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Congruence Among Mathematics Skills Used On The Job By Practical Nurses vs. The Prerequisite Skills Required For Admission Into The Practical Nursing Program

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Congruence Among Mathematics Skills Used On The Job By Practical Nurses vs. The Prerequisite Skills Required For Admission Into The Practical Nursing Program

by

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ABSTRACT

The standard for evaluating a student's mathematic ability (grade level) for admission to many vocational-technical programs is through the administration of the Tests of Adult Basic Education (TABE). There has come forth a concern from vocational educators, that students entering programs may not be prepared for the mathematics required by the curriculum, even though the student has met the criteria for entry as established by the state curriculum frameworks as evidenced by their scores on a TABE which had recently been administered. Furthermore, questions raised among instructional, administrative and guidance personnel about the congruence of math skills required on the TABE vs. those used by practical nurses on the job supported the need for a study to determine the congruence of these sets of mathematics skills. Using the OMRA inventory developed by David Pucel, the mathematic operations required for job related math applications are indicated by samples collected from active nursing practitioners. Three analysis teams consisting of practical nurses and math experts were established and determined the math operations required for solving the job related math samples collected. The math skills tested by the TABE were then compared to the job related math samples. With the math operations of the variables ranked, the Spearman Rank Correlation was used to evaluate the correlation across the TABE and the mathematic job requirements of practical nursing. Based on 19 math operations identified from the Practical Nursing job math

requirements, the results showed that there was little correlation among these two variables (r=. 4974).

Keywords: Practical Nursing, Mathematics Skills, Postsecondary Vocational Education, TABE.

Chapter 1: Introduction

Mathematics is viewed as a basic skill required by all citizens in society. Yet many employed adults and those preparing for employment do not have the minimal basic mathematics skills needed to function successfully in the workplace (U.S. Department of Labor, 1991).

The Educational Testing Service reported that only 25 out of 100 young adults can use a bus schedule to select the appropriate bus for a given departure or arrival, and only ten percent can select the least costly product from a list of grocery items on the basis of unit-pricing information (1989). These tasks are hardly complex, yet only a fraction of young people aged twenty-one through twenty-five can perform them. In today's workforce, the need for employees to think analytically and have the basic skills to do so is ever increasing.

American businesses are estimated to lose $60 billion in productivity each year due to employees' lack of basic skills (Ivy, 2002). "When we hired a production worker in the old days, we used to say crudely that we hired his hands and not his head. Very frankly, what we are finding out is that there is an awful lot in his head" (John Foley, Xerox Corporation, [n.d.]).

Motorola Corporation found out that it had a serious problem with the skills of its front-line workers only when it was well into its program of restructuring for Total

Quality Management. "If you take one of our mainline factories in Chicago . . . we have about 7,500 people, roughly 3,200 or 3,300 are . . . production workers. One thousand of those individuals lack basic math skills - adding, subtraction, multiplication, division . . . " (Bill Wiggenhorn, VP, 1987).

The NAEP 2000 results show that roughly one-third of U.S. students fail to meet "basic" levels of competence, about one-third demonstrate basic levels, and about one-third are proficient or advanced in all of the tested areas. The average score of twelfth-graders increased between 1990 and 1996, but then declined between 1996 and 2000. Despite this recent downturn in performance, the twelfth-grade average score in 2000 was higher than that in 1990 (NAEP, 2000).

While the jobs in most occupations will grow on average by only 20 percent between 1990 and 2005, the U.S. Department of Labor, Bureau of Labor Statistics, predicts that employment in major technical fields such as health and other "science-and math-related" areas will increase on average by 33 percent from 1990 to 2005 - from 3.7 million jobs to 5.1 million jobs (May, 1992). Health services which accounted for 7% of total wage and salary worker employment in 1975 and 8% in 1990, will approach 9% of total employment in 2005 (Workforce 21, 2001).

Technical education in secondary and two-year postsecondary schools has made significant efforts in the last 10 years to become more relevant to the needs of industry. Technical educators are assisting industry associations in the creation of national voluntary skill standards administered through grants by the Education and Labor Departments. They were also the leading proponents behind the drive for industryrecognized standards for occupational education, implemented in all states in September 1992 (NACFAM, 1992)

In vocational-technical education curriculum frameworks, the state of Florida recommends a minimum grade level of mathematics skill required for entry into any specific occupational training program area. Detailed student performance standards have been established that dictate the mathematic functions which the student must master in order to satisfy the program requirements for completion. Beyond this, it is at the discretion of each individual school, program or instructor to include additional math competencies to be mastered in order to meet more stringent conditions for program completion. One such program is Practical Nursing.

As in many technical areas, individuals facing the rigorous challenges of the medical profession need a knowledge of mathematics. Theirs is an occupational area in which a mathematical error in the calculation of the quantity or mixture of medication can be critical to a patient's survival. This occupation requires a demanding daily routine in which the use of mathematics is significant, from measuring medications, to taking temperatures, to timing intravenous feedings; they must be consistent in their ability to complete these tasks with accuracy.

Statement of the Problem

The standard for evaluating a student's mathematic ability (grade level) for admission to many vocational-technical programs is through the administration of the *Tests of Adult Basic Education* (TABE). These are norm-referenced tests designed to measure achievement in reading, mathematics, and language. Because the tests combine the most useful characteristics of norm-referenced and criterion-referenced tests, they provide information about the relative ranking of examinees against a norm group as well as specific information about the instructional needs of examinees. The tests enable teachers and administrators to diagnose, evaluate, and successfully place examinees in adult education programs. TABE tests are designed to measure the understanding and application of conventions and principles, and are not intended to measure specific knowledge or recall of facts.

There has come forth a concern from vocational educators, that students entering programs are not prepared for the mathematics required by the curriculum, even though the student has met the criteria for entry established by the state curriculum frameworks as evidenced by their scores on a TABE which had recently been administered. For example, a student may demonstrate an ability to score at the appropriate level on the TABE to be admitted to the program, but still fail to complete the program based on an inability to satisfactorily perform the required mathematic operations. Further, there is concern among vocational educators that the math skills required for program entry and the math skills needed to complete the training program may be out of synch with the math skills ultimately used by the graduate on the job.

There is an uncertainty of knowing just what the specific math skills are that are needed on the job versus the specific math skills taught in the curriculum versus the math skills tested on the TABE. The problem may be the possible lack of validity of math on the TABE and curriculum as compared to actual math required on the job.

Questions raised among instructional, administrative and guidance personnel supported the need for a study comparing the mathematics skills tested on the TABE to the math skills needed by entry-level workers on the job.

The problem addressed by this study was the uncertainty regarding the congruence among the level of mathematics required for admission into the Practical Nursing program, the math addressed in the TABE, and the level of math required by practical nurses as they go about their duties.

The Practical Nursing Program

One area in which particular concern has been expressed about mathematics requirements is in the Practical Nursing program. The program is designed to prepare students for employment as licensed practical nurses or to provide supplemental training for a person previously or currently employed in this occupation. The Florida State Board of Nursing must approve the program so the graduate may take the examination to practice as a Licensed Practical Nurse.

The content includes, but is not limited to, theoretical instruction and clinical experience in medical, surgical, obstetric, pediatric, and geriatric nursing; theoretical instruction and clinical experience in both acute and long term care situations; theoretical instruction and clinical application of vocational role and function; personal, family and community health concepts; nutrition; human growth and development over the life span; body structure and function; interpersonal relationship skills, mental health concepts; pharmacology and administration of medications; legal aspects of practice; America

Heart Association Basic Life Support (BLS) course C or equivalent and current issues in nursing. Clinical experience should make up 50% of the total program. The Health Careers Core must be taken by all students (secondary, postsecondary adult and postsecondary vocational) planning to complete any Health Occupations program (Florida DOE, 2003). This core consists of the first eleven intended outcomes of the program, as outlined in the curriculum framework (Appendix A), and introduces the student to health careers, personal responsibilities, medical terminology, computation and math, computers, employability skills, anatomy, basic procedures, nutrition, infection control, safety, and holistic care. Completion of the core allows the student ease of transferability among health care programs.

