AN ABSTRACT OF THE THESIS OF

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TITLE: A MODEL TO IDENTIFY PERFORMANCE STANDARDS FOR MATHEMATICS IN A TWO YEAR POST HIGH SCHOOL OCCUPATIONAL PROGRAM.

Abstract approved: Redacted for Privacy

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PURPOSE OF THE STUDY

This study developed a model which identified mathematical needs in various vocational technical programs. This model provides a method which can be used to develop an adequate mathematics curriculum to support occupational offerings at community college/technical institutes, and can also help high schools and the colleges/technical institutes articulate their mathematics curriculum. The study also established a method to identify the high school mathematics prerequisites for the various occupational programs through a statistical model of significant differences of levels of high school mathematics.

STATISTICAL DESIGN OF THE STUDY

The study was divided into four major statistical subtopics:

Subtopic I consisted of a two-way statistical test of significance establishing the need for mathematics in an occupational vocational program.

Subtopic II utilized a two-way statistical test of significance establishing the need for mathematics in a particular vocational occupation.

Subtopic III established a relationship between high school mathematics programs and the problems used in Subtopic II.

Subtopic IV established a rank order list of mathematics subtopics as they relate to the occupation that was tested for this study and also established a curriculum subject outline for the occupation studied.

PROCEDURE

The Business Data Processing Program at Northeast Wisconsin Technical Institute (NWTI), Green Bay, Wisconsin was designated as the sample occupational program for the study. The student population for the study consisted of 105 persons who graduated with an Associate of Arts Degree in Business Data Processing at NWTI during the period 1968-75. Also surveyed were 41 high school mathematics instructors located within the NWTI district boundaries, 22 data processing instructors located and teaching within the technical institutes throughout Wisconsin, and 45 business data processing practitioners located within the NWTI area.

The first subtopic addressed itself to the a priori need of mathematics for a business data processing program. Grade point averages of the students in business data processing were analyzed and reported in terms of the amount of prior mathematics studied.

Subtopics II, III, and IV sought to develop a mathematics curriculum which would be relevant to the practicing programmer after graduation. A questionnaire containing 63 possible mathematics topics and 34 problems was submitted to three groups--data processing instructors, graduates, and practitioners. The respondents in each group were requested to answer each question by means of a 1-5 Likert scale, in terms of the degree of need for a typical business data processing programmer.

The high school mathematics instructors were asked to establish the level of mathematics expected of a person to be able to solve the 34 problems submitted to the data processing community.

FINDINGS

The results of this study indicate that the use of instructors and practitioners of an occupation combined with the a priori study of students mathematics achievement levels provide an effective means to establish a mathematics support curriculum for that occupation.

The model can identify areas where high schools and community colleges/technical institutes do and do not coordinate curricula so that they can work to better establish career education from job exploration through job preparation. The model establishes check points to indicate when conferences may be needed to bring curricular philosophies into accord in the event that these purposes do not mesh.

The occupation studied seems to indicate that a "bare bones" utilization of the topic list and the student a priori mathematics analysis can establish a mathematics support curriculum for the occupation. The other elements of the study act as checks on the validity of the study.

A Model to Identify Performance Standards for Mathematics in a Two-Year Post High School Occupational Program

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A MODEL TO IDENTIFY PERFORMANCE STANDARDS FOR MATHEMATICS IN A TWO-YEAR POST HIGH SCHOOL OCCUPATIONAL PROGRAM

I. INTRODUCTION

Statement of the Problem

Today's society with its complex industries points more and more to an increasing dependence on the concepts of mathematics. Schools that train persons for occupations in these industries obviously must include studies of the necessary mathematics. A concern of the schools has been to delineate the particular mathematics that is required for each occupation. This study was designed to identify a model which could be used to establish the prerequisite level of mathematics for students who enter any vocational technical program which leads to job entry. Furthermore this study was undertaken to identify a model which would establish whether or not any particular industry does recognize the similarity between an occupational mathematics problem and the mathematics process model of that problem. The two models together, then, should be comprehensive enough to establish those mathematics subtopics that must be incorporated in the curriculum of the vocational technical program being studied.

Subproblem 1

This study was established to identify, by means of a model, the level of high school mathematics which is prerequisite for student success in a particular occupational program offered at a community college/technical institute.

Subproblem 2

This investigation was developed to establish whether or not there is a significant difference between occupational instructors and occupational practitioners of a particular occupation in relation to the recognition of mathematics required for that occupation.

Subproblem 3

The study was also designed to establish whether or not the occupational practitioner and the occupational instructor recognize the similarity of the mathematics process problem and the occupational mathematics product problem.

Subproblem 4

The goal of this study was to establish, by means of the designed models, a prescriptive mathematics curriculum for students of a particular vocational technical program or occupational offering.

Definition of Terms

The following definitions were included for purposes of standardizing the use of terms in the study. Other terms or phrases used in the study were considered to be self-explanatory.

ANOVA is the analysis of variance technique.

Area is a geographical location.

Boundary is the legal limits of a vocational district.

Daily Living Problem is that type of problem which might be encountered as a societal living problem (not job).

Data Processing Instructors are teachers of data processing who are certified by the State of Wisconsin Board of Vocational, Technical and Adult Education, and teaching at any of the 16 technical institutes of Wisconsin.

General Subject Area refers to such areas as algebra, trigonometry, etc.

Graduates are those who graduated from the Business Data Processing program at Northeast Wisconsin Technical Institute.

High School Mathematics Instructor Questionnaire was that questionnaire sent to various mathematics instructors.

High School Mathematics Instructors are those who teach in high schools located within the boundaries of Northeast Wisconsin Technical Institute.

Institute refers to Northeast Wisconsin Technical Institute.

Job Problem is that type of mathematics problem which might be encountered by an occupational practitioner in any field considered.

L.S.D. Test (or Least Significant Difference test) is a statistical test of significant differences between groups within a parent population.

Mathematics Process Problem is a mathematical problem expressed in mathematical terms.

Mathematics Product Problem is a mathematical problem expressed in word form.

Mathematics Spiral Process is a building block approach to a learning process whereby each separate mathematics topic is developed to build on another to give the skills to the person to enable him to become an occupational mathematician.

NWTI is Northeast Wisconsin Technical Institute.

Occupational Offering includes any offering which is established for improvement of occupational skills and knowledge.

Occupational Practitioners are those persons who are business data processing personnel who are practicing programmers within the local area of Northeast Wisconsin Technical Institute, but did not graduate from Northeast Wisconsin Technical Institute, nor are instructors in the field of data processing.

Occupational Problem is the same as job problem.

Practitioner Questionnaire is a questionnaire sent to the three groups of data processing practitioners--instructors, graduates and practitioners.

Prescriptive Curriculum is a curriculum so designed as to provide full course subject support for an occupational program and yet allow for the learning needs of each student enrolled.

Program Leaver is one who exits an occupational program.

VTAE is Vocational Technical and Adult Education.

Vocational Technical Program is a program offered at a vocational technical and adult institution which carries a degree or diploma status. This includes community colleges and technical institutes.

WVTAE is Wisconsin Vocational Technical and Adult Education.

Purpose of the Study

The purpose of this study was to develop a model which would identify mathematics needs in various vocational technical programs so that adequate mathematics curriculum articulation might be accomplished between high school and post high school technical institutions; and so that adequate mathematics curriculum might be developed to support occupational offerings at the community college/technical institute. The study was also established to identify the high school mathematics prerequisites for the various occupational programs through the development of a statistical model of significant differences of achievement levels of high school mathematics.

Rationale for the Study

The world is becoming increasingly interdisciplinary in nature, and the increased dependence on mathematical concepts for the sophisticated business systems of today are easily substantiated (Wilder, 1973). Yet, as was the case in the 1920's and 1930's, failure on the part of today's curriculum managers to recognize this dependence on mathematics in various fields could lead to a serious deficiency on the part of students in their chosen fields of study (Newsom, 1972).

On the other hand, it also becomes essential to allocate economically the study of applied mathematics and work attitudes, human relations skills, and communication skills so as to complement the students' chosen careers (Hoyt, 1972). In addition, society can ill afford to educate mathematical geniuses who cannot relate to their own culture according to the Toffler concept of the evolving society (Hoyt, 1972), nor can educators afford to frustrate students beyond their capabilities by pressing mathematical concepts beyond the future (Toffler, 1970). Mathematics curriculum has undergone exhaustive studies made by the Committee on the Undergraduate Programs in Mathematics (CUPM), The Cambridge Conference on Mathematics, and the School Mathematics Study Group (SMSG) to update mathematics education for college (Foreman, 1971). Mathematics groups have studied specialized areas. Research has been dedicated to the study of mathematics for the disadvantaged and the handicapped (Weiss, 1969). Individualized instruction programs have been established by such distinguished people as McHale to improve the mathematics programs for vocational students (McHale, 1971). In the area of problem solving, the Oregon Vo-Tec Mathematics Problem Sets have proven to be invaluable in linking mathematics to the various occupational programs at the community college/technical institute level (Swearingen, 1974).

There is also a continued effort to complete task analyses of the various vocational programs offered at the community college/ technical institute level (Bailey, 1974). The problem which remains is that research barely includes task analysis on the support subjects, such as mathematics. The instructors and advisory committees of the various occupational offerings, however, do make numerous suggestions as to what should be developed in the mathematics support courses. Yet, the suggestions tend to be so general in nature that even with a full graduate program in mathematics, student needs would be met only by chance. One possible problem in the articulation of mathematics with industry is that the industry may not recognize the need to study mathematical systems of the various mathematical topics, but instead only recognize the need to meet the immediate occupational goal, which is to answer the occupational problem in question. A second problem might be that the educational institution becomes so involved in the mathematical process that the application to the industrial objectives, that problem, is neglected.

Need for the Study

A systematic approach to deal with an occupational problem requires that it must be translated into a quantifiable mathematical relationship or equation in order to develop a meaningful solution (Jamison, 1973). This implies that the person required to solve the problem must be capable of the basic procedures:

1. He must be able to translate the occupational problem into a mathematical model.

2. He must be able to solve the model.

3. He must be able to translate the model solution into the occupational problem solution.

However, caution must also be expressed in the application of such models. In the "1963 Report on the Cambridge Conference on School Mathematics," the writers warn of the dangers of forcing application of mathematical models on mathematically immature persons.

> For an external application to be valuable, the experimental background and the mathematical identification of the model must be in the student's experience, taught to him previously in the curriculum of the other discipline, or supplied in the mathematics course (Goals for School Mathematics, 1963).

This requirement establishes the need to articulate the high school mathematics curriculum with that of the community college/technical institute in order to provide the mathematical spiral process and occupational application required in the chosen vocational program the student pursues (Goals for School Mathematics, 1963). Further, there is a need to develop within the industry an awareness of the close articulation necessary for proper mathematics support to that industry.

Limitations of the Study

1. Although this study was established to arrive at a model to provide a particular mathematics curriculum for any occupational program, it was expedient to utilize one occupation. For this reason, this study limited itself to the Business Data Processing program leading to the Associate of Arts Degree at Northeast Wisconsin Technical Institute.

2. The student population identified for this study consisted of the students who entered into the Northeast Wisconsin Technical Institute Data Processing Program from August 1968 through June 1975, and graduated with an Associate of Arts Degree in Data Processing.

3. The data processing instructors surveyed in this study were from the population of instructors in data processing located within the Wisconsin State Board of Vocational Technical and Adult Education boundaries and teaching within the State Vocational Technical and Adult Education system.

4. The practitioners in the business data processing area were chosen from the population of practicing programmers within the Northeast Wisconsin Technical Institute District area. These practitioners did not graduate from NWTI.

II. STATISTICAL DESIGN OF THE STUDY

The study was divided into four major statistical subtopics:

Subtopic I consisted of a two-way statistical test of significance establishing the need for a priori mathematics in an occupational vocational program.

Subtopic II utilized a two-way statistical test of significance establishing the need for mathematics in a particular vocational occupation.

Subtopic III established a relationship between high school mathematics programs and the problems used in Subtopic II.

Subtopic IV established a rank order list of mathematics topics as they relate to the occupation tested and a curriculum subject outline for business data processing.

Subtopic I

This subtopic was designed to establish whether or not there is an a priori need for mathematics in a particular occupation. The parent population for this subtopic consisted of 105 students who completed a two-year business data processing program at Northeast Wisconsin Technical Institute during the period August 1968 through June 1975.

During the period 1968-1975 the NWTI Student Services records showed that approximately 250 students had enrolled in the business data processing program, but that only 105 of the students actually graduated. The others, approximately 145 students, dropped from the data processing program for various reasons. Since there were so many program leavers, the author originally intended the experiment to establish whether or not there was a significant difference in NWTI course grades between the successful group and the program leavers in terms of the high school mathematics level completed. A search of the records indicated that those students who dropped out of the program tended to have incomplete records. Of a sample of 30 former student records, only three records were complete enough to be incorporated in the research model. The three students who had complete records had changed majors from data processing to accounting and had graduated. The rest of the 30 students leaving the program lacked records such as high school transcripts, or had left NWTI before completing even one semester. Since it was impossible to develop an adequate sample of program leavers, the study was limited to only the successful group, the data processing graduates from the years 1968-1975.

The investigation utilized a fixed statistical model, and management of the statistical procedures was accomplished through the use of a two-way analysis of variance technique. The basic experimental design incorporated a 2 x 5 factorial design, with two course type factors, and five levels of high school mathematics factors.

The mathematical model used was:

$Y_{jk} = \mu + T_j + L_k + TL_{jk} + \varepsilon_{jk}$, where,

μ was the true mean Grade Point Average score,

T_j was the differential effect associated with course types,

L_k was the differential effect associated with mathematics level of study.

TL_{jk} was the differential effect associated with interaction,

ε_{jk} was a random variable normally distributed, with $\mu = 0$ and a variance of σ^2.

Three null hypotheses were tested in the statistics of this study.

H 1 - There was no significant course type effect.

H 2 - There was no significant high school mathematics level effect.

Alternate a priori hypotheses were:

H 2.1 - $m_2 > m_1$, i.e., Level 2 math > Level 1 math

H 2.2 - $m_3 > m_1$, i.e., Level 3 math > Level 1 math

H 2.3 - $m_4 > m_2$, i.e., Level 4 math > Level 2 math

H 2.4 - $m_5 > m_2$, i.e., Level 5 math > Level 2 math

H 3 - There was no significant interaction effect between high school mathematics level and course type.

The arrangement of the statistical design is provided in Table I on page 13. This lists the tests of significance for primary effects and the interaction effects for the null hypotheses. The critical F ratio utilized in each case for the purposes of rejection was the tabulated F, where degrees of freedom were 1, 189, and alpha = .05.

The population universe for this substudy was derived from the graduates who completed the Data Processing Associate of Arts Degree Program at Northeast Wisconsin Technical Institute during the period August 1968 through June 1975. The collection of the data was accomplished by a systematic search of the academic files of the population

TABLE I. ANOVA ARRANGEMENT (TWO-WAY) FIXED DESIGN

(2 x 5 Design)

Source of Variation	DF	SS	MS	F
Types	1	A	A/1	MS(A)/MS(D)
Levels	4	B	B/4	MS(B)/MS(D)
Level x Type	4	C	C/4	MS(C)/MS(D)
Error	189	D	D/340	
Total	198	E		

TABLE II. ARRANGEMENT OF DATA FOR ANALYSIS OF TWO-WAY ANOVA

(Distribution of Population)

	Graduates of Data Processing Program				
High School Math Course Completion / Types of Courses	Level 1 General Math	Level 2 One Year Algebra	Level 3 Algebra Plus Geometry	Level 4 Two Years Algebra Geometry	Level 5 Level 4 Plus Trig/ Analysis
Data Processing Courses	N = 5	N = 14	N = 22	N = 35	N = 23
All Other Course Work	N = 5	N = 14	N = 22	N = 35	N = 23
Total	N = 10	N = 28	N = 44	N = 70	N = 46

universe. The population was first categorized into five levels relative to the amount of mathematics the students had completed on graduation from high school. Each level was further categorized two ways. One category was based on the grade point average of each student in data processing subjects taken at the Institute, and the other was based on the grade point average of all the course work completed at the Institute other than in data processing. The data processing mathematics courses were eliminated from the grade point average of the students. The statistical model as developed is shown in Table II on page 13. The grade point average was based on the Likert scale A = 4, F = 0. A data deck was prepared to provide for the arrangement of the two-way analysis of variance as established in Table II. The computer card layout is provided in Table III on page 15. For the purposes of this study, the delineation of courses defined the following as courses belonging to the category, "data processing" courses:

NWTI NUMBER	COURSE DESCRIPTION	CREDITS
107-110	Computer Programming 1	4
107-111	Data Processing Concepts	3
107-120	Computer Programming 2	4
107-121	Data Design Techniques	3
107-130	Computer Programming 3	4
107-131	Programming Systems	3
107-140	Computer Programming 4	3
107-141	Advanced Programming Procedures	3
107-142	Data Processing Project	3

In general, all NWTI numbers prefixed with 107 were included with data processing. All other course work completed at NWTI was considered in the category, "other courses."

TABLE III. DATA CARD LAYOUT FOR SUBTOPIC I

Card Column 2-10	I.D. No.
Card Column 12	Group I.D. 1 = Graduates 2 = Nongraduates
Card Column 16	High School Course Completion Level 1 = General Math 2 = One Year Algebra 3 = One Year Algebra Plus Plane Geometry 4 = Two Years Algebra Plus Plane Geometry 5 = Two Years Algebra Plus Plane Geometry Plus Trig or Analysis
Card Column 21-24	Grade Point Average of Data Processing Courses Completed at NWTI
Card Column 26-29	Grade Point Average of All Other Courses Completed at NWTI

Where the high school mathematics level effect hypothesis was rejected, an L.S.D. test was used to establish whether or not the alternate hypotheses were true. The .05 level of significance was used to establish the retention or rejection of the hypotheses.

