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ABSTRACT

A study was conducted to determine what mathematics skills were needed for Dental Laboratory Technology, Medical Laboratory Technology, and Respiratory Therapy. Data obtained from studies, course outlines, textbooks, and reports were used to construct a 79-item mathematics skill questionnaire. This questionnaire was administered to employers, employees, technical instructors, licensing bodies, and mathematics instructors, who indicated skills considered important. The information was then rank ordered. Findings were that a wide range of mathematics content was being taught to students in the health occupations under investigation, within a technical area respondents agreed as to which skills were considered important, mathematic skills needed by the dental laboratory technician were different from that needed by other health technicians, and there were high levels of agreement between rankings of mathematics skills by mathematics faculty and other respondents. Some conclusions and implications from the data analyses included agreement as to importance of skills indicating communication between schools and employers, a common core of mathematics needed by dental laboratory technicians that is different from that needed by other health technicians, and implementation of the study through use of the survey for needs assessment and development of a curriculum responsive to local needs. (Three data tables are appended.) (YLB)

A STUDY OF MATHEMATICS NEEDED FOR DENTAL LABORATORY TECHNOLOGY, MEDICAL LABORATORY TECHNOLOGY, AND RESPIRATORY THERAPY

by

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INTRODUCTION

Many studies have been done during the past decade concerning which mathematics skills are needed for technicians working in business and industry. The Committee on the Undergraduate Program in Mathematics (CUPM) of the Mathematics Association of America made recommendations concerning general and applied mathematics curricula during the late 1960s and early 1970s. None of those recommendations involved mathematics needed by technicians working in the health fields.

The Milwaukee Area Technical College (MATC) Technical Mathematics Project was conducted from 1965 to 1970 with the goals of reducing student dropouts in technical mathematics. The criteria for curriculum development for the Technical Mathematics Project were as follows:

1. Each mathematics topic had to be relevant for technicians.
2. The content had to begin at a level which coincided with the entry skills of students.
3. The instruction had to proceed at a pace which coincided with the learning speed of the students.

The Technical Mathematics Project developed a mathematics curriculum for industrial technicians. Since the development of that curriculum, there has been an increase in enrollment in mathematics by health technology students. MATC has a history of offering mathematics courses that are responsive to community needs. It was therefore, with the support of the MATC Mathematics Department and Administration, that a study was conducted to determine what mathematics skills were needed for Dental Laboratory Technology, Medical Laboratory Technology, and Respiratory Therapy.

KEY QUESTIONS

The study was conducted during 1978 and 1979 and provided answers to the following questions:

1. What is the content of the mathematics courses that are currently being taught to students enrolled in dental laboratory technology, medical laboratory technology, and respiratory therapy?
2. What do employers, employees, technical instructors, and licensing bodies perceive the content to be?
3. What mathematics skills do most of these students possess when they enter MATC?
4. Is the mathematics needed by students in these health occupations programs different from the mathematics currently being taught?
5. Can the input into mathematics curriculum development be increased by requesting cooperation from people outside the area of mathematics?

As a first step in answering these questions, data were obtained from several studies, course outlines, textbooks, and reports. This information was used to construct a seventy-nine item mathematics skill questionnaire that was administered to employers, employees, technical instructors, licensing bodies, and mathematics instructors.

Opinions of Employers, Employees, Technical Instructors, and Licensing Bodies

The questionnaire was used to determine the opinions of employers, employees, technical instructors, and licensing bodies. The health technology instructors at each of the appropriate institutions in the Wisconsin Vocational, Technical and Adult Education (VTAE) System were contacted by mail and asked to complete the questionnaire. Eighteen of the 25 instructors replied. The information gathered was rank ordered to determine which skills were considered most important by those instructors.

Each of the appropriate institutions in the VTAE system was contacted by mail requesting a list of recent graduates from the dental laboratory technology, medical laboratory technology, and respiratory therapy programs. All of these graduates were then contacted by mail and asked to complete the questionnaire. Eighty-eight of the 157 graduates replied. The information was rank ordered to determine the opinion of employees.