This study was concerned with the computation and math standards of this program. Nursing Program instructors have expressed concern where students fail to master the math skills required, even though they have scored at the established level on the TABE for entry into the program.

The Trend Toward Relevant Mathematics

In his research, David Pucel (1992) cited a number of supporting opinions for the need for mathematics to be relevant to the occupation for which one is being trained. Mathematics is viewed as a basic skill required by all citizens in society. Yet many employed adults and those preparing for employment do not have the minimal basic mathematics skills needed to function successfully in the workplace (U.S. Department of labor, 1991). This has led to a re-examination of how mathematics is taught in elementary and secondary education programs and in programs designed to prepare people for employment (National Research Council, 1989). Pucel points out that a central theme of the movement to revise mathematics education is the "Teaching for understanding is in; learning rote skills is out" (Burns, 1994, p.471).

"The challenge is to adopt new approaches that have the potential for allowing adults to be more successful. Those approaches must allow people not only to learn mathematics but to be able to apply it in the workplace" (Pucel, 1995, p.52). Math courses are often ineffective because students view many of the mathematics skills that are taught as irrelevant. Such perceived irrelevance often causes adults to drop out of such programs and forsake their occupational preparation (Shelby & Johnson, 1988).

It is becoming a popular conception that more is not necessarily better. It is becoming clear that it is not possible to teach all people all of the mathematics skills that could be taught, especially during our current era of increased knowledge in all fields, especially mathematics. It has been suggested that we "not call on the schools to cover more and more (mathematics) material, but instead recommend a set of learning goals that will allow them to concentrate on teaching less and doing it better" (Blackwell & Henkin, 1989, p.ix).

"Too much of school reform has focused on more--a longer day, a longer year, more courses, higher standards, more teaching and more testing. What we need is not more, but different--a different mission, a different philosophy, different content, a different structure, different methods and a different view of testing" (Blank, 1996).

Pucel (1995) points out that there are a couple of major groupings of approaches to teaching mathematics.

1. Applied academics, in the context of preparing people for work, refer to teaching academic content around work related applications. The emphasis is on teaching the academic content. Integrated academic and vocational education programs are designed to emphasize both academic and vocational content and to teach them together as complimentary.
2. Related academics shift the emphasis from academic to vocational education. The process starts with examining the type of vocational education content to be taught and then determining the academic content that is needed to support that occupational content.

Differences exist in perceptions of whether the mathematics skills for specific occupations are substantially different, or whether occupational mathematics skills are essentially the same for all occupations prepared for through vocational education (Pucel, 1995).

If the TABE test accurately measures a student's ability to perform the mathematics requirements required by the student performance standards of the Practical Nursing program, do those student performance standards reflect the actual occupational mathematics skills needed on the job by a Licensed Practical Nurse?

Purpose of the Study

The purpose of this study was to (1) determine the specific math skills required on the job for entry level Licensed Practical Nurses, (2) identify the math skills tested by the TABE, and (3) to determine the congruence among these two sets of math skills. This study utilized the Occupational Mathematics Requirements Assessment (OMRA) instrument developed by David Pucel of the University of Minnesota in 1992 as a tool with which to accomplish this task (Appendix B). This study did not involve the collection of individual student data.

"The Occupational Math Requirements Assessment (OMRA) was designed to determine the mathematics operations (skills) required for success in an occupation. The results of OMRA can be used as a basis for curriculum development and/or for judging an individual's occupational math preparation" (Pucel, 1992, p.C-1).

The intent of this study was not to question the validity or reliability of the TABE test in evaluating an individual's basic skills level, but rather to determine its suitability in being the sole determining factor of a student's eligibility for entry into a specific occupational program area. For example, a quick scan of the mathematics portion of the TABE test (Form 5, Level A) revealed that there are no questions relating to the metric system, while in reality, the medical occupations deal almost entirely with metric measurement in all of its applications.

Research Questions

This project investigated the following research questions.

1. What are the specific mathematics operations used routinely on the job by entry level Licensed Practical Nurses?
2. What are the specific mathematics operations tested by the mathematical subtests of the TABE?

3. To what extent are the specific mathematical operations identified for each of the above consistent?

Educational Implications

State of Florida curriculum frameworks dictate the minimum grade level ability in basic skills to enter occupational programs. The minimum basic skills grade level required for mathematics for the Practical Nursing program when offered at the postsecondary adult vocational level is grade eleven (rule 6A-10.040 FAC). This grade level number corresponds to a grade equivalent score obtained on a state designated basic skills examination (TABE). When students are admitted to a program such as Practical Nursing, based on a test score measuring their abilities and meeting state requirements for admission, they are expected to be successful. Nursing instructors have observed that when students do not meet the realistic mathematic achievement levels required by the curriculum or by the occupation, the end result is that they often fail to complete their occupational program.

Learning more about the degree of non-congruence among the skills required for admission and those required in the curriculum with those required on the job can assist in the development of a more effective curriculum, a better admissions test, and more appropriate entrance criteria.

Definition of Terms

For the purposes of this study, and to promote a common basis for understanding, the following definitions are used:

1. *TABE*: Tests of Adult Basic Education. Norm referenced tests designed to measure achievement in reading, mathematics, language, and spelling. (TABE Examiner's Manual)

2. *OMRA*: The Occupational Mathematics Requirements Assessment is designed to determine the mathematics operations (skills) required for success in an occupation. (OMRA Coordinator Manual)

3. *Curriculum Frameworks*: Outline of State Department of Education requirements, intended outcomes and student performance standards for programs and areas of study in which the student will be involved.

4. *Student Performance Standards*: Specific occupational tasks which the student is expected to master in order to receive a certificate of completion. (Curriculum Framework, Florida Department of Education)

5. *Job Related Material*s**:** Written materials specifically containing math applications routinely used by workers in an occupation. (OMRA Coordinator's Manual).

5. *Math Category**:*** A major division of math such as integers, fractions, decimals, percents, algebra, or geometry. (OMRA Coordinator's Manual).

7. *Math Expert:* A person formally trained in mathematics that has command of the structure and skills of mathematics, such as a math instructor. . (OMRA Coordinator's Manual).

8. *Occupational Expert:* A person who has mastered the skills of the occupation to be analyzed, such as an occupational instructor. (OMRA Coordinator's Manual).

Assumptions

The only assumption that is being made in conducting this study is that the math skills evident, or implied, by work samples collected are generally representative of the math skills required on the job.

Limitations

(1) This study is limited to the Practical Nursing instructional program and the Practical Nursing occupation. (2) The results of this study cannot be generalized beyond the limited geographical setting in which the study was conducted.

Organization of the Study

Chapter 2 contains a review of literature related to practical nursing as a career, the TABE test, occupational mathematics, the use of standardized tests as predictors of student success, and the OMRA instrument. Chapter 3 identifies the methods and procedures to be used in completing this study. Chapter 4 includes the findings of the study and an interpretation of the results, and Chapter 5 presents a summary of the study, its conclusions, and recommendations for continuing research.

Chapter 2: Review of Related Literature

This chapter presents a review of the status of mathematics skills of the American student, Practical Nursing as a career, the TABE test, OMRA instrument, and other studies conducted relevant to predicting student success in Nursing programs.

Mathematics in America

The April, 1983 U.S. government publication A Nation At Risk reported to the American people . . . “that while we can take justifiable pride in what our schools and colleges have historically accomplished and contributed to the United States and the well-being of its people, the educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people.” This report points out that between 1975 and 1980, remedial mathematics courses in public 4-year colleges increased by 72 percent and now constitute one-quarter of all mathematics courses taught in those institutions. The average graduate of our schools and colleges today is not as well educated as the average graduate of 25 or 35 years ago, when a much smaller proportion of our population completed high school and college. Business and military leaders complain that they are required to spend millions of dollars on costly remedial education and training programs in such basic skills as reading, writing, spelling, and computation. “These deficiencies come at a time when the demand for highly skilled workers in new fields is accelerating rapidly" (p.3). Although a million and a half new workers enter the economy each year from our schools and colleges, the adults working today will still make up about 75 percent of the workforce in the year 2000.

