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ABSTRACT

Research reported dealt with designing a mathematics course for undergraduate business students. Of the three groups formed by matching, the control group received traditional instruction in college algebra, utilizing one text, while the two experimental groups used materials selected for their relevance to business students. One experimental group emphasized discovery learning experiences, the other did not. Hypotheses were: (1) greater transfer of training occurs when materials are taught through discovery experiences; and (2) a mathematics program that is specially tailored to cover basic concepts of decision theory, Boolean Algebra, and numerical analysis will afford significant help for business students to understand and solve management and computer problems. The experiment was discontinued because the material planned was too ambitious to be covered within the scheduled time constraints. It was not possible to completely cover the subject matter as originally outlined in the experiment. (JG)

FINAL REPORT
Project No. S_461
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DEVELOPMENT OF A MATHEMATICS CURRICULUM FOR UNDERGRADUATE BUSINESS STUDENTS

June 1968

U.S.DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

DEVELOPMENT OF A MATHEMATICS CURRICULUM FOR UNDERGRADUATE BUSINESS STUDENTS

Project No. S_461
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Dr. Edward Y. George

June 1968

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Bentley College of Accounting and Finance
Boston, Massachusetts

Introduction:

PROBLEM

Mathematics has undergone in recent years an impressive growth and has expanded into extensive applications which have outrun the curriculum in most business colleges. The traditional curriculum in business fails to reflect adequately the essence of contemporary mathematics which is based upon logically organized systems of thought and behavior and which is the basis of decision making processes and building models for business behavior.

The computer is assuming increasingly more importance as a determining force in business practice. The expanding capabilities of the computer makes it incumbent upon business graduates to become not only familiar with methods of mathematical analysis of data but also to become knowledgable of the methods of manipulating and reorganizing such data in terms of the computational capabilities of the computer.

Traditionally, the business graduate and/or accountant realized no need for any mathematical knowledge beyond arithmetic and elementary algebra. However, the computer revolution, the explosion of knowledge in mathematics and its applicability in modern decision theory, operations research and sound business decisions make it extremely important for business schools to re_examine their mathematical curriculum.

Background and Related Research

Within the past few years, a number of reports, surveys and studies that deal with business education were published. To name a few:

The American Statistical Association published, in 1964, a report of an A. S. A. committee on the study for teaching of statistics in business schools. The report indicates that for the teaching of statistics to business students to be meaningful, and to acheive its purpose of motivating growth in their professional life, the students must have a more_rounded background in mathematical analysis, and must be cognizant of the computer and its potentialities for modern business decision making and problem solving.

Dartmouth College held a conference in Nov. 1964, to discuss the subject, "New Directions in Math." The report on the conference indicates that the mathematical curriculum must aim at giving the student some under_standing of the assumptions and rules upon which a mathematical system is based. Such understanding of the abstract nature of mathematics will enable the student to use assumptions, definitions, and rules beyond the simple manipulation based on the given traditional "bag_of_tricks." Developing an understanding of mathematical concepts will help the business graduate to handle raw data, and to develop his inductive abilities.

In Dec. 1962, Dr. Charles J. Weiss, Professor of Accounting wrote in the Journal of Business (published by the Division of Business Research, School of Business Administration, Seton Hall University, pp 10-17) a report on a survey concerning the role of the Certified Public Accountant. Dr. Weiss maintained that, "the future growth of the C. P. A. profession and its worth to the general economy is in the management advisory service field."

The above cursory surveys indicate a general awareness of the fact that the future role of general business trainees lies in the field of management. There is also a consensus that a business graduate must have a well developed mathematical background to be able to fulfill requirements of his job and to be able to handle the computer.

Some institutes have gone a long way in upgrading and developing their course offerings but none so far has developed a well tested mathematical program to meet the needs of undergraduate business students.

Objectives and Hypothesis

A rigorous sophisticated knowledge of mathematical concepts and procedures is gradually becoming a desired requirement for a successful introduction into and future advancement in business careers. It therefore seems necessary for business schools to develop their curriculum in such a way that the business graduate will be given the opportunity to acquire the needed mathematical proficiency and the operational motivation to apply this proficiency to realistic business problems.

The basic hypothesis of this project is that an educational program in mathematics which exposes the student to basic concepts and ideas, and gives the student an opportunity to guided participation in, and 'discover' for himself the general arguments of mathematics, has an intellectually broadening influence and increases the probability of motivating the application of mathematical logic to other problem areas. In addition, a mathematics program that is specifically tailored to cover the underlying and basic concepts used in decision theory, Boolean Algebra, and numerical analysis will greatly help in understanding and solving management and computer problems.

The specific questions that this pilot experiment attempts to explore are:

(1) Is modern mathematics more effective in understanding management and computer science than traditional mathematics?

(2) Does the business student need a larger infusion of mathematics to be able to cope effectively with management and computer problems?

Inferred here is, of course, the idea that specific educational techniques impart factual and conceptual information of a type transferable, and directly applicable, to new situations and problem areas.

Method

A. Selection of control and experimental groups

The files containing the background of all Freshmen (Fall 1967) admitted to the College were carefully examined and systemized for the selection process. The four steps of this part of the procedure are listed on A_1. Selection of specific students on a matching basis, to form the three project groups, was completed under the direction of Prof. D.B. Cameron, Dean of Students. Matching criteria used were those stated in steps 1 to 4 on A_1, and the Scolastic Aptitude Test_Verbal scores. Group characteristics are presented in Tables A and B on B_1.

The preliminary number selected for each group was 45, which is deliberately higher that the proposal's suggested number of 36. The excess will allow for any necessary changes should any student fail to enter the college or refuse to participate in the experiment.

It was impossible to insure an even distribution of sex in the selected groups since the overall number of female students in the incoming Freshmen class is quite small in relation to the number of male students.

An analysis of variance for the objective criteria of selection indicates no significant differences between the three project groups. It also indicates no significant differences between the project groups and the parent population (the universe).

B. Preparation of the mathematics curriculum for the first academic semester under the project.

After numerous conferences with Dr. Ralph Johanson (Ph.D. Mathematics, University of Chicago), the Chairman of the Mathematics Department at Bentley College, and his staff, the following contents were agreed upon for the mathematics curriculum for Semester 1;

1. Control Group

The basic text used is College Algebra, by M. Richardson, 3rd edition, Prentice_Hall, Englwood Cliffs, N.J., 1966

The instructor will attempt to cover the following chapters:
Ch 1 Preliminary Consideration and the Language of Sets
Ch 2 The Number System
Ch 3 Algebraic Expressions
Ch 4 Functions and Graphs
Ch 5 Elementary Operations and Polynomials
Ch 6 Factoring of Polynomials
Ch 7 Elementary Operations with Fractional Expressions
Ch 8 Linear Equations and Linear Functions
Ch 9 Integral and Fractional Exponents
Ch10 Radicals
Ch11 Quadratic Equations

Instruction for the control group will follow the text book very closely. Incidentally, the text and subject matter covered are identical to the mathematics ...iculum followed for the rest of the Freshmen class of 1967 at Bentley ...ege_theexperimental groups being the only exception.

2. Experimental Groups A and B

It was decided to use the following text books as source material for the subject matter covered:

(1) Allendoerfer, Carl B. and Oakley, Cletus O., Fundamentals of College Algebra, New York, McGraw Hill, Inc., 1967.

(2) Fisher, Robert C. and Ziebur, Allen D., Integrated Algebra and Trigonometry, 2nd edition, New Jersey, Prentice Hall, Inc., 1967.

(3) Horner, Donald R., A Survey of College Mathematics, New York, Holt Rinehart and Winston, Inc., 1967.

(4) Mancill, Julian D. and Gonzalez, Mario O., Contemporary Mathematics, Boston, Allyn and Bacon, Inc., 1966.

(5) Richardson, M., College Algebra, 3rd edition, New Jersey, Prentice Hall, Inc., 1966.

(6) Rider, Paul R., First Year Mathematics for Colleges, 2nd edition, New York, Macmillan Company, 1966.

In cooperation with Dr. Ralph Johanson and his staff, I prepared an outline of the topics to be covered by the mathematics curriculum for the first semester. This detailed outline is found in the Appendix.

The details of the course were mimeographed for distribution to the students concerned. The publishers of the text books used in the mimeographed sheets gave their permission a copy of the credit letter is enclosed in the appendix to incorporate portions of their text materials in the text prepared (specifically for the purposes of this pilot experiment only.)

The subject matter for both experimental groups A and B is practically the same. The main difference between them is in teaching methodology. In group A the emphasis is on the level of sophistication, acceleration and depth of coverage as reflected in the level of problems assigned, while the emphasis in group B is on the conceptual application of modern mathematical notation, and dependence on the discovery method.

On the opening day of classes the Contemporary Mathematics Test, Advanced form W, published by the California Test Bureau was administered to the three groups of students selected. No significant statistical differences were reflected in the score.

The same procedure of preparing mimeographed subject matter based on a diversity of text materials was planned for the second term. However, the instructors of the experimental groups expressed real concern about the ability of their students to carry the planned mathematical course load for the term especially as they were not able to cover the material designated for the first term with the required depth. The material covered in the second term included fundamentals of algebra and an introduction to analytic geometry

and trigonometry. It did not include calculus. The basic reference used was College Algebra by M. Richardson, 3rd edition, Prentice_Hall, Englewood Cliffs, N. J., 1960.

Results

After one year's implementation of the experiment, we cannot draw significant conclusions relative to our original goals. In order to assure the students a thorough understanding of the mathematical contents and their implementation for the topics covered (algebra, trigonometry, and analytic geometry) time limitations made it necessary and advisable to omit the calculus content of the course as originally planned.

Several meetings were held with the participating faculty members and the Chairman of the Mathematics Department at the College to review the situation to consider the possibilities of acheiving our basic goals. We reached the conclusion that the planned experiment was overly ambitious and that the subject matter content could not be adequately covered within the time constraints as specified in the experiment.

Conclusion

The experience gained from the experiment to date is inconclusive for drawing any significant conclusions concerning the validity of the basic hypothesis. It has become clear that the mathematical content originally planned for the experiment was overly ambitious for our freshmen students within the scheduled constraints of the experiment. Thus we have decided to discontinue this experiment since planned material for the third semester's course cannot be satisfactorily covered in a way that would contribute to a meaningful completion of the experiment.

Recommendations

Although we were not able to prove or disprove our hypothesis on the basis of our one year's experiment, we are still convinced that business students do need an expanded and improved mathematics curriculum. Furthermore, we are convinced that it is possible to prove, empirically at least, that a program of expanded and improved mathematics under the proper conditions can contribute appreciably to a better understanding of management science and associated computer applications. To this end, a new experiment must be designed which can be effectively implemented taking into consideration the appropriate mathematics subjects, allowing sufficient time for thorough understanding and assimilation by the participating students.

Summary

We recognize the increasing use of mathematics in formulating sound business decisions, and the associated need for an expanded knowledge of mathematical logic and concepts to gain a firm understanding of computer capabilities. We also accept the premise of the transferability of basic skills in logic and factual concepts. Thus we designed an experiment to impart to a group of

students a broad mathematical curriculum. The experiment attempted to test the differential impact of three different teaching methodologies with expanded and improved mathematical subject matter content. The experiment had to be discontinued because the material planned was too ambitious to be covered within the scheduled time constraints. It was not possible to completely cover the subject matter as originally outlined in the experiment.

The insights gained from this limited experiment will be valuable in designing a new experiment which will be more meaningful and beneficial to the objectives of the U. S. Office of Education and Bentley College.

APPENDIX

Subject Matter Covered in Semester 1 For Experimental Groups A+B

Sets

1. Explanation
   - Identity
   - Subsets
   - Proper Set
   - 1 to 1 Correspondence

2. Open Sentences
   - The Statement
   - The Universal Set U
   - Variables and Constants
   - The Truth Set
   - Equivalent Open Sentences
   - Negations

3. Set Operations
   - Complement
   - Union
   - Intersection

The Number System

1. Rational vs. Irrational
2. Real Numbers
3. Laws of Addition and Multiplication
4. Factoring and Expanding
5. Zero as "identity element"
6. Additive Inverse
7. Absolute Value
8. Multiplicative Identity
9. Multiplicative Inverse
10. Natural Numbers

Algebraic Expressions

1. Positive Integral Exponents and Radicals
   - Order of Operations
2. Removal and Insertion of Parentheses
   - Combination of Like Terms
3. Standard form of Polynomials
4. Equations and Identities
5. Verification of Identities _ Reversible Steps
6. Elementary Operations with Equations
7. Degree of an Equation

Functions, Graphs, and Relations

1. List of Ordered Pairs
2. Eqiations
3. Inequalities
4. Simultaneous Systems
5. Functions
6. Domain
7. Rectangular Coordinates
8. The Graphs of Equations and Functions
9. Graphical Solution of Equations
10. Graph of a Linear Function
11. Cartesian Coordinates and the Distance Furmula
12. Supply and Demand Functions

Operations with Polynomials

1. Algebraic Expressions
2. Addition of Polynomials
3. Multiplication of Polynomials
4. Division of Polynomials
5. Non_decimal Scale of Notation

Factoring Polynomials

1. Removal of a Common Factor
2. Trinomials with Integral Coefficients
3. Types of Products
4. Elementary Factor Types and Others
5. Suggestions for Factoring
6. Highest Common Factor and Lowest Common Multiple

Operations with Fractional Expressions

1. Rational Fractions
2. Simplification of Fractions
3. Fundamental Principles of Fractions
4. Addition and Subtraction of Fractions

Linear Equations and Linear Functions

Slope_Intercept Form
Point_Slope Form

1. Solution of Linear Equations in One Variable
2. Equations Leading to Linear Equations

3. Linear Equations and Formulas
4. Systems of Two Linear Equations in Two Unknowns
5. Solution of Two Equations by Determinants
6. Linear Equations in Three or More Unknowns
7. Worded Problems

Inequalities, Graphs, Linear Programming

1. Positive Integral Exponents
2. Zero and Negative Exponents
3. Fractional Exponents
4. Special Problems Concerning Square Roots
5. Special Problems Concerning Odd Roots
6. Laws and Exponents
7. Rational and Irrational Numbers
8. Laws and Radicals
9. Removing Factors from and Introducing them into Radicals
10. Rationalizing the Denominator
11. Reduction of Radical Expressions to Simplest Form
12. Addition and Subtraction of Radicals
13. Multiplication and Division or Radicals
14. Imaginary and Complex Numbers

Quadratic Equations, Quadratic Functions, Quadratic Inequalities

1. Polynomials of the Second Degree
2. Solution by Factoring
3. Completing the Square
4. Solution by Formula
5. Equations in Quadratic Form
6. Equations Involving Radicals
7. Sum and Product of Roots
8. Formation of an Equation with Given Roots
9. Factoring by Solving a Quadratic
10. Maximum or Minimum Value of a Quadratic Function
11. Equations Containing Fractions

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