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AN INVESTIGATION OF THREE APPROACHES TO THE TEACHING OF THE IBM 82 SORTER.

BY- GRAVES, LAWRENCE E.

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THE OPERATION OF THE IBM 82 SORTER WAS TAUGHT TO THREE GROUPS OF STUDENTS IN THREE DIFFERENT 2-HOUR SESSIONS. THE GROUPS WERE STATISTICALLY EQUATED ON THE BASIS OF THE STUDENT'S SCORES ON THE SCAT AND IBM MACHINE OPERATORS TESTS. A "STANDARD CLASSROOM" METHOD (INVOLVING A LECTURE AND SUCH AIDS AS A CHALKBOARD AND HAND-OUTS) WAS FOLLOWED IN INSTRUCTING THE FIRST ("A") GROUP. AN "OVERHEAD PROJECTOR" METHOD WAS FOLLOWED IN INSTRUCTING THE SECOND ("B") GROUP. A "HANDS-ON" METHOD (IN WHICH THE STUDENTS ACTUALLY OPERATED THE SORTER) WAS FOLLOWED IN INSTRUCTING THE THIRD ("C") GROUP. LEARNING WAS MEASURED BY COMPARING THE STUDENTS' PERFORMANCE ON PRE- AND POST-TESTS OF 20 MULTIPLE-CHOICE QUESTIONS. GROUPS A AND C PERFORMED ABOUT EQUALLY WELL, GROUP B SIGNIFICANTLY LESS WELL. INVESTING IN SORTERS AND OVERHEAD PROJECTORS TO TEACH THE SUBJECT THEREFORE SEEMS UNNECESSARY. (A STATISTICAL ANALYSIS OF THE CHARACTERISTICS OF THE SAMPLE GROUPS AND A DISCUSSION OF SOME OF THE DETAILS AND LIMITATIONS OF THE STUDY ARE INCLUDED.) (AD)

AN INVESTIGATION OF THREE APPROACHES TO THE TEACHING OF THE IBM 82 SORTER

by

LAWRENCE E. GRAVES

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Dr. B. Lamar Johnson
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INTRODUCTION

When new curricula are proposed in junior colleges, administrative decisions are required for the appropriate staffing, scheduling and equipping of the endeavours. In the case of data processing the procurement of equipment becomes a matter of major concern. Frequently administrators are obliged to make decisions regarding equipment without sufficient evidence of its instructional value. When unable to finance data processing machines administrators must consider the use of conventional classroom techniques, the use of special aids, and the possibility of providing no instruction at all.

Information regarding the instructional value of data processing equipment and associated teaching methods is practically non-existent.[1] Information provided by vendors, manufacturers and experienced persons of other institutions frequently is considered inadequate for proper decision-making. More precise and reliable information is necessary. One avenue for improving the quality of decisions is that of appropriate instructional research. This paper describes one effort of that type.

PURPOSE

Specifically the purposes of this investigation are:

1. To develop a method of measuring the differences in learning resulting from three methods of teaching the functions and operational features of the IBM Sorter.

2. Assuming the existence of a reliable method of measurement, to measure and compare the learning resulting from three methods of teaching the functions and operational features of the IBM 82 Sorter.
3. Based upon the preceding, to develop objective evidence supporting the procurement of a specific set of materials and equipment for the teaching of the IBM 82 Sorter.

STUDY DESIGN

Teaching Points - This investigation was limited to the teaching of five points pertinent to the understanding of sorting operations as part of the data processing cycle and the type of machine most commonly used to accomplish these operations. The specific teaching points were:

1. The need for sorting data in the preparation of business reports
2. The reverse - order sorting technique
3. The operating principles of the IBM 82 Sorter
4. How the IBM 82 Sorter is used for numerical sorting
5. How the IBM 82 Sorter is used for alphabetical sorting

Terminal Behavior - Upon completion of two hours of instruction students were asked to demonstrate their knowledge of the above points by completing a multiple choice test of twenty questions.