Another government education research report Meeting Goal 3: How Well Are We Doing? (1992), examined the achievement of today's 17 year olds and 9 year olds in math, reading, and science. The data in the report are from the National Assessment of Educational Progress (NAEP) report Trends in Academic Progress (1991). It provides information on student achievement patterns across time at ages 9, 13, and 17 in math, reading, and science. The results show that many of the nation's 17 year olds are failing to acquire the skills they need, but also that today's 9 year olds, who leave high school at the turn of the century, are not performing better than 9 year olds in the past.

As measured by the NAEP data, the nation's 17 year olds do not appear to be well prepared for today's workforce or further education. Only 56 percent of 17 year olds can compute with decimals, fractions, and percents; recognize geometric figures; solve simple equations; and use moderately complex mathematical reasoning. Only seven percent can solve problems that involve fractions and percents, solve two-step problems involving variables, identify equivalent algebraic expressions, and solve linear equations and inequalities. Nearly one out of every five (18 percent) nine year olds in 1990 could not add and subtract two digit numbers or recognize relationships among coins. It is clear from these results that students are not leaving high school with the skills they need.

"It is difficult to understand why so many people must struggle with concepts that are actually simpler than most of the ideas they deal with every day. It is far easier to calculate a percentage than it is to drive a car" (Dewdney, 1993, .1). Innumeracy is more socially acceptable and tolerated than illiteracy (Dewdney, 1993).

Numeracy involves the functional, social, and cultural dimensions of mathematics. Numeracy is the type of math skills needed to function in everyday life, in the home, workplace, and community (Withnall, 1995). Low levels of numeracy limit access to education, training, and jobs; on the job, it can hinder performance and productivity. Numeracy is not just about numbers, but rather is a socially based activity that requires the ability to integrate math and communication skills (Withnall, 1995). Words can have everyday meanings as well as math meaning: for example, "and" is a conjunction, but in math it can also mean "plus". Some words are math specific: numerator, multiplicand, and divisor. Interpretation of these words can cause confusion for people with low literacy levels. Despite the myth that mathematical principles are fixed for all time, new discoveries and theories about math continue to emerge. The uses of math in the world evolve as societal needs change. For example, computers are changing the need for some kinds of math skills and creating the need for others (Bishop et al., 1993).

Numeracy has an uncertain place in adult basic education. Instructors are not always prepared to teach math and may even share some of their students' anxieties about it. Adult math instruction often focuses on preparation for the General Educational Development Test, which is based on high school math and perhaps "cannot serve as a complete road map for what adult numeracy provision should encompass" (Gal 1992, p.22).

Major curriculum reform is not new in the field of school mathematics. The last such reform was the "new math" of the late 1950s and 1960s which emphasized the unifying mathematical concepts of logic and set theory. For a variety of reasons the new math did not receive widespread acceptance. It did not pay close attention to how students learn and what they are capable of learning at different ages. The new math was followed by the "back to basics" movement, which emphasized rote memorization of arithmetic facts and the learning of paper and pencil algorithms. The current reform movement grew out of the inability of the back to basics movement to address key issues, including:

- Neglect of higher order thinking and problem solving skills
- Disquieting findings about American students in recent international studies on mathematics achievement.
- Changing mathematical skills needed in the work force.

(U.S. Department Of Education, 1994)

The need for a workforce equipped with more and different mathematical concepts is transforming the mathematics curriculum. Routine problems rarely involve ideas from just one part of mathematics. Thus the curriculum at all grade levels needs to include geometry and measurement, probability and statistics, pre algebra or algebra, patterns, relations, functions, and discrete mathematics (Lacampagne, 1993).

Curricular and pedagogical changes in mathematics must transform how students are assessed. As mathematics curricula and pedagogy are changed, the instruments for measuring student achievement must also be changed. It is not fair to students, teachers, or school districts to be measured by outdated standards. The majority of standardized tests our children take are still overly reliant on multiple-choice items that measure predominantly low-level mathematics skills. Although they are beginning to reflect the changes in mathematics teaching and learning, these tests include few types of questions that require higher order problem-solving skills (Lacampagne, 1993).

Practical Nursing

As defined by the Occupational Outlook Handbook (U.S. Department of Labor, 1996) licensed practical nurses (LPN's) care for the sick, injured, convalescing, and handicapped, under the direction of physicians and registered nurses.

Most LPN's provide basic bedside care. They take vital signs such as temperature, blood pressure, pulse, and respiration. They treat bedsores, prepare and give injections and enemas, apply dressings, give alcohol rubs and massages, apply ice packs and hot water bottles, and insert catheters. LPN's observe patients and report adverse reactions to medications or treatments. They may collect samples from patients for testing and perform routine laboratory tests. They help patients with bathing, dressing, and personal hygiene, feed them and record food and liquid intake and output, keep them comfortable, and care for their emotional needs. In states where the law allows, they may administer prescribed medicines or start intravenous fluids. Some LPN's help deliver, care for, and feed infants. Some LPN's supervise nursing assistants and aides. In doctor's offices and clinics they may also make appointments, keep records, and perform other clerical duties.

Most licensed practical nurses in hospitals and nursing homes work a 40-hour week, often including nights, weekends and holidays. They often stand for long periods of time and help patients move in bed, stand, or walk. They also face the stress of working with sick patients and their families. LPN's may face hazards from caustic chemicals, radiation, and infectious diseases. LPN's also are subject to back injuries when moving patients and shock from electrical equipment. They often face heavy workloads.

Licensed practical nurses held about 702,000 jobs in 1994, working in hospitals, nursing homes, doctor's offices, clinics, temporary help agencies, home health care services, or government agencies.

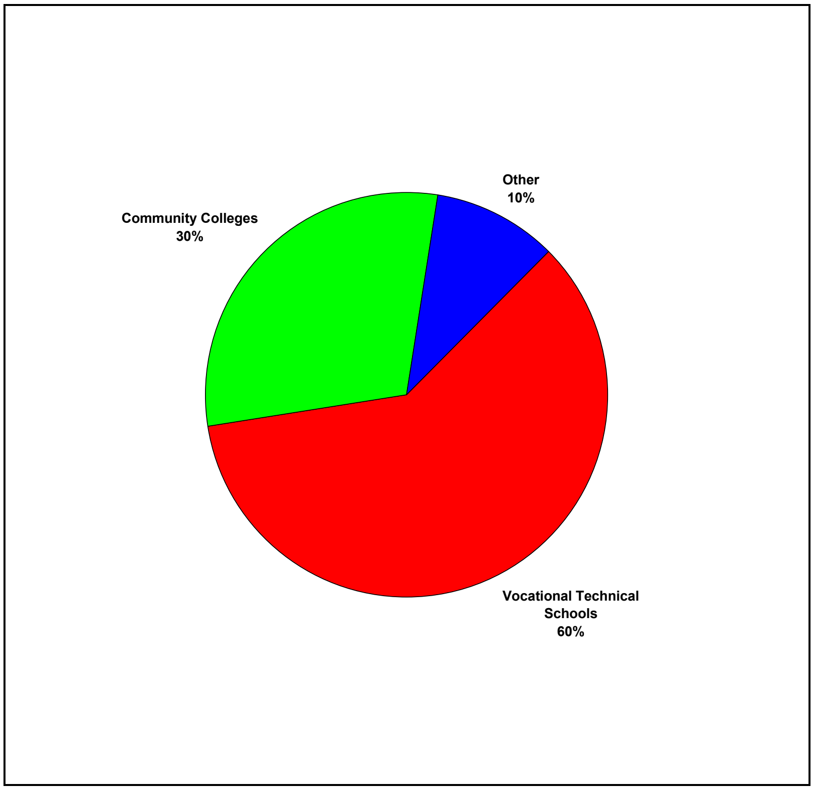
All States require LPN's to pass a licensing examination after completing a State approved practical nursing program. In 1993, approximately 1,098 State approved programs provided practical nursing training. Almost 6 out of 10 students were enrolled in technical or vocational schools, while 3 out of 10 were in community and junior colleges, with the balance in high schools, hospitals, and colleges and universities (Figure 1).