Each of the previously mentioned VTAE schools was also asked for the names of the employers of their graduates. The names of all of the employers were not available from the schools. The schools supplied the names of several employers and the graduates themselves supplied the names of additional employers. These employers were then contacted by mail and asked to complete the questionnaire. Forty-nine employers were contacted and thirty-two replied. The information gathered from these employers was rank ordered to determine which skills they considered most important.

The following licensing bodies were contacted by mail and asked to complete the same questionnaire that the instructors, employers, and employees completed.

1. National Board for Certification (Dental Laboratory Technology).
2. Board of Registry - American Society of Clinical Pathologists (Medical Laboratory Technology).
3. National Board for Respiratory Therapy (Respiratory Therapy).

The National Board for Certification completed the questionnaire. The National Board for Respiratory Therapy, Inc., completed four questionnaires; one by each of the following: the President of NBRT, the Chairman of the Technician Written Examination Committee, the Chairman of the Therapist Written Examination Committee, and the Chairman of the Clinical Simulation Examination Committee. The Executive Director of NBRT indicated that the responses of these three officers cannot be considered to be the official

position, or opinion of the NBRT, but must be considered as personal opinions held by each individual.

The Board of Registry of the American Society of Clinical Pathologists replied as follows:

> "The examinations which we offer are based on content guidelines in various laboratory disciplines such as chemistry, hematology, immunology, microbiology, and miscellaneous topics. Whatever mathematics knowledge and/or skills are relevant to those knowledge areas are generally assumed by the committees without giving conscious consideration to the mathematical aspect of the knowledge being tested and probably not in any instance at the level of conception which you have specified in your questionnaire."

The information gathered from the employers, employees, technical instructors, and licensing bodies was used to determine what these professionals perceive as important mathematics content.

Each of the responses was assigned a numerical value as follows:

5 Extremely Important
4 Very Important
3 Important
2 Moderately Important
1 Not Important.

The responses were analyzed and a mean response and rank order were calculated for each item. A Spearman Rank-Order correlation coefficient was used to determine if there was agreement among the respondents as to the ranking of these mathematics skills. Tables 1-3 contain a list of skills considered important. A limited number of more complete tables are available from the author. (After the data were collected, a Spearman Rank-Order Correlation Coefficient was used to determine if there was agreement among the respondents as to the ranking of these mathematics skills.)

CONCLUSIONS AND FINDINGS

1. There is currently a wide range of mathematics content being taught to students in these health occupations. Of the 19 schools surveyed nationwide, five required no mathematics course, six required intermediate algebra or college algebra, four required statistics, and four required a special health occupations mathematics course.

2. Within a technical area, employers, employees, technical instructors, and licensing bodies agree as to which skills are considered important. No trigonometry skills are considered important for any of the careers. While arithmetic skills are considered important for all technologies, only medical laboratory technology and respiratory therapy judge algebra and statistics as important by all respondents.
3. Data collected at MATC show that entering students score well on test items for whole numbers and decimals. A few students have problems with adding fractions and with percentages. Most of the entering students are acquainted with the metric system and formulas.
4. The mathematics needed by the dental laboratory technician is different from the mathematics needed by the other health technicians. Most of the mathematics skills needed by the medical laboratory technicians and respiratory therapists are included in the current course.
5. There are high levels of agreement between the rankings of mathematics skills by the mathematics faculty and by the selected health technology employers, employees, technical instructors, and licensing bodies.

DISCUSSION

Several interesting questions arose as a result of analyzing the data.

Why was there agreement as to the order of importance of the items in the questionnaire?

In each of the three areas researched, there appeared to be agreement as to the order of importance of the mathematics skills and objectives. This can be attributed to two factors: first, the VTAE schools train a large percentage of the technicians in these areas, these technicians become supervisors and technical instructors which tends to build a closed system which reinforces

itself; second, each VTAE district has an advisory committee consisting of practitioners which help to determine the curriculum and keep the program relevant. This evidence of communication between schools and employers is commendable.

Were the broad general education objectives of the mathematics curriculum accepted by respondents?

It was found that five of the seven general education objectives were ranked high by medical laboratory technology and respiratory therapy respondents. These five objectives were:

1. To develop ease, accuracy, and competency in the use of computational skills.
2. To develop an understanding of the use of common mathematical symbols and concepts such as charts, graphs, elementary statistical presentations, and formulae.
3. To develop the ability to think logically and critically.
4. To be able to use numerical symbols in presentation of quantitative information.
5. To understand basic logical procedures so that education into specialized fields may be continued.

The dental laboratory technology respondents ranked the following two objectives high:

1. To develop the ability to think logically and critically.
2. To understand basic, logical procedures so that education into specialized fields may be continued.

The high rankings of these general education objectives tend to support the attitude that the process of mathematics is important. This does not imply that content is not also important, but that the respondents feel that in addition to specific content the processes of mathematics are also important.

Why was electronic computing ranked low in the study?

CUPM panels on mathematics curriculum made recommendations to include electronic computing as early as 1964. Significant developments have been made in the use of electronic computers in medical areas. This was the reason that a section on electronic computing was included in this study. The low ranking of electronic computing in the study seems to indicate that even though there has been an increased use of computers in medical areas these particular technicians feel they can function effectively without formal education in computing. One possible reason for this may be that the increased sophistication of the computers has made the input and output easier for the layperson (noncomputer specialist) to interpret. Therefore, the technician can use the computing equipment effectively without possessing knowledge of the internal workings of the system.

Were there any variations in the respondents rankings of items?

It would be appropriate at this time to comment on variations in the respondents ranking of some of the items. The most noticeable variation is in the ranking of basic definitions in geometry by the dental laboratory technology respondents. The item "Basic Definitions" (point, line, etc.) received the following ranks: 19 by the employees, 13 by the employers, and 5 by the licensing body. The dental laboratory technology teachers ranked the item 58th and the mathematics teachers ranked the item 32nd. This variation in ranking could be a result of the fact that geometry is very often played down in the two-year college mathematics curriculum. Therefore, the respondents from within the institution would tend to rank geometry lower than the other respondents.

There was also a variation in the dental laboratory technician respondents' rankings of "special products and factoring.". These rankings are: 12 for the employees, 57.5 for the employer, 58 for the dental laboratory

technology teachers, and 68 for the mathematics teachers. This variation in ranking is probably the result of several of the employee respondents misinterpreting the meaning of "special products and factoring." If "special products and factoring" were interpreted to mean "special products and factoring in arithmetic" then the high ranking would be consistent with other rankings in arithmetic, and the discrepancy would be explainable.

The variation in the ranking of the "apothecary system" by the medical laboratory technology respondents was the result of the mathematics teachers being less familiar with the career area than the rest of the respondents. The mathematics teachers ranked the apothecary system 10.5 while the other respondents ranked it 39.5 and 45.5.

Is there a common core of mathematics needed by health technicians?

Several researchers have found that a common core of mathematics is needed for similar occupational areas. Bailey (1) developed a model core curriculum in mathematics for two-year programs in electronics technology, machine shop technology, drafting technology, and automobile technology. A Business Mathematics Analysis Questionnaire was used by Scrittorale (2) to determine that there is a common core of business mathematics applications that all business majors should know for their job. Laws (3) found that there were certain common mathematics skills that were needed by technicians in Michigan industries.

This study has found that the mathematics needed by dental laboratory technicians is different from the mathematics needed by other health technicians. There is, therefore, a common core of mathematics needed by respiratory therapists and medical laboratory technicians which is different from the mathematics needed by dental laboratory technicians.

The medical laboratory technology and respiratory therapy programs are both science intensive. This dictates mathematics skills that are similar

to the skills needed by industrial technicians. In addition, current development of electronic technology relative to the medical field will require more mathematical sophistication in the future.

Dental laboratory technology, on the other hand, appears to be more skill oriented. That is, the technician's development of a product based on his/her skills is more important than interpreting data and reacting to that data.