Subtopic II

The primary objective of this subtopic was to ascertain whether or not practitioners within a particular occupation recognized the similarity between mathematics product problem and its mathematics process problem model. Further, the study sought to ascertain whether or not there was a significant difference in problem matching between the operating practitioners of the occupation, the graduates of a particular institution offering the particular occupation program, and the instructors of that program. For the purpose of this substudy, there were three mutually exclusive parent populations from which the samples for the study were taken. The model for this study was derived from the occupational area of business data processing programmers. The D.P. instructor sample was derived from the parent population of business data processing instructors practicing within the State of Wisconsin Vocational Technical and Adult Education Board jurisdiction. Questionnaires were sent to certified data processing instructors, as listed in the Wisconsin VTAE system. There were 38 instructors listed, and of that population, 22 instructors responded and 16 failed to complete the survey.

The student graduate sample was selected from the parent population of those graduates of Northeast Wisconsin Technical Institute who graduated between August 1968 and June 1975. Questionnaires were sent to 105 students of which 44 completed the questionnaire. The third population sampled consisted of those business data processing practitioners who work within the Northeast Wisconsin Technical Institute District area, and who are neither instructors in the occupation nor graduates of the Northeast Wisconsin Technical Institute. A list of 84 practitioners was established through the help of the Northeast Wisconsin Data Processing Managers Association.

The investigation utilized a fixed statistical model and the management of the statistical procedures was accomplished through the use of a two-way analysis of variance technique. The basic experimental design incorporated a 2 x 3 factorial design with two types of problems and three groups of people surveyed. Table VI, page 21, contains the distribution of population for analysis of the two-way model.

The basic mathematical model used was:

$Y_{ij} = \mu + G_i + T_j + GT_{ij} + \varepsilon_{ij}$, where,

μ was the true mean level of agreement,

G_i was the differential effect associated with groups,

T_j was the random effect associated with problem types,

GT_{ij} was the differential effect associated with interaction.

ε_{ij} was a random variable normally distributed with $\mu = 0$ and a variance of σ^2.

Eight null hypotheses were tested in the statistics of this study. For each job oriented question the following null hypotheses were tested:

H 8 - There was no significant group effect.

Alternate hypotheses were:

H 8.1 - D.P. instructor group was significantly different from student group.

H 8.2 - D.P. instructor group was significantly different from practitioner group.

H 9 - There was no significant type effect.

H 10 - There was no significant interaction effect between groups and problem types.

H 11 - There was no significant difference among professional programmers in selecting data processing mathematics problems.

For each question on daily living oriented problems the following hypotheses were tested:

H 12 - There was no significant group effect.

Alternate hypotheses were:

H 12.1 - D.P. instructor group was significantly different from student group.

H 12.2 - D.P. instructor group was significantly different from practitioner group.

H 13 - There was no significant type effect.

H 14 - There was no significant interaction effect between groups and problem types.

H 15 - There was no significant difference among professional practitioners in the area of data processing mathematics problems.

The arrangement of the statistical design provided in Table IV, page 19, lists the tests of significance for primary effects and the interaction effects for the null hypothesis. A critical F ratio utilized in each case for the purpose of rejection was the tabular F, where degrees of freedom were 1, 216, and alpha = .05.

The problem types were paired according to particular mathematics subtopics by a panel of mathematics teachers presently teaching in community colleges and four-year mathematics programs. The 2 x 3 analysis model was utilized for two groups of 34 separate, paired problems which were partially represented by the mathematics subtopics as listed in Table V, Appendix E, page 71.

TABLE IV. ANOVA ARRANGEMENT (TWO-WAY) FIXED DESIGN

(2 x 3 Design)

Source of Variation	DF	SS	MS	F
Group	2	A	A/S	MS(A)/MS(D)
Type	1	B	B/1	MS(B)/MS(D)
Interaction Group x Type	2	C	C/2	MS(C)/MS(D)
Error	216	D	D/216	
Total	221	E		

The Practitioner Questionnaire submitted to the three groups--D.P. instructors, practitioners, and graduates--consisted of 34 separate mathematics problems (see Appendix A, page 61, for questionnaire sample). These problems were chosen with the assistance of a mathematics panel consisting of five members who are presently teaching at the college/junior college level. The problems selected were chosen from the topics listed in Table V on page 71. For each problem, the survey asked two questions:

1. This problem represents a typical problem that a business data processing programmer might encounter in his job.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

2. This problem represents a typical problem that a business data processing programmer might be expected to solve in daily living (daily living includes from home to job).

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Since each problem actually asks two separate questions, the paired questions were submitted to the analysis of variance model to test whether or not there was significant difference between the mathematics process model problem and the occupational mathematics problem for each question. There were, therefore, two sets of 17 paired questions submitted to analysis of variance procedure to test whether or not data processing personnel recognized the mathematical process model of an occupational problem.

In the ANOVA's which showed a significant group effect--that is to say, the null hypothesis that the groups are not different was rejected--a Least Significant Difference Test (L.S.D.) was applied to establish whether or not:

D.P. instructors differed from graduates

D.P. instructors differed from practitioners

in the choice of the mathematics for data processing. The .05 level of significance was used to establish the acceptance or rejection of the data.

In order to establish whether or not there was an overall significant difference among the 34 selected problems, the study incorporated a Chi Square test of significance. A problem pair was considered as significantly different only if the paired occupational problem was significantly less in value than that of the mathematics model as expressed in the F ratio taken at alpha = .05. The null hypothesis of the model was H 11--there was no significant difference among professional practitioners in choice of data processing mathematics problems.

TABLE VI. ARRANGEMENT OF DATA FOR ANALYSIS OF TWO-WAY MODEL DISTRIBUTION OF POPULATION

	Groups of D.P. Practitioners			
Types of Problems	Data Processing Instructors	Graduates of DP Program at NWTI	Practitioners Not Instructors Not NWTI Graduates	Total
Occupational Word Problem	22	44	45	111
Math Process Problem	22	44	45	111
Total	44	88	90	222

Subtopic III

The survey described in Subtopic II was developed by a panel of five mathematics instructors who are presently teaching at the community college/technical level and included 34 problems representing the various mathematics subtopics listed in Table V on page 71. The data collected was tabulated and listed by rank order of selection according to average (grand mean) agreement of need for the problems. A table was developed for each of the two questions asked. The layout of the table is as shown in Table VII below.

TABLE VII. RANK ORDER OF PERCEIVED NEED FOR BUSINESS DATA PROCESSING MATHEMATICS

Question Number	Level of Agreement Count	Average (Grand Mean)	Average Expected Level of Mathematics Study Required to Solve Problem (High School Instructor Rating)

The rating of levels of study expected of a student was established through the High School Mathematics Instructor Questionnaire sent to high school mathematics instructors who were teaching within the Northeast Wisconsin Technical Institute boundaries. This survey sought to establish whether or not each of the 34 problems submitted to the practitioners is studied at the high school level, and to determine the level of mathematics achievement the student needs to adequately perform the mathematical process of problem solving. The latter was the primary objective.

The questionnaire was sent to 41 selected instructors of high school mathematics, teaching within the Northeast Wisconsin Technical Institute District boundaries. These individuals were recommended by their school principals on the basis of:

a. knowledge and organization of subject matter,

b. adequacy of plans and procedures in class,

c. enthusiasm in working with students.

High school instructors selected were contacted and asked to participate. They were assured that their responses would not be reported by name or school affiliation. The survey utilized the mathematical levels of study recognized by Subtopic I plus the additional subtopic, post high school mathematics. Appendix B on page 65 shows the layout of the questionnaire.

The survey was tabulated showing the mean score and the standard deviation calculated. The arithmetic mean was truncated to the next lower level of study. The author assumed that if a student began a level of study he either completed that particular course or dropped the course and in that case no transcript showing such study would exist.

Subtopic IV

Also included in the practitioner questionnaire was a set of topics (Table V on page 71) which might possibly be included in a typical business data processing mathematics course. (See Appendix A on page 58.)

The topics list was submitted to the three data processing groups: D.P. instructors, graduates, and practitioners. A five-point Likert scale was used to establish the need for each topic. A choice of 5 indicated a strong need for the program and thus indicated that such a topic should be covered within a mathematics data processing program. A score of 1 indicated no need for such a topic. The survey contained 63 separate mathematics topics to which the three data processing groups were requested to respond. For each topic, the respondent was asked to circle the number which most closely indicated his or her thinking as to whether a two-year business data processing student should study and meet specific performance standards in the indicated topics prior to graduation with an Associate Degree in Data Processing. The topic questionnaire was included with the problem questionnaire as indicated in Subtopic II.

In order to establish continuity within the data processing community, this investigation utilized a fixed statistical model and the management of the statistical procedure was accomplished through the use of a one-way analysis of variance technique. The basic experimental design incorporated a 1 x 3 factorial design with three groups of people surveyed: instructors, graduates, and practitioners.

The basic mathematics model used was:

$Y_j = \mu + G_j + \varepsilon_j$, where

μ was the true mean level of agreement

G_j was the differential effect associated with the groups

ε_j was the random variable normally distributed with $\mu = 0$ and a variation of σ^2.

One hypothesis was tested in the statistics of this study:

H 16 - There was no significant group effect.

Alternate hypotheses were:

H 16.1 - Instructor group was significantly different from graduate group.

H 16.2 - Instructor group was significantly different from practitioner group.

The arrangement of the statistical design is provided in Table VIII on page 25.

A critical F ratio utilized in each case for the purposes of rejection was the tabular F, where degrees of freedom were 1, 108, and alpha = .05.

TABLE VIII. ANOVA ARRANGEMENT (ONE-WAY) FIXED DESIGN

(1 x 3 Design)

Source of Variation	DF	SS	MS	F
Main Effect	2	A	A/2	MS(A)/MS(B)
Residual	108	B	B/108	
Total	110	C		

For the ANOVA's which showed a significant group effect, i.e., we rejected the null hypothesis that the groups were not different, a Least Significant Difference Test was applied to establish whether or not:

D.P. instructors differed from graduates

D.P. instructors differed from practitioners

in the choice of the mathematics for data processing.

On completion of the 63 ANOVA's the topics were then rank ordered according to need by subject area, and an average mean was recorded for each area. Scores of 3.19 or less were omitted from the list of "needed" topics.

Design of the Questionnaire

A primary purpose of this research project was to establish a model which could be used to provide a prescription-type curriculum in mathematics for a typical data processing student at Northeast Wisconsin Technical Institute. In order to establish that curriculum, the author felt it necessary to establish a common link between three groups involved with business data processing--instructors in the field, practicing graduates, and practitioners--as well as high school instructors who prepare future data processing students in the mathematics curriculum area.

Two questionnaires were designed. Within the practitioners' questionnaire were two basic questions. The first basic question concerned only the topic outline of curriculum content. The second basic question attempted to establish whether or not practitioners in the business data processing field truly recognized a problem in terms of its product content as well as its mathematics process content.

The practitioner questionnaire was developed by the author with the assistance and advice of fellow community college and college mathematics instructors and data processing instructors. A series of problems was selected from various data processing mathematics and business mathematics textbooks. A total of 17 word problems was selected and modified for the purposes of the questionnaire. To avoid compromise within the questionnaire, for each product problem a parallel mathematics process model was written using constants that were different from that of the product problem. These 34 problems were selected as being somewhat typical to those problems found in data processing programs throughout the country.

To facilitate the handling of the questionnaires in the data processing phase each group of questions was color coded. Each of the three practitioner questionnaires was color coded:

NWTI graduates - blue

Instructors of data processing - yellow

Practitioners/nongraduates - green

The questionnaire was designed to ask two questions for each problem presented. The first question asked the respondent to evaluate the relevance of each problem for the field of data processing. A Likert scale of 1-5 was used to establish agreement of need. Level 1 meant that the problem was not needed for the business data processing program. Level 5 indicated that the ability to solve the problem was essential to the business program. The second question sought to establish whether any of the problems represented a typical problem encountered by an individual in daily living. A daily living problem was considered to be one which a person in any field should be able to solve in meeting his personal needs from the home to the job. The design of the daily living questionnaire portions utilized the same Likert scale as the business programs questions.

In order to establish a topic outline for a data processing mathematics curriculum, a list of 63 separate topics was submitted to the respondents. (See Table V on page 71.) The respondents were asked to utilize a five-point Likert scale--1 indicating no need, 5 indicating strong need--to establish a consensus of curriculum content in the data processing mathematics program. One hundred thirty-five questions were asked of each respondent. The respondents were asked the following four questions to verify the validity of their responses in terms of groups:

1. Your present capacity in the data processing field is:

Student	Instructor	Business Data Processing Practitioner	Other
1	2	3	4

2. Did you graduate from Northeast Wisconsin Technical Institute with an Associate Degree in Data Processing?

3. Did you attend any courses offered at the Northeast Wisconsin Technical Institute in data processing?

4. Since graduation from high school, you have completed _____ semester hours of mathematics.

A copy of the practitioner questionnaire is included in Appendix A on page 61.

The high school mathematics instructor questionnaire was established essentially from the practitioner questionnaire. For each problem established within the practitioner questionnaire for instructors, practitioners and supervisors, the high school instructors in the high school mathematics instructor questionnaire were asked to establish the level of study expected of a student in order to solve the problem.

The levels of study were established according to the following categories.

Level 1 - General mathematics without any basic algebra

Level 2 - A first course in algebra

Level 3 - One year of geometry and algebra

Level 4 - Two years of algebra and geometry

Level 5 - Two years of algebra and geometry plus trigonometry or analysis

Level 6 - The student would not be expected to solve the problem without further post high school mathematics

A copy of the High School Mathematics Instructor questionnaire is included in Appendix B on page 65. The high school questionnaire was coded pink.

III. ANALYSIS OF THE DATA

Subtopic I

Subtopic I was designed to establish whether or not there is an a priori need for mathematics in a particular occupation. The parent population for this study consisted of 105 students who had graduated from Northeast Wisconsin Technical Institute during the period August 1968 through June 1975.

The investigation utilized a fixed statistical model, and management of the statistical procedure was accomplished through the use of a two-way analysis of variance technique. A 2 x 5 factorial design was incorporated with two course type factors and five levels of high school mathematics factors. Three null hypotheses were tested in the study.

H 1 - There was no significant course type effect.

H 2 - There was no significant high school mathematics level effect.

Alternate a priori hypotheses were:

H 2.1 - Level 2 math > Level 1 math

H 2.2 - Level 3 math > Level 1 math

H 2.3 - Level 4 math > Level 2 math

H 2.4 - Level 5 math > Level 2 math

H 3 - There was no significant interaction effect between high school mathematics level and course type.

Student records of each of the 105 graduates were searched and the population was distributed according to Table II on page 13.

The data were collected and submitted to the computer at Oregon State University. The results of the two-way analysis of variance are found in Table IX below:

TABLE IX. RESULTS OF 2 x 5 ANOVA TEST FOR A PRIORI MATHEMATICS NEED IN A BUSINESS DATA PROCESSING CURRICULUM

Source of Variation	Sum of Squares	DF	Mean Square	F	Level of Significance of F
Math Level	4.943	4	1.236	5.241	.001*
Course Type	.000	1	.000	.001	.999
Interaction	.821	4	.205	.871	.999
Residual	44.331	188	.236		
Total	50.096	197	.254		

*Significant at .05 level.

The results indicated that the null hypothesis H 2--there was no significant group effect--was rejected. In order to establish the alternate hypotheses, a Least Significant Difference (L.S.D.) test was used.

$$\text{L.S.D.} = t_{.05}\sqrt{\left(\frac{1}{44} + \frac{1}{88} + \frac{1}{90}\right) s^2}, \text{ where}$$

$$t_{.05} = 1.96$$

$$s^2 = .236$$

$$\text{L.S.D.} = .42$$

The grand mean for the graduates from 1968-1975 was 3.20. Means for each math level were as follows:

Level 1 Math - General Math - 2.63

Level 2 Math - Algebra I - 3.12

Level 3 Math - Geometry - 3.21

Level 4 Math - Algebra II - 3.18

Level 5 Math - Analysis - 3.38

Alternate hypothesis H 2.1 stated that students who completed level two mathematics showed a significantly higher grade point average than students who completed level one mathematics. The difference between level two and level one was .49 > L.S.D. at .42. Therefore alternate hypothesis H 2.1 was retained; there was a significantly better grade point average for those who completed algebra than for those who completed general mathematics. Alternate hypothesis H 2.2 was tested, and level three mathematics showed a significantly higher grade point average than level one mathematics (.58 > L.S.D. at .42).

Alternate hypotheses H 2.3 and H 2.4 showed no significant difference in grade point average results. (H 2.3 at .06 and H 2.4 at .26 < L.S.D. at .42.)

It must be noted that all the individuals were successful in that they all completed the business data processing program; but there were only five individuals who entered the program with a general mathematics background who were successful and their success level was significantly lower than that of all other levels of high school mathematics.

The results indicated that there was no type effect nor any interaction effect. There was also no difference indicated between the success in the data processing course work and the general support subjects.

Subtopic II

The primary objective of this subtopic was to ascertain whether or not practitioners within a particular occupation recognize the similarity between an occupational mathematics problem and its mathematics process solution model. Further, the study sought to establish whether or not there was a significant difference in problem matching in comparison with the practitioners of the occupation, the graduates of a particular institution offering the occupational program, and the instructors of that program.

Three survey forms were printed for each of the three groups surveyed: graduates, instructors, and practitioners. The only difference between each of the surveys was the letter portion of the survey which addressed itself to each of the parent populations. The instructor population consisted of all the data processing instructors within the Wisconsin State Vocational Technical and Adult Education system as listed by each of the parent schools. Of the 16 districts in Wisconsin, 14 responded to a letter requesting names of data processing instructors. (See Letter Sent to Districts in Appendix C on page 68.) Surveys were mailed to the 38 instructors as listed by the responding districts. Of the 38 questionnaires sent, 23 were returned. One survey was rejected because the person filling out the form indicated that he was not a data processing instructor, but an economics instructor. Sixteen instructors failed to return the questionnaires. Success was 57.9% of those solicited.