Most practical nursing programs last about one year and include both classroom study and supervised clinical practice.

LPN's should have a caring, sympathetic nature, and should be emotionally stable because work with the sick and injured can be stressful. As part of a health care team, they must be able to follow orders and work under close supervision.

Figure 1

Practical Nursing Programs in the United States



The Curriculum Framework in the state of Florida (rule 6A-10.040 FAC) requires a minimum basics skills grade level of 11.0 in mathematics for Practical Nursing programs when offered at the postsecondary adult vocational level. This grade level number corresponds to a grade equivalent score obtained on a state designated basic skills examination. In the state of Florida, the TABE test is such a basic skills examination.

The TABE Form 5, level A mathematics test is designed to measure the following computation abilities (Appendix A):

- Addition of decimals and fractions.
- Subtraction of decimals and fractions.
- Multiplication of whole numbers, decimals and fractions.
- Division of whole numbers, decimals and fractions.
- Integers and percents
- Exponents and algebraic expressions

Additionally, the TABE Form 5, level A mathematics test is designed to measure concepts and applications in the following categories:

- Numeration.
- Number sentences.
- Number theory.
- Problem solving
- Measurement
- Geometry

The TABE

The Tests of Adult Basic Education, Forms 5 and 6 (TABE 5 and 6) are norm-referenced tests designed to measure achievement in reading, mathematics, language, and spelling -- the subject areas commonly found in adult basic education curricula. TABE 5 and 6 focus on basic skills that are required to function in society. Because the tests combine the most useful characteristics of norm-referenced and criterion-referenced tests, they provide information about the relative ranking of examinees against a norm group as well as specific information about the instructional needs of examinees. The tests enable teachers and administrators to diagnose, evaluate, and successfully place examinees in adult education programs. The TABE test items reflect language and content that is appropriate for adults and measure the understanding and application of conventions and principles; they are not intended to measure specific knowledge or recall of facts. TABE can be used to provide pre-instructional information about an examinee's level of achievement in basic skills, to identify areas of weakness in these skills, to measure growth in the skills after instruction, to involve the examinee in appraisal of his or her learning difficulties, and to assist in preparing an instructional program to meet the examinee's individual needs (TABE Examiner's Manual, 1987).

The mathematics portion of the TABE test consists of two sections. First (Test 3) is mathematics computation, 48 items that measure the operations of addition, subtraction, multiplication and division. Depending on the level of the test, content includes whole numbers, decimals, fractions, integers, algebraic expressions, exponents, and percents. Second (Test 4) are mathematics concepts and applications, 40 items that measure understanding of mathematics concepts. Specific skills include numeration, number sentences, number theory, problem solving, measurement, and geometry.

Throughout the development of the TABE test, careful considerations were made to control for content bias, where questions of ethnic background, age and gender were concerned. The item selection process involved a three-parameter statistical model that took into account item discrimination, difficulty and guessing.

The math operations included in the TABE test are summarized through the Modular Analysis of Learning Difficulties (MALD) developed by the Florida Department of Education, Division of Vocational, Adult, and Community Education in 1989 (Appendix B). The Department of Technical & Vocational Studies through the University of West Florida, Pensacola produced this evaluation tool for the SAIL project. The SAIL project is concerned with remedial training of vocational students in order to elevate their basic skills to an acceptable level, and utilizes student scores on the TABE test as an indicator of their ability level. This Modular Analysis of Learning Difficulty (MALD) is a summary sheet of the results of student scores on the TABE, forms 5 and 6, level A, for tests 3 and 4. In this study, form 5, Level A will be used for analysis.

Approaches in Determining Occupational Math Requirements

In his review of the literature, Pucel (1992) points out that there are two general approaches for determining occupation-related math requirements. The two general approaches are (a) occupational analysis of job or training requirements and the math associated with fulfilling those requirements, and (b) standardized testing and establishing norms for occupations.

The occupational analysis approach is primarily used by educators interested in determining the basic skills needed by a person on the job as a basis for the development of a training program, with the goal being to determine the requirements of a job and to prepare people to meet those requirements. The state's student performance standards are a good example of the result of this approach. The main problem with this is in the often-used group consensus method in which the occupational and related mathematics skills are identified through expert judgment, group opinion and formal analysis, and the taxonomy of math skills used as a basis for analyzing the math requirements. Through this process, various groups of experts often generate disparate lists of math skills. Each group creates its list around a math classification system uniquely agreed upon by the members of that particular group. The justification or the lack of reliability seems to be based on the assumption that the list will only be used in relation to the particular training program being developed (Greenan, 1984).

The standardized testing approach is generally used to determine the global math requirements of a job as a basis for assessing the extent to which individuals have met those requirements. This approach often yields a grade level score or cut-off scores on test subscales. It is often used to screen people in terms of their ability to succeed in training or on the job with little or no concern for providing training to meet the psychological requirements of the job. There are two basic types of standardized tests related to math: (a) those tests which have been developed to measure student potential or aptitude and (b) basic skills achievement tests. These tests rarely provide sufficient information to direct curriculum development for specific math skills used in a particular occupation (Pucel, 1992).

The OMRA Instrument

In an article published in the Journal Of Industrial Teacher Education (1995), Pucel describes the development of the performance based Occupational Mathematics Requirements Assessment (OMRA*)* instrument, the primary purpose of which is to assist in determining if the types of mathematics skills and the applications of those skills differ substantially among occupations prepared for through vocational education (Appendix B). The problem was stated that if there are substantial differences in the mathematics skill requirements of different occupations, and/or if the same skills are applied differently in different occupations, it might be more appropriate to tailor mathematics instruction to each occupation.

The range of mathematics operations included in the OMRA inventory was developed for occupations requiring less than a baccalaureate degree - those typically taught through vocational and technical education. The technique provides a vehicle for recording the number of occupational applications that require mathematics skills and the specific mathematics operations required for the completion of those applications. The OMRA instrument includes 63 specific mathematic operations, but as with the TABE, does not address the metric system.

Pucel's initial study in 1992 included the occupations of (1) secretary and (2) electronics technician, representing two different types of occupations that might require different types of mathematics skills.

The study concluded that mathematics instruction for adults preparing for employment should not be taught again using traditional techniques used in elementary and secondary schools. The results clearly indicated that there are major differences in not only the mathematics skills required in different occupations but in the ways mathematics is applied in different occupations, and that these differences have curricular implications. The application of mathematics in one occupation may have little relevance for people in other occupations.

Other Studies: Predictors of Student Success

A 1988 study was conducted to evaluate the effectiveness of the Tests of Adult Basic Education in predicting success or lack of success in selected postsecondary health occupations programs, including Practical Nursing. The total population for the research was 1,485 students enrolled in postsecondary health occupations programs in the state of Kentucky. The predictor variables used were the TABE reading and mathematics grade equivalent scores and the number of times each section of the TABE was taken. Criterion variables were (1) successful completion of a health program or withdrawal and (2) scores from the Kentucky Vocational Achievement Test (KVAT). Pearson product moment correlation coefficients and true stepwise multiple regression analysis were used to test the correlation using .05 level of significance. The conclusion was that the TABE reading and mathematics grade equivalent scores and number of attempts were not good predictors of program completion or withdrawal. Discriminant analysis failed to classify completion or withdrawal correctly from any of the health programs (Author /KC).

At the University of South Florida, the purpose of a 1992 dissertation was to examine the predictive capabilities of the Tests of Adult Basic Education for Adult Vocational/Technical programs of Licensed Practical Nursing and Business Education. Each of the three sections of the TABE was examined to determine which contributed to the prediction of success in the two programs, and for those sections that did contribute to the prediction of success, a linear equation was developed to help counselors determine what combinations of scores best predict success. The variables sex and race were examined to establish if either added significantly to the prediction equation. The sample consisted of 100 students from each of the two programs. Discriminant analysis was used to ascertain the predictive capabilities of the variables as well as provide a means to assign group membership to the criterion variable. The TABE and the variables Sex and Race were found significant predictors of success in the LPN program. The three sections of the TABE together classified students better than the other combinations of variables. Reading alone classified students almost as well as the three sections of the TABE. Recommendations included (1) removing an existing cut-off grade level and examining the predictive capabilities again for possible changes, and (2) examining other variables for their predictive capabilities in conjunction with the TABE (Kittner, 1982).

