science curriculum. A procedure for writing good objectives is discussed with reference to the basic ideas presented by Mager. The Taxonomy is described and suggested as a tool for critically examining objectives to see whether they reflect all of the desired outcomes of Science instruction.


The comprehensiveness and adaptability of the Taxonomy to various curricula and courses is an often examined question. Investigated here is whether it could be adapted to a specific secondary level Mathematics curriculum. Questions examined in the study are: (1) Is it possible to determine psychological mechanisms which underly performance of Mathematical tasks classified under the various Taxonomy categories?; (2) Is it possible to
obtain high rater agreement on a classification of a set of items dealing with mathematical tasks, according to the various levels of the Taxonomy?


Factor analyses were conducted on a 40 item multiple-choice test. The items were classified according to the Taxonomy in order to provide a criterion for rotation of factors and to check on the adequacy of the classification. The hierarchical structure of the Taxonomy was supported. The study suggests the analyses of longer tests which utilize more of the Taxonomy categories.


According to the author, this paper might well be titled “Adapting Bloom’s Taxonomy to a Subject Area or Discipline at the State or Local Level.” It attempts to explain some of the factors which have affected the slow acceptance of the Taxonomy. There is also a report on the procedures that were developed in Alberta, Canada, for putting in the hands of teachers, revised and expanded descriptions of Bloom’s Taxonomy in each of a number of subject areas. These descriptions, which were then available in three subject areas, were developed by classroom teachers and faculty of Education personnel at the University of Alberta. (See also Alberta, Department of Education).

A set of criteria was proposed for the development of problem situations in elementary school Mathematics which promote use of general heuristic cognitive patterns. Polya's How to Solve It was used to describe general heuristic patterns, and the Taxonomy was selected as the basis for describing the intellectual abilities used in the heuristic reasoning process.


During the first four meetings of the Leadership Training Project, twenty-five people in positions of active responsibility for curriculum design, construction and evaluation studied and discussed the Taxonomy. The next four meetings were conducted by speakers who discussed the implications of the Taxonomy for education. Subsequent meetings included a curriculum theorist's view on the Taxonomy and discussions of student typologies, curriculum, and guidance in reference to the Taxonomy. During the first and last meetings the participants were asked to list objectives for a K-6 program. Of the 64 objectives suggested in the first meeting, only 41 (64 percent) could be classified according to the Taxonomy categories. In the final meeting the same participants listed 306 objectives, with 256 (84 percent) classifiable according to the Taxonomy.
Benson M. James. Do your students learn - or memorize? *Industrial Arts and Vocational Education*, 1967, 56 (8), 24-25.

The Taxonomy is described and discussed in relation to the field of industrial education. The author suggests that there needs to be an intentional provision for studying industry at the different taxonomic levels and discusses how course content, student activities and outcomes, teaching methods and materials, as well as time and place of instruction, are affected by and reflected in the levels of the classification of course objectives.


Teachers' rankings of the importance of the Taxonomy objectives were compared with the original taxonomic ranking. It was hypothesized that since the objectives in one class are supposed to make use of, and be built upon, the behaviors found in the preceding classes in the Taxonomy, the "basic" objectives would be perceived as more imperative than the higher-ordered ones. Findings included: (1) there is only a rough degree of agreement between teachers' perceived importance and Bloom's theoretical hierarchy; (2) the respondents' reference group, slow, average or accelerated learner, has a great effect on the perceived importance of the objectives. The author concludes that teachers are not sufficiently aware of levels of cognitive functioning, which makes the dissemination and utilization of a systematic, ordered curriculum difficult.
California Project Talent

The Taxonomy was utilized to a great extent in the California Project Talent endeavor. It was especially helpful in correlation of curriculum content with intellectual operations and products. In the final report it is stated that perhaps the most important long term outcome of the project will be the demonstration of the feasibility of applying theoretical models such as the Taxonomy to the construction of curriculum content.

Actually there are too many documents from California Project Talent to be referenced and abstracted here. The following list is intended to be representative of references mentioning the Taxonomy.


Being the final report, this document is probably the first place to look for references to Taxonomy based aspects of California Project Talent. A quick examination of the selected position papers and references will give the reader some feeling for the type of approach taken by Project personnel with respect to the Taxonomy.


Of special note in this document is Appendix B, Models for Curriculum Development and Evaluation. Two of the articles in this Appendix describe models specifically based upon the Taxonomy.

Part V, Additional Resources and Instruments, cites the Taxonomy as an experimental approach which is an important conceptualization that broadens the scope of intellectual behaviors. One of the rating scales which serves as an example of idea implementation needed in public education is an adaptation of the sub-categories of the Taxonomy.

California Project Talent Film Series I: "The Development of Scientific Discovery, Methodology and Investigation Through a Study of Graphic Representation of Statistical Information."


Mary P. Broderick, Enrichment Demonstration Consultant Distributed by: Great Plains Instructional Television Library University of Nebraska, Lincoln, Nebr., 68408

The six filmed lessons based on the Taxonomy: Cognitive Domain are part of a series of fourteen developed by California Project Talent to demonstrate "enrichment programs for intellectually gifted students". The series of lessons, each one-half hour in length, is designed for teacher education. In the first six, the application of the Taxonomy to the study of mathematics is depicted in actual classroom situations.

The relationship between anxiety and performance at different levels of cognitive functioning was investigated with samples of university and high school students. Four evaluative instruments were constructed to reflect the Taxonomy categories of Knowledge, Comprehension, Application, and Analysis. Anxiety was measured by the Autobiographical Survey developed by Sarason. Significant negative correlations between test anxiety and Knowledge, and test anxiety and Comprehension were found for the university sample. The results are discussed in terms of interfering effects to task performance that anxiety may produce when the examinee must rely on memory.


Objectives of alcohol education were classified according to the Taxonomy. The appropriateness of the objectives for general education was then judged by ten alcohol education specialists and ten school health educators. The two groups of judges had 68 percent agreement on the acceptance or rejection of each objective, but disagreed about their degree of importance. This may have been because of judges’ individual values and different interpretations of the Taxonomy, general education, and the importance of alcohol education. It was concluded that the Taxonomy can be a useful logical schema for organizing alcohol education.

An item pool of 379 multiple-choice items was classified using the Taxonomy categories. From this item pool the 100 most discriminating items were examined in order to determine the effect that statistical item selection has on the final form of a test as compared with the original item pool. Findings indicate that statistical selection of items has a biasing effect on tests in terms of percentage of items in each Taxonomy category. The proportion of items in the selected tests (100 items) which measure certain instructional objectives is unlike the proportion of items in the total item pool. Statistical selection of items from the total item pool appears to operate differentially for male and female groups.


The impact of the Taxonomy is assessed with reference to four criteria. In order to be considered a useful and effective tool, the Taxonomy must be (1) communicable, (2) comprehensive, (3) stimulating to thought concerning educational problems, and (4) acceptable and useful to workers in the field. Studies are cited which exemplify how well the Taxonomy meets each of these criteria. Considerable discussion is devoted to educational problems brought to light by the Taxonomy. As a whole the Taxonomy appears to meet all four criteria successfully.

The purpose of this study was to investigate empirically the internal structure of tests designed to measure the processes defined in A Taxonomy of Intellectual Processes, (see McGuire, 1963). Questions for which data and dis-
cussion are provided include: (1) Are examination items constructed to measure the same intellectual processes, statistically homogeneous? ; (2) Are the intellectual processes general over academic disciplines? ; (3) Are the intellectual processes hierarchical? ; (4) Is there a relationship between the complexity of an intellectual process and the difficulty of the items constructed to measure it?


There has been a lot of argument that test items which measure more complex processes (like those included in the higher categories of the Taxonomy) are more difficult than items measuring the less complex pro-
cesses. In this study multiple-choice items were con-
structed to measure the specific intellectual processes defined in A Taxonomy of Intellectual Processes, (see McGuire, 1963). Results indicated no relationship between the complexity of intellectual processes and the difficulty of items which purportedly measure them.


The Taxonomy was used in judging the cognitive emphasis of selected fifth-grade Social Studies textbook questions.
Experienced teachers categorized questions from three texts according to Taxonomy classes and subclasses. Of 732 questions, 87 percent dealt with Knowledge, 73 percent falling into the category, knowledge of specifics. Of major note is the observation that in these three textbooks, none of the questions required analytic thinking, one required pupils to engage in synthesis, and only two questions necessitated evaluative thinking. Implications and suggestions for teachers of Social Studies are discussed.


The Taxonomy was applied to an analysis of questions in classroom interaction. A Teacher-Pupil Question Inventory was developed, with seven of the nine categories based on the Taxonomy and the formulation of Sanders (1966). Memory was the major cognitive objective apparent in teachers' and pupils' verbal questions in 44 Social Studies classrooms. The authors suggest that (1) more deliberate attention to different cognitive objectives in Social Studies classrooms is necessary, and (2) specific understandings and skills of classroom questioning need major attention in teacher education.


The author is concerned with the development of higher order thinking through classroom discussion. He briefly outlines the Taxonomy and suggests that it may be viewed as representative of the levels of thought that may be present in the classroom. A previous study by the author indicated that upward of 90 percent of classroom verbalization was at the Knowledge and Comprehension levels of the Taxonomy.

An in-service education program developed by the Portland Public School System is suggested as a prototype for other community schools. Classroom teachers engaged in defining instructional objectives and constructing workshops and courses based on the objectives. Exploration was made to see whether material in the *Taxonomy* could play a supporting role in the work of the course development committees. The author concludes that most classroom teachers have had insufficient experience with the process goals found in the *Taxonomy* to use them in organizing teaching, but that given time and more familiarity with the *Taxonomy* this approach may gain more favor.


Examinations submitted by Science teachers were separated according to their relevance for the biological and physical sciences. The items in each test were then classified using the subcategories of the *Taxonomy* in order to provide a test bank of science items.


The author proposes a model for using a modified structure of the *Taxonomy* in the design of curricula and self-pacing teaching materials, and in the classroom by the teacher engaging in long and short range planning. A procedure is provided for identifying long range behavioral goals, analyzing these goals in terms of the *Taxonomy*, and then placing them at the appropriate course, unit, sub-unit or lesson levels.

also


This study investigates the feasibility of developing a procedure enabling educators to utilize the Taxonomy in evaluating lesson plan objectives. The study explores (a) using the Taxonomy to analyze the lesson objectives of student teachers; (b) using judges to independently categorize these objectives according to a prescribed graphic scaling format based on the Taxonomy; and (c) determining which of two such formats was most practicable. Correlational analyses of data failed to support the hypothesized inter-rater agreement and reliability. The data also failed to support the hypothesis that the level of raters' prior knowledge of the use of the Taxonomy makes a difference in their classification.


The Taxonomy was utilized to identify different levels of thinking in relation to specific health content and to help select objectives and content for health teaching. The Taxonomy was the framework used to generate 354 objectives. The major conclusion regarding the Taxonomy purports that the categories are applicable to the field of health education in helping to define substantive content and objectives.

The study was conducted to determine if: (1) student-teacher who had received instruction in the use of the Taxonomy would operate in the classroom at a higher cognitive level than student teachers who had not; (2) trained observers and regular teachers could correctly identify the cognitive classroom behavior level stimulated by the classroom instructor. One conclusion was that student teachers who employ the Taxonomy as a teaching tool will achieve higher cognitive behavior in the classroom.


The Taxonomy is suggested as a guide for curriculum construction. The Taxonomy can be useful at the more abstract levels of curriculum construction but a more specific model is required to guide the selection of instructional materials. A reformulation of the objectives using test items as a basis would help in the development of a specific model.


The differential effect of programmed and conventional material on the achievement of educational objectives in junior high school science was investigated. Questions on the cooperative General Science Test were categorized.
according to three levels of the Taxonomy, Knowledge, Comprehension, and Application. The data indicated that students using programmed materials achieved selected educational objectives as well as those using conventional materials, and also that programmed materials can be used effectively to teach objectives more complex than the accumulation of basic knowledge.


A modern Chemistry curriculum (CHEM) and a conventional Chemistry course were compared in terms of the gain in cognitive abilities exhibited by the students. A Chemistry test based on the six categories of the Taxonomy was constructed and administered to a sample of students stratified by ability level. Validity of the instrument was investigated by having five individuals knowledgeable in the field classify the items according to the Taxonomy. Perfect agreement was attained on 33 of the 83 items and when differences occurred they normally represented a deviation of only one level from the mode. The author suggests that tests based on the Taxonomy might well afford a tool through which a more complete description of mental competencies developed by various courses may be obtained.


This study was designed to answer the following questions: (1) Are the affective and cognitive Taxonomies reasonable tools for use in the statement and measurement of objectives?; (2) Is the cognitive Taxonomy cumulative in Social Science subject matter?; (3) Is performance at various cognitive levels affected by intelligence?; (4) What is the relationship between the affective and cognitive domains? Achievement tests based on the first three levels of the
cognitive Taxonomy were developed for use in high school Home Economics classes. Guttman simplex analysis supported the postulated cumulative nature of the cognitive domain. A low, positive relationship between student achievement on test items and expressed attitudes toward the topics studied was found.


The Taxonomy has been suggested as a guide for the development of behavioral objectives and for designing test items consistent with these objectives. The utilization of the Taxonomy is discussed with reference to the construction of multiple-choice test items. It is pointed out that some of the categories of the Taxonomy, not necessarily the highest levels, present some unique difficulties in writing of test items.


This study attempts (a) to determine if the dominant use of Analysis and Evaluation questions in Social Studies text-type materials would stimulate the development of pupils' critical thinking in sixth grade Social Studies; and (b) to discover if this emphasis would improve achievement in Social Studies. Major conclusions of the study relevant to the Taxonomy were as follows: (1) there were no significant differences in the critical thinking abilities among pupils using materials with question emphasis on Analysis and Evaluation and pupils using materials with question emphasis on Knowledge; (2) pupils receiving Analysis and Evaluation type questions had significantly higher scores in Social Studies achievement than did pupils receiving Knowledge type questions.

This study was designed to investigate the "functional residue" of the humanities in the experiences of undergraduate college students as evidenced by a critical incident measurement technique. Students' responses were classified according to the Taxonomy processes they represented. The cognitive structure of humanities content was described both a-priori and on the basis of responses. Relationships between types of responses and certain characteristics of the respondents were also investigated using chi-square techniques. A general conclusion was that more attention should be given to development of skills in the upper taxonomic categories in the college curriculum.


The Taxonomy is suggested as a model in planning for differentiating instruction in elementary social studies. The teacher can prepare the various categories in chart form to assist in (a) the planning of a unit; (b) the specification of objectives; (c) the diagnosis of student weaknesses; (d) the planning of appropriate learning activities; and (e) the presentation of a highly diversified attack on the study of problems.


The cognitive and affective Taxonomies were used in the development of an instrument for high school Chemistry courses consisting of 40 cognitive items with an affective response scale attached to each. The cognitive items
were selected to represent the first four levels of the cognitive Taxonomy. Two questions were posed in the study: (1) What relationships exist between cognitive and affective outcomes of instruction?; (2) Are cognitive tasks, arranged by Taxonomy level, differentiable and hierarchically related? The study revealed only a small relationship between cognitive achievement and enjoyment of the cognitive task and only weak support was provided for the hierarchical nature of the cognitive Taxonomy. A suggestion was made to attempt validation of the cognitive Taxonomy by use of physiological indices of cognitive involvement.


A collection of American History test questions was compiled by the committee to demonstrate how student achievement might be evaluated at several cognitive levels. The paper is intended as a model and working paper for teachers in San Diego County.

See also, Lessinger (1963) and Metos, et. al. (1966).


An interim report is presented on the use of the Taxonomy in devising mathematics tests for all cognitive levels in grades K-12. The tests will be further developed and used for assessing math abilities and cognitive styles of attacking problems as part of the National Longitudinal Study of Mathematical Abilities.
Klein, Minnie F. Evaluation of instruction: measurement of cognitive behavior as defined by the "Taxonomy of Educational Objectives." Dissertation Abstracts, 1965, 26, 158.

This study investigated whether a particular definition of cognitive behaviors could be elicited and detected in seven through nine year old children. Cognition was defined by the 21 behaviors outlined in the Taxonomy. An objective test based on these behaviors was developed as the means for eliciting and detecting the behavior. Of specific interest was the following hypothesis which was tentatively accepted after the data analysis: a paper- and- pencil instrument can be developed for the age range of seven, eight and nine which will measure discretely all the behaviors at each level as defined by the Taxonomy.


The Biological Sciences Curriculum Study's adaptation of the Taxonomy for examination of tests to determine if they actually incorporate BSCS aims is presented. Two BSCS tests and the Cooperative Biology Test were analyzed. A difficulty encountered was that of classifying test items when the relevant prior learning experiences of the students in unknown.


The nature of the Taxonomy as an "educational - logical - psychological classification system" is described and its value in curriculum construction discussed. It is suggested as a basis for (1) working with objectives with a specificity not usually employed; (2) providing a range of possible outcomes which can be adopted as curricular goals; (3) com-
paring objectives of different curricula; (4) suggesting a hierarchy of learning experiences; and (5) analyzing test items in reference to curriculum objectives.


The use of educational objectives at several levels of detail in the educational process is discussed. The Taxonomy is described as a framework which can facilitate the development and analysis of objectives at the intermediate level. The Taxonomy is suggested as a relatively concise model for the analysis of objectives. It may provide a panorama of objectives to be explored, a basis for precise comparison, and it may suggest a readiness relationship existing between lower and higher level objectives in the hierarchy.


The major problems that may be encountered in an attempt to validate the Taxonomy are discussed in order to provide an investigator with some insight into some theoretical and practical problems.

a. The choice of a response measure is a critical problem. A process response measure requires detecting whether or not the student uses the intended process, whereas a product response measure requires detecting whether or not the student selects the keyed response.

b. The test content and format are the two major factors to be considered when choosing the conditions under which the response measure will be collected.
c. Ambiguity of the Knowledge category of the Taxonomy may indicate that this category is two-dimensional. A careful analysis of this area should precede any validation study.

d. Statistical difficulty created by the hierarchical nature of the Taxonomy demands the selection of appropriate test construction methodology and perhaps the development of new statistical models.

Several studies which would relate scores on Taxonomy type tests to certain criterion measures are suggested.


A three-year long series of studies designed to explore the construct validity of the Taxonomy is reported. The three questions under consideration were the following:

1. Can empirical evidence be found to support or refute the imputed hierarchical structure?

2. Can empirical evidence be found to support or refute the imputed generality of the several cognitive processes?

3. Can each level of the structure be explained by more elemental cognitive aptitudes, and, if so, do the combinations or numbers of them change systematically from one major level to the next?

The hypothesis of inverse relationships between mean performance and taxonomic level was generally supported; the data gave evidence for the imputed hierarchical structure of the Taxonomy. The hypothesis of the generality of process was not clearly supported; the data suggest that the specific test score being analyzed is determined by a highly complex interaction of content and process. Investigation of the third question revealed the obvious need for more highly developed analytic techniques and data from more refined taxonomy-type tests.
Lawrence, Gordon D. Analysis of teacher-made tests in social studies according to the "Taxonomy of Educational Objectives". (Clarmontians Collection) On file at Honold Library of the Claremont Colleges, Claremont, California, 1963.

Tests and final examinations in Social Studies were collected from 63 high schools in Southern California. From 74 randomly selected tests, 4562 items were classified according to the Taxonomy subcategories. The data were analyzed with respect to four subject fields: Geography, American History, World History and U.S. Government. Resultant data indicated (1) approximately 98 percent of the items were classified in the Knowledge category and 75 percent of these were classified under the Knowledge of Specific Facts subcategory; (2) the 2.4 percent of the items which fell above the Knowledge category were classified in only two of the upper five categories, Comprehension and Application; and (3) the four subject fields had a slightly different pattern of distribution of items.


The Taxonomy can be utilized to upgrade classroom test construction. Teachers in the Grossmont Union High School District are instructed in the use of the Taxonomy and, subsequently, use the categories to aid in construction and revision of test questions. A by-product of this approach has been the collection of 566 carefully prepared geography test items. Similar test banks are being prepared in English, Social Studies, foreign languages and Math.

See also Kellogg (1964) and Metes et al. (1966).

In this study of teaching fifth-grade students the addition of fractions and their application to problem solving and evaluation tasks, the Taxonomy was used as a reference point in a variety of ways. First, it was used as a guide in the formulation of specific and measurable objectives applicable to the task. The categories of the Taxonomy also served as a guide in the development of programmed text materials. Finally, it was utilized in the planning and construction of the criterion measure, the Taxonomic Skills Achievement Test.


As assessment of teacher-made tests in use in public high schools throughout Virginia is reported. The Taxonomy was employed as a model for the classification of over 14,000 test items. Slightly more than 70 percent were classified as Knowledge items, and of this 70 percent more than half were in the lowest subdivisions. The author encourages teachers to reappraise the methods by which they measure their course objectives.

Original findings reported in: Heiges, W. D., McDougal, M. and Lockheed, Ian C. Teacher-made Science tests in selected Virginia high schools. Division of Educational Research, University of Virginia, 1964.


The construction of better classroom tests may be realized using the Taxonomy as a functional guide. General types of Science questions which test the six categories of cognitive objectives are suggested as
prototypes for many specific items in different subject-matter areas.

The distinction between the categories of the Taxonomy is not crucial since the purpose of the outline is to help in avoiding undue emphasis on certain categories. Also, the difficulty of an item is not necessarily related to its classification. There is a spread of difficulty levels within each category.


Under contract to the Exploratory Committee on Assessing the Progress of Education, an extensive compilation was made of current objectives of Science education. The objectives were classified according to the Taxonomy, Handbook 1 and Handbook 2, since they cut across both the cognitive and affective domains. The objectives are being used in developing test items to form the basis of the national assessment of education in Science.

Marksberry, Mary Lee et. al. The cognitive objectives in the elementary education blocks and teacher behaviors, in *The Teacher Education Project of the School of Education, Final Progress Report*, University of Missouri at Kansas City, 1967, 120-138.

In this project the Taxonomy was used to classify objectives for the elementary education blocks, and as a basis for the development of an instrument to analyze verbal behavior through tape recordings. The resultant instrument called *An Analysis Chart for Evaluating the Verbal Behavior of Teachers* contains the six major classifications included in the Taxonomy. Under each classification, activities are given which might be demonstrated in elementary classrooms with examples of verbal behavior illustrating these activities.
Marksberry, Mary Lee, McCarter, Mayme and Noyce, Ruth. A study of the relationship of classroom verbal behavior of first-year teachers and the suggestions for verbal behavior given in teachers' editions of tests, in The Teacher Education Project of the School of Education, Final Progress Report, University of Missouri at Kansas City, 1967, 139-146.

A utilization of An Analysis Chart for Evaluating the Verbal Behavior of Teachers (see above reference) is described.


Cognitive objectives in textbooks from four curriculum areas were compared with cognitive objectives from national committees and with questions and activities suggested by teachers' editions of these textbooks. The textbook objectives, questions and activities were categorized according to the Taxonomy. The data point to inconsistencies between objectives implied by selected national committees and objectives stated by the writers of the textbook. The implications from the national committee reports are that the entire range of problem-solving skills should be taught at all levels of the elementary school. Relatively minor emphasis, however, was placed by textbook writers on Analysis, Synthesis, and Evaluation objectives and the writers of teachers' editions are not fully utilizing the objectives stated by textbook authors.

A procedure which uses the Taxonomy for the development of cognitive objectives for undergraduate home management courses is described. A list of 50 objectives, each adapted from Taxonomy statements, was presented as a rating sheet to 279 undergraduate home management professors. Analysis of the results indicated that 17 of the 50 objectives were rated essential by a majority of the sample. Although Application objectives were rated as the most essential class, the Knowledge class was rated on the average more essential than all the other classes combined. A set of 18 cognitive objectives for undergraduate home management courses was formulated by revising the statement of highest ranking essential objectives.


An achievement test was constructed to identify and evaluate the ability to recall specific material and to deal with higher level cognitive tasks. The six objectives of the Taxonomy were grouped into two major areas, recall and higher mental processes, and used as a basis for developing test items. A procedure was introduced to facilitate the establishment of concurrent validity for this type of measuring instrument.

The following adaptation of the Taxonomy is used to examine the reproducibility and significance of process analysis of medical examinations:

**TAXONOMY OF INTELLECTUAL PROCESSES**

1. Items testing predominantly the *RECALL* of isolated information.
2. Items testing the *RECOGNITION OF MEANING* (Comprehension).
3. Items requiring the student to *SELECT A RELEVANT GENERALIZATION* for explaining specific phenomena.
4. Items requiring the student to make *SIMPLE INTERPRETATIONS OF DATA*.
5. Items requiring the student to *APPLY PRINCIPLES* to situations of a *FAMILIAR TYPE*.
6. Items requiring the student to *APPLY PRINCIPLES* to situations of an *UNFAMILIAR TYPE*.
7. Items requiring the *EVALUATION* (including analysis) of a *TOTAL SITUATION*.
8. Items requiring *SYNTHESIS* of data into an original and meaningful whole.

Three independent raters classifying each question in the 1961 National Board Examinations in their specialty agreed unanimously on 61 percent of 683 items rated. Two or more raters agreed on 93 percent of the items.

In order to achieve better congruence with the objectives of medical education the following revision of the original Taxonomy of Intellectual Processes is suggested:

1.0 Knowledge
2.0 Generalisation
3.0 Problem Solving of a Familiar Type
4.0 Problem Solving of an Unfamiliar Type
5.0 Evaluation
6.0 Synthesis
Conclusions include: (a) process analysis yields reproducible results when applied to medical examinations; (b) medical examinations can reliably test the complex intellectual processes; and (c) medical examinations constructed according to process specifications reveal behavior patterns which tend to support the basic hypothesis in terms of which the Taxonomy has been developed.


Process approach is defined as the description of an examination in terms of required intellectual activity of the examinee. An exploratory investigation of process analysis applied to the evaluation of medical education programs suggests: (a) that certifying examinations currently employed measure chiefly recall of isolated information; (b) that reliable examinations of more complex intellectual processes can be designed; and (c) that varied patterns of student behaviors are revealed in examinations constructed by the process approach.


The Taxonomy of Intellectual Processes is described and discussed as a tool in the evaluation of medical curricula. New approaches in both individual and program assessment at several levels of medical education are suggested. (See other articles by McGuire for details of the process approach and results of research studies.)

A brief summary is presented of a project developed by the San Diego county Department of Education in 1963-64 to develop evaluative instruments based on the conceptual approach for use by American History teachers. During an in-service program, teachers constructed questions representative of each of the six levels of the Taxonomy. Questions indicative of those in the resulting test bank are presented for each of the cognitive levels. Possible relationships of the Taxonomy to six elements of instruction—teachers, students, methods, materials, times, and places—are also suggested.

See also, Lessinger (1963) and Kellogg (1964).


The author surveys briefly the present status of achievement tests, discusses critically the implications of this status, and sets forth some proposals for the role of Guilford's structure of intellect theory in achievement testing. In reference to the Taxonomy, it is proposed that employing the structure of intellect model to validate the objectives. It is suggested that for each of the six Guilford products (units, classes, relations, systems, transformations, implications) a model be constructed with the Taxonomy categories on one dimension, the five Guilford Operations on a second dimension, and four Content categories on a third dimension. Two hypotheses are presented: (1) that the Taxonomy categories are factorially complex with respect to the structure of intellect model; and (2) that the six Taxonomy dimensions could be accounted for in most achievement tests by perhaps no more than 20 factors.

The Committee on Criterion for the First Course, of the Division in Teaching of the American Psychological Association has utilized the Taxonomy in the generation of objectives and in the classification of items for a criterion test. Subtests which were designed to measure various types of objectives were developed in an attempt to identify differential patterns of achievement. A factor analysis of the subtest data provided little evidence that the subtest scores represent the objectives they were designed to measure.


The cumulative hypothesis of the Taxonomy is tested using the Guttman simplex analysis. Approximately 100 students were tested with items representing the first three levels of the Taxonomy. The correlation matrices yield the general pattern of a simplex. The pattern of the regression weights also is consistent with that expected for the simplex model for the first three levels of the Taxonomy in basic physical and biological sciences.


The Questioning Strategies Observational System makes possible a record of the cognitive levels of teachers' questions and other behaviors related to successful questioning strategy. Included in the system are
categories for recording the manner by which teachers direct questions, the types of responses elicited, and the teacher's reaction to pupil responses. This system, containing 24 categories, includes the six levels of the Taxonomy as the core of the analysis of questioning strategies.


This study investigated the effect of dogmatism, as defined by Rokeach's scale, on the first five levels of cognitive processes as described in the Taxonomy. A taxonomy based test developed by Stoker and Kropp (1966) was administered to teacher education students. Persons identified as open-minded on the dogmatism scale tended to increase in the mean performance of tasks as the tasks became more complex or autonomous. Those identified as close-minded tended to decrease in mean performance as the tasks became more autonomous.

New South Wales, Department of Education, Australia, 1966.

Under the direction of Leo F. Hanney the Examinations Committees of the New South Wales Department of Education, Sydney, Australia have used the Taxonomy in constructing School Certificate Examinations, primarily in the area of science. The Taxonomy provides a guide for classifying objectives and suggesting techniques of examining those objectives. Reports on the tests to schools also use the Taxonomy as a model.

The taxonomic classification of test items in the semester examinations of 9th grade teachers was studied. Percentage of items in each of the six major categories were compared across courses, ability group levels, and programs of study. In all cases the highest percentage of questions fell into the Knowledge category, with Application second highest. Very few questions were classified into the upper three categories, and these were found primarily in some English courses. It was suggested that teachers should be aware of which cognitive processes they are emphasizing in their test questions, and that there should be more emphasis on the higher objectives for all students in all courses. Also, a study should be made to compare the emphasis of instruction and examination questions.


Two studies which illustrate the usefulness of the Taxonomy in analyzing classroom questions are described. The results of these studies illustrate the need for teachers to analyze test questions for the following reasons: (1) so that proper emphasis is given to all cognitive functions; (2) so that the test will be highly related to the cognitive function the teacher hopes to encourage; (3) so that the teacher realizes that more stimulating questioning is demanded for achieving high quality in the educational process.

Five teachers each of whom taught classes of two different ability levels were interviewed to obtain estimates of their emphases on various cognitive goals. The Taxonomy was used to analyze cognitive goals inferred by items on the teacher-made tests. Findings included the following:

1) Teachers emphasized less complex skills in lower ability classes.
2) Test items revealed differentiation of cognitive goals for different ability classes.
3) Teachers generally indicated that they felt one pattern of cognitive goals was important but tested for another.

**Picard, Anthony J.** An analysis of the objectives of a first year calculus sequence, a test for the achievement of these objectives, and an analysis of results. *Dissertation Abstracts, 28A, 3379.*

The cognitive and affective Taxonomies were used as one aid in developing a collection of objectives for a first-year calculus sequence. Ratings were made by faculty members and later by students concerning the importance of objectives, and test items constructed for several of the statements. Results indicated that the group of objectives associated with the Knowledge level of the cognitive domain was achieved more satisfactorily than the objectives associated with either Comprehension or Application.
Subcategories and categories of the Taxonomy are suggested as useful variables for planning individualized and small group instruction. Listed as higher intellectual skills are the subcategories of translation, interpretation and extrapolation as well as the categories of Application, Analysis, Synthesis and Evaluation. It is suggested that these variables, along with others, be examined when planning educational objectives, classroom dialogue, assignments, criteria for developing curricular materials and examination questions.

Plowman, Paul D. An interpretation of the taxonomy of educational objectives, 1968, copyrighted monograph.

This monograph reviews the development of the Taxonomy as a conceptual educational tool and discusses its present and possible future uses. Questions and activities illustrative of each of the taxonomic levels are included. Projected application of the Taxonomy to the preparation and selection of classroom materials and to the appraisal and accreditation of programs, schools, and institutions of higher education is covered.


Instructional objectives, inferred from appropriate content, were formulated according to Taxonomy classifications of cognitive behavior related to Knowledge, Comprehension, and Application. These objectives were then used as the framework for the development of a pool of 120 five-option, multiple-choice items which were utilized in the construction of the instrument. It was concluded that use of such objectives as the source of a representative pool of items was a valid process for the construction of improved health education tests.

Two groups of prospective secondary school teachers were exposed to different approaches to principles of curriculum construction. One group (1) studied a five point rationale suggested by Tyler for selecting instructional objectives; the other group (2) studied principles based on the Taxonomy. One prediction made by the investigators was that group two would select a greater proportion of objectives classified at higher levels of the Taxonomy. The data did not substantiate this prediction. The study in general indicated that the brief exposure to certain curriculum principles did result in some differences in the selection of objectives by the two groups.


This study was designed to provide a framework within which teachers could work cooperatively to develop specific goals of instruction and then to consider approaches to evaluation which might assess various levels of understanding attained by students. The construction of instructional tests included categorization of items according to Taxonomy categories in order that tests be designed, where possible, to assess understandings beyond recall.


Work is in progress by the Yorkshire Regional Examinations Board concerning the application of the Taxonomy to the field of Geography. Teachers responsible for constructing the Certificate of Secondary Education examination will
receive a description of Taxonomy categories with
test items illustrative of each. Present thinking
is that questions representative of the upper three
levels (Analysis, Synthesis and Evaluation) may be
too difficult for CSE candidates.

Romberg, Thomas A. and Kilpatrick, Jeremy. Preliminary study
on evaluation in mathematics education. Leland Stanford Junior
University, 1966 (mimeographed report).

A seminar group listed objectives of Mathematics
education for grades K-12 and wrote sample test
questions to illustrate the various topics in the cur-
rriculum. The first step involved the identification
of basic Mathematics topics which pupils are
expected to master at each grade level. The topics
were then classified according to the Taxonomy
categories. A set of 50 test items classified
according to content and behavioral skills are pre-
sented to illustrate the various levels of the Tax-
onomy by topic in the curriculum.

Romberg, Thomas A. and Wilson, James W. The development of
Mathematics achievement tests for the national longitudinal
study of mathematical abilities. The Mathematics Teacher,
1968, 61, 489-499. Also published as Romberg, Thomas A.
Leland Stanford Junior University, 1966 (mimeographed
report).

Content validity was a concern in the development
of Mathematics achievement tests. Units of subject
matter were identified and the behaviors included in
each unit were classified using the Taxonomy as a
starting point. The resultant matrix of Mathematical
behaviors served as a table of specifications for test
construction procedures.

The basic ideas underlying this volume come from the Taxonomy. A taxonomy of questions, which is structured along the subcategories of the Taxonomy, is suggested as a tool to improve the intellectual climate of a classroom. This taxonomy of questions may provide a useful standard for the selection and evaluation of instructional materials and may suggest hypotheses for educational research.

Chapters two through eight, which are entitled memory, translation, interpretation, application, analysis, synthesis and evaluation respectively, define and illustrate questions for each category. Sample questions are from the field of Social Studies. The last chapter contains suggestions for composing questions.


The Taxonomy was used to classify both educational objectives and test items. Objectives and final examinations were collected from high school Chemistry teachers in order to compare the relationship between the statement and the measurement of the objective.

Findings include:
1. Over 50 percent of the objectives and 60 percent of the test items related to accumulation of knowledge.
2. Very seldom were students required to exhibit complex cognitive skills (understanding of various degrees) on final examinations.
3. There was seldom a direct relationship between the levels of stated goals and the levels of required examination behavior.

Students given instruction within a modern (CHEM) and a conventional chemistry curriculum were compared using tests based on the behavioral descriptions of the Taxonomy. An instrument was designed to measure the cognitive abilities of Knowledge and Evaluation.


The author hypothesized that certain of the creative thinking abilities described by Guilford's "structure of intellect" might contribute to achievement success. Tests of Evaluation and Synthesis, as defined by the Taxonomy were used as one of the achievement measures in a multiple regression model. Low correlations between the scores on these tests and other achievement measures (California Achievement Tests) are reported.


An analysis was made of cognitive behaviors required by an elementary science curriculum plan. Science--A Process Approach. Behaviors for each activity were categorized according to the Taxonomy. The curriculum plan was found to be systematically progressive in that books for earlier grades tend to
require fewer of the more complex cognitive behaviors than later books. No instances of Evaluation behaviors were found. The author concludes that the Taxonomy can be used in making cognitive analysis of curriculum materials in which expected student behaviors are described.


The Taxonomy is suggested as one possible aid in determining sequence in literature study in the secondary schools. The author discusses matching principles of literature with the Taxonomy categories to give a general picture of the sophistication of the objectives and an indication of the need for reworking them. It is suggested that the Taxonomy can lead to the identification of a pattern of relative maturity of principles and/or prerequisites.


Criteria which should be used in evaluating a teaching instrument are specified in detail using a modified structure of the Taxonomy (cognitive, affective, and motor domains). The Knowledge and Understanding (Comprehension) categories are restructured in an attempt to reduce overlap of factors in the Taxonomy. Conceptual descriptions of educational objectives as well as a manifestation dimension of criterial variables are presented.

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A conceptual model for Health education (grades K-12) includes a classification of goals into three domains — cognitive, affective, and action. The classifications for the cognitive and affective domains were taken from both the Bloom and Krathwohl Taxonomies.


The Knowledge and Comprehension categories of the Taxonomy were used as the basis for generating multiple-choice items dealing with five basic Educational Psychology concepts. Item analysis indicates a general but not perfect scaling of difficulty levels as one proceeds through the Knowledge category. Examination of the intercorrelations of the subclasses of the Knowledge and Comprehension categories failed to yield a hypothesized simplex.


The reputed hierarchical categories of the Taxonomy are utilized in an attempt to develop scalable sets of test items in the physical sciences. Item sets consisted of seven or either multiple-choice items which attempt to build upon one another so that each succeeding item required all the knowledge and
processes of the preceding item plus a little more. Sample sets of items are presented and discussed in reference to the above criteria. Problems were encountered in trying to construct multiple-choice items for the Application, Analysis, and Synthesis categories.


An attempt is made to verify a simple to complex continuum at the Knowledge and Comprehension levels of the Taxonomy. A logical progression from "knowledge of terminology" to "extrapolation" from a principle involving the use of the specific term was hypothesized. The results do not support the hypothesis but indicate the lack of relationship between items supposedly dealing with levels of understanding of the same principle.


Empirical data is presented concerning (1) the ease or difficulty with which test items can be classified according to the Taxonomy and (2) the levels into which such items fall. Eight graduate students in a class which had studied the Taxonomy for four weeks were asked to classify Gerberich's test items according to the subcategories of the Taxonomy. Results indicate that on one half of the items, five or more classifiers indicated perfect agreement. Taking into consideration that each item had to be classified into an exact subcategory, the results indicate that the Taxonomy can be used with considerable precision.

A Taxonomy of Intellectual Abilities (TIA) which represents a revision of the Taxonomy is suggested to categorize teachers' stated objectives and their test questions. The TIA was developed as part of an illustrated procedure for the analysis and description of course structure in terms of its internal consistency. Categories in the TIA include Memory, Translation, Interpretation/Extrapolation, Application, Synthesis, Evaluation, and Formal Analysis.


A broad outline of a tentative taxonomy suited to the central purpose of special education is presented. The outline, which is decimally coded, is clarified by a discussion of each separate element.

Suggestions for using the taxonomy and suggestions which may lead to studies designed to refine the taxonomic structure are presented.


A research project designed as a validation study of the Taxonomy is described. Two major questions investigated were: (1) Can judges agree on the classification of test items into the Taxonomy categories?; and (2) Can empirical evidence be obtained to support the theoretical hierarchical structure of the Taxonomy?
Test items from two standardized tests (reading comprehension and arithmetic computation) were classified by a panel of judges. Results indicate that raters do tend to agree and do tend to classify items congruent with the behaviors the items were intended to evoke.

Experimental tests generated using the Taxonomy categories were administered to 1,000 students in grades 9-12. Results supported the hypothesized order of mean category scores thus providing general evidence for the imputed hierarchical structure of the Taxonomy.


Two questions are investigated: Can judges agree about the cognitive process which a test item is intended to measure? Can the imputed hierarchical structure of the Taxonomy be empirically validated? Interjudge agreement was found with respect to the classification of test items in the intended category. General support for the hierarchical structure of the Taxonomy is suggested by the data; however, a hypothesized factor structure was not supported by various factor matrices.


Specially constructed taxonomy-based tests were administered on the high school level to investigate the imputed hierarchical structure of the Taxonomy. This hypothesized hierarchical structure was examined according to Gutman's simplex theory, the data generally supporting the inverse relationship between
process level mean scores and the level of complexity of the process. Support was thus given to the hierarchical structure and to the construct validity of the specific tests.

Sumner, R. The objectives of craft education. The Vocational Aspect, 1968, 20, (46), 137-149.

It is suggested that all three domains (cognitive, affective and psychomotor) of the Taxonomy provide a conceptual framework which is well suited to the consideration of craft behaviors. Each of the subcategories of the cognitive and affective domains are listed with an example appropriate to craft education. There are also some suggestions provided for a proposed psychomotor taxonomy. It is concluded that such a taxonomic approach can demonstrate how finer conceptual tools lead to the more precise statement of educational objectives.


Research involving the Australian Council for Educational Research, Prematriculation Physics Examination included an analysis based upon the levels of the Taxonomy - Knowledge, Application, and Understanding (Comprehension). Results indicate that (a) Knowledge items were less reliable as a group, than the other type items; and (b) various groups of subjects showed greatest relative differences on understanding type items and smallest differences on Knowledge type items.

Frames in a sixth grade self-instructional program were classified according to the Taxonomy categories. Agreement of raters varied from 63 to 97 percent. The Taxonomy was found to be an efficient tool since 354 frames were classified in only ten hours. The Taxonomy was also recommended as a useful instrument for program evaluation.


The Taxonomy was utilized to classify course materials and examinations for a teacher education program. Findings include: (a) a noticeable discrepancy between course descriptions and actual behaviors required; (b) a considerable emphasis upon Knowledge type behaviors; and (c) a lack of attention given to developing certain important cognitive skills. The Taxonomy provided a useful structure for looking at course behaviors.


The development of a conceptual system which prospective teachers could use reliably in the study of teaching behavior is discussed. This study of teacher-learner behavior proceeded through three stages: (1) classifying teacher behavior; (2) classifying pupil responses; and (3) classifying teaching episodes. An adaptation of the Taxonomy into three levels (knowledge, comprehension, reasoning) was used in stage two as a basis for classifying the magnitude of pupil response.

Concurrent and construct validity of the Synthesis and Evaluation processes described in the Taxonomy were investigated. Concurrent validity was determined by the extent to which patterns of student behavior identified as Synthesis and Evaluation agreed with student performance on tests constructed to measure these Taxonomy processes. The construct validity was investigated by relating student performance on the Taxonomy measures to a battery of measures selected to sample abilities of the Guilford "structure of intellect" model which were thought to be logically related to the Taxonomy processes.


Teachers are urged to produce a classroom environment less concerned with facts and more conducive for problem solving and independence of thought. The author suggests the Taxonomy as the most promising model for evaluation of teaching objectives, and briefly describes the six major taxonomic levels.


The organization and internal structure of the Taxonomy was examined. An attempt was made to resolve the dilemma of whether the Taxonomy's logical arrangement restricts the very objectives from which it is supposed to be generated. It was concluded that the empirical ground of the Taxonomy...
is weak since the data to be classified are teacher-intended student behaviors while the class and subclass terms refer to actual student performance. However, if teacher intentions are based on actual events rather than intuitions and personal preferences, then the terms are less prescriptive. Finally, if significance is retained and formulated as definiens of verbal definitions, then the abstracted Taxonomy is verifiable and efficacious.


The Taxonomy was used to classify educational objectives of teacher training institutions as stated in the 1959 catalogues of colleges and universities accredited by the National Council of Accreditation of Teacher Education. The distribution of objectives in each major category is presented with 200 of 369 objectives falling in the Knowledge category.


The purpose of this article is to review various sets of objectives in Mathematics teaching which people have found useful in clarifying and arranging their thoughts. Considerable attention is given to the Taxonomy as being especially applicable to the field of Mathematics where most significant behaviors appear to have cognitive origins. Other classification schemes useful in analysing instructional objectives are discussed in a quite thorough way. The list of 32 references is valuable for anyone interested in curriculum building in Mathematics. Especially inter-
tating is the reporting on what kind of thinking about this problem is being done in countries other than the United States.


After summarizing the cognitive and affective Taxonomies, the author suggests applications to the field of religious education.


Primary concern in this study is with the empirical differentiation of measures of achievement in the cognitive domain, for instance, differentiation of scores on tests labeled interpretation, application, analysis and evaluation. The test used in the study was initiated by the Committee on Criteria of the First Course of the Division on Teaching of the American Psychological Association and was developed along the lines of the Taxonomy. Findings advise a conservative interpretation of the results of differential tests of achievement representing such general cognitive objectives.

The author covers several areas of research interest to him which involve the Taxonomy. His review of other taxonomic classifications has led him to suggest a domain of taxonomies which includes dimensions of purpose of language and referents for the language. Several adaptations of the Taxonomy for use in the construction of classroom tests are reviewed and a computerized approach suggested to aid instructors in developing behavioral objectives. A procedure involving the computerized assembling of test items and generation of test sequences is presented as a means of examining the differentiability of achievement scores based on the Taxonomy.