The graduate survey was mailed to the 105 students who graduated from NWTI with an associate degree in business data processing during the period 1968-1975. Out of 195 solicitations, 50 graduates responded, and of those 50, only 44 completed the questionnaire. The six respondents who had incomplete questionnaires indicated that they were no longer practicing in the data processing field. Only 37.1% of the students returned completed surveys; 52% of the students failed to respond. A factor unknown to the author was that these students had been surveyed at least six times on various topics since graduation. This may have affected the response ratio.

In order to test whether the NWTI graduates differed in their opinions from practitioners active within the district area but are not NWTI graduates, a list of nongraduate practitioners was solicited from the Northeast Wisconsin Data Processing Managers Association. A list of 84 non-NWTI graduate practitioners was developed. Fifty practitioners responded to the questionnaire, but five declined to complete the questionnaire for various reasons. Of the 84 questionnaires solicited, 53.6% were completed.

The survey data were keypunched and verified at NWTI prior to being submitted to the computer at Oregon State University. The investigation utilized a fixed statistical model which was accomplished through the use of a two-way analysis of variance technique. The basic design incorporated a 2 x 3 factorial design with two types of problems and three groups of people surveyed. There were two sets of 17, 2 x 3 ANOVA's processed. The first set of ANOVA's analyzed the need for the 34 sample problems for the field of data processing. The ANOVA results for each of the 17 paired problems are contained in Table X, page 72. Table XXI, page 91, contains the listing of the 17 paired problems used in the ANOVA's.

Three null hypotheses were tested in each of the 17 paired problems.

H 8 - There was no significant group effect.

Alternate hypotheses were:

H 8.1 - Instructor group was significantly different from student group.

H 8.2 - Instructor group was significantly different from practitioner group.

H 9 - There was no significant problem type effect.

Alternate hypothesis was:

H 9.1 - The mathematics process model was significantly less than the product model.

H 10 - There was no significant interaction effect between groups and problem types. Significance level was established at .05.

The significance of group effect was tested on the 17 paired problems and the results indicated that there was no group effect in any of the 17 paired problems. That is, all three groups--graduates, instructors, and practitioners--agreed at the .05 level of significance as to degree of need for the practitioners to be able to solve the problems.

Hypothesis H 9 tested whether or not the respondents recognized the product problem in terms of the mathematics process model of the problem. This author assumed that to adequately solve the word problem an understanding of the mathematics process model is essential. Thus the alternate hypothesis was: The respondents found no difference in terms of need for each of the paired problems. The process problem was recognized as more essential than the product model. Of the 17 paired problems, 14 indicated a significant difference between the problem types and only three indicated no differences. Of the 14 which were significantly different, nine indicated that the respondents recognized the product problem as more important than the mathematics solution model and five indicated that the respondents recognized the process problem as more important than the word problem. The null hypothesis was H 11--there was no significant difference among professional practitioners in choice of data processing mathematics problems.

A Chi Square significance test was utilized according to the following:

$$X^2 = \sum_{i=1}^{3} \frac{(O_i - E_i)^2}{O_i}, \text{ where}$$

O_i = the observed response,

E_i = the expected response.

TABLE XI. TEST OF SIGNIFICANCE OF 17 PAIRED BUSINESS DATA PROCESSING PROBLEMS (JOB)

	Product Model Significantly Greater	No Significance	Process Model Significantly Greater	Total
Observed	9	3	5	17
Expected	5.667	5.667	5.667	17

$$X^2 = \frac{11.109}{5.667} + \frac{7.113}{5.667} + \frac{.523}{5.667}$$

$$= 3.294$$

X^2 at .05 with 2 degrees of freedom = 5.991.

Thus, there was no overall significant difference among the 17 paired problems.

Further analysis indicated that only in problem sets 11, 12, 14, 15, and 16 was there agreement that at least one of the paired problems was not essential to the data processing programmers, and when that occurred, the process model was the rejected item. Of the 34 problem analyses by the respondents only six problems were rejected as not needed for a business data processing programmer. Not one of these problems used words related to the language of data processing.

The test of significance for H 10--there was no significant interaction effect between groups and problem types--was incorporated in each of the 17 paired data processing mathematics problems, and in all cases there proved to be no interaction effect between group and type.

The second set of 17 paired problems tested the need for each problem in terms of the business data processing programmers' daily living. (See Table XII on page 73.) The same 34 problems were utilized in this portion of the substudy as in the previous section. The question asked of the respondent was:

> You are asked to circle a number from 1-5 that most closely indicates your thinking as to whether the problem represents a typical problem that a business data processing programmer might encounter and be expected to solve in daily living. (Daily living includes all that is not on the job.)

Three null hypotheses were tested in each of the 17 paired problems.

H 12 - There was no significant group effect.

Alternate hypotheses were:

H 12.1 - Instructor group was significantly different from student group.

H 12.2 - Instructor group was significantly different from practitioner group.

H 13 - There was no significant problem type effect.

Alternate hypothesis was:

H 13.1 - The mathematics process model was significantly less than that of the product model.

H 14 - There was no significant interaction effect between groups and problem types. The significance level was established at .05.

The significance of H 14, the interaction effect, was tested on the 17 paired problems and it was found that there was no interaction effect in any of the 17 paired daily living problem questions.

The significance of group effect was tested on the 17 paired problems and the results indicated that there was a significant group effect in problems 11 and 14. In problem set 11 the significant difference occurred between the instructors and the graduates; that is, the instructors felt that there was less need for the problems in daily living than the students. However, all agreed that the problem was not important (grand mean 1.96). Problem set 14 also indicated the same results as problem set 11 (grand mean 2.61). Of the 17 paired problem sets, 15 proved to have no significant effects in terms of the three groups tested.

Hypothesis H 13 tested whether or not the respondents recognized the product problem in terms of the mathematics process model of the problem. The hypothesis was: The respondent found no difference in terms of need for each of the paired problems. The alternate hypothesis was that the process problem was recognized as more essential than the product model. Of the 17 paired problems 13 indicated a significant difference between the problem types and four indicated no difference. Of the 13 which were significantly different, ten indicated that the respondents recognized the product problem as more important than the mathematics process model and three indicated that the respondents recognized the process problem as more important than the word problem. The null hypothesis H 15--there was no significant difference among professional programmers in choice of data processing mathematics problems--tested whether or not the respondents indicated an overall difference in problem choices. A Chi Square significance test was utilized according to the following:

$$X^2 = \sum_{i=1}^{3} \frac{(O_i - E_i)^2}{O_i}, \text{ where}$$

O_i = the observed response

E_i = the expected response.

TABLE XIII. TEST OF SIGNIFICANCE OF 17 PAIRED DAILY LIVING PROBLEMS

	Product Model Significantly Greater	No Significance	Process Model Significantly Greater	Total
Observed	10	4	3	17
Expected	5.667	5.667	5.667	17

$$X^2 = \frac{18.775}{5.667} + \frac{.445}{5.667} + \frac{7.113}{5.667}$$

$$= \frac{26.333}{5.667}$$

$$= 4.647$$

X^2 at .05 with 2 degrees of freedom = 5.991.

Thus there was no overall significant difference among the 17 paired problems.

The study showed that of the 34 problems, 19 responses indicated that the problem was not needed for daily living, whereas 15 indicated that solving the problem was needed for daily living.

In order to establish which problems were needed in terms of curriculum development, a rank order list of the problems was developed in terms of need for a business data practitioner on the job. In

Table XIV on pages 74-76, each problem is ranked according to the mean score developed by the total group. Since all three groups agreed in all but one ANOVA, the author felt that the use of the total group means was valid in the statistics of the table. For each problem the table includes the percentage responses at each level of the Likert scale used and the grand mean.

Table XV on pages 77-79 includes the rank order list of need of the problems for daily living.

The combination of Table XIV and Table XV shows that only five problems were considered not needed for the business data processor both on the job and for daily living. Every one of these problems was considered a mathematics process model supporting the product models which were found to be needed by the respondents. The problems and their basic topic areas of study are shown in Table XVI on page 80.

Subtopic III

The primary purpose of Subtopic III was to establish the expected level of mathematics achievement a person needs to adequately solve the 34 problems established in Subtopic II. The high school mathematics instructors questionnaire was developed (Appendix B on page 65) in which selected high school instructors were asked to rank, according to the Likert scale, the level of completion of mathematics study required to solve such a problem. The Likert scale established the following:

MATHEMATICS STUDY	LEVEL	MATHEMATICS STUDY	LEVEL
General Mathematics	1	Two Years Algebra Plane Geometry	4
One Year Algebra	2	Two Years Algebra Plane Geometry Trigonometry/Analysis	5
One Year Algebra Plane Geometry	3	Post High School Mathematics Study	6

The rating of levels of study expected of a student in order to solve the problem was established through the survey of high school mathematics instructors who were teaching within the Northeast Wisconsin Technical Institute boundaries. The survey sought to establish whether or not each of the 34 problems submitted to the practitioner is studied at the high school level; and what level of high school mathematics the student must complete in order to adequately perform the mathematical process of problem solving.

A letter was sent to each of the high schools located within the Northeast Wisconsin Technical Institute boundaries. The responding principal was requested to select two mathematics instructors on his high school staff who would be willing to assist by answering the questionnaire. Criteria for selection were:

1. Knowledge and organization of subject matter
2. Adequacy of plans and procedures in the classroom
3. Enthusiasm in working with the students.

The responding principals answered by filling out an NWTI Mathematics Assessment card (Appendix D, page 70).

Of 36 high schools surveyed, 30 responded, and only one high school refused to participate in the study. The high school principals provided an 83% return.

The responding principals provided a list of 51 high school mathematics instructors. Forty-four instructors, or 86%, returned the High School Instructor Survey, of which 41 were complete. Three surveys were returned incomplete. Seven instructors failed to return the questionnaire.

The questionnaires were keypunched and verified by Northeast Wisconsin Technical Institute, and then the data were submitted for evaluation. A mean score and standard deviation were computed for each of the 34 problems. The results are shown in Table XVII on page 81.

The mean scores were truncated to the next lowest whole number. This was done since a student would have either completed the particular level of study or would have failed, and thus no record of that course would be indicated as completed. Of the 34 problems, instructors indicated that:

10 problems required general mathematics;

7 problems required a minimum of one year of algebra;

5 problems required a minimum of one year of algebra and one year of geometry;

9 problems required at least two years of algebra;

3 problems required some analysis level study.

The primary intent of the high school questionnaire was to establish the high school competency level needed for students entering into the business data processing program. The combined results of

Subtopic II and Subtopic III show that virtually all of the problems are perceived as needed for the practitioner, at least to some degree. The five problems established as not needed are required mathematics process problems in which the solution was required for the word problem. The High School Instructor Questionnaire indicated that a minimum level of study for the data processing student prior to entering the program should include at least one year of algebra, and preferably mathematics at the second year algebra level, or even analysis.

In order to establish a relationship between the opinion of need as established by the data processing community, and the opinion as to required level of mathematics study as established by the high school instructors, Tables XIV and XV on pages 74-79 include in Column 8 the high school level of mathematics required for each problem. The table indicated that a number of the high ranking problems require only general mathematics for solution, but among those problems ranking 3.75 or better, nine required algebra for solution.

Subtopic IV

The objective of this subtopic was to develop a list of data processing mathematics topics which should be incorporated in the business data processing mathematics curriculum. The Practitioner Questionnaire (Appendix A on page 58) was submitted to instructors, graduates, and practitioners. They responded by indicating the level of need which most closely indicated their thinking about whether a two-year business data processing student should study and meet specific performance standards in each indicated topic prior to graduation with an Associate

Degree in Data Processing. The following Likert scale was used:

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

The survey data were keypunched and verified at Northeast Wisconsin Technical Institute and then submitted to a computer at Oregon State University for analysis. The investigation utilized a fixed statistical model which was accomplished through the use of a one-way analysis of variance technique. The basic design incorporated a 1 x 3 factorial design with three groups: instructors, graduates, and practitioners. Sixty-three ANOVA's were processed. For each of the 63 ANOVA's the following hypothesis was tested:

H 16 - There was no significant group effect.

Alternate hypotheses were:

H 16.1 - Instructors differed significantly from graduates.

H 16.2 - Instructors differed significantly from practitioners.

In 20 topics a significant difference was noted. These topics are noted by an asterisk (*) in the topic column of Table XVIII on page 82. In order to establish the alternate hypothesis H 16.1 (There was a significant difference between instructors and graduates) and H 16.2 (There was a significant difference between instructors and practitioners), a least significant difference test (L.S.D.) was used.

The basic formula was:

$\text{L.S.D.}_{.05} = 1.98\sqrt{\left(\frac{1}{22} + \frac{1}{44} + \frac{1}{45}\right) s^2}$, where $t_{.05}$ for 108 degrees of freedom is $z = 1.98$ and s^2 = mean square of the residual.

Table XVIII on page 82 lists the topics which showed significant difference among the groups and also lists whether instructors did differ with students and practitioners. Table XIX shows the results of the 63 ANOVA's and indicates the resulting means for each group member--instructor, graduate, and practitioner.

In every case where instructors disagreed with the graduates or practitioners, the instructors were stronger in their opinions on need or lack of need for the topic. Using Level 3 on the Likert scale as the neutral point, the instructors recorded a stronger negative vote in all negative cases and also recorded a stronger positive vote in all positive cases where disagreement occurred.

Since a major objective of the project was to provide a topic outline for a data processing mathematics curriculum, each topic within a general subject area containing a grand mean of 3.2 or better was regarded as needed. For each general subject area a mean was computed from the topic grand means and then a rank order was established to show importance of each general subject area. This was also computed for the negative portion of the curriculum. Table XX on page 89 indicates the subject means of the topics in rank order of need.

Three topics were omitted from the rank order list of needed curriculum: Logarithms (3.04), Quadratic Equations (3.05), and Bayes Formula (3.13). The respondents indicated there was no need for study in three general areas. These areas included plane geometry, trigonometry, and analysis.

One exception was noted within the geometry subject area. Inductive and deductive reasoning showed a positive need (3.56) and thus was incorporated within the general area, Logic.

The six general subject areas indicated as necessary for the data processing curriculum were by rank order: Arithmetic, Measurement and Conversion, Logic, Statistics, Algebra, and Probability. No attempt was made in this study to establish an order of teaching the developed instructional curriculum but only to provide a rank according to need.

IV. SUMMARY, CONCLUSIONS AND IMPLICATIONS

Restatement of the Problem

The study had several purposes. The major purpose was to establish a model which would identify mathematics needs in various occupations. This model could then be used to provide a mathematics curriculum for the occupational education program chosen. There were four basic subproblems implicit within the model:

1. The study sought to identify the level of high school mathematics which provided the most significant support for the occupation, business data processing.

2. The study sought to establish whether or not there was any significant difference between how instructors, graduates of the program, and non-Northeast Wisconsin Technical Institute practitioners perceived the need for mathematics required for the occupation.

3. Subproblem three tested whether members of the data processing community recognized the need for a mathematics process problem for the solution of a product (word) problem.

4. This study sought to establish a mathematics topic outline which would adequately support a business data processing curriculum.

In order to develop the model, the program, Business Data Processing, offered at Northeast Wisconsin Technical Institute, was chosen as the sample program. Information was gathered for subproblem one with the help of the Registrar at Northeast Wisconsin Technical Institute, and surveys were developed to collect the data in subproblems two, three, and four.

The survey population for the study was developed from four groups:

1. All graduates of the Business Data Processing program at Northeast Wisconsin Technical Institute during the period 1968-1975.

2. Instructors of data processing certified and teaching within each of the 16 Vocational Technical and Adult Education Districts of Wisconsin.

3. Practitioners within the Northeast Wisconsin Technical Institute area who did not graduate from the Northeast Wisconsin Technical Institute program.

4. High school mathematics instructors teaching within the Northeast Wisconsin Technical Institute District boundaries.

A total of 22 instructors of data processing, 44 graduates, 45 practitioners, and 41 high school mathematics instructors responded to the questionnaires. The data were coded and then processed at the Oregon State University Computer Center. Data were analyzed utilizing analysis of variance techniques.

Summary of Findings

A flow chart illustrating the procedure for implementation of the model is listed in Appendix E, page 93.

Subtopic I sought to develop a model which would establish the a priori mathematics needs for a particular occupation. Analysis of the sample occupation, business data processing, revealed that a significantly higher grade point average was achieved by students who completed at least one year of mathematics beyond general mathematics. There proved to be no significant difference in grade point average between major subject and support subjects studied.

Subtopic II sought to develop a model which would establish whether or not practitioners in a particular occupation recognized the similarity of word problems to that of a mathematics solution problem. Analysis of the sample occupation revealed that significance did occur 19 out of 34 times, but the Chi Square test applied indicated that there was no significant pattern to the direction of significance. Generally neither product problems nor process problems were selected as more important. It was also revealed that all but five of the 34 problems were recognized as needed for the student of business data processing. Subtopic II was also designed to establish whether there was a significant difference among instructors, graduates and other practitioners in establishing the need for the problems. In the sample occupation there was no significant difference noted.

Subtopic III evaluated a survey of high school instructor opinions as to the level of study required for solution of the problems utilized in Subtopic II. In the sample occupation studied, the high school instructors tended to establish that the problems needed for the occupation required at least algebra for solution of the problem. This result acted as a cross check of Subtopics I and II. More than 50% of the problems required mathematics beyond general mathematics.

Subtopic IV sought to establish a basic curriculum by topic which would support the occupation surveyed. Analysis of the survey indicated that a proper curriculum for a student of business data processing included the general subject areas of: Arithmetic, Measurement and Conversion, Logic, Statistics, Algebra, and Probability (see Table XX for subtopics included). The results of the data also indicated that graduates and nongraduate practitioners agreed on the topic outline.

Conclusions

The results of this study indicate that the use of instructors and practitioners of an occupation combined with the a priori study of students' mathematics achievement levels provides an effective means to establish mathematics support curriculum for that occupation.

The model can identify areas where high schools and community colleges/technical institutes do not coordinate curricula so that they can establish career education from job exploration through job preparation. The flow chart establishes checkpoints to indicate when conferences may be needed to bring curriculum philosophies into accord in the event that these purposes do not mesh.