Another ED.D dissertation study conducted at Florida Atlantic University, although not directly relating to the TABE, used predictive discriminant analysis to determine the existence of variable subsets that predicted success in practical nursing programs. Chi-square analysis was used to test the significance of differences between program completion rates of remediated and nonremediated groups of practical nursing students. Of the 362 practical nursing students who entered this particular program approximately sixty percent completed. Analysis revealed that a number of cross-validated models, or predictor sets, were significantly better at predicting success than both maximum and proportional chance criterion. The model that was the best predictor of dropouts contained the variables age, reading sub-test score and math sub-test score. Significant differences ($p<.05$) between the program completion rates of Licensed Practical Nursing students requiring remediation before program entry and those not requiring remediation were found for all sub-tests except reading (Booth, 1992).

Summary

The review of the literature demonstrates that there is indeed a concern in the value of the Tests of Adult Basic Education as a predictor of student success in Nursing and other vocational program areas. The TABE Examiner's Manual admits that the test is not designed to measure specific knowledge. Pucel concludes that the application of mathematics in one occupation may have little relevance for people in other occupations, thus substantiating the question of whether the TABE can measure student ability levels pertaining to all occupations with the same criteria.

The concern over the status of American education in the global environment, and the need for a work force equipped with more and different mathematical concepts, dictates that there be a transformation of our current mathematics curriculum. As this transformation has begun to occur over recent years, has there also become a need to change the instruments for measuring student achievement, and if so, does the TABE reflect these changes? As Lacampagne (1993) points out, the majority of standardized tests are still overly reliant on multiple-choice items that measure predominantly low-level mathematics skills. Does this also hold true for the TABE? Does the TABE in fact measure lower level skills where higher-level skills are required for successful completion of the Practical Nursing program?

Finally, the review of the literature demonstrates that the additional studies cited are contradictory to one another and inconclusive.

Chapter 3: Methods

This chapter describes the procedures followed for this investigation, which were consistent with the procedures outlined by Pucel in the coordinator manual for the Occupational Math Requirements Assessment (OMRA) instrument (Appendix C), which has been adjusted to meet the needs of this study, an analysis comparing the mathematics skills measured by the TABE vs. the mathematics requirements of the Practical Nursing program vs. what is indicated to be the math used on the job.

Research Design

This is a validation study of the TABE and the practical math operations required in the real world of the Practical Nursing occupation.

The variables studied were (1) Math skills identified in job related application samples and (2) the math skills tested on the TABE. The congruence of these two sets of math skills was determined by using the OMRA inventory and the Spearman Rank Correlation.

Using the OMRA inventory, the job related mathematic skills as indicated by the samples collected from active nursing practitioners were evaluated by three review teams, each consisting of an occupational expert and a math expert, and prioritized in regard to the frequency of use as an indicator of relative importance in the workplace.

A listing of the specific mathematic operations tested by the mathematical subtest of the TABE was published by the State of Florida Department of Education, Division of Vocational, Adult, and Community Education in 1989 in the form referred to as the "Modular Analysis of Learning Difficulties"(MALD). This document was produced by the Department of Technical & Vocational Studies "SAIL" project at the University of West Florida.

Following the analysis of each of these sets of mathematic skills, a comparison was made in order to determine whether the math skills tested on the TABE are consistent with the job related math skills identified by the samples collected from nursing practitioners. The correlations across the Practical Nursing mathematics job requirements and the TABE were determined using the Spearman Rank Correlation.

The Setting

The concern of students passing the math section of the TABE and subsequently not succeeding in the Practical Nursing program was expressed by the nursing program staff at the Sarasota County Technical Institute in Sarasota Florida. Most of the support, data collection and evaluation involved these people. Data was collected through a survey of program advisory committee members, local hospitals, medical offices and practicing nursing professionals.

Teams of occupational and math experts were solicited from this same institution. The nursing occupation experts were nursing program instructors, and the math experts included instructional, administrative, and classified staff from the same school.

The OMRA Instrument

The Occupational Math Requirements Assessment (OMRA) is designed to determine the mathematics operations (skills) required for success in an occupation. The results of OMRA can be used as a basis for curriculum development and/or for judging an individual's occupational math preparation.

OMRA was designed for use with occupations requiring less than baccalaureate degree preparation; therefore, the range of mathematics operations presented includes skills typically used in such occupations. It was also designed as a tool for local curriculum and training program development. Consequently, results are not necessarily generalizable beyond a local setting (Pucel, 1992).

The OMRA Coordinator Manual points out that the OMRA can be used to determine the math operations required in an occupation, or as a basis for curriculum development in determining job applications which require math operations. This study was concerned with the math operations used in the Practical Nursing occupation.

The resources required for using the OMRA include (1) a project coordinator, (2) occupational practitioners from whom samples of on-the-job materials which contain applications requiring math can be obtained, (3) occupational experts, (4) math experts and (5) sample job-related materials which include applications requiring math.

In order to conduct the analysis, the occupation which will be the focus of the analysis must be clearly defined. An occupational title which clearly communicates the occupation to be analyzed (in this case Practical Nursing) and a description of the occupation is required.

One or more review teams, each of which includes an occupational expert proficient in the occupation to be analyzed and a math expert who has had experience with students preparing for the occupation, should be assembled. The more teams that are involved, the more valid the analysis will be. Three teams are recommended. Each of the occupational experts should be asked to recommend two or more people who have direct contact with job-related materials used by people in the occupation. People selected should include those individuals who actually engage in or supervise an occupation and who can furnish samples of on the job math requirements.

OMRA is designed for use with samples of job-related materials, which include job applications requiring math. Job related math materials include any materials that contain references to the use of math and which are used by a worker on the job. They include, but are not limited to, materials containing charts, manuals, job aids, and tables used on the job. They can also include verbal references to job activities requiring math. The examples may contain actual math calculations, or they may verbally call for a job application, which requires math. The accuracy of the math assessment generated by the OMRA is enhanced when the job-related math materials are up-to-date and when the accurately represent the entire range of occupational skills. Pucel suggests that the materials can be gathered entirely by mail or through a combination of mail and interviews.

Job Related Materials

Job related mathematic work samples (Appendix E) were obtained through sources supplied by nursing instructors and their advisory committee members and other practicing health care providers and facilities in a three county area. These sources included hospitals, assisted living facilities, pharmacies, doctor's offices, governmental agencies, home health care providers, Nursing textbooks and other printed references. Some sources offered mathematic solutions to specific tasks, while others simply listed tasks without examples (Appendix F). The nature of the data requested was to supply examples of job related math materials used by practical nurses in their particular work environment while performing on the job. The information received demonstrated a range of mathematics applications associated with the occupation, including taking vital signs (temperature, blood pressure, respiration), collecting samples for testing and performing routine lab tests, and measure and administer pharmaceuticals.

The TABE

The Tests of Adult Basic Education (TABE) was examined since it must be taken by Practical Nursing students for entry into the program. TABE 3, form 5 was used. A related document produced by the Department of Technical & Vocational Studies (SAIL project) at the University of West Florida for the Florida Department of Education was published in 1989. This Modular Analysis of Learning Difficulties (MALD) itemized the math operations tested by the TABE, and prioritized the operations listed (Appendix A).

This existing document was used as being representative of the math operations included in the TABE.

The Analysis Teams

Three analysis teams, each of which included an occupational expert proficient in the occupation to be analyzed and a math expert who has had experience with students preparing for the occupation, were assembled.

