COGNITIVE LEVELS IN COMPUTER EDUCATION FOR BUSINESS

by

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THE PROBLEM

INTRODUCTION

Few developments of our age have exceeded the influence of the computer on our society. The introduction of the digital computer into the office allowed business to keep pace with the increasing amount of paper work.

Bangs related the advent of the computer to business education:

> The computer in the office, the big technological change of the 1950's, made obsolete business education as it has been known and taught. A new dimension, business data processing, was added to the sphere of training for business. The need for training young people for living in a computerized world is with us.[1]

Educational programs in data processing vary from simple machine training to education for managerial decision-making and from high school to the graduate level. In a recent study of collegiate business programs, over 90 percent of the deans responding ageed that the minimal goal of their overall curriculum should be to advance the applicability of computers to business.[2]

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[1]U.S., Department of Health, Education, & Welfare, Curricular Implications of Automated Data Processing for Educational Institutions, Project No. BR-50144 (September, 1968), p. 1.

[2]J. Daniel Couger, Computers and the Schools of Business (University of Colorado, Business Research Division, September, 1968), p. 1

The dynamic nature of the field causes problems for educators as well as for the business community. Job opportunities and computer applications are subject to rapid change. However, personal characteristics needed to work "around" computers are thought to be more stable. Job descriptions and textbook prefaces generally advocate logical thinking and problem-solving ability as primary requisites for higher-level positions in electronic data processing.

While the educational role of the textbook is sometimes questioned, especially in view of newer educational media and devices, it is still a common classroom device as Huckabay explains:

> Regardless of the expensive equipment now available and the wealth of teaching materials placed at a teacher's disposal, the textbook used in the class plays a major role in determining the success or failure of the students. Even master teachers rely to some extent on the guidance of a textbook. To a student, a textbook is often the final authority.[3]

In addition, Herber asserts:

> Publishers and authors of textbooks must begin to view them not as sources of information but as vehicles for conscious development of appropriate skills, so that students can continue their education independently beyond their years of formal training.[4]

The increasing number of new textbooks in computer education indicates the concern of educators to meet the expanding needs in this area. Yet data processing instructors often lament the quality of textbooks for instructional purposes. Perhaps the thinking processes

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[3]Reba K. Huckabay, "Weaknesses of the Past and Present," Business Education: An Evaluative Inventory, (National Business Education Association, Yearbook No. 6, Washington, D.C., 1968), p. 23.

[4]Harold L. Herber, "New Trends in Textbook Development and Use," Scholastic Teacher, Vol. 87, (November 18, 1965), p. 10.

advocated for students in the business data processing curriculum are not fostered in corresponding textbooks.

Bloom's Taxonomy of Education Objectives[5] is a well-documented and useful tool for analyzing educational outcomes in the cognitive areas of remembering, thinking, and problem solving. In this regard, Scott concluded:

> The taxonomy can be used in making cognitive analyses of curriculum materials in which expected student behaviors are described or suggested. Preliminary work indicates that analyses can also be made of several other new science curriculum proposals, of textbooks, of verbatim classroom reports, and of evaluation instruments.[6]

Used primarily in the physical sciences, the Taxonomy has value, likewise, for research in business education. Textbook questions, exercises, and problems are often guides to instruction and evaluation. A study of the level of cognition in current textbook materials in a field may facilitate the definition of instructional objectives and lead to needed textbook revisions. This paper will explore cognition in the field of computer education for business students.

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[5] Benjamin S. Bloom (editor), Taxonomy of Educational Objectives, The Classification of Educational Goals, Handbook I: Cognitive Domain (New York: David McKay Company, 1956).

[6] Harry V. Scott, "Cognitive Analysis of a Curriculum: An Application of Taxonomy of Educational Objectives: Handbook I; Cognitive Domain to Science-A Process Approach" (Unpublished Ed.D. Dissertation, Columbia University, 1966), Dissertation Abstracts, Vol. 27, 3637-A.

THE PROBLEM

Statement of the Problem

The purpose of this study was to analyze questions and problems from selected textbooks used in the collegiate computer curriculum for business to determine (1) the level of intellectual abilities reflected in current introductory textbooks in the instructional areas of (a) computer fundamentals, (b) programming, and (c) information systems; and (2) the relationship between these textbooks and educational objectives recommended by a panel of computer professionals.

The Taxonomy of Educational Objectives[7] was used as the basis for classifying the cognitive levels of textbook materials and for developing those same levels in the instrument distributed to the panel of computer practitioners and educators.