The occupation studied seems to indicate that a "bare bones" utilization of the topic list and the student a priori mathematics analysis can establish mathematics support curriculum for the occupation. The other elements of the study act as checks on the validity of the study.

The first subtopic of this study addressed itself to the a priori need of mathematics for an occupational program. Analysis of the data indicated that students entering the sample occupational program--business data processing--accumulated a significantly better grade point average when they completed at least one course in algebra beyond general mathematics.

The second subtopic examined the opinion of practitioners in business data processing when selecting mathematics problems to support the field. Analysis of the data indicated that practitioners did not choose problems just because they were product problems, but that selection was random.

The high school instructors' responses indicated that the majority of problems included in the questionnaire sent to practitioners required at least a completion of Algebra I. This conclusion reinforced the results of Subtopic I. Further, the data processing practitioners established that the 34 problems represented problems which one might encounter as a business data processing practitioner.

Subtopic IV, which developed a probable curriculum for the business data processing practitioner, also verified the 34 problems as representative of the field.

A mathematics curriculum, according to Subtopic II, should include Arithmetic, Measurement and Conversion, Logic, Statistics, Algebra, and Probability.

Implications

The following implications were derived from examination of the results:

1. The model does delineate a mathematics support curriculum for an occupational program.

2. The use of the model is an effective means to develop mathematics support curriculum.

3. Surveys for various occupations should include a well defined mathematics topic outline.

4. Students interested in a business data processing curriculum should include at least a first year course in algebra, and that study beyond the first year algebra course is encouraged.

5. High schools might consider an alternate mathematics curriculum to include such topics as Logic, Measurement and Conversion, Probability, and Statistics.

6. Business data processing mathematics should emphasize the areas of Logic, Probability, and Statistics.

7. Measurement and Conversion plays an extremely important role in data processing, and respondents are increasingly aware of English-metric conversions.

8. This research model supports the cluster concept of career education.

Suggestions for Further Study

The following are suggestions for further study:

1. The replication of this study for various business occupations might indicate commonality of mathematics topics in the business field and thus one might be able to establish common curricula for certain subtopics. Further replication would verify the findings of this study.

2. A prescriptive technique for mathematics study should be developed for the data processing mathematics curriculum. This developed program should include pretest and posttest procedures which

could also be used for credit by examination. The six-credit curriculum at Northeast Wisconsin Technical Institute might be subdivided into nine courses of one and two credits each.

3. While the particular findings of this study may be restricted to the population in which the data were collected, this method of verifying a priori needs with posteriori needs has been sufficiently suggestive to warrant its further use in the study of curriculum development in various occupations.

4. Further studies should be developed to test program leaver populations in terms of prior preparation. The high school mathematics level of study appears to be a predictor of program success. This factor should be studied to determine if it is also a predictor of program exit.

5. There is a possibility that the topic portion of the practitioner questionnaire should have been randomized to avoid cluster contamination; therefore, a study should be conducted to establish whether there is a significant difference between a randomized version of the questionnaire and the subject cluster form used in the present study.

6. There is a probability that this model will work to develop curricula in support subjects other than mathematics.

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APPENDICES

APPENDIX A

Questionnaire Sample for

Instructors

Graduates

Practitioners

Northeast Wisconsin Technical Institute

Green Bay Campus

2740 West Mason St.
Green Bay, WI 54303
414 499 3125

K. W. Haubenschild, District Director

September 15, 1975

Research is currently underway at the Northeast Wisconsin Technical Institute to determine the most meaningful content of the Data Processing Mathematics courses at NWTI. As a graduate of the Business Data Processing Program, and an actual practitioner in the field, we believe that you can provide the best information as to what is meaningful in the curriculum.

We are aware of the demands on your time, and are very appreciative of your professional assistance. You are being asked to help us by completing the enclosed research instrument containing 135 questions; enclosing the questionnaire in the self-addressed, stamped envelope provided; and mailing the envelope at your earliest convenience. The questionnaire is not a test, and we only ask for your professional opinion as to whether or not each item listed is needed in the Data Processing Mahtematics curriculum.

In compliance with the human rights acts, we will make no disclosures of individual responses to the questionnaire, and all data will be grouped for statistical purposes. A copy of the final results will be available through NWTI for those who wish to study the results of the research. You are free at any time to withdraw from the study if you so desire. If there are any inquiries concerning the study, please contact Mr. John Howlett, Project Director, at 499-3125, Ext. 316.

Your assistance will produce meaningful direction in the development of the best possible study program offered at NWTI in your occupation of Data Processing.

Sincerely,

Redacted for Privacy

Gerald Prindiville
Research & Planning

GP:mah
ENC.

Northeast Wisconsin Technical Institute

Green Bay Campus

2740 West Mason St.
Green Bay, WI 54303
414 499 3125

K. W. Haubenschild, District Director

September 15, 1975

Research is currently underway at the Northeast Wisconsin Technical Institute to determine the most meaningful content of the Data Processing Mathematics courses offered at NWTI. As an Instructor in Data Processing, we believe that you are in a position to best help us establish a proper mathematics curriculum for a meaningful Data Processing Mathematics course.

We are aware of the demands on your time, and are very appreciative of your professional assistance. You are being asked to help us by completing the enclosed research instrument containing 135 questions; enclosing the questionnaire in the self-addressed, stamped envelope provided; and mailing the envelope at your earliest convenience. The questionnaire is not a test, and we only ask for your professional opinion as to whether or not each item listed is needed in the Data Processing Mathematics curriculum.

In compliance with the human rights acts, we will make no disclosure of individual responses to the questionnaire, and all data will be grouped for statistical purposes. A copy of the final results will be available through NWTI for those who wish to study the results of the research. You are free at any time to withdraw from the study if you so desire. If there are any inquiries concerning the study, please contact Mr. John Howlett, Project Director, at 499-3125, Ext. 316.

Your assistance will produce meaningful direction in the development of the best possible Data Processing Mathematics Program at NWTI.

Sincerely,

Redacted for Privacy

Gerald Prindiville
Research & Planning

GP:mah
ENC.

NORTHEAST WISCONSIN
VOCATIONAL, TECHNICAL AND ADULT EDUCATION DISTRICT

Northeast Wisconsin Technical Institute

Green Bay Campus

2740 West Mason St.
Green Bay, WI 54303
414 499 3125

K. W. Haubenschild, District Director

September 15, 1975

Research is currently underway at the Northeast Wisconsin Technical Institute to determine the most meaningful content of the Data Processing Mathematics courses offered at NWTI. As a member of the Data Processing community in the NWTI District area, we believe that you can provide the best information as to what will be most meaningful in the curriculum.

We are aware of the demands on your time, and are very appreciative of your professional assistance. You are being asked to help us by completing the enclosed research instrument containing 135 questions; enclosing the questionnaire in the self-addressed, stamped envelope provided; and mailing the envelope at your earliest convenience. The questionnaire is not a test, and we only ask for your professional opinion as to whether or not each item listed is needed in the Data Processing Mathematics curriculum.

In compliance with the human rights acts, we will make no disclosure of individual responses to the questionnaire, and all data will be grouped for statistical purposes. A copy of the final results will be available through NWTI for those who wish to study the results of the research. You are free at any time to withdraw from the study if you so desire. If there are any inquiries concerning the study, please contact Mr. John L. Howlett, Project Director, at 499-3125, Ext. 316.

Your assistance will produce meaningful direction in the development of the best possible Data Processing Mathematics Program at NWTI.

Sincerely,

Redacted for Privacy

Gerald Prindiville
Research & Planning

GP:mah
ENC.

PLEASE RESPOND TO THE FOLLOWING QUESTIONS BY PLACING A CIRCLE AROUND THE NUMBER YOU THINK INDICATES YOUR PRESENT STATUS.

1. Your present capacity in the Data Processing Field is:

Student	Instructor	Business Data Processing Practitioner	Other
1	2	3	4

2. Did you graduate from Northeast Wisconsin Technical Institute with an Associate Degree in Data Processing?

YES	NO
1	2

3. Did you attend any courses offered at the Northeast Wisconsin Technical Institute in Data Processing?

YES	NO
1	2

4. Since graduation from High School, you have completed ____________ semester hours of mathematics.

0 - 5 credits	6 - 10 credits	11 - 15 credits	16 - 20 credits	21 - 25 credits	26 - 30 credits	above 30
1	2	3	4	5	6	7

QUESTIONNAIRE ON MATHEMATICS TOPICS NEEDED BY BUSINESS DATA PROCESSING PROGRAMMERS

MARKING INSTRUCTIONS: For each topic you are asked to circle the number which most closely indicates your thinking as to whether a Two-Year Business Data Processing Student should study and meet specific performance standards in the indicated topics prior to graduation with an Associate Degree in Data Processing.

STRONGLY DISAGREE 1 — DISAGREE 2 — NEUTRAL 3 — AGREE 4 — STRONGLY AGREE 5

ITEM NO.	AGREEMENT OF NEED (SD)				(SA)	TOPIC
						ARITHMETIC
1.	1	2	3	4	5	Add
2.	1	2	3	4	5	Subtract
3.	1	2	3	4	5	Multiply
4.	1	2	3	4	5	Divide } Rational Nos., Integers, Irrational Nos., Fractions, Decimals
5.	1	2	3	4	5	Square Roots
						ALGEBRA
6.	1	2	3	4	5	Set Theory
7.	1	2	3	4	5	Functional Notation
8.	1	2	3	4	5	Equalities and Inequalities
9.	1	2	3	4	5	Polynomial Operations
10.	1	2	3	4	5	Graphs
11.	1	2	3	4	5	Ratio and Proportion
12.	1	2	3	4	5	Roots of an Equation
13.	1	2	3	4	5	Logarithms
14.	1	2	3	4	5	Factoring
15.	1	2	3	4	5	Exponentiation
16.	1	2	3	4	5	Quadratic Equations
17.	1	2	3	4	5	Determinants and Matrices
18.	1	2	3	4	5	Formula Manipulation
19.	1	2	3	4	5	Systems of Equations
20.	1	2	3	4	5	Linear and Non-Linear Functions
						GEOMETRY
21.	1	2	3	4	5	Angles
22.	1	2	3	4	5	Polygons
23.	1	2	3	4	5	Constructions
24.	1	2	3	4	5	Perimeters
25.	1	2	3	4	5	Areas and Volumes
26.	1	2	3	4	5	Planes
27.	1	2	3	4	5	Coordinate Systems
28.	1	2	3	4	5	Geometric Relationships
29.	1	2	3	4	5	Inductive and Deductive Reason
						MEASUREMENT AND CONVERSION
30.	1	2	3	4	5	Number Bases, i.e., 2, 4, 8, 10, 16
31.	1	2	3	4	5	English - Metric
32.	1	2	3	4	5	Arithmetic Operations on Bases

ITEM NO.	AGREEMENT OF NEED (SD)				(SA)	TOPIC
						TRIGONOMETRY
33.	1	2	3	4	5	Identities and Functions
34.	1	2	3	4	5	Laws of Sines and Cosines
35.	1	2	3	4	5	Arc Functions
36.	1	2	3	4	5	Roots and Powers
37.	1	2	3	4	5	Exponents
38.	1	2	3	4	5	Trigonometric Tables
						ANALYSIS
39.	1	2	3	4	5	Vectors
40.	1	2	3	4	5	Analytic Geometry
41.	1	2	3	4	5	Functions and Continuity
42.	1	2	3	4	5	Derivatives and Integrals
						PROBABILITY
43.	1	2	3	4	5	Approximations
44.	1	2	3	4	5	Sample Spaces
45.	1	2	3	4	5	Events
46.	1	2	3	4	5	Mathematical Expectation
47.	1	2	3	4	5	Conditional Events
48.	1	2	3	4	5	Bayes Formula
						STATISTICS
49.	1	2	3	4	5	Tables and Graphs
50.	1	2	3	4	5	Mean, Median, Mode, Range
51.	1	2	3	4	5	Standard Deviation
52.	1	2	3	4	5	Approximation
53.	1	2	3	4	5	Distributions
54.	1	2	3	4	5	Non-Parametric Statistics
55.	1	2	3	4	5	Population Sampling
56.	1	2	3	4	5	Types of Data
57.	1	2	3	4	5	Regressions
						LOGIC
58.	1	2	3	4	5	Conditional Statements
59.	1	2	3	4	5	And, Or, Nand, Nor Networks
60.	1	2	3	4	5	Complements, Contrapositives
61.	1	2	3	4	5	Truth Tables
62.	1	2	3	4	5	Boolean Algebra
63.	1	2	3	4	5	Set Theory

QUESTIONNAIRE ON SAMPLE MATHEMATICS PROBLEMS WHICH MIGHT BE TYPICAL OF THOSE ENCOUNTERED BY A BUSINESS DATA PROCESSING PROGRAMMER

MARKING INSTRUCTIONS

For each problem presented, you are asked to answer two questions. On the left-hand side, you are asked to circle a number from 1 - 5 that most closely indicates your thinking as to whether the problem represents a typical problem that a Business Data Processing Programmer might encounter and be required to solve on his or her job.

On the right-hand side, you are asked to circle a number from 1 - 5 that most closely indicates your thinking as to whether the problem represents a typical problem that a Business Data Processing Programmer might encounter and be expected to solve in daily living. (Daily living includes all that is not on the job.)

STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
1	2	3	4	5

<table>
<tr><th>ITEM NO.</th><th>JOB PROBLEM
(SD) (SA)</th><th>SAMPLE MATHEMATICS PROBLEM</th><th>DAILY LIFE PROBLEM
(SD) (SA)</th><th>ITEM NO.</th></tr>
<tr><td>1.</td><td>1 2 3 4 5</td><td>What is the volume, in cubic meters, of a box 27" x 32" x 48"?</td><td>1 2 3 4 5</td><td>35.</td></tr>
<tr><td>2.</td><td>1 2 3 4 5</td><td>If 12 file cabinets require 18' of wall space, then 32 cabinets will require how many feet of wall space?</td><td>1 2 3 4 5</td><td>36.</td></tr>
<tr><td>3.</td><td>1 2 3 4 5</td><td>A man owns 2/3 of a computer service bureau business and sells 3/4 of his share for $75,000. What is the value of the business?</td><td>1 2 3 4 5</td><td>37.</td></tr>
<tr><td>4.</td><td>1 2 3 4 5</td><td>Complete the following form and turn into the records department:
<table>
<tr><th>ITEM</th><th>SHIPPING WT.</th><th>NET WEIGHT</th><th>DIFFERENCE</th></tr>
<tr><td>A</td><td>1500#</td><td>1343#</td><td></td></tr>
<tr><td>B</td><td>2800#</td><td>2551#</td><td></td></tr>
<tr><td>C</td><td>6756#</td><td>6659#</td><td></td></tr>
<tr><td>TOTAL</td><td></td><td></td><td></td></tr>
</table></td><td>1 2 3 4 5</td><td>38.</td></tr>
<tr><td>5.</td><td>1 2 3 4 5</td><td>An appliance manufacturer sold 56,583 refrigerators during the first quarter of the year. Second quarter sales were 65,325 units. What was the average sales per month for the first half of the year?</td><td>1 2 3 4 5</td><td>39.</td></tr>
<tr><td>6.</td><td>1 2 3 4 5</td><td>Quick Inc. has a monthly usage for Part No. 5 of 125 units. Inventory carrying costs are 25% of average inventory and ordering costs are $15 per order. Each part costs $2.00. Find the economic ordering quantity. The freight on shipping 300 units if $95. If 500 units are shipped, the freight is $122. Should a quantity of 500 units be purchased in order to effect a savings in freight?</td><td>1 2 3 4 5</td><td>40.</td></tr>
<tr><td>7.</td><td>1 2 3 4 5</td><td>A computer installation has the following rate schedule for one of its machines: $120 per hour for the first 5 hours each month, $110 per hour for the next 15 hours each month, and $100 per hour for all time over 20 hours per month. Using this relationship, compute the charges for 28 hours per month; for 18 hours per month.</td><td>1 2 3 4 5</td><td>41.</td></tr>
<tr><td>8.</td><td>1 2 3 4 5</td><td>A company manufactures 2 types of electric knives -- a standard and a deluxe model. For greater efficiency, the required production and assembly operations are performed in two separate shops. The standard model requires 5 hours work in Shop 1 and 7 hours in Shop 2, while the deluxe model requires 8 hours in Shop 1 and 6 hours in Shop 2. Because of the scarcity of skilled labor, only 400 hours of work per week can be performed in Shop 1, and 420 hours in Shop 2. The company can sell its total production and realize a profit of $3.00 on the standard model and $4.00 on the deluxe model. How many of each type should the company produce in order to achieve the greatest possible profit?</td><td>1 2 3 4 5</td><td>42.</td></tr>
<tr><td>9.</td><td>1 2 3 4 5</td><td>Convert 3 ft., 5 in. to meters.</td><td>1 2 3 4 5</td><td>43.</td></tr>
<tr><td>10.</td><td>1 2 3 4 5</td><td>Solve for X: $\frac{X}{288} = \frac{42}{96}$</td><td>1 2 3 4 5</td><td>44.</td></tr>
<tr><td>11.</td><td>1 2 3 4 5</td><td>If 5/6 of 2/3 X = 25,000; then X = ______</td><td>1 2 3 4 5</td><td>45.</td></tr>
<tr><td>12.</td><td>1 2 3 4 5</td><td>Find the average: 12,476 14,865 28,437 46,596</td><td>1 2 3 4 5</td><td>46.</td></tr>
<tr><td>13.</td><td>1 2 3 4 5</td><td>Complete the following:
ADD: 2395, 3574, 457, 263, 44, 3509
SUBTRACT: 20578394.75 - 19568473.29
MULTIPLY: 34.8 x .259
DIVIDE: $\frac{3/4}{5/7}$</td><td>1 2 3 4 5</td><td>47.</td></tr>
<tr><td>14.</td><td>1 2 3 4 5</td><td>Solve for Q, where: $CI = 2RS/Q^2$
GIVEN: R = 1500 I = .25 C = 2 S = 15</td><td>1 2 3 4 5</td><td>48.</td></tr>
<tr><td>15.</td><td>1 2 3 4 5</td><td>Solve for Y.
$Y = \begin{cases} 50X + 250, \text{ when } X > 20 \\ 60X + 50, \text{ when } 5 < X \leq 20 \\ 100X, \text{ when } X \leq 5 \end{cases}$
GIVEN:
X = 28
X = 18</td><td>1 2 3 4 5</td><td>49.</td></tr>
<tr><td>16.</td><td>1 2 3 4 5</td><td>Maximize the function, X + 5Y, given the constraints:
$2X + Y \leq 10$
$X + 2Y \leq 10$
$X \geq 0$
$Y \geq 0$</td><td>1 2 3 4 5</td><td>50.</td></tr>
</table>

QUESTIONNAIRE ON SAMPLE MATHEMATICS PROBLEMS WHICH MIGHT BE TYPICAL OF THOSE ENCOUNTERED BY A BUSINESS DATA PROCESSING PROGRAMMER

MARKING INSTRUCTIONS

For each problem presented, you are asked to answer two questions. On the left-hand side, you are asked to circle a number from 1 - 5 that most closely indicates your thinking as to whether the problem represents a typical problem that a Business Data Processing Programmer might encounter and be required to solve on his or her job.

On the right-hand side, you are asked to circle a number from 1 - 5 that most closely indicates your thinking as to whether the problem represents a typical problem that a Business Data Processing Programmer might encounter and be expected to solve in daily living. (Daily living includes all that is not on the job.)

STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
1	2	3	4	5

ITEM NO.	JOB PROBLEM (SD) (SA)	SAMPLE MATHEMATICS PROBLEM	DAILY LIFE PROBLEM (SD) (SA)	ITEM NO.
17.	1 2 3 4 5	A druggist has 1000cc of a 10% acid solution (10% acid and 90% water) and he wants to know how much water to add to obtain a series of varying acid values. Compile a table for him showing the amounts of water that must be added to obtain acid solution of 9.9% to 2.0%, in increments of 0.1%.	1 2 3 4 5	51.
18.	1 2 3 4 5	A consultant in data processing charges $25 an hour for his own services and $10 an hour for those of his assistant. On a given job, for which the consultant's total bill is $880, he works 3 hours more than his assistant does. How many hours did each man put on the job?	1 2 3 4 5	52.
19.	1 2 3 4 5	Write a program which uses a subroutine to perform the following calculations: accepts 3 two-dimensional arrays A, B, C; multiplies the corresponding elements of A and B; then subtracts the corresponding elements of C; and finally writes the new array D.	1 2 3 4 5	53.
20.	1 2 3 4 5	A corporation has 32 female and 26 male consultants. In how many ways can a team be formed such that there are 7 members and the majority are men?	1 2 3 4 5	54.
21.	1 2 3 4 5	Complete the following table:	1 2 3 4 5	55.

DECIMAL	BINARY	OCTAL	HEXADECIMAL
242			
	1101110		
		374	
			1ED4

22.	1 2 3 4 5	A room with two doors is to have a light switch at each door. The switches are to be connected so that either one can turn the light on or off. Construct the required circuit.	1 2 3 4 5	56.
23.	1 2 3 4 5	A contractor finishes a job 15 days later than required by contract. If he must pay a penalty of $30 the first day, and $32 the second day, $34 the third day, and so on, what will be the total penalty?	1 2 3 4 5	57.
24.	1 2 3 4 5	An employer pays at the rate of $5000 per year, but grants a 10% increase each year based on the current salary. Express the relationship as an equation. How much will an employee be earning after 10 years?	1 2 3 4 5	58.
25.	1 2 3 4 5	A soft drink producer wants to insure that bottles are filled to specifications 99% of the time. The machines are set to fill each bottle with 12 fluid ounces with a standard deviation of 0.3 ounces. Every five hours, 9 bottles are sampled from the lot. In this sample, a bottle is found to contain 11.8 fluid ounces. Should the machine be inspected?	1 2 3 4 5	59.
26.	1 2 3 4 5	Solve for X: $.65(1000 + X) = .45(1000) + X$	1 2 3 4 5	60.
27.	1 2 3 4 5	Solve: $X - Y = 5$ $5X + 2Y = 20$	1 2 3 4 5	61.
28.	1 2 3 4 5	If $A = \begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$ $B = \begin{bmatrix} 2 & -1 \\ 3 & -2 \end{bmatrix}$ FIND: 1. A + B 2. A • B 3. B • A 4. 4B 5. Det. A 6. Inverse of A	1 2 3 4 5	62.
29.	1 2 3 4 5	Solve: C^{26}_{7} = __________	1 2 3 4 5	63.
30.	1 2 3 4 5	If $16^3 = 4096$, and $16^4 = 65536$ in base 10, then: $2(16^3) + 3(16^4)$ = __________	1 2 3 4 5	64.
31.	1 2 3 4 5	Evaluate: $(A \wedge B) \vee \sim(A \wedge B)$ for all possible values of A and B.	1 2 3 4 5	65.
32.	1 2 3 4 5	Find the sum of the Arithmetic Progression, where: N = 15 a = 30 d = 2	1 2 3 4 5	66.
33.	1 2 3 4 5	Solve for A, given: $A = 2000(1.04)^5$	1 2 3 4 5	67.
34.	1 2 3 4 5	Using the table for Z distribution, determine the following: a. A Z of ± 1.83 is what in terms of percentage? b. The mean diameter of a cylinder is 0.024 inches with a standard deviation of 0.005 inches. What is the probability that a given cylinder will have a diameter greater than 0.031 inches?	1 2 3 4 5	68.

APPENDIX B

High School Instructor

Questionnaire

Northeast Wisconsin Technical Institute

Green Bay Campus

2740 West Mason St.
Green Bay, WI 54303
414-499-3125

K. W. Haubenschild, District Director

September 15, 1975

Research is currently underway at the Northeast Wisconsin Technical Institute to determine the mathematics content of various occupational programs at NWTI. Your school has been selected to participate in this important study. As a Mathematics Instructor, you have been one of several especially designated to represent the opinion of qualified high school mathematics instructors throughout the NWTI District Area. The administration of your school, as well as the Wisconsin State Board of Vocational, Technical and Adult Education, have been contacted and give their support to this research. The data that only you can provide will have significant implications for mathematical support of vocational programs at NWTI.

We are aware of the demands on your time, and are very appreciative of your professional assistance. You are being asked to help us by completing the enclosed research instrument which contains 34 questions. This instrument is not a test, but is designed to allow you to professionally indicate at what level of study a student can solve various problems found in vocational programs.

Individual responses to the questionnaire will not be reported by name or school affiliation. A copy of the final results will be made available through NWTI. You may withdraw your consent and discontinue participation on the project at any time. Any inquiries concerning the project may be made to Mr. John Howlett, Project Director, at 499-3125, Ext. 316.

On completion of this instrument, please enclose it in the self-addressed, stamped envelope provided and mail it at your earliest convenience.

Your assistance will make meaningful direction in the coordination between the local high schools and the Technical Institute.

Sincerely,

Redacted for Privacy

Gerald Prindiville
Research & Planning

GP:mah
ENC.

NORTHEAST WISCONSIN
VOCATIONAL, TECHNICAL AND ADULT EDUCATION DISTRICT

QUESTIONNAIRE FOR HIGH SCHOOL MATHEMATICS TEACHERS

MARKING INSTRUCTIONS: For each problem, you are asked to circle a number from 1 - 6 which most closely indicates your thinking as to what level of completion of mathematics study is required for him or her to solve such a problem.

GENERAL MATHEMATICS	ONE YEAR ALGEBRA	ONE YEAR ALGEBRA PLANE GEOMETRY	TWO YEARS ALGEBRA PLANE GEOMETRY	TWO YEARS ALGEBRA PLANE GEOMETRY TRIGONOMETRY/ANALYSIS	POST HIGH SCHOOL MATHEMATICS STUDY
1	2	3	4	5	6

ITEM NO.	LEVEL OF MATHEMATICS REQUIRED FOR SOLUTION	PROBLEM
1.	1 2 3 4 5 6	What is the volume, in cubic meters, of a box 27" x 32" x 48"?
2.	1 2 3 4 5 6	If 12 file cabinets require 18' of wall space, then 32 cabinets will require how many feet of wall space?
3.	1 2 3 4 5 6	A man owns 2/3 of a computer service bureau and sells 3/4 of his share for $75,000. What is the value of the business?
4.	1 2 3 4 5 6	Complete the following form and turn into the records department: (see form below)
5.	1 2 3 4 5 6	An appliance manufacturer sold 56,583 refrigerators during the first quarter of the year. Second quarter sales were 65,325 units. What was the average sales per month for the first half of the year?
6.	1 2 3 4 5 6	Quick Inc. has a monthly usage for Part No. 5 of 125 units. Inventory carrying costs are $15 per order. Each part costs $2.00. Find the economic ordering quantity. The freight on shipping 300 units is $95. If 500 units are shipped, the freight is $122. Should a quantity of 500 units be purchased in order to effect a savings in freight?
7.	1 2 3 4 5 6	A computer installation has the following rate schedule for one of its machines: $120 per hour for the first 5 hours each month, $110 per hour for the next 15 hours each month, and $100 per hour for all time over 20 hours per month. Using this relationship, compute the charges for 28 hours per month; for 18 hours per month.
8.	1 2 3 4 5 6	A company manufactures 2 types of electric knives -- a standard and a deluxe model. For greater efficiency, the required production and assembly operations are performed in 2 separate shops. The standard model requires 5 hours work in Shop 1 and 7 hours in Shop 2, while the deluxe model requires 8 hours in Shop 1 and 6 hours in Shop 2. Because of the scarcity of skilled labor, only 400 hours of work per week can be performed in Shop 1, and 420 hours per week in Shop 2. The company can sell its total production and realize a profit of $3.00 on the standard model, and $4.00 on the deluxe model. How many of each type should the company produce in order to achieve the greatest possible profit?
9.	1 2 3 4 5 6	Convert 3 ft., 5 in. to meters.
10.	1 2 3 4 5 6	Solve for X: $\frac{X}{288} = \frac{42}{96}$
11.	1 2 3 4 5 6	If 5/6 of 2/3 X = 25,000, then X = ________

Form for item 4:

ITEM	SHIPPING WT.	NET WEIGHT	DIFFERENCE
A	1500#	1343#	
B	2800#	2551#	
C	6756#	6659#	
TOTAL			

QUESTIONNAIRE FOR HIGH SCHOOL MATHEMATICS TEACHERS

MARKING INSTRUCTIONS: For each problem, you are asked to circle a number from 1 - 6 which most closely indicates your thinking as to what level of completion of mathematics study is required for him or her to solve such a problem.

GENERAL MATHEMATICS	ONE YEAR ALGEBRA	ONE YEAR ALGEBRA PLANE GEOMETRY	TWO YEARS ALGEBRA PLANE GEOMETRY	TWO YEARS ALGEBRA PLANE GEOMETRY TRIGONOMETRY/ANALYSIS	POST HIGH SCHOOL MATHEMATICS STUDY
1	2	3	4	5	6

ITEM NO.	LEVEL OF MATHEMATICS REQUIRED FOR SOLUTION	PROBLEM
12.	1 2 3 4 5 6	Find the average (mean): 12,476 14,865 28,437 46,596
13.	1 2 3 4 5 6	Complete the following: SUBTRACT: $\begin{array}{r} 20578394.75 \\ \underline{-19568473.29} \end{array}$ MULTIPLY: $\begin{array}{r} 34.8 \\ \underline{\times .259} \end{array}$ DIVIDE: $\frac{3/4}{5/7}$ ADD: $\begin{array}{r} 2395 \\ 3574 \\ 457 \\ 263 \\ 44 \\ \underline{3509} \end{array}$
14.	1 2 3 4 5 6	Solve for Q, where $CI = 2RS/Q^2$, Given: R = 1500 I = .25 C = 2 S = 15
15.	1 2 3 4 5 6	Solve for Y, where $Y = \begin{cases} 50X + 250, \text{ when } X > 20 \\ 60X + 50, \text{ when } 5 < X \leq 20 \\ 100X, \text{ when } X \leq 5 \end{cases}$ GIVEN: X = 28 X = 18
16.	1 2 3 4 5 6	Maximize the function X + 5Y, given the constraints: $2X + Y \leq 10$ $X + 2Y \leq 10$ $X \geq 0$ $Y \geq 0$
17.	1 2 3 4 5 6	A druggist has 1000 cc of a 10% acid solution (10% acid and 90% water), and he wants to know how much water to add to obtain a series of varying acid values. Compile a table for him showing the amounts of water that must be added to obtain acid solutions of 9.9% to 2.0%, in increments of 0.1%.
18.	1 2 3 4 5 6	A consultant in data processing charges $25 an hour for his own services and $10 an hour for those of his assistant. On a given job, for which the consultant's total bill is $880, he works 3 hours more than his assistant does. How many hours did each man put on the job?
19.	1 2 3 4 5 6	Write a program which uses a subroutine to perform the following calculations: accepts 3 two-dimensional arrays A, B, C,; multiplies the corresponding elements of A and B; then subtracts the corresponding elements of C and finally writes the new array D.
20.	1 2 3 4 5 6	A corporation has 32 female and 26 male consultants. In how many ways can a team be formed such that there are 7 members and the majority are men?
21.	1 2 3 4 5 6	Complete the following table: <table><tr><th>DECIMAL</th><th>BINARY</th><th>OCTAL</th><th>HEXADECIMAL</th></tr><tr><td>242</td><td></td><td></td><td></td></tr><tr><td></td><td>1101110</td><td></td><td></td></tr><tr><td></td><td></td><td>374</td><td></td></tr><tr><td></td><td></td><td></td><td>1ED4</td></tr></table>
22.	1 2 3 4 5 6	A contractor finishes a job 15 days later than required by contract. If he must pay a penalty of $30 the first day, and $32 the second day, $34 the third day, and so on, what will be the total penalty?
23.	1 2 3 4 5 6	A room with two doors is to have a light switch at each door. The switches are to be connected so that either one can turn the light on or off. Construct the required circuit.

QUESTIONNAIRE FOR HIGH SCHOOL MATHEMATICS TEACHERS

MARKING INSTRUCTIONS: For each problem, you are asked to circle a number from 1 - 6 which most closely indicates your thinking as to what level of completion of mathematics study is required for him or her to solve such a problem.

GENERAL MATHEMATICS	ONE YEAR ALGEBRA	ONE YEAR ALGEBRA PLANE GEOMETRY	TWO YEARS ALGEBRA PLANE GEOMETRY	TWO YEARS ALGEBRA PLANE GEOMETRY TRIGONOMETRY/ANALYSIS	POST HIGH SCHOOL MATHEMATICS STUDY
1	2	3	4	5	6

ITEM NO.	LEVEL OF MATHEMATICS REQUIRED FOR SOLUTION	PROBLEM
24.	1 2 3 4 5 6	An employer pays at the rate of $5000 per year, but grants a 10% increase each year based on the current salary. Express the relationship as an equation. How much will an employee be earning after 10 years?
25.	1 2 3 4 5 6	A soft drink producer wants to insure that bottles are filled to specifications 99% of the time. The machines are set to fill each bottle with 12 fluid ounces with a standard deviation of 0.3 ounces. Every 5 hours, 9 bottles are sampled from the lot. In this sample, a bottle is found to contain 11.8 fluid ounces. Should the machine be inspected?
26.	1 2 3 4 5 6	Solve for X: $.65(1000 + X) = .45(1000) + X$
27.	1 2 3 4 5 6	Solve: $X - Y = 5$ $5X + 2Y = 20$
28.	1 2 3 4 5 6	If $A = \begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & -1 \\ 3 & -2 \end{bmatrix}$, find: 1. A + B 2. $A \bullet B$ 3. $B \bullet A$ 4. 4B 5. Det A 6. Inverse of A
29.	1 2 3 4 5 6	Solve: C^{26}_{7}
30.	1 2 3 4 5 6	If $16^3 = 4096$, and $16^4 = 65536$ in base 10, then $2(16)^3 + 3(16)^4 =$ __________.
31.	1 2 3 4 5 6	Evaluate: $(A \wedge B) \vee \sim (A \wedge B)$ for all possible values of A and B.
32.	1 2 3 4 5 6	Find the sum of the Arithmetic Progression where: N = 15 a = 30 d = 2
33.	1 2 3 4 5 6	Solve for A, given: $A = 2000(1.04)^5$
34.	1 2 3 4 5 6	Using the table for z distribution, determine the following: a. A z of $\pm$ 1.83 is what in terms of percentage? b. The mean diameter of a cylinder is 0.024 inches with a standard deviation of 0.005 inches. What is the probability that a given cylinder will have a diameter greater than 0.031 inches?

APPENDIX C

Letter Sent to Various

Vocational Education Districts

Throughout Wisconsin

Northeast Wisconsin Technical Institute

Green Bay Campus

2740 West Mason St.
Green Bay, WI 54303
414-499-3125

K. W. Haubenschild, District Director

August 1, 1975

Dear Sir:

Research is currently underway at the Northeast Wisconsin Technical Institute to determine the mathematics requirements for the Business Data Processing Occupation. This effort represents one of several steps in a comprehensive plan to develop a performance-based curriculum in Data Processing Mathematics which will support the Business Data Processing Program at NWTI.

In order to complete our project, we must be able to survey Data Processing Instruction personnel throughout the State Vocational System. NWTI requests that you furnish a list of personnel within your institution who teach Data Processing courses. Your institution may be assured that any list provided NWTI will be used exclusively for purposes of this research project; and in compliance with the human right acts, no individual surveyed will be identified. The data compiled will be grouped data indicating the general opinion of instructors of Data Processing within the State VTAE.

Sincerely,

Redacted for Privacy

Gerald Prindiville
Research & Planning
NWTI

GP:dcg

APPENDIX D

Letter Sent to High Schools in Northeast Wisconsin Technical Institute Boundaries

Northeast Wisconsin Technical Institute

Green Bay Campus

2740 West Mason St.
Green Bay, WI 54303
414-499-3125

K. W. Haubenschild, District Director

September 15, 1975

Research is currently underway at the Northeast Wisconsin Technical Institute to determine the mathematics requirements for performance-based occupational programs. This research is designed to establish a model for comprehension articulation with the NWTI District Area High Schools and the Industries supported by our occupational programs. Your High School has been chosen as one of the local high schools from which we are seeking to draw appropriate information.

As principal, you will play a very important part in the project, and we would greatly appreciate the willingness of your school to participate. We are seeking the best possible responses on our instrument and are, therefore, asking cooperating principals, based on the following criteria, to select the two (2) most effective mathematics instructors in the high school staff.

Criteria:

A. Knowledge and organization of subject matter.
B. Adequacy of plans and procedures in class.
C. Enthusiasm in working with students.

Instructors selected by you will be contacted personally, and asked individually to participate. Please be assured we will respect your confidence regarding these names. Individual responses to the questionnaire will not be reported by name or school affiliation. If you are not able to recommend two instructors, please suggest as many as you can.

Enclosed is a response card to indicate your willingness to participate. If your answer is affirmative, please indicate the names of suggested respondents in the envelope supplied by us. We look forward to hearing from you at your earliest convenience.

Sincerely,

Redacted for Privacy

Gerald Prindiville
Research & Planning

GP:mah
ENC.

NWTI MATH ASSESSMENT STUDY

Response Card

Please check one and return within three (3) days:

____ I wish to participate in the study.

____ I do not wish to participate in the study.

NAME________________________ HIGH SCHOOL________________

Recommended Respondents:

1. ____

2. ____

Thank you. Gerald Prindiville, Research & Planning, NWTI

APPENDIX E

Table

V List of mathematics topics considered for a data processing mathematics curriculum

X Analysis of variance results of 17 paired problems in terms of need for business data processing

XII Analysis of variance results of 17 paired problems in terms of need for daily living

XIV Rank order of perceived need for business data processing mathematics on the job

XV Rank order of perceived need for daily living mathematics

XVI Problems from questionnaire listed as not needed by respondents

XVII Mean scores and standard deviation of high school instructors opinions on solvability level of various problems

XVIII List of mathematics topics in which instructors, graduates and practitioners disagreed significantly as to need for business data processing

XIX One way analysis of variance indicating need for various mathematics topics in business data processing

XX Subject rank order of need for business data processing mathematics curriculum

XXI Problems paired into 17 problem sets (product problem--process problem)

XXII Flow chart establishing mathematics task analysis procedures

TABLE V. LIST OF MATHEMATICS TOPICS CONSIDERED FOR A DATA PROCESSING MATHEMATICS CURRICULUM

ARITHMETIC

add, subtract, multiply, divide, square roots

fractions, percents, integers rational and whole numbers

ALGEBRA

sets and set operations, functional notation, equalities and inequalities, graphs, ratios and proportions, polynomial operations, roots of an equation, logarithms, factoring, exponentiation, quadratics, determinants and matrices, formula manipulation, systems of equations, linear and nonlinear functions

GEOMETRY

angles, polygons, constructions, perimeters, areas, volumes, planes, coordinate systems, geometric relationships, inductive and deductive reasoning

TRIGONOMETRY

basic identities and functions, roots, exponents, laws of sines and cosines, powers, arc functions, use of tables

ANALYSIS

vectors, analytic geometry, functions, continuity, derivatives, integrals

PROBABILITY

approximations, sample spaces, events, mathematical expectation, conditional events, Bayes formula

LOGIC

truth tables, conditional statements, converses, contrapositives, complements, AND, OR, NAND, NOR circuits

STATISTICS

graphs, tables, mean, median, mode, range, estimation, comparisons, approximations, distribution, nonparametric statistics, hypothesis tests, population sampling, nominal, ordinal, equidistant data

MEASUREMENT AND CONVERSIONS

number bases, i.e., 2, 4, 8, 10, 16: English-metric conversions, arithmetic operations of bases

TABLE X

ANALYSIS OF VARIANCE RESULTS OF 17 PAIRED PROBLEMS
IN TERMS OF NEED FOR BUSINESS DATA PROCESSING

Problem Set	Computed F			Significance of F			Decision		
	Group	Type	Interaction	Group	Type	Interaction	Group	Type	Interaction
1	.112	5.744	.633	.999	.016	.999	Retain	Reject	Retain
2	.159	3.847	1.806	.999	.048	.165	Retain	Reject	Retain
3	2.889	.016	1.165	.056	.999	.314	Retain	Retain	Retain
4	2.863	4.164	1.948	.058	.040	.143	Retain	Reject	Retain
5	2.08	.021	1.447	.125	.999	.236	Retain	Retain	Retain
6	2.801	45.944	2.004	.061	.001	.135	Retain	Reject	Retain
7	2.606	47.711	1.062	.074	.001	.348	Retain	Reject	Retain
8	.011	40.204	.885	.999	.001	.999	Retain	Reject	Retain
9	.292	4.662	.891	.999	.030	.999	Retain	Reject	Retain
10	.202	1.968	.513	.999	.158	.999	Retain	Retain	Retain
11	1.809	72.530	.179	.164	.001	.999	Retain	Reject	Retain
12	.215	16.329	.496	.999	.001	.999	Retain	Reject	Retain
13	.511	40.794	.513	.999	.001	.999	Retain	Reject	Retain
14	1.318	5.204	.517	.269	.022	.999	Retain	Reject	Retain
15	.135	46.631	.722	.999	.001	.999	Retain	Reject	Retain
16	1.105	20.866	2.068	.333	.001	.127	Retain	Reject	Retain
17	1.318	29.493	.081	.269	.001	.999	Retain	Reject	Retain

TABLE XII

ANALYSIS OF VARIANCE RESULTS OF 17 PAIRED PROBLEMS
IN TERMS OF NEED FOR DAILY LIVING

Problem	Computed F			Significance of F			Decision		
Set	Group	Type	Interaction	Group	Type	Interaction	Group	Type	Interaction
1	.994	8.239	.636	.999	.005	.999	Retain	Reject	Retain
2	1.625	2.067	2.756	.198	.148	.064	Retain	Retain	Retain
3	1.438	5.228	.984	.088	.022	.999	Retain	Reject	Retain
4	1.085	3.090	.794	.340	.076	.999	Retain	Retain	Retain
5	.186	71.449	.749	.999	.001	.999	Retain	Reject	Retain
6	.6	8.816	.285	.999	.004	.999	Retain	Reject	Retain
7	.490	18.229	1.743	.999	.001	.175	Retain	Reject	Retain
8	.308	6.543	.629	.999	.011	.999	Retain	Reject	Retain
9	.095	5.540	.519	.999	.018	.999	Retain	Reject	Retain
10	.601	6.871	.176	.075	.009	.999	Retain	Reject	Retain
11	.732	.766	.059	.010	.999	.999	Reject	Retain	Retain
12	.450	14.292	.015	.087	.001	.999	Retain	Reject	Retain
13	.701	.622	.223	.999	.999	.999	Retain	Retain	Retain
14	.627	138.511	.408	.027	.001	.999	Reject	Reject	Retain
15	.204	97.530	1.996	.999	.001	.136	Retain	Reject	Retain
16	.305	58.265	1.295	.999	.001	.275	Retain	Reject	Retain
17	.041	13.606	.011	.356	.001	.999	Retain	Reject	Retain

TABLE XIV

RANK ORDER OF PERCEIVED NEED FOR BUSINESS DATA PROCESSING MATHEMATICS ON THE JOB

<table>
<tr><th rowspan="2">Problem</th><th colspan="5">Level of Agreement Scale
(% of Responses)</th><th rowspan="2">Average Indicated Need</th><th rowspan="2">Expected Level of Mathematics Study Required to Solve Problem</th></tr>
<tr><th>1
SD</th><th>2</th><th>3</th><th>4</th><th>5
SA</th></tr>
<tr><td>Complete the following:

SUBTRACT: 20578394.75 −19568473.29
MULTIPLY: 34.8 x.259
DIVIDE: 3/4 / 5/7
ADD: 2395 3574 457 263 44 3509</td><td>1</td><td>2</td><td>6</td><td>32</td><td>58</td><td>4.61</td><td>1</td></tr>
<tr><td>An appliance manufacturer sold 56,583 refrigerators during the first quarter of the year. Second quarter sales were 65,325 units. What was the average sales per month for the first half of the year?</td><td>2</td><td>4</td><td>5</td><td>29</td><td>60</td><td>4.41</td><td>1</td></tr>
<tr><td>Quick Inc. has a monthly usage for Part No. 5 of 125 units. Inventory carrying costs are $15 per order. Each part costs $2.00. Find the economic ordering quantity. The freight on shipping 300 units is $95. If 500 units are shipped, the freight is $122. Should a quantity of 500 units be purchased in order to effect a savings in freight?</td><td>0</td><td>5</td><td>4</td><td>35</td><td>36</td><td>4.41</td><td>3</td></tr>
<tr><td>Complete the following form and turn into the records department:
<table><tr><th>ITEM</th><th>SHIPPING WT.</th><th>NET WEIGHT</th><th>DIFFERENCE</th></tr><tr><td>A</td><td>1500#</td><td>1343#</td><td></td></tr><tr><td>B</td><td>2800#</td><td>2551#</td><td></td></tr><tr><td>C</td><td>6756#</td><td>6659#</td><td></td></tr><tr><td>TOTAL</td><td></td><td></td><td></td></tr></table></td><td>1</td><td>2</td><td>9</td><td>33</td><td>55</td><td>4.41</td><td>1</td></tr>
<tr><td>A computer installation has the following rate schedule for one of its machines: $120 per hour for the first 5 hours each month, $110 per hour for the next 15 hours each month, and $100 per hour for all time over 20 hours per month. Using this relationship, compute the charges for 28 hours per month; for 18 hours per month.</td><td>1</td><td>2</td><td>7</td><td>36</td><td>54</td><td>4.41</td><td>1</td></tr>
<tr><td>Find the average (mean): 12,476 14,865 28,437 46,596</td><td>3</td><td>2</td><td>5</td><td>32</td><td>58</td><td>4.40</td><td>1</td></tr>
<tr><td>Complete the following table:
<table><tr><th>DECIMAL</th><th>BINARY</th><th>OCTAL</th><th>HEXADECIMAL</th></tr><tr><td>242</td><td></td><td></td><td></td></tr><tr><td></td><td>1101110</td><td></td><td></td></tr><tr><td></td><td></td><td>374</td><td></td></tr><tr><td></td><td></td><td></td><td>1ED4</td></tr></table></td><td>3</td><td>5</td><td>7</td><td>27</td><td>58</td><td>4.32</td><td>4</td></tr>
<tr><td>Write a program which uses a subroutine to perform the following calculations: accepts 3 two-dimensional arrays A, B, C; multiplies the corresponding elements of A and B; then subtracts the corresponding elements of C and finally writes the new array D.</td><td>4</td><td>5</td><td>9</td><td>37</td><td>45</td><td>4.14</td><td>5</td></tr>
<tr><td>A company manufactures 2 types of electric knives--a standard and a deluxe model. For greater efficiency, the required production and assembly operations are performed in 2 separate shops. The standard model requires 5 hours work in Shop 1 and 7 hours in Shop 2, while the deluxe model requires 8 hours in Shop 1 and 6 hours in Shop 2. Because of the scarcity of skilled labor, only 400 hours of work per week can be performed in Shop 1, and 420 hours per week in Shop 2. The company can sell its total production and realize a profit of $3.00 on the standard model, and $4.00 on the deluxe model. How many of each type should the company produce in order to achieve the greatest possible profit?</td><td>2</td><td>6</td><td>15</td><td>42</td><td>35</td><td>4.02</td><td>4</td></tr>
</table>

TABLE XIV--Continued

Problem	Level of Agreement Scale (% of Responses) 1 SD	2	3	4	5 SA	Average Indicated Need	Expected Level of Mathematics Study Required to Solve Problem
An employer pays at the rate of $5000 per year, but grants a 10% increase each year based on the current salary. Express the relationship as an equation. How much will an employee be earning after 10 years?	3	9	13	44	31	3.93	4
Solve for X: $\frac{X}{288} = \frac{42}{96}$	2	12	13	42	31	3.88	1
A contractor finishes a job 15 days later than required by contract. If he must pay a penalty of $30 the first day, and $32 the second day, $34 the third day, and so on, what will be the total penalty?	5	5	18	46	26	3.84	4
If 5/6 of 2/3X = 25,000, then X = ______	2	9	26	37	26	3.77	2
A consultant in data processing charges $25 an hour for his own services and $10 an hour for those of his assistant. On a given job, for which the consultant's total bill is $880, he works 3 hours more than his assistant does. How many hours did each man put on the job?	4	11	17	43	25	3.77	3
A man owns 2/3 of a computer service bureau and sells 3/4 of his share for $75,000. What is the value of the business?	5	10	20	38	27	3.75	2
Solve for X: .65(1000 + X) = .45(1000) + X	5	8	21	47	19	3.69	2
Convert 3 ft. 5 in. to meters.	5	15	21	35	24	3.60	1
A soft drink producer wants to insure that bottles are filled to specifications 99% of the time. The machines are set to fill each bottle with 12 fluid ounces with a standard deviation of 0.3 ounces. Every 5 hours, 9 bottles are sampled from the lot. In this sample, a bottle is found to contain 11.8 fluid ounces. Should the machine be inspected?	5	10	24	42	19	3.59	5
If 12 file cabinets require 18' of wall space, then 32 cabinets will require how many feet of wall space?	5	14	21	36	24	3.59	1
Solve: $X - Y = 5$ $5X + 2Y = 20$	7	8	23	46	16	3.56	2
Solve for Y, where Y = $50X + 250$, when $X > 20$; $60X + 50$, when $5 < X \leq 20$; $100X$, when $X \leq 5$ GIVEN: X = 28 X = 18	6	11	26	40	17	3.56	2
Solve for Q, where $CI = 2RS/Q^2$, Given: R = 1500 I = .25 C = 2 S = 15	9	13	22	34	22	3.54	2
A druggist has 1000 cc of a 10% acid solution (10% acid and 90% water), and he wants to know how much water to add to obtain a series of varying acid values. Compile a table for him showing the amounts of water that must be added to obtain acid solutions of 9.9% to 2.0%, in increments of 0.1%.	8	18	20	37	17	3.37	3
If $16^3 = 4096$, and $16^4 = 65536$ in base 10, then $2(16)^3 + 3(16)^4 =$ ________	12	14	25	29	20	3.32	3
Solve for A, given: $A = 2000(1.04)^5$	9	17	26	36	12	3.26	3

TABLE XIV--Continued

Problem	Level of Agreement Scale (% of Responses) 1 SD	2	3	4	5 SA	Average Indicated Need	Expected Level of Mathematics Study Required to Solve Problem
What is the volume, in cubic meters, of a box 27" x 32" x 48"?	11	19	24	31	15	3.22	1
A corporation has 32 female and 26 male consultants. In how many ways can a team be formed such that there are 7 members and the majority are men?	11	16	32	30	11	3.14	4
Maximize the function X + 5Y, given the constraints: $2X + Y \leq 10$ $X + 2Y \leq 10$ $X \geq 0$ $Y \geq 0$	7	25	32	25	11	3.10	4
If $A = \begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & -1 \\ 3 & -2 \end{bmatrix}$, find: 1. A + B 2. A · B 3. B A 4. 4B 5. Det A 6. Inverse of A	15	25	29	22	9	2.85	4
Using the table for Z distribution, determine the following: a. A Z of ±1.83 is what in terms of percentage? b. The mean diameter of a cylinder is 0.024 inches with a standard deviation of 0.005 inches. What is the probability that a given cylinder will have a diameter greater than 0.031 inches?	11	27	36	20	6	2.82	5
Find the sum of the Arithmetic Progression where: N = 15 a = 30 d = 2	17	28	22	24	9	2.78	4
Evaluate: $(A \wedge B) \vee \sim(A \wedge B)$ for all possible values of A and B.	18	27	30	19	6	2.69	4
Solve: C^{26}_{7}	20	28	34	14	4	2.53	4
A room with two doors is to have a light switch at each door. The switches are to be connected so that either one can turn the light on or off. Construct the required circuit.	29	32	23	11	5	2.33	2

TABLE XV

RANK ORDER OF PERCEIVED NEED FOR DAILY LIVING MATHEMATICS

Problem	Level of Agreement Scale (% of Responses)					Average Indicated Need	Expected Level of Mathematics Study Required to Solve Problem
	1 SD	2	3	4	5 SA		
Complete the following: SUBTRACT: 20578394.75 −19568473.29 MULTIPLY: 34.8 x.259 DIVIDE: 3/4 / 5/7 ADD: 2395 3574 457 263 44 3509	1	1	7	29	62	4.50	1
Find the average (mean): 12,476 14,865 28,437 46,596	5	5	14	43	33	3.92	1
Convert 3 ft. 5 in. to meters.	5	8	24	37	26	3.73	1
If 12 file cabinets require 18' of wall space, then 32 cabinets will require how many feet of wall space?	5	11	18	43	23	3.67	1
Complete the following form and turn into the records department: ITEM / SHIPPING WT. / NET WEIGHT / DIFFERENCE A / 1500# / 1343# / B / 2800# / 2551# / C / 6756# / 6659# / TOTAL / / /	5	19	15	31	30	3.64	1
A man owns 2/3 of a computer service bureau and sells 3/4 of his share for $75,000. What is the value of the business?	7	12	24	34	23	3.53	2
Solve for X: $\frac{X}{288} = \frac{42}{96}$	7	14	22	43	14	3.45	1
A room with two doors is to have a light switch at each door. The switches are to be connected so that either one can turn the light on or off. Construct the required circuit.	8	13	26	38	15	3.40	4
A contractor finishes a job 15 days later than required by contract. If he must pay a penalty of $30 the first day, and $32 the second day, $34 the third day, and so on, what will be the total penalty?	7	12	30	37	14	3.39	2
An appliance manufacturer sold 56,583 refrigerators during the first quarter of the year. Second quarter sales were 65,325 units. What was the average sales per month for the first half of the year?	8	18	25	30	19	3.35	1
An employer pays at the rate of $5000 per year, but grants a 10% increase each year based on the current salary. Express the relationship as an equation. How much will an employee be earning after 10 years?	6	16	30	35	13	3.35	4
What is the volume, in cubic meters, of a box 27" x 32" x 48"?	11	19	21	32	17	3.27	1
If 5/6 of 2/3X = 25,000, then X = _____	7	19	35	28	11	3.18	2
A computer installation has the following rate schedule for one of its machines: $120 per hour for the first 5 hours each month, $110 per hour for the next 15 hours each month, and $100 per hour for all time over 20 hours per month. Using this relationship, compute the charges for 28 hours per month; for 18 hours per month.	10	22	28	30	10	3.08	1

TABLE XV--Continued

Problem	Level of Agreement Scale (% of Responses)					Average Indicated Need	Expected Level of Mathematics Study Required to Solve Problem
	1 SD	2	3	4	5 SA		
A consultant in data processing charges \$25 an hour for his own services and \$10 an hour for those of his assistant. On a given job, for which the consultant's total bill is \$880, he works 3 hours more than his assistant does. How many hours did each man put on the job?	8	25	32	29	6	3.03	3
Quick Inc. has a monthly usage for Part No. 5 of 125 units. Inventory carrying costs are \$15 per order. Each part costs \$2.00. Find the economic ordering quantity. The freight on shipping 300 units is \$95. If 500 units are shipped, the freight is \$122. Should a quantity of 500 units be purchased in order to effect a savings in freight?	12	24	33	22	9	2.93	3
Solve for X: .65(1000 + X) = .45(1000) + X	10	35	36	14	5	2.72	2
Solve: X - Y = 5 5X + 2Y = 20	15	31	35	14	5	2.64	2
A company manufactures 2 types of electric knives--a standard and a deluxe model. For greater efficiency, the required production and assembly operations are performed in 2 separate shops. The standard model requires 5 hours work in Shop 1 and 7 hours in Shop 2, while the deluxe model requires 8 hours in Shop 1 and 6 hours in Shop 2. Because of the scarcity of skilled labor, only 400 hours of work per week can be performed in Shop 1, and 420 hours per week in Shop 2. The company can sell its total production and realize a profit of \$3.00 on the standard model, and \$4.00 on the deluxe model. How many of each type should the company produce in order to achieve the greatest possible profit?	18	32	33	14	3	2.50	4
Solve for Q, where CI = $2RS/Q^2$, Given: R = 1500 I = .25 C = 2 S = 15	19	34	33	10	4	2.49	2
Solve for Y, where Y = 50X + 250, when X > 20 60X + 50, when 5 < X ≤ 20 100X, when X ≤ 5 Given: X = 28 X = 18	15	40	34	8	3	2.47	2
A druggist has 1000 cc of a 10% acid solution (10% acid and 90% water), and he wants to know how much water to add to obtain a series of varying acid values. Compile a table for him showing the amounts of water that must be added to obtain acid solutions of 9.9% to 2.0%, in increments of 0.1%.	21	35	30	13	1	2.40	3
A soft drink producer wants to insure that bottles are filled to specifications 99% of the time. The machines are set to fill each bottle with 12 fluid ounces with a standard deviation of 0.3 ounces. Every 5 hours, 9 bottles are sampled from the lot. In this sample, a bottle is found to contain 11.8 fluid ounces. Should the machine be inspected?	21	36	30	9	4	2.40	5
A corporation has 32 female and 26 male consultants. In how many ways can a team be formed such that there are 7 members and the majority are men?	24	31	33	10	2	2.36	4
Solve for A, given: A = $2000(1.04)^5$	28	35	26	8	3	2.25	3
Maximize the function X + 5Y, given the constraints: 2X + Y ≤ 10 X + 2Y ≤ 10 X ≥ 0 Y ≥ 0	28	38	28	4	2	2.15	4

TABLE XV--Continued

<table>
<tr><th rowspan="2">Problem</th><th colspan="5">Level of Agreement Scale (% of Responses)</th><th rowspan="2">Average Indicated Need</th><th rowspan="2">Expected Level of Mathematics Study Required to Solve Problem</th></tr>
<tr><th>1 SD</th><th>2</th><th>3</th><th>4</th><th>5 SA</th></tr>
<tr><td>If $16^3 = 4096$, and $16^4 = 65536$ in base 10, then $2(16)^3 + 3(16)^4 =$ ___</td><td>33</td><td>35</td><td>25</td><td>5</td><td>2</td><td>2.09</td><td>3</td></tr>
<tr><td>Write a program which uses a subroutine to perform the following calculations: accepts 3 two-dimensional arrays A, B, C; multiplies the corresponding elements of A and B; then subtracts the corresponding elements of C and finally writes the new array D.</td><td>33</td><td>40</td><td>21</td><td>3</td><td>3</td><td>2.02</td><td>5</td></tr>
<tr><td>Find the sum of the Arithmetic Progression where:
N = 15
a = 30
d = 2</td><td>38</td><td>36</td><td>17</td><td>7</td><td>2</td><td>2.00</td><td>4</td></tr>
<tr><td>Complete the following table:<table><tr><th>DECIMAL</th><th>BINARY</th><th>OCTAL</th><th>HEXADECIMAL</th></tr><tr><td>242</td><td></td><td></td><td></td></tr><tr><td></td><td>1101110</td><td></td><td></td></tr><tr><td></td><td></td><td>374</td><td></td></tr><tr><td></td><td></td><td></td><td>1ED 4</td></tr></table></td><td>39</td><td>35</td><td>19</td><td>3</td><td>4</td><td>1.98</td><td>4</td></tr>
<tr><td>Using the table for Z distribution, determine the following:
a. A Z of 1.83 is what in terms of percentage?
b. The mean diameter of a cylinder is 0.024 inches with a standard deviation of 0.005 inches. What is the probability that a given cylinder will have a diameter greater than 0.031 inches?</td><td>39</td><td>34</td><td>25</td><td>1</td><td>1</td><td>1.92</td><td>5</td></tr>
<tr><td>Solve: C^5_7</td><td>39</td><td>35</td><td>24</td><td>2</td><td>0</td><td>1.91</td><td>4</td></tr>
<tr><td>If $A = \begin{bmatrix} 4 \\ 1 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & -1 \\ 3 & -2 \end{bmatrix}$, find: 1. A + B
2. A · B
3. B · A
4. 4B
5. Det A
6. Inverse of A</td><td>38</td><td>36</td><td>22</td><td>4</td><td>0</td><td>1.89</td><td>4</td></tr>
<tr><td>Evaluate: $(A \wedge B) \vee \sim(A \wedge B)$ for all possible values of A and B.</td><td>42</td><td>35</td><td>21</td><td>2</td><td>0</td><td>1.83</td><td>4</td></tr>
</table>

TABLE XVI. PROBLEMS FROM QUESTIONNAIRE LISTED AS NOT NEEDED BY RESPONDENTS

Problem	Topic Area
Using the table for Z distribution, determine the following: a. A Z of ± 1.83 is what in terms of percentage? b. The mean diameter of a cylinder is 0.024 inches with a standard deviation of 0.005 inches. What is the probability that a given cylinder will have a diameter greater than 0.031 inches?	<u>Statistics</u> Mean Standard Deviation <u>Probability</u> Mathematical Expectation Events
Solve: $\binom{26}{7}$	<u>Probability</u> Events
Find the sum of the Arithmetic Progression where: N = 15 a = 30 d = 2	<u>Algebra</u> Formula Manipulation Progression
Evaluate $(A \wedge B) \vee \sim (A \wedge B)$ for all possible values of A and B.	<u>Logic</u> Set Theory Truth Tables
If $A = \begin{bmatrix} 1 & 2 \\ & 3 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & -1 \\ 3 & -2 \end{bmatrix}$, find: 1. A + B 2. A · B 3. B · A 4. 4B 5. Det A 6. Inverse of A	<u>Algebra</u> Matrix Algebra

TABLE XVII. MEAN SCORES AND STANDARD DEVIATION OF HIGH SCHOOL INSTRUCTORS OPINIONS ON SOLVABILITY LEVEL OF VARIOUS PROBLEMS

Problem Number	Mean	Standard Deviation	Problem Number	Mean	Standard Deviation
1	1.34	.76	18	3.07	.99
2	1.56	.67	19	5.29	1.1
3	2.12	.78	20	4.85	.69
4	1.05	.22	21	4.17	1.90
5	1.24	.44	22	2.90	1.46
6	3.27	1.61	23	4.22	1.73
7	1.63	.83	24	4.00	.89
8	4.05	1.16	25	5.07	1.13
9	1.29	.68	26	2.24	.66
10	1.76	.62	27	2.32	.72
11	2.24	.73	28	4.76	.58
12	1.02	.16	29	4.93	.57
13	1.07	.26	30	2.59	1.38
14	2.68	.96	31	4.32	1.21
15	3.39	1.07	32	4.56	.63
16	4.66	.86	33	3.05	1.20
17	3.85	1.11	34	5.49	1.05

TABLE XVIII. LIST OF MATHEMATICS TOPICS IN WHICH INSTRUCTORS, GRADUATES AND PRACTITIONERS DISAGREED SIGNIFICANTLY AS TO NEED FOR BUSINESS DATA PROCESSING

Topic	Grand Mean	Instructors vs. Graduates	Instructors vs. Practitioners
Geometry			
Angles	2.69	disagree	agree
Polygons	2.52	disagree	agree
Constructions	2.62	disagree	disagree
Perimeters	2.73	disagree	agree
Areas & Volumes	3.05	disagree	agree
Planes	2.62	disagree	disagree
Coordinate Systems	3.03	disagree	agree
Geometric Relationships	2.86	disagree	agree
Trigonometry			
Identities	2.63	disagree	agree
Laws of Sines & Cosines	2.58	disagree	agree
Arc Functions	2.48	disagree	agree
Roots and Powers	3.03	disagree	agree
Exponents	3.14	disagree	disagree
Analysis			
Vectors	2.69	disagree	disagree
Analytical Geometry	2.70	disagree	disagree
Functions & COntinuity	2.72	disagree	disagree
Derivatives & Integrals	2.66	disagree	disagree
Statistics			
Mean, Median, Mode and Range	4.24	disagree	disagree
Logic			
Complements & Contrapositives	4.20	disagree	disagree
Truth Tables	4.19	disagree	disagree

TABLE XIX

ONE WAY ANALYSIS OF VARIANCE INDICATING NEED FOR VARIOUS MATHEMATICS TOPICS IN BUSINESS DATA PROCESSING

Scale of Need
SD SA
1 2 3 4 5

Topic	Source of Variation	Sum of Squares	DF	Mean Square	F	Sig. of F	Means
Arithmetic Addition	Group	1.769	2	.884	1.849	.160	Instructor: 4.91
	Residual	51.655	108	.478			Graduate: 4.59
	Total	53.423	110	.486			Practitioner: 4.80
Arithmetic Subtraction	Group	1.769	2	.884	1.849	.160	Instructor: 4.91
	Residual	51.655	108	.478			Graduate: 4.59
	Total	53.423	110	.486			Practitioner: 4.80
Arithmetic Multiplication	Group	1.660	2	.830	1.716	.183	Instructor: 4.91
	Residual	52.232	108	.484			Graduate: 4.59
	Total	53.892	110	.490			Practitioner: 4.78
Arithmetic Division	Group	1.660	2	.830	1.716	.183	Instructor: 4.91
	Residual	52.232	108	.484			Graduate: 4.59
	Total	53.892	110	.490			Practitioner: 4.78
Arithmetic Square Roots	Group	1.184	2	.592	.405	.999	Instructor: 3.50
	Residual	158.005	108	1.463			Graduate: 3.72
	Total	159.189	110	1.447			Practitioner: 3.78
Algebra Set Theory	Group	.352	2	.176	.123	.999	Instructor: 3.46
	Residual	154.891	108	1.434			Graduate: 3.59
	Total	155.243	110	1.411			Practitioner: 3.60
Algebra Functional Notation	Group	3.326	2	1.663	1.227	.297	Instructor: 3.73
	Residual	146.404	108	1.356			Graduate: 3.57
	Total	149.730	110	1.361			Practitioner: 3.29
Algebra Equalities and Inequalities	Group	2.082	2	1.041	.753	.999	Instructor: 3.91
	Residual	149.341	108	1.383			Graduate: 3.82
	Total	151.423	110	1.377			Practitioner: 3.58
Algebra Polynomial Operations	Group	5.324	2	2.662	2.211	.112	Instructor: 3.60
	Residual	130.045	108	1.204			Graduate: 3.28
	Total	135.369	110	1.231			Practitioner: 3.00
Algebra Graph	Group	5.466	2	2.733	2.817	.062	Instructor: 4.41
	Residual	104.768	108	.970			Graduate: 4.25
	Total	110.234	110	1.002			Practitioner: 3.87
Algebra Ratio and Proportions	Group	5.545	2	2.772	2.821	.062	Instructor: 4.45
	Residual	106.149	108	.983			Graduate: 4.25
	Total	111.694	110	1.015			Practitioner: 3.88

* Significant at .05 level

TABLE XIX--Continued

Topic	Source of Variation	Sum of Squares	DF	Mean Square	F	Sig. of F	Means	
Algebra Roots of an Equation	Group	.612	2	.306	.263	.999	Instructor:	3.27
	Residual	125.820	108	1.165			Graduate:	3.31
	Total	126.432	110	1.149			Practitioner:	3.15
Algebra Logarithms	Group	1.474	2	.737	.536	.999	Instructor:	2.82
	Residual	148.382	108	1.374			Graduate:	3.05
	Total	149.856	110	1.362			Practitioner:	3.15
Algebra Factoring	Group	2.971	2	1.485	1.156	.319	Instructor:	3.27
	Residual	138.723	108	1.284			Graduate:	3.70
	Total	141.694	110	1.288			Practitioner:	3.46
Algebra Exponentiation	Group	.771	2	.385	.221	.999	Instructor:	3.64
	Residual	188.473	108	1.745			Graduate:	3.64
	Total	189.243	110	1.720			Practitioner:	3.47
Algebra Quadratic Equations	Group	.225	2	.122	.089	.999	Instructor:	2.96
	Residual	136.550	108	1.264			Graduate:	3.07
	Total	136.775	110	1.243			Practitioner:	3.07
Algebra Determinants and Matrices	Group	.786	2	.393	.266	.999	Instructor:	3.32
	Residual	159.773	108	1.479			Graduate:	3.50
	Total	160.559	110	1.460			Practitioner:	3.34
Algebra Formula Manipulation	Group	5.574	2	2.787	2.145	.120	Instructor:	4.14
	Residual	140.336	108	1.299			Graduate:	3.82
	Total	145.910	110	1.326			Practitioner:	3.54
Algebra Systems of Equations	Group	6.241	2	3.120	2.199	.114	Instructor:	3.50
	Residual	153.237	108	1.419			Graduate:	3.70
	Total	159.477	110	1.450			Practitioner:	3.18
Algebra Linear and Nonlinear Functions	Group	.090	2	.045	.029	.999	Instructor:	3.32
	Residual	167.334	108	1.549			Graduate:	3.25
	Total	167.423	110	1.522			Practitioner:	3.24
Geometry Angles*	Group	14.681	2	7.341	7.148	.002	Instructor:	2.18
	Residual	110.905	108	1.027			Graduate:	3.11
	Total	125.586	110	1.142	LSD = .603		Practitioner:	2.53
Geometry Polygons*	Group	10.607	2	5.304	6.024	.004	Instructor:	2.00
	Residual	95.086	108	.880			Graduate:	2.84
	Total	105.694	110	.961	LSD = .558		Practitioner:	2.46
Geometry Constructions*	Group	17.608	2	8.804	8.763	.001	Instructor:	1.86
	Residual	108.500	108	1.005			Graduate:	2.95
	Total	126.108	110	1.146	LSD = .597		Practitioner:	2.67

* Significant at .05 level

TABLE XIX--Continued

Topic	Source of Variation	Sum of Squares	DF	Mean Square	F	Sig. of F	Means	
Geometry Perimeters*	Group	10.922	2	5.461	4.796	.010	Instructor:	2.23
	Residual	122.970	108	1.139			Graduate:	3.07
	Total	133.892	110	1.217	LSD = .635		Practitioner:	2.64
Geometry Areas and Volumes*	Group	9.434	2	4.717	3.709	.027	Instructor:	2.55
	Residual	137.341	108	1.272			Graduate:	3.35
	Total	146.775	110	1.334	LSD = .671		Practitioner:	3.00
Geometry Planes*	Group	14.153	2	7.077	7.802	.001	Instructor:	2.00
	Residual	97.955	108	.907			Graduate:	2.98
	Total	112.108	110	1.019	LSD = .567		Practitioner:	2.58
Geometry Coordinate Systems*	Group	9.803	2	4.902	4.037	.020	Instructor:	2.68
	Residual	131.116	108	1.214			Graduate:	3.39
	Total	140.919	110	1.281	LSD = .656		Practitioner:	2.85
Geometry Geometric Relationships*	Group	11.077	2	5.539	4.989	.009	Instructor:	2.31
	Residual	119.896	108	1.110			Graduate:	3.18
	Total	130.973	110	1.191	LSD = .627		Practitioner:	2.82
Geometry Inductive and Deductive Reasoning	Group	3.346	2	1.673	1.038	.359	Instructor:	3.41
	Residual	174.023	108	1.611			Graduate:	3.77
	Total	177.369	110	1.612			Practitioner:	3.42
Measurement and Conversion Number Bases	Group	.424	2	.212	.433	.999	Instructor:	4.77
	Residual	52.873	108	.490			Graduate:	4.61
	Total	53.297	110	.485			Practitioner:	4.62
Measurement and Conversion English-Metric	Group	4.897	2	2.448	2.493	.085	Instructor:	4.55
	Residual	106.076	108	.982			Graduate:	3.98
	Total	110.973	110	1.009			Practitioner:	4.09
Measurement and Conversion Arithmetic Operations on Bases	Group	2.672	2	1.336	1.598	.205	Instructor:	4.54
	Residual	90.319	108	.836			Graduate:	4.16
	Total	92.991	110	.845			Practitioner:	4.42
Trigonometry Identities and Functions*	Group	9.295	2	4.647	4.381	.015	Instructor:	2.09
	Residual	114.561	108	1.061			Graduate:	2.89
	Total	123.856	110	1.126	LSD = .613		Practitioner:	2.64
Trigonometry Laws of Sines and Cosines*	Group	10.940	2	5.470	5.782	.004	Instructor:	2.00
	Residual	102.160	108	.946			Graduate:	2.87
	Total	113.099	110	1.028	LSD = .579		Practitioner:	2.58
Trigonometry Arc Functions*	Group	7.766	2	3.883	4.283	.016	Instructor:	2.00
	Residual	97.927	108	.907			Graduate:	2.73
	Total	105.694	110	.961	LSD = .567		Practitioner:	2.47

* Significant at .05 level

TABLE XIX--Continued

Topic	Source of Variation	Sum of Squares	DF	Mean Square	F	Sig. of F	Means
Trigonometry Roots and Powers*	Group	10.483	2	5.241	3.763	.026	Instructor: 2.55
	Residual	150.436	108	1.393			Graduate: 3.37
	Total	160.919	110	1.463	LSD = .703		Practitioner: 2.94
Trigonometry Exponents*	Group	14.016	2	7.008	5.057	.008	Instructor: 2.50
	Residual	149.677	108	1.386			Graduate: 3.47
	Total	163.694	110	1.488	LSD = .701		Practitioner: 3.13
Trigonometry Trigonometric Tables	Group	4.648	2	2.324	2.321	.101	Instructor: 2.27
	Residual	108.109	108	1.001			Graduate: 2.81
	Total	112.757	110	1.025			Practitioner: 2.53
Analysis Vectors*	Group	10.136	2	5.068	4.582	.012	Instructor: 2.09
	Residual	119.450	108	1.106			Graduate: 2.88
	Total	129.586	110	1.178	LSD = .626		Practitioner: 2.80
Analysis Analytic Geometry*	Group	20.021	2	10.010	10.280	.001	Instructor: 1.86
	Residual	105.169	108	.974			Graduate: 3.00
	Total	125.189	110	1.138	LSD = .588		Practitioner: 2.82
Analysis Functions and Continuity*	Group	18.347	2	9.173	9.347	.001	Instructor: 1.53
	Residual	105.995	108	.981			Graduate: 2.98
	Total	124.342	110	1.130	LSD = .59		Practitioner: 2.87
Analysis Derivatives and Integrals*	Group	20.430	2	10.215	12.182	.001	Instructor: 1.82
	Residual	90.561	108	.839			Graduate: 2.98
	Total	110.991	110	1.009	LSD = .545		Practitioner: 2.76
Probability Approximations	Group	4.739	2	2.370	2.579	.079	Instructor: 3.95
	Residual	99.225	108	.919			Graduate: 3.79
	Total	103.964	110	.945			Practitioner: 3.44
Probability Sample Spaces	Group	1.961	2	.981	1.153	.320	Instructor: 3.64
	Residual	91.894	108	.851			Graduate: 3.30
	Total	93.856	110	.853			Practitioner: 3.31
Probability Events	Group	.535	2	.268	.268	.999	Instructor: 3.50
	Residual	108.023	108	1.000			Graduate: 3.32
	Total	108.559	110	.987			Practitioner: 3.43
Probability Mathematical Expectation	Group	1.605	2	.802	.871	.999	Instructor: 3.82
	Residual	99.494	108	.921			Graduate: 3.53
	Total	101.099	110	.919			Practitioner: 3.51
Probability Conditional Events	Group	.855	2	.427	.419	.999	Instructor: 3.73
	Residual	110.244	108	1.021			Graduate: 3.59
	Total	111.099	110	1.010			Practitioner: 3.49

* Significant at .05 level

TABLE XIX--Continued

Topic	Source of Variation	Sum of Squares	DF	Mean Square	F	Sig. of F	Means
Probability Bayes Formula	Group	.085	2	.043	.047	.999	Instructor: 3.19
	Residual	98.149	108	.909			Graduate: 3.12
	Total	98.234	110	.893			Practitioner: 3.11
Statistics Tables and Graphs	Group	1.191	2	.595	1.008	.370	Instructor: 4.54
	Residual	63.800	108	.591			Graduate: 4.32
	Total	64.991	110	.591			Practitioner: 4.26
Statistics Mean Median Mode Range*	Group	7.882	2	3.941	6.033	.004	Instructor: 4.77
	Residual	70.550	108	.653			Graduate: 4.16
	Total	78.432	110	.713	LSD = .481		Practitioner: 4.06
Statistics Standard Deviation	Group	1.307	2	.654	.886	.999	Instructor: 4.23
	Residual	79.684	108	.738			Graduate: 3.96
	Total	80.991	110	.736			Practitioner: 3.96
Statistics Approximations	Group	1.097	2	.548	.706	.999	Instructor: 4.18
	Residual	83.894	108	.777			Graduate: 3.98
	Total	84.991	110	.773			Practitioner: 3.91
Statistics Distributions	Group	5.003	2	2.501	2.376	.096	Instructor: 4.32
	Residual	113.700	108	1.053			Graduate: 3.77
	Total	118.703	110	1.079			Practitioner: 3.80
Statistics Non Parametric Statistics	Group	2.132	2	1.066	.981	.999	Instructor: 3.73
	Residual	117.345	108	1.087			Graduate: 3.36
	Total	119.477	110	1.086			Practitioner: 3.40
Statistics Population Sampling	Group	3.094	2	1.547	1.223	.298	Instructor: 3.86
	Residual	136.546	108	1.264			Graduate: 3.50
	Total	139.640	110	1.269			Practitioner: 3.42
Statistics Types of Data	Group	.669	2	.334	.346	.999	Instructor: 4.18
	Residual	104.250	108	.965			Graduate: 3.98
	Total	104.919	110	.954			Practitioner: 4.00
Statistics Regressions	Group	.243	2	.121	.109	.999	Instructor: 3.59
	Residual	120.316	108	1.114			Graduate: 3.66
	Total	120.559	110	1.096			Practitioner: 3.55
Logic Conditional Statement	Group	.312	2	.156	.417	.999	Instructor: 4.82
	Residual	40.463	108	.375			Graduate: 4.68
	Total	40.775	110	.371			Practitioner: 4.69
Logic AND OR NAND Non Networks	Group	.847	2	.423	.685	.999	Instructor: 4.50
	Residual	66.793	108	.618			Graduate: 4.63
	Total	67.640	110	.615			Practitioner: 4.44

* Significant at .05 level

TABLE XIX--Continued

Topic	Source of Variation	Sum of Squares	DF	Mean Square	F	Sig. of F	Means	
Logic Complements Contrapositives*	Group	5.616	2	2.808	3.446	.034	Instructor:	4.59
	Residual	88.023	108	.815			Graduate:	4.23
	Total	93.640	110	.851	LSD = .537		Practitioner:	3.98
Logic Truth Tables*	Group	8.232	2	4.116	4.324	.015	Instructor:	4.73
	Residual	102.795	108	.952			Graduate:	4.11
	Total	111.027	110	1.009	LSD = .581		Practitioner:	4.00
Logic Boolean Algebra	Group	1.962	2	.981	.822	.999	Instructor:	4.04
	Residual	128.849	108	1.193			Graduate:	3.75
	Total	130.811	110	1.189			Practitioner:	3.69
Logic Set Theory	Group	.585	2	.293	.223	.999	Instructor:	3.77
	Residual	141.811	108	1.313			Graduate:	3.91
	Total	142.396	110	1.295			Practitioner:	3.76

* Significant at .05 level

TABLE XX. SUBJECT RANK ORDER OF NEED FOR BUSINESS DATA PROCESSING MATHEMATICS CURRICULUM (SUBJECT AND TOPIC BY RANK)

General Subject Area	Topic	Topic Mean	Grand Mean (Average)	Rank
Arithmetic	Addition	4.74	4.53	1
	Subtraction	4.74		
	Multiplication	4.73		
	Division	4.73		
	Square Root	3.70		
Measurement and Conversion	Number Bases	4.65	4.38	2
	Arithmetic Operations on Bases	4.34		
	English Metric	4.14		
Logic	Conditional Statements	4.71	4.11	3
	AND, OR, NAND, NOR	4.53		
	Complements, Contrapositives	4.20		
	Truth Tables	4.19		
	Set Theory	3.82		
	Algebra	3.78		
	Inductive & Deductive Reasoning	3.56		
Statistics	Tables & Graphs	4.34	3.89	4
	Mean, Median, Mode & Range	4.24		
	Types of Data	4.03		
	Standard Deviation	4.01		
	Approximations	3.99		
	Distributions	3.89		
	Regressions	3.60		
	Population Sampling	3.53		
	Nonparametric Statistics	3.45		
Algebra	Ratio & Proportions	4.14	3.58	5
	Graphs	4.13		
	Formula Manipulation	3.77		
	Equalities & Inequalities	3.74		
	Set Theory	3.57		
	Exponentiation	3.57		
	Factoring	3.52		
	Functional Notation	3.49		
	Systems of Equations	3.45		
	Determinants & Matrices	3.40		
	Linear and Nonlinear Functions	3.26		
	Roots of an Equation	3.24		
	Polynomial Operations	3.23		

TABLE XX--Continued

General Subject Area	Topic	Topic Mean	Grand Mean (Average)	Rank
Probability	Approximations	3.68	3.52	6
	Mathematical Expectation	3.58		
	Conditional Events	3.58		
	Events	3.40		
	Sample Spaces	3.37		
Geometry	Areas & Volumes	3.05	2.77	7
	Coordinate Systems	3.03		
	Geometric Relationships	2.86		
	Perimeters	2.73		
	Angles	2.69		
	Planes	2.62		
	Constructions	2.62		
	Polygons	2.52		
Trigonometry	Exponents	3.14	2.74	8
	Roots & Powers	3.03		
	Identities & Functions	2.63		
	Trigonometric Tables	2.59		
	Laws of Sines and Cosines	2.58		
	Arc Functions	2.48		
Analysis	Functions & Continuity	2.72	2.69	9
	Analytic Geometry	2.70		
	Vectors	2.69		
	Derivatives and Integrals	2.66		

TABLE XXI. PROBLEMS PAIRED INTO 17 PROBLEM SETS

<table>
<tr><th></th><th>Product Problem</th><th>Process Problem</th><th></th></tr>
<tr><td>1.</td><td>What is the volume, in cubic meters, of a box 27" x 32" x 48"?</td><td>Convert 3 ft. 5 in. to meters.</td><td>*</td></tr>
<tr><td>2.</td><td>If 12 file cabinets require 18' of wall space, then 32 cabinets will require how many feet of wall space?</td><td>Solve for X: $\frac{X}{288} = \frac{42}{96}$</td><td></td></tr>
<tr><td>3.</td><td>A man owns 2/3 of a computer service bureau business and sells 3/4 of his share for $75,000. What is the value of the business?</td><td>If 5/6 of 2/3X = 25,000; then X =</td><td></td></tr>
<tr><td>4.</td><td>Complete the following form and turn into the records department:
<table>
<tr><th>Item</th><th>Shipping Wt.</th><th>Net Weight</th><th>Difference</th></tr>
<tr><td>A</td><td>1500#</td><td>1343#</td><td></td></tr>
<tr><td>B</td><td>2800#</td><td>2551#</td><td></td></tr>
<tr><td>C</td><td>6756#</td><td>6659#</td><td></td></tr>
<tr><td>Total</td><td></td><td></td><td></td></tr>
</table></td><td>Complete the following:
Add: 2395
3574
457
263
44
3509
Subtract:
20578394.75
-19568473.29
Multiply: 34.8
x.259
Divide: $\frac{3/4}{5/7}$</td><td></td></tr>
<tr><td>5.</td><td>An appliance manufacturer sold 56,583 refrigerators during the first quarter of the year. Second quarter sales were 65,325 units. What was the average sales per month for the first half of the year?</td><td>Find the average: 12,476 14,865 28,437 46,596</td><td>*</td></tr>
<tr><td>6.</td><td>Quick, Inc., has a monthly usage for Part No. 5 of 125 units. Inventory carrying costs are 25% of average inventory and ordering costs are $15 per order. Each part costs $2. Find the economic ordering quantity. The freight on shipping 300 units is $95. If 500 units are shipped, the freight is $122. Should a quantity of 500 units be purchased in order to effect a savings in freight?</td><td>Solve for Q, where: $CI = 2RS/Q^2$
Given: R = 1500 I = .25 C = 2 S = 15</td><td>*</td></tr>
<tr><td>7.</td><td>A computer installation has the following rate schedule for one of its machines: $120 per hour for the first 5 hours each month, $110 per hour for the next 15 hours each month, and $100 per hour for all time over 20 hours per month. Using this relationship, compute the charges for 28 hours per month; for 18 hours per month.</td><td>Solve for Y.
Y = $50X + 250$, when $X > 20$
$60X + 50$, when $5 < X \leq 20$
$100X$, when $X \leq 5$
Given:
X = 28
X = 18</td><td>*</td></tr>
<tr><td>8.</td><td>A company manufactures 2 types of electric knives--a standard and a deluxe model. For greater efficiency, the required production and assembly operations are performed in two separate shops. The standard model requires 5 hours work in Shop 1 and 7 hours in Shop 2, while the deluxe model requires 8 hours in Shop 1 and 6 hours in Shop 2. Because of the scarcity of skilled labor, only 400 hours of work per week can be performed in Shop 1, and 420 hours in Shop 2. The company can sell its total production and realize a profit of $3 on the standard model and $4 on the deluxe model. How many of each type should the company produce in order to achieve the greatest possible profit?</td><td>Maximize the function, X + 5Y, given the constraints:
$2X + Y \leq 10$
$X + 2Y \leq 10$
$X \geq 0$
$Y \geq 0$</td><td>*</td></tr>
<tr><td>9.</td><td>A druggist has 1000 cc of a 10% acid solution (10% acid and 90% water) and he wants to know how much water to add to obtain a series of varying acid values. Compile a table for him showing the amounts of water that must be added to obtain acid solution of 9.9% to 2.0%, in increments of 0.1%.</td><td>Solve for X: .65(1000 + X) = .45(1000) + X</td><td>*</td></tr>
</table>

TABLE XXI--Continued

<table>
<tr><th>Product Problem</th><th>Process Problem</th><th></th></tr>
<tr><td>10. A consultant in data processing charges $25 an hour for his own services and $10 an hour for those of his assistant. On a given job, for which the consultant's total bill is $880, he works 3 hours more than his assistant does. How many hours did each man put on the job?</td><td>Solve: $X - Y = 5 \quad 5X + 2Y = 20$</td><td>*</td></tr>
<tr><td>11. Write a program which uses a subroutine to perform the following calculations: accepts 3 two-dimensional arrays A, B, C; multiplies the corresponding elements of A and B; then subtracts the corresponding elements of C; and finally writes the new array D.</td><td>If $A = \begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix} \quad B = \begin{bmatrix} 2 & -1 \\ 3 & -2 \end{bmatrix}$
Find: 1. A + B
2. A · B
3. B · A
4. 4B
5. Det. A
6. Inverse of A</td><td>0</td></tr>
<tr><td>12. A corporation has 32 female and 26 male consultants. In how many ways can a team be formed such that there are 7 members and the majority are men?</td><td>Solve:
C_7^{26} = ________</td><td>*</td></tr>
<tr><td>13. Complete the following table:
<table><tr><th>DECIMAL</th><th>BINARY</th><th>OCTAL</th><th>HEXADECIMAL</th></tr><tr><td>242</td><td></td><td></td><td></td></tr><tr><td></td><td>1101110</td><td></td><td></td></tr><tr><td></td><td></td><td>374</td><td></td></tr><tr><td></td><td></td><td></td><td>1ED4</td></tr></table></td><td>If $16^3 = 4096$, and $16^4 = 65536$ in base 10, then:
$2(16^3) + 3(16^4)$ = ________</td><td></td></tr>
<tr><td>14. A contractor finishes a job 15 days later than required by contract. If he must pay a penalty of $30 the first day, and $32 the second day, $34 the third day, and so on, what will be the total penalty?</td><td>Find the sum of the Arithmetic Progression, where:
$N = 15 \quad a = 30 \quad d = 2$</td><td>*0</td></tr>
<tr><td>15. A room with two doors is to have a light switch at each door. The switches are to be connected so that either one can turn the light on or off. Construct the required circuit.</td><td>Evaluate: $(A \wedge B) \vee \sim (A \wedge B)$ for all possible values of A and B.</td><td>*</td></tr>
<tr><td>16. An employer pays at the rate of $5000 per year, but grants a 10% increase each year based on the current salary. Express the relationship as an equation. How much will an employee be earning after 10 years?</td><td>Solve for A, given: $A = 2000(1.04)^5$</td><td>*</td></tr>
<tr><td>17. A soft drink producer wants to insure that bottles are filled to specifications 99% of the time. The machines are set to fill each bottle with 12 fluid ounces with a standard deviation of 0.3 ounces. Every five hours, 9 bottles are sampled from the lot. In this sample, a bottle is found to contain 11.8 fluid ounces. Should the machine be inspected?</td><td>Using the table for Z distribution, determine the following:
a. A Z of ± 1.83 is what in terms of percentage?
b. The mean diameter of a cylinder is 0.024 inches with a standard deviation of 0.005 inches. What is the probability that a given cylinder will have a diameter greater than 0.031 inches?</td><td>*</td></tr>
</table>

[0] Group effect significant at .05 level
* Type effect significant at .05 level

TABLE XXII. FLOW CHART ESTABLISHING MATHEMATICS TASK ANALYSIS PROCEDURES