It is not reasonable to assume that an occupational expert has the necessary knowledge of math, nor that a math expert has the knowledge of the occupation needed to analyze the math requirements of an occupation. Therefore, teams consisting of an occupational expert and a math expert reviewed the materials to identify the math skills involved. Three pairs of occupational and mathematics experts were identified. The occupational experts were vocational nursing instructors at the technical institute where the study took place. The instructors recommended math experts to be invited to work with them. The math experts included a high school math teacher, a testing center statistician and pharmacologist. Each team was charged with the task of evaluating both the mathematics functions included in the student performance standards of the program and the samples of mathematics applications provided from the workplace.

Procedures

The following procedures were adapted from David Pucel's OMRA Coordinator Manual (1992). The process for coordinating the assessment followed the steps outlined below.

A. Determine the specific mathematic operations used routinely on the job by entry level Licensed Practical Nurses.

1. The researcher identified three pairs of occupational and math experts to fulfill the need of analysis teams for the purpose of this study.
2. Occupational practitioners were identified through the recommendations of the members of the analysis teams, nursing experts, program nursing instructors and the Practical Nursing program advisory committee.
3. Samples were obtained from occupational practitioners of job related materials that include applications requiring math. These materials were later compiled and became the job related material source used by occupational experts and math experts when completing their part of OMRA. (Appendix E)
4. A pilot sample application was administered to the analysis teams to review and to confirm their comprehension of the procedures required of the OMRA instrument. (Appendix D)
5. The teams of occupational and math experts were provided with Team Member Evaluation Packets (sets of materials collected pertaining to

this study) including job related materials, the OMRA Inventory, OMRA Applications Supplement, and directions. (Appendix B) These materials were reviewed with each team for understanding. Using the OMRA inventory, each team evaluated the mathematics operations required to complete each of the workplace mathematics applications as supplied in the workplace samples package. For each workplace sample, team members would record the question number in the OMRA inventory box beside the math operations required to solve that sample. Upon completing this process for each sample math application, each team submitted their results to the researcher for compilation

6. After receiving the results for each of the analysis teams, the math operations noted in the OMRA inventory boxes were prioritized, and a list of math operations for the occupation was developed.

B. Determine the specific math operations tested by the mathematical subtests of the TABE.

1. The math operations tested by the TABE are identified and prioritized by the published MALD for Test 3, Form 5. (Appendix A)

C. Determine to what extent the specific mathematical operations identified for each of the variables were congruent.

1. The prioritized lists of job related math operations and the math operations tested by the TABE were compared using the Spearman rank correlation.
2. The job related math applications were compared to the math applications tested on the TABE by a "side by side" comparison of related math operations.

Pilot

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Prior to commencing the study of occupational math requirements for the Practical Nursing program, a pilot was conducted to test each team's understanding of the procedures to be followed, and also to check for internal reliability. The following example was used:

> The perimeter of a shape is 275 feet. Four of its six sides
> add up to 195 feet. The remaining to sides are equal.
> What is the length of each remaining side?
> 275 – 195 = 80 / 2 = 40

The mathematic operations involved in this calculation include subtraction of whole numbers and division of whole numbers. These operations would be recorded for this question on the OMRA inventory in the appropriate blocks for Integers, sections 1-4 and 1-6 as noted in Appendix D.

Compiling of Data

The specific mathematic operations used routinely on the job by Practical Nurses was determined through the collection of samples of job related math applications acquired through a variety of practicing nursing professionals. Using the OMRA inventory, these applications were then broken down into specific math operations as itemized by the OMRA instrument, by each team. The team results were compiled and compared item by item to examine the intergroup consistency. Operations identified by only one team were reviewed to determine if there appeared to be any systematic bias. This was done by reviewing the actual job-related materials and to verify that math was required. A list containing only those operations which were selected by more than one team (or were selected by one group and verified by the other analysis teams) was developed.

A prioritized list of these math operations was created, determined by the frequency of use of an operation. This was done by adding the frequencies of use for all math operations indicated in the cells in the tally block for that operation on the OMRA instrument. Once the total frequency of usage had been calculated for each operation for each team, an average frequency across all three teams was calculated. The prioritized list was created, based first on the number of teams indicating the operation was required, then on the average frequency of use calculated across the teams.

The specific mathematic operations tested by the TABE were published by the Florida Department of Education in the form on a Modular Analysis of Learning

Difficulties (MALD) for the test (Appendix A). This form was used for the prioritizing of the math operations tested by the TABE.

Chapter 4: Findings

This project investigated the following research questions.

1. What are the specific mathematics operations used routinely on the job by entry level Licensed Practical Nurses?
2. What are the specific mathematics operations tested by the mathematical subtests of the TABE?
3. To what extent are the specific mathematical operations identified for each of the above consistent?

The findings of this study are presented for each specific research question relating to mathematics and the Practical Nursing occupation.

Job Related Math Operations

To address research question number one, it was necessary to determine what specific mathematic applications are routinely involved on the job for entry level Licensed Practical Nurses as evidenced by work samples. This was accomplished through the solicitation of a variety of nursing practitioners, including hospitals, assisted living facilities, medical offices, program instructors and advisory committee members. The practitioners were asked for samples of job related materials which include job applications requiring the use of math. These job related math materials could include any materials that contain references to the use of math and which are used by practical nurses on the job They could include, but were not limited to materials containing charts, manuals, job aids, and tables used on the job. They could also include verbal references to job activities requiring math. The materials received in response to the request included textbook examples, hospital patient medication records, physicians' order sheets, classroom learning modules, hospital employment test, lists of job tasks involving math (applications), some sample math problems with solutions, and blood bank procedural examples where math calculations or skills would be required.

Three pairs of occupational and mathematics experts were identified for the purpose of evaluating the materials collected. Occupational experts were vocational nursing instructors at the technical institute where the study took place. The instructors recommended math experts to be invited to work with them. The math experts included two math teachers and a statistician. The teams of occupational and math experts were provided with Team Member Evaluation Packets which included the job related math work sample problems and documents collected by the practitioners, and through consensus agreed on the math applications which were required by the profession to be calculated.

The applications ranged from calculating medicinal dosages to intravenous drip flow rates to household conversions. From all of the examples submitted by all of the contributors, duplications and redundancies were eliminated, condensed or combined to a representative total of fifteen math applications (sample problems) to be broken down into specific math operations (Appendix E). Although the list of summarized math applications is not extensive, it was deemed to be representative of the math needs of the Practical Nursing profession and suitable for the research purposes.

Using the OMRA inventory, each team determined the mathematics operations (multiplication, division, addition, etc.) required to complete each of the workplace mathematics applications as indicated on the workplace samples package solicited from the practical nurses. For example, the math application of converting temperatures from Centigrade to Fahrenheit would involve the two math operations of multiplying decimals and adding whole numbers. Upon completing their evaluations using the materials supplied to them, each team submitted their results to the researcher for compilation.

The job related math applications required for the Practical Nursing profession consisted of a total of 19 of the 63 mathematics operations contained on the OMRA *Inventory* (Table 1). Based on the analyses of the work samples provided by the nursing practitioners conducted by the evaluation teams, it appears as if the nurses surveyed used approximately 30% of the 63 math operations listed on the OMRA. Each math operation was identified as being a part of the work samples by at least one of the three teams. Those skills identified by only one team were verified by all analysis teams as being an acceptable method to perform the applications based on the job materials review, or to be an acceptable alternative method of calculation. Six math operations were identified by all three groups, six by two groups, and seven by only one group. The frequency of these operations were determined by the members of the analysis teams with math experts ranging from a math teacher on team #1, a pharmacist on team #2, and a statistician on team #3 and do not necessarily reflect the preferred methods of mathematic calculations that would be used by any or all individual nurses. For example, where one might prefer to multiply fractions, another might use decimal equivalents. Where one might prefer to use algebraic equations, another may not. This might explain the dramatically varying frequency of some math operations while all teams looked at the same materials.

The frequency of each operation was recorded for each team and then averaged. The operations used were then ranked by priority based on the average number of times it was identified (Table 1).

In examining the correlation between the teams preference in math operations used, using the frequency of each math operation as ranked by each team, the Spearman Rank Correlation was used. With n=19, and a significance at the a_1=.05 level, the critical value for rejecting the null hypothesis p=0 is .338. The results are as follow.