Definitions

Several educational terms are of specific importance to the Taxonomy and hence this report. Good's definitions of three widely used terms are given here.[8]

Cognition.--(1) the faculty of knowing, especially as distinguished from feeling and willing; (2) the act of gaining knowledge or becoming acquainted with an object through personal experience; (3) knowledge that extends beyond mere awareness.

Behavior.--(1) broadly, anything that an organism does, including overt, physical action, internal, physiological, and emotional

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[7] Ibid.

[8] Carter V. Good, Editor, Dictionary of Education (New York: McGraw-Hill, 1959).

processes, and implicit mental activity; (2) as conceived by some behaviorists, overt, observable, physical action of muscles and glands.

Educational Objective.--aim, end in view, or purpose of a course of action or a belief; that which is anticipated as desirable in the early phases of an activity and serves to select, regulate, and direct later aspects of the act so that the total process is designed and integrated.

Computer education courses for business are comparatively new. Much of the terminology considered to be peculiar to this field has not been sufficiently established to afford a uniform meaning. The following terms are defined according to the interpretation intended in this investigation.

Computer.--An electronic machine that utilizes stored-program techniques and operates on discrete (digital) data.

Computer Fundamentals Course.--A course appropriate as an introduction to the use of computers in business for students pursuing higher education.

Data.--Any representations such as symbols, numbers, and letters to which meaning might be assigned.

Data Processing.--Any operation (e.g. classifying, sorting, calculating, summarizing, and recording) or combination of operations on data. The operations may involve either unit record equipment or a computer system. "Information processing" is often used synonymously.

EDP (Electronic Data Processing).--A system of processing data with the use of a computer.

Information.--Processed and evaluated data, especially as derived from a collection of documents or other graphic records. Information can be derived from data only if they are accurate, timely, and relevant to the subject under consideration.

Information System.--A set of methods and procedures designed to supply decision makers with information needed to keep informed on the current status of a business, to understand its implications, and to make and implement the appropriate operating decisions.

Information System Course.--Generally an upper division college course concerned with the definition and principles of computerized information systems for business management.

Programmer.--A person who converts a problem into a set of directions acceptable for computer solution.

Programming.--The art of reducing the plan for the solution of a problem to machine-sensible instructions.

Programming Course.--A college course concerned with Fortran or Cobol programming for business applications.

System.--A set of methods and procedures utilizing a combination of personnel, equipment, and facilities to produce outputs.

Systems Analyst.--One who defines problems of and details plans for implementing information systems.

Textbook.--A book containing questions, exercises, and/or problems relating to the textual material.

Assumptions

1. The textbooks selected are representative of all computer textbooks appropriate for instruction in the three areas of concern.

2. Textbook questions, exercises, and problems can be accurately rated according to the Taxonomy. Reliability reported in other studies of this type will be cited; likewise, the opinions of two qualified observers will be used to verify the author's ratings.

3. The panel of computer professionals, twelve educators and twelve practitioners, selected to determine educational objectives represent views shared by others in their professions.

4. The taxonomic rating instruments used in this study are valid and reliable.

Delimitation and Scope

This study includes currently available textbooks written primarily for instruction in collegiate schools of business. However, several of the texts are also used in high schools, junior colleges, vocational schools, and private business schools.

Only textbooks for the following three computer courses were considered: computer fundamentals, computer programming, and information systems. Although numerous programming languages are available, only Fortran and Cobol were considered in this study. The author did not investigate reference books, manuals, workbooks, or programmed instruction books.

Questions to be Answered

1. Which introductory data processing textbooks are available for instruction in computer fundamentals, programming, and information systems courses?

2. What is the relative emphasis of major topics in computer fundamentals textbooks? computer programming textbooks? information

systems textbooks?

3. What levels of cognition are motivated by questions, exercises, and problems in introductory textbooks in computer fundamentals for business? programming for business applications? information systems principles for management?

4. What level of behavioral objectives do computer educators and practitioners view as appropriate for instruction in computer fundamentals? computer programming? information systems?

5. What is the cognitive relationship between statements of educational objectives selected by computer professionals and questions, exercises, and problems in computer textbooks?

Hypothesis to be Tested

There is a significant relationship between the levels of cognition reflected in the Taxonomy of Educational Objectives[9] and the three curricular areas of computer fundamentals, programming, and information systems. Significance is related to (a) textbook questions, exercises, and problems and (b) statements of educational objectives.

SIGNIFICANCE OF STUDY

Much of the current campus unrest can be traced to students' concern about irrelevant, nonapplicable courses. On the other hand, computer faculty seek to develop instruction for computer occupations as well as to promote the use of computers in other business courses. Research is needed to relate the current emphasis on application and analysis of educational objectives and behavioral goals to improved

[9] Bloom, Taxonomy.

instruction and evaluation in education for business, specifically computer education. A study of the role of such mental processes as logical thinking and problem solving at various levels of computer education for business may help to clarify curricular approaches in secondary as well as higher education.

ORGANIZATION OF THE REPORT

This study is organized into five chapters: The Problem; Review of the Literature; Methods of Procedure; Analysis of Data; and Summary, Conclusions, and Recommendations. Chapter I defines the problem and its importance. Chapter II summarizes the development of the Taxonomy and several related studies using the device. The rationale used to select the three curricular areas is also discussed. Chapter III is a report of the procedures used to research the two primary phases of this study, textbook materials and panel opinions. Chapter IV analyzes the data and notes the relationship between the textbooks and opinions of computer professionals. This analysis of the data provides the basis for the conclusions given in Chapter V, where a summary and recommendations complete the report.

CHAPTER II

REVIEW OF THE LITERATURE

INTRODUCTION

This chapter includes an explanation of the Taxonomy of Educational Objectives, Handbook I: Cognitive Domain[1] edited by Benjamin S. Bloom. The development and utilization of this curricular tool in relation to this study is reported. The rationale for emphasizing particular computer courses is also discussed.

DEVELOPMENT OF THE TAXONOMY

The idea for the Taxonomy was formed by college examiners attending the 1948 American Psychological Association Convention.[2] The original plans called for an overall taxonomy in three major domains: cognitive, affective, and psychomotor. The purpose of the classification system for educational objectives was to facilitate communication about test items, educational objectives, and testing procedures. The committee that was delegated the task of organizing and writing the cognitive portion of the Taxonomy included the following college and university examiners: Benjamin S. Bloom, editor;

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[1] Benjamin S. Bloom (editor), Taxonomy of Educational Objectives, The Classification of Educational Goals, Handbook I: Cognitive Domain (New York: David McKay Company, 1956).

[2] Ibid., p. 4.

Max D. Engelhart; Edward J. Furst; Walker H. Hill; and David R. Krathwohl. The cognitive domain was subsequently published in 1956. It deals with the recall or recognition of knowledge and the development of intellectual abilities and skills. The affective domain was also published in 1956. It includes objectives that describe changes in interest, attitudes, and values, and the development of appreciations and adequate adjustment. The psychomotor or manipulative domain has not been developed at this time.

Several organizational principles were agreed upon by the committee. Primary importance was given to educational consideration. Secondly, precise and consistent definitions were sought. Thirdly, relevant and accepted psychological principles and theories were emphasized. Finally, neutrality was to be achieved to permit the inclusion of objectives from all education orientations.

Bloom states:

> We are of the opinion that although the objectives and test materials and techniques may be specified in an almost unlimited number of ways, the student behaviors involved in these objectives can be represented by a relatively small number of classes. Therefore, this taxonomy is designed to be a classification of the student behaviors which represent the intended outcomes of the educational process. It is assumed that essentially the same classes of behavior may be observed in the usual range of subject-matter content, at different levels of education (elementary, high school, college), and in different schools. Thus, a single set of classifications should be applicable in all these instances.[3]

Though global statements of educational objectives may be analyzed, the major concern of this study are those objectives inferred from problems and observations used to test or evaluate the presence

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[3] Ibid., p. 12.

of these behaviors. The Taxonomy constantly stresses "intended" rather than "actual" behavior.

The six major classes as historically organized and used as the basis for this study are:

1.00 Knowledge
2.00 Comprehension
3.00 Application
4.00 Analysis
5.00 Synthesis
6.00 Evaluation

A description of the six major classes and 21 subclasses of the Taxonomy is included in Appendix A. This condensed version was taken intact from the Taxonomy and appears by permission of the publisher as an aid to the reader.

To understand the nature of the device, one must study the hierarchical structure. The broad groups as well as subclasses of behaviors are organized in an ordered fashion.

Bloom concludes:

> As we have defined them, the objectives in one class are likely to make use of and be built on the behaviors found in the preceding classes in this list. . . . Thus our classifications may be said to be in the form where behaviors of type A form one class, while behaviors of type AB form another, while behaviors of type ABC form still another class. . . . We have studied a large number of problems occurring in our comprehensive exams and have found some evidence to support this hypothesis.[4]

The following chart illustrates the sequential and cumulative nature of the taxonomy categories.[5]

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[4] Ibid., p. 18.

[5] Note the substitution of "memory" for "knowledge" in Level 1.0. It is felt the term "memory" better describes the intellectual activity under consideration. This convention will be used in the remaining chapters of this report.

Level 1.0	Level 2.0	Level 3.0
Memory	Memory + Comprehension	Memory + Comprehension + Application

Level 4.0	Level 5.0	Level 6.0
Memory + Comprehension + Application + Analysis	Memory + Comprehension + Application + Analysis + Synthesis	Memory + Comprehension + Application + Analysis + Synthesis + Evaluation

This chart illustrates the concept that higher categories do not neglect memory, since memory is the only cognitive process that is a part of every kind of thinking. Rankings are to be made at the highest level possible.

Sanders' book[6] is a useful extension of the Taxonomy. It suggests questions for fostering the several types of higher order operations. Problems and projects as well as verbal questions are included. The Sanders' convention of substituting the term "memory" for "knowledge" is followed in this study. He also related classification disputes of Taxonomy levels to the colors on a spectrum. There the primary colors are plainly visible. Between each color, however, is an area that is no one distinctive color, but a part of both.

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[6]Norris M. Sanders, Classroom Questions: What Kinds? (New York: Harper & Row, 1966), pp. 1-176.

The most common educational objective, supported by the research studies of this chapter, is the acquisition of knowledge or information. The main objective here is the psychological process of remembering. Some relating and judging may be involved in seeking the stimuli, signal, or cue originally learned. Computer education should consider Bloom's assertion:

> In fields undergoing rapid transition, knowledge may be taught, not so much with the expectation that it will prove eternally 'true' but as a basis for learning the methodology of the field and as a basis for attacking the problems therein.[7]

Sanders adds to the description of memory:

> The memory category is indispensable on all levels of thinking. The more important and useful knowledge a student possesses, the better his chances for success in other categories of thought. However, the importance of the memory category should not be permitted to completely overshadow its three weaknesses. The first is the inevitably rapid rate of forgetting. Numerous studies show that arbitrary facts are forgotten more quickly than generalizations or principles and even the latter have limited longevity. . . .
>
> The second weakness is that memorized knowledge does not necessarily represent a high level of understanding. A student who memorizes the Preamble to the United States Constitution and records it accurately on an examination may possess only a vague or distorted idea of its meaning.
>
> The third weakness of an education concentrating on memory is that it neglects other intellectual processes learned only through practice. A student best learns to draw inductive conclusions by practice--not by memorizing the inductive conclusions of others.[8]

Bloom defines all levels above the Knowledge category as intellectual abilities and skills. Educators often seek the development of these higher-level objectives, as Bloom describes:

> As we have defined intellectual abilities and skills, they are more widely applicable than knowledge. If we are

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[7]Bloom, Taxonomy, p. 33.

[8]Sanders, Classroom Questions, p. 27.

> concerned with the problem of transfer of training, by definition we would select intellectual abilities and skills as having greater transfer value.
>
> A second reason for the efficiency of intellectual abilities and skills in learning is their permanence. From psychological theory (e.g., reinforcement theory) it would seem reasonable to expect greater permanence of learning for those outcomes of education which can be generalized and applied in a number of different situations throughout the individual's formal educational experience than for those outcomes which are so specific that they are likely to be encountered only once or at most a few times throughout the educational program.[9]

Bloom also contrasts the two primary phases of this study:

> The task of classifying test exercises is somewhat more complicated than that of classifying educational objectives. Before a reader can classify a particular test exercise he must know, or at least make some assumptions about, the learning situations that have preceded the test.[10]

The author assumes only that the student has studied the textbook material preceding the questions, exercises, or problems in textbooks selected for this study.

RELATED TAXONOMY RESEARCH

Few research studies utilizing the Taxonomy appear in the literature. Three studies using ratings by judges are summarized in this section:

(1) An inter-judge reliability of item classifications was studied by Kropp and Stoker at Florida State University in 1962 and in subsequent research.[11] Forty-five items of the Reading Test and

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[9]Bloom, Taxonomy, p. 42. [10]Ibid., p. 51.

[11]Russell P. Kropp and Howard W. Stoker, The Construction and Validation of Tests of the Cognitive Processes as Described in the Taxonomy of Educational Objectives, Florida State University and U. S. Department of Health, Education and Welfare Cooperative Research Project No. 2117 (February, 1966).