It is, therefore, not surprising that the medical laboratory technology and respiratory therapy respondents' ranking of needed skills overlapped with the skills currently being taught to industrial technicians. It is also no surprise that the dental laboratory technology respondents indicated a need for very little mathematics.

How could this study be implemented?

The intent of this study was not to create a rigid curriculum that is nonresponsive to local needs. The intent is, rather, to offer a useful study to help others with mathematics curriculum decisions. A high ranking of an item by the respondents should be rationale for including that item in the curriculum. If that item is excluded, or if other items are included, the rationale for the decision should be at least as good as the rationale provided by this study.

For example, a committee considering the mathematics curriculum for a specific health technology could use the survey instrument developed for this study to ascertain local needs. In addition, it could examine the results of this study and review current literature to get a broad picture of mathematics needs. The end result would be a curriculum that utilized the information in this study and was responsive to local needs.

SUGGESTIONS FOR FURTHER STUDY

The completion of this study indicates that it is possible to gather curriculum information from several sources with a single instrument. The methodology developed for this study can be easily applied to several related studies. The following are studies which might be completed using this study's methodology:

1. Selected health technologies were the subject of this study. The same methodology could be used to gather curriculum information for mathematics needed by other technical areas.
2. Although this study was concerned with mathematics, other disciplines could be studied in the same manner. Science for health technologies and industrial technologies could easily be studied using this methodology.
3. This study was restricted to the state of Wisconsin. The methodology could be used to compare curriculum needs from different geographic locations. The questionnaire used was derived from course outlines from throughout the country. Regional and national studies, plus reports of national committees were also used in developing the questionnaire. It would, therefore, be appropriate to use the questionnaire to determine mathematics needs of health technicians in other states.

Technical areas are constantly changing and technical education must react to these changes. The methodology of this study can be used to supply the schools with the information needed to adjust to these changes.

TABLE 1

MATHEMATICS SKILLS/COMPETENCIES CONSIDERED IMPORTANT FOR DENTAL LABORATORY TECHNOLOGY

(Mean response for 18 highest ranked mathematics skills/competencies)
(Not listed in rank order)

Skill/Competency	Employee	Employer	Technical Instructor	Licensing Body	Mathematics Teacher
1. Fundamental Operations with Whole Numbers	3.57	3.25	4.75	4	4.91
2. Fundamental Operations with Fractions	2.50	3.00	4.25	4	4.73
3. Fundamental Operations with Decimals	2.64	2.50	3.75	4	4.82
4. Ratio and Proportion	2.57	3.38	3.25	4	4.73
5. Percentage and Its Uses	2.64	3.00	2.75	2	4.73
6. Hand Calculator Operations	2.07	1.00	1.25	2	4.09
7. Approximation and Estimation	2.28	2.00	2.50	4	4.00
8. Metric System	3.36	3.38	3.75	4	4.18
9. Apothecary System	1.93	2.00	2.00	4	4.00
10. Conversions	2.64	1.50	1.50	4	2.91
11. Use of Measuring Devices	3.36	3.25	4.50	4	4.27
12. Tables and Interpolation	1.50	1.50	1.50	4	2.91
13. Special Products	2.33	1.00	1.00	1	1.45
14. To understand basic, logical procedures so that education into specialized fields may be continued.	1.93	2.38	4.50	3	3.18
15. To know methods of proof and reasoning.	2.00	2.38	3.50	1	2.55
16. To think and work in a systematic manner.	2.29	2.25	4.00	4	4.27
17. To develop ease, accuracy, and competency in the use of computational skills.	2.36	2.13	2.75	2	4.64
18. To develop the ability to think logically and critically.	2.86	2.86	4.75	2	3.91

TABLE 2

MATHEMATICS SKILLS/COMPETENCIES CONSIDERED IMPORTANT FOR MEDICAL LABORATORY TECHNOLOGY

(Mean response for 20 highest ranked mathematics skills/competencies)
(Not listed in rank order)