Correlation of Team #1 and Team #2: r = -.9

Correlation of Team #1 and Team #3: r = .64211

Correlation of Team #2 and Team #3: r = -.5535

The variety of the teams' opinions on the priority of math preferences is evidenced by the rejection of the null hypothesis this for each of the correlations among the teams.

Table 1

Practical Nursing – Occupational Math Operations
(Ordered by Frequency Ratings Across Teams)

Cell	OMRA Operation Identified in Work Samples	Team 1	Team 2	Team 3	Avg. f	Priority
Three Teams Selected the Operation						
1-5	Multiply Whole Numbers	5	20	16	13.7	1
1-6	Divide Whole Numbers	2	14	11	9	2
2-4	Multiply Fractions	3	8	8	6.33	3
5-2	Solve the Proportion	4	5	9	6	4
1-4	Subtract Whole Numbers	3	4	3	3.3	5
3-1	Add Decimals	1	2	2	1.7	6
Two Teams Selected the Operation						
2-5	Divide Fractions	0	7	4	3.7	7
5-3	Conversion of Units	0	3	7	3.3	8
6-6	Solve Equations for x	0	41	4	2.7	9
6-7	Solve Equations for fractions for x	0	5	1	2	10
3-5	Multiply Decimals by Decimals	0	2	3	1.7	11
1-3	Add Whole Numbers	0	1	2	1	12
One Team Selected the Operation						
1-7	Round Off	0	0	6	2	13
2-7	Reduce Fractions	0	0	4	1.3	14
4-6	Determine the Percent	0	0	2	0.7	15
2-8	Write as a Mixed Number	0	0	1	0.3	16
2-13	Fraction of a Whole Number	0	0	1	0.3	17
3-2	Subtract Decimals	0	0	1	0.3	18
6-5	Transpose Formulas	1	0	0	0.3	19

TABE Math Operations

To answer research question number two, the published Modular Analysis of Learning Difficulties (MALD) for TABE 3, Form 5 was used since the math operations itemized for this test are already listed and prioritized, not necessarily by the number of times used on the exam, but in their assumed relative importance (Appendix A). Not all of the math operations used in the practical nursing job samples were listed in the MALD, thereby increasing the number of outliers encountered in the analysis. The top 19 prioritized math operations listed by the MALD are listed in Table 2. When compared to the ranked 19 job related math operations on Table 4, a difference in priorities can be observed.

Table 2

Top Prioritized Math Operations TABE

Priority	TABE
1	Expanded Notation
2	Multiply Whole Numbers
3	Divide Whole Numbers
4	Add Fractions
5	Subtract Fractions
6	Multiply Fractions
7	Divide Fractions
8	Add Decimals
9	Subtract Decimals
10	Multiply Decimals
11	Divide Decimals
12	Recognize Numbers
13	Place Value
14	Numeration Comparisons
15	Rounding
16	Estimating
17	Number Lines
18	Exponential Notation
19	Scientific Notation

Congruence Among the Sets

The third research question was to determine to what extent the specific mathematical operations identified from each of the two sources were congruent. The unranked math operations listed on the OMRA instrument are listed in the column on the left in Table 3, and those operations identified in the job related samples and on the TABE MALD are listed in the appropriate column to the right. An "X" in the cells indicates if that math operation was used in the work related math samples and/or on the

TABE. With 19 math operations identified from the work related samples, and 31 from the TABE MALD, a mis-match between the two variables is initially evident.

Table 3

OMRA Instrument Math Operations Used in Work Related Samples, and the TABE

OMRA Operation	Work Related Samples	TABE MALD
INTEGERS		
Words to Arabic Numbers		
Add Whole Numbers	X	X
Subtract Whole numbers	X	
Multiply Whole Numbers	X	X
Divide Whole Numbers	X	X
Round Off	X	X
Add Signed Numbers		
Subtract Signed Numbers		
Multiply Signed Numbers		
Divide Signed Numbers		
FRACTIONS		
Order Fractions		
Add Fractions		X
Subtract Fractions		X
Multiply fractions	X	X
Divide Fractions	X	X
Least Common Denominator		
Reduce Fractions	X	
Write as a Mixed Number	X	
Add Mixed Numbers		X
Subtract Mixed Numbers		X
Multiply Mixed Numbers		X
Divide Mixed Numbers		X
Fraction of a Whole Number	X	X
DECIMALS		
Add Decimals	X	X
Subtract Decimals	X	X
Decimal to a Fraction		
Fraction to a Decimal		
Multiply a Decimal by a Decimal	X	X
Divide a Decimal by a Decimal		X

OMRA Operation	Work Related Samples	TABE MALD
PERCENTS		
Convert Percents to Fractions		
Convert Percents to Decimals		
Convert Fractions to Percents		X
Take the Percent		X
Determine the Percent	X	X
RATIOS		
Ratio in Lowest Terms		X
Solve the Proportion	X	X
Conversion of Units	X	
ALGEBRA		
Add Monomials		
Subtract Monomials		
Divide Monomials		
Transpose Formulas	X	
Solve Equations for x	X	X
Solve Equations with Fractions for x	X	X
Solve Equations: Graphically		
Solve Equations: Algebraically		
Find the Root		X
Factor Quadratic Equation		
Quadratic Equation – Complete the Square		
Quadratic Equation – Use Quadratic Formula		
GEOMETRY		
Identify Two Dimensional Figures		
Identify Three Dimensional Figures		
Estimate Angles		X
Name Angles		
Name Combination of Angles		
Perimeter		X
Circumference or Diameter of a Circle		
Area of a Square or Rectangle		X
Area of a Triangle or Circle		X
Volume of a Rectangular Solid		X
Volume of a Cylinder or Sphere		X
Total Math Skills	19	31

Correlation Between TABE and Job Sample Rankings.

With the job related math operations and the TABE math operations being prioritized, or ranked, the Spearman rank correlation was used to determine the correlation between the TABE test and the practical nursing mathematics job samples.

The mathematic operations in the left column of table 4 are listed according to the ranked list of the job related math requirements (x). The TABE MALD rankings of those same operations are listed in the next column (y). Where the math operation of multiplying whole numbers was ranked number 1 in the job related math skills listing from Table 1, the TABE MALD rated that same operation as number 2. The same was done for each of the 19 job related math operations identified from the work samples. In some cases the TABE MALD did not include a ranked job related math operation at all. These are reflected as the highest rankings in the TABE column. The differences were subtracted and squared, thus preparing for the calculation of the value of r.

Table 4
Correlation of Math Skill Priorities between the TABE and the Practical Nursing Job Samples.

Prioritized Description of Operation	Job Related Math (x) Ranking	TABE (y) Ranking	D	D^2
Multiply Whole Numbers	1	1	0	0
Divide Whole Numbers	2	2	0	0
Multiply Fractions	3	3	0	0
Solve the Proportion	4	15	11	122
Subtract Whole Numbers	5	17	12	144
Add Decimals	6	5	1	1
Divide Fractions	7	4	3	9
Conversion of Units	8	10	2	4
Solve Equations for x	9	14	5	25
Solve Equations for fractions of x	10	9	1	1
Multiply Decimals by Decimals	11	7	4	16
Add Whole Numbers	12	18	6	36
Round Off	13	8	5	25
Reduce Fractions	14	12	2	4
Determine the Percent	15	13	2	4
Write as a Mixed Number	16	11	5	25
Fraction of a Whole Number	17	19	2	4
Subtract Decimals	18	6	12	144
Transpose Formulas	19	16	3	9