Teaching Methods - Three teaching methods were devised and labelled (1) standard classroom (2) overhead projector and (3) hands-on.

1. The standard classroom method was primarily a lecture technique utilizing a standard classroom with standard equipment such as chalkboard, lecture notes, paper hand-outs, etc.
2. The overhead projector method utilized transparent foils prepared from masters provided by IBM and the instructor.

3. The hands-on method utilized the IBM Sorter as the teaching tool. Students were given opportunities to operate the machine as a part of their instruction. All instruction was presented in sight of the IBM 82 Sorter and other punched card machines.

Subjects - Students taking the introductory course in data processing at Bakersfield College during the fall semester of 1966 were used as subjects. Students were divided into three sections. The total number of students involved was 103 from which 87 cases were selected. Selection was made on the basis of completeness of data, perfect attendance during the period of investigation and amount of previous experience with IBM punched card machines.

Equating Groups - Groups A, B and C were equated statistically on the following counts:

1. Total SCAT Score earned upon admission to Bakersfield College
2. IBM Machine Operators Aptitude Test - a standardized test prepared and distributed by IBM for the purpose of selecting customer employees for customer training in punched card machine operation. The test measures numerical ability and symbolic reasoning ability. The test was administered in class during the first week of the semester.[2]

The following data, analysed on the basis of frequency distribution and central tendencies, were judged to be of insufficient importance to warrant a more rigorous statistical analysis (see appendix):

1. Sex - Males 40, Females 46
2. Scholastic achievement in the course for first six weeks prior to this investigation.
3. Nelson-Denny Reading Test (converted total)
4. ITED No. 3 (converted score)

Pre-test and Post-test - Both tests contained twenty multiple choice questions, 4 for each of the five teaching points. Questions were selected from IBM's standard final examination for the 82 Sorter and from those developed by the instructor during previous courses.

Standardizing the Level of Instruction - In an attempt to assure equal treatment of the three teaching methods the following precautions were taken:

1. One instructor, the author of the present report, taught all lessons.
2. The instructor prepared and tested his presentations one semester in advance of the investigation.
3. In the days prior to the actual investigation the instructor rehearsed his presentations several times under simulated conditions.
4. An expert, impartial observer attended all class meetings.[3] His instructions were to:
   1. Observe the instructor in order to detect and record any evidence of bias, favoritism, aptness or ineptness which would tend to make one method more or less effective than another.
   2. Observe the student response for overt signs of learning (or the lack of it) which may assist in the evaluation of the method used.
   3. Analyse each presentation and record any evidence of departure from the study design.
   4. Make any other observations felt to be pertinent.
5. Sessions were recorded on magnetic tape for future reference.

Procedure - Three sections were labelled Groups A, B, and C. Group A received instructions by Method 1, Group B by Method 2 and Group C by Method 3. Each group received two hours of instruction. The teaching points were presented in the same sequence, each receiving the same amount of time for development. In each method, the teaching points were stated as learning objectives, discussed individually, reviewed individually and summarized at the end of the session.

The second lesson contained a review of the first. Students in all groups were asked to listen, take notes, respond to oral questions and perform manual learning tasks. The manual tasks performed in the classroom by Groups A and B were designed to simulate the way punched cards flow through the machine for numerical and alphabetical sorting. Group C, which met in the Data Processing Center, did not manipulate cards but actually operated the Sorter to perform the numerical and alphabetical sorting functions.

RESULTS

Tested Achievement

The operating hypothesis upon which the design was based was that one or another of the teaching approaches might prove more effective. The null hypothesis, therefore, became: There are no significant differences in achievement as represented by test score changes among the groups of students involved in three instructional approaches. This null hypothesis was rejected on the grounds of the F score values presented in Tables I and II.

TABLE I

Sum of Squares - Raw Change Scores

Group A	Group B	Group C	Total
$\Sigma X_a = 305$	$\Sigma X_b = 243$	$\Sigma X_c = 317$	$\Sigma X_t = 865$
$\Sigma X_a^2 = 3651$	$\Sigma X_b^2 = 2381$	$\Sigma X_c^2 = 3689$	$\Sigma X_t^2 = 9721$
$\bar{X}_a = 10.89$	$\bar{X}_b = 8.38$	$\bar{X}_c = 10.93$	$\bar{X}_t = 10.06$
$N_a = 28$	$N_b = 29$	$N_c = 29$	$N_t = 86$

TABLE II

ANALYSIS OF VARIANCE - RAW CHANGE SCORES

	Sum of Squares	Degrees of Freedom	Mean Square (Variance)	F
Between Groups	123.34	2	61.67	5.70
Within Groups	897.37	83	10.81	
Total	1020.71	85		

As an analysis of Table I shows, Group A (standard classroom) and Group C (hands-on) increased their mean scores by 10.80 and 10.93 points respectively. Group B (overhead projector) increased its mean score by 8.38 points The F score value of 5.70 was significant at the .001 level of confidence (Table II). Additional F test between Groups A and B and Groups B and C confirmed the significance of the lesser score achieved by Group B.

Equating the Groups

Analysis of variance indicated no significant differences between nor within the groups with regard to SCAT Total Scores and numerical and symbolic logic ability as measured by the IBM Punch Card Machine Operator's Test. Inspection of mean score gave no evidence to indicate differences with regard to ITED No. 3, age, sex, and previous experience.

The expert observer found no indication of instructor bias which would render the results invalid. However, the learning environment in the Data Processing Center was found to be less than ideal. Excessive noise, other activities and improper seating rendered that portion of the investigation invalid.

CONCLUSIONS

The first objective of this investigation was to develop a method of measuring the differences in learning resulting from three methods of teaching the functions and operational features of the IBM 82 Sorter. This objective was satisfied for two of the three methods involved. (See Discussion)

The second objective was to measure and compare the learning resulting from three methods of teaching the functions and operational features of the IBM 82 Sorter. This objective was satisfied and may be summarized as follows:

1. Lecture and hands-on methods produced approximately the same amount of learning under the conditions described.

2. The use of transparencies and the overhead projector produced significantly less learning than either the lecture or the hands-on methods.

The third objective was to develop objective evidence supporting the procurement of a specific set of materials and equipment for the teaching of the IBM 82 Sorter. This objective was partially met and can be summarized as follows:

1. When used under the conditions which existed during this investigation there is no evidence to support the procurement of the IBM 82 Sorter as a tool for teaching the specified subject matter. (See Discussion)

2. There is sufficient evidence that overhead projectors and special foil transparencies should not be procured specifically for teaching the points included in this investigation.

3. There is sufficient evidence that the five points included in this investigation can be taught efficiently using standard classroom teaching methods.

DISCUSSION

The above conclusions tend to contradict two beliefs often held by educators regarding teaching aids. First, it has been held that prepared transparencies projected overhead are superior to the chalk board and paper and pencil as teaching aids. Second, it is often thought that hands-on experience is superior to both. The following discussion may help clarify these points:

Hands-on is generally regarded as a highly efficient method of teaching machine operation. It must be emphasized that this study did not require the subjects to operate the Sorter as a test of achievement. Rather, they were asked to demonstrate their understanding of how the machine is used to accomplish the arranging of punched cards, much in the same manner as students of aerodynamics are asked to describe how an aircraft is flown but are not required to actually fly the machine. Further, it must be emphasized that, in the judgment of the expert observer, the two sessions in the Data Processing Center were "short of ideal." Reference was made to the lack of a proper learning environment due to noise, other activities going on in the same room and inadequate seating space for the students. This opinion was shared by the instructor. Nevertheless, the expert observer noted that learning increased sharply when the students began operating the sorter. This was observed by the instructor as well. Unfortunately, it cannot be discerned to what extent the students were learning the operational features as opposed to learning how to run the machine. Hence, general conclusions regarding this aspect of the study must be avoided, except to say that laboratory training, as conducted in this study, is not superior to standard classroom instruction.

The failure of Group B to score as high as the other group was surprising. Some educators feel that subject matter is better communicated by means of carefully prepared transparencies than by the conventional chalk board. Interviews with the students, a review of the tape recording and an analysis of transparencies hinted that the classroom lighting, dimmed to make the projections more visable, and the class hour, 1:30 - 2:30, may have affected the attentive qualities of the students. One student remarked that watching the projections on the screen was too much like watching television. Presumably this meant that he was more entertained than trained. Further investigation in this area is recommended.

The expert observer, commenting on Group A (standard classroom), noted that student interest and response was noticeably higher during their second meeting. He attributed this to the use of a set of fill-in lecture notes which were distributed at the beginning of the

second meeting. The lecture notes contained numerous illustrations which were the same as those used to make transparencies. The hand-out itself was a portion of the Student's Notebook prepared by IBM as part of a programmed instruction course entitled "Punched Card Data Processing Principles."[4] The success of the students using this technique suggests an area for future study.

APPENDIX

TABLE OF MEANS

	GROUP A		GROUP B		GROUP C		TOTAL
	Mean	Variation From M	Mean	Variation From M	Mean	Variation From M	M
SCAT SCORES							
Verbal	288.7	-0.4	289.5	+1.2	286.7	-1.6	288.3
Quantitative	300.2	-0.6	304.1	+3.3	298.3	-2.5	300.8
Total	293.9	-2.1	295.0	-1.0	299.0	+3.0	296.0
NELSON-DENNY							
Vocabulary	29.4	-0.9	32.2	+1.9	29.3	-1.0	30.3
Comprehension	39.0	+0.4	39.9	+1.3	37.0	-1.6	38.6
Total	66.9	-1.6	72.3	+3.8	66.3	-2.3	68.5
Rate	306.8	19.1	282.9	-4.8	273.3	-14.4	287.7
ITED No. 3	16.5	-0.9	18.1	+0.7	17.6	+0.2	17.4
IBM							
Numerical	17.6	-0.6	18.9	+0.7	18.2	+0.0	18.2
Symbolic	8.8	-0.3	9.8	+0.7	8.8	-0.3	9.1
Total	26.6	-0.8	28.7	+1.3	27.0	-0.4	27.4
DP 50 TESTS							
Tests 1-5	81.7	-2.5	82.2	-2.0	88.6	+ 4.4	84.2
Pre-Test	4.4	-0.3	5.0	0.9	4.1	± 0	4.1
Post-Test	15.3	+1.2	13.7	-0.4	15.0	+0.9	14.1
Change	+10.9	+0.9	+8.7	-1.3	+10.9	+0.9	10.0
% Learning	69.8	+7.3	58.0	-4.5	68.1	+5.6	62.5

NOTES

1. Hardware manufacturers, notably International Business Machines, Minnesota Mining and Manufacturing Co., National Cash Register, Minneapolis-Honneywell and Control Data, have conducted educational studies regarding the effectiveness of programmed instruction, classroom instruction and field training. It must be noted, however, that such studies have been commercially oriented, aimed at training customer employees who are usually selected for their interest and aptitude. In addition, the manufacturers, intent upon selling additional equipment, tend to use specially selected equipment and specially trained instructors - conditions not always found in junior colleges.

2. Of the qualifying devices used, the IBM Machine Operators Aptitude Test has proven to be the most reliable predictor of achievement in the data processing courses offered at Bakersfield College.

3. The author was extremely fortunate in securing the services of Thomas B. Merson, Director of Research, California Junior College Association. Dr. Merson's observations and comments were written in great detail, very complete and highly perceptive.

4. "Punched Card Data Processing Principles," Programmed Instruction Course, IBM Ref R29 - 0127.