Skill/Competency	Employee	Employer	Technical Instructor	Mathematics Instructor
1. Fundamental Operations with Whole Numbers	4.13	4.62	5.00	4.77
2. Fundamental Operations with Fractions	3.44	3.92	5.00	4.77
3. Fundamental Operations with Decimals	4.15	4.38	5.00	4.77
4. Ratio and Proportion	4.00	4.23	4.83	4.69
5. Percentage and Its Uses	4.21	4.31	5.00	4.77
6. Scientific Notation and Significant Figures	3.28	3.92	4.50	4.23
7. Hand Calculator Operations	3.51	3.46	4.17	4.08
8. Competency in the Use of Computational Skills	4.13	4.31	4.67	4.46
9. To develop the ability to think logically and critically.	4.28	4.31	5.00	4.08
10. To develop an understanding of the use of common mathematical symbols and concepts such as charts, graphs, statistical presentations, and formulae.	4.21	4.23	4.50	4.54
11. To be able to use numerical symbols in presentation of quantitative information.	3.62	3.38	4.33	3.69
12. To think and work in a systematic manner.	4.05	4.31	4.67	4.46
13. To develop strategies and techniques for problem solving.	3.59	4.00	4.67	3.54
14. To know methods of proof and reasoning.	3.44	3.38	4.67	2.23
15. Presentation of Data	3.49	3.23	4.33	3.31
16. Conversions	3.38	3.92	4.50	4.00
17. Use of Measuring Devices	4.05	4.00	4.50	4.54
18. Metric System	4.58	4.69	5.00	4.31
19. Normal Distribution	3.21	4.00	1.25	3.54
20. To understand basic, logical procedures so that education into specialized fields may be continued.	3.59	3.85	4.50	3.54

TABLE 3

MATHEMATICS SKILLS/COMPETENCIES CONSIDERED IMPORTANT FOR RESPIRATORY THERAPY

(Mean response for 20 highest ranked mathematics skills/competencies)
(Not listed in rank order)

Skill/Competency	Employee	Employer	Technical Instructor	Licensing Body	Mathematics Instructor
1. Fundamental Operations with Whole Numbers	4.35	4.62	5.00	5.00	4.78
2. Fundamental Operations with Fractions	4.00	4.54	4.75	5.00	4.67
3. Fundamental Operations with Decimals	4.41	4.62	5.00	5.00	4.78
4. Ratio and Proportion	3.91	4.23	5.00	5.00	4.78
5. Percentage and Its Uses	4.15	4.46	5.00	5.00	4.67
6. Scientific Notation and Significant Figures	3.03	3.31	4.25	4.00	4.44
7. Hand Calculator Operations	2.94	3.15	3.38	3.50	4.33
8. Approximation and Estimation	3.29	3.31	3.88	4.25	4.22
9. Metric System	4.56	4.69	4.75	5.00	4.67
10. Apothecary System	3.24	2.69	3.63	4.25	4.00
11. Conversions	3.88	3.92	4.75	4.50	3.67
12. Use of Measuring Devices	3.35	3.77	3.88	4.75	4.44
13. To think and work in a systematic manner.	4.24	4.62	4.25	4.75	4.33
14. To develop strategies and techniques for problem solving.	3.94	4.00	4.25	4.75	3.78
15. To know methods of proof and reasoning.	3.74	3.62	4.25	4.50	2.00
16. To develop ease, accuracy, and competency in the use of computational skills.	4.09	4.23	4.25	4.25	4.56
17. To develop the ability to think logically and critically.	4.47	4.77	4.63	5.00	4.11
18. To develop an understanding of the use of common mathematical symbols and concepts such as charts, graphs, elementary statistical presentations, and formulae.	4.09	4.54	4.13	4.75	3.89
19. To be able to use numerical symbols in presentations of quantitative information.	3.55	4.46	4.00	4.25	3.67
20. To understand basic, logical procedures so that education into specialized fields may be continued.	4.00	3.38	4.00	3.75	3.33

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