$\sum D^2 = 573$

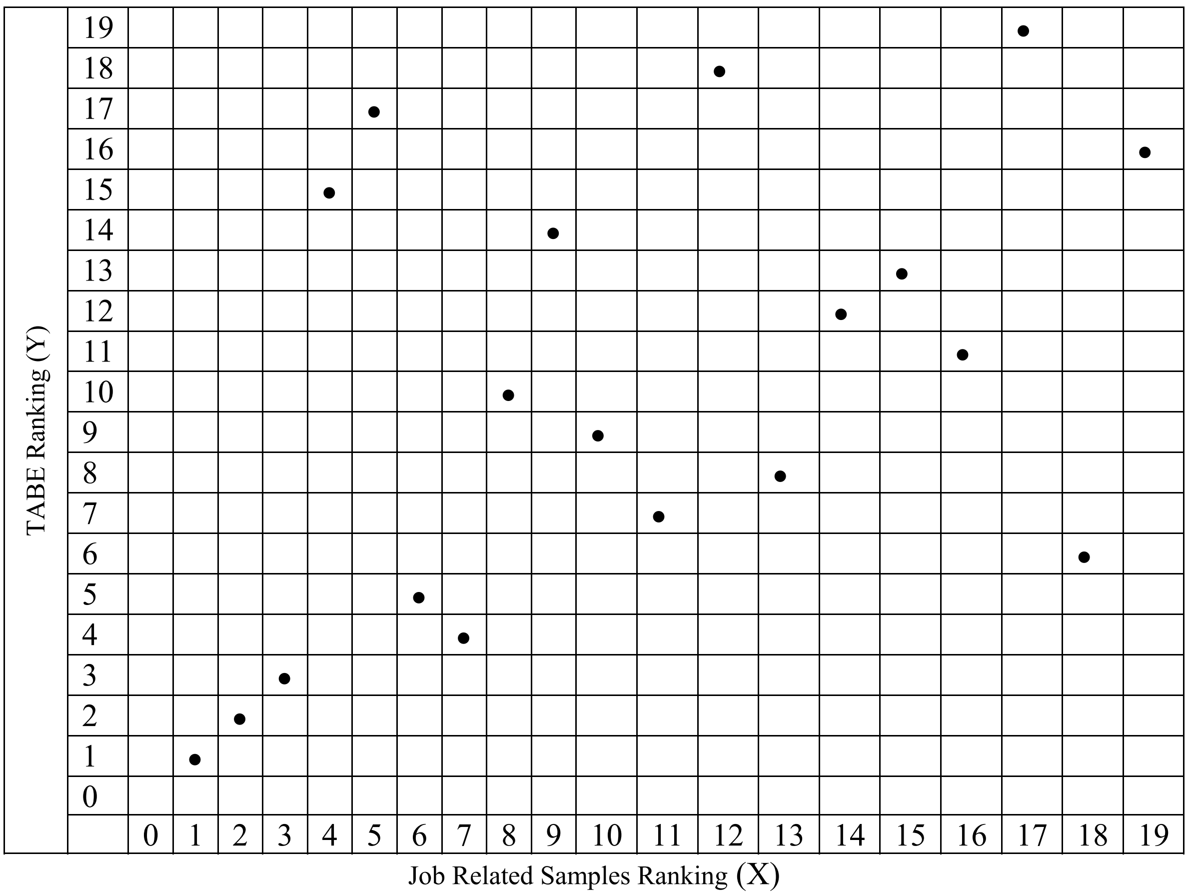
Calculated value of r $= 1 - \frac{6\sum D^2}{n(n^2-1)} = 1 - \frac{6(573)}{19(361-1)} = 1 - \frac{3438}{6840} = 1 - .5026 = .4974$

With a significance at the $a_1 = .05$ level when n=19, the critical value for rejecting the null hypothesis p=0 is 0.338 (Glass & Hopkins, Table K, 1984).

With an r of .4974, the null hypothesis will be rejected, demonstrating little correlation among the Practical Nursing job requirements math and that tested by the TABE.

A visual reference to the correlation between the Practical Nursing mathematics job requirements (X) and the TABE test (Y) is demonstrated by the following scatter plot (Figure 2).

Figure 2
Scatter Plot of Spearman Rank Correlation across Practical Nursing Mathematics Job Requirements and the TABE



It can be observed that there exists little correlation among the Practical Nursing job related math skill priorities and priorities of the math skills tested by the TABE. Although some operations such as subtracting whole numbers may seem to be inclusive in math operations in daily life, they were not specifically included in the TABE MALD and as such were given the highest of the TABE rankings.

Chapter 5: Discussion, Conclusions, Implications and Recommendations

This preliminary study was based on a concern expressed by Practical Nursing staff at a technical institute. The concern was that students who had scored acceptably on the Tests of Adult Basic Education (TABE) for program entry very often were unable to succeed in the actual math requirements of the program. They were not prepared for the mathematics required by the curriculum of the program as outlined by the Florida Department of Education Curriculum Frameworks. In accordance with rule 6A-10.040 FAC, as stated in the curriculum frameworks, the minimum skills grade required for the program when offered at the postsecondary adult vocational level 11.0 for mathematics. This grade level number corresponds to a grade equivalent score obtained on a state designated basic skills examination (the TABE). Instructors were concerned that the TABE, while testing general math skills, did not reliably test the specific math skills necessary for successful completion of the Practical Nursing program.

The intent of this study was to compare job related math requirements of the Practical Nursing occupation as evidenced from work samples collected, and then determine how congruent these math skills were with those measured by the TABE math sections.

The Occupational Math Requirements Assessment (OMRA), developed by David Pucel in 1992, was chosen as the instrument to be used for this purpose. The procedures for this study were based on those suggested by the instrument.

Summary of Study Procedures

Three occupational experts were selected nursing instructors from a Practical Nursing program. These three occupational experts selected three math experts with which to form teams for the purpose of assessing the scope of math in question. Additional participants also suggested by the nursing instructors included nursing program advisory committee members representing a sampling of local hospitals, assisted living facilities, medical offices, blood banks and other current practitioners. These sources were instrumental in the collection of samples of job related work mathematics required for the profession.

Following the selection of participants and the forming of the teams of experts as outlined by the OMRA instrument, samples of job related mathematics requirements were collected from a variety of sources.

Using the OMRA instrument, each of the three teams evaluated the job math applications, and determined the specific mathematics operations required to complete these applications.

The mathematics portion of the TABE (Form 5, Level A) was used as the sample test, as this version of the TABE was in effect at the time of the initiation of this study for admission standards required by the Practical Nursing and other occupational program areas. The mathematic operations determined by the teams to be required for job related math applications were compared to the operations stated on the TABE "MALD". The job related operations were prioritized by the average usage of each as determined by the teams, and ranked accordingly. The TABE math operations were ranked as stated by the MALD.

The Spearman rank correlation was used to evaluate the correlation between the TABE and the Practical Nursing program mathematic job requirement rankings.

Discussion of Findings

A summary of the findings of this study are as follow:

- Based on a collection of work related math samples submitted by local practitioners, it was determined that the Practical Nursing occupation requires 15 math applications which utilize 19 math operations to solve.

- It appears that the Practical Nursing practice uses only a moderate amount of math on the job, as evidenced by utilizing only 19 of the 63 math operations contained on the OMRA inventory.

- The TABE does measure to some extent the mathematics required by the Practical Nurses. This was determined by the use of the Spearman rank correlation between the top ranked TABE math operations and those determined by the OMRA instrument from the job related math applications. With an r of .2202, the correlation was near the critical value of 0.338.

Conclusions

It may be concluded from this study that assumptions that are often made by educators and policy makers regarding the level of mathematics needed for entry into and for success in the completion of a vocational education program may not be consistent with the level of math skills that workers in that occupation need to perform their job related duties.

Through the collection of job related math samples (applications) supplied by Practical Nursing practitioners, the actual mathematic operations required to calculate those applications were determined through the use of the OMRA instrument. When compared to the TABE mathematic operations identified on the TABE MALD, it was determined that the TABE is not a very adequate tool for measuring a student's basic understanding of math, although it is far from perfect for measuring the requirements of the Practical Nursing program with an r =. 4974.

One major problem found with the math skills evaluated on the TABE in relation to the Practical Nursing program is that reference to the metric system in the TABE math sections is not evident. The medical field, including Practical Nursing, is primarily driven by the metric system. Although the same math operations (add, subtract, multiply, divide, etc.) are required to work a problem whether in metric or standard measures, the possible lack of understanding of metrics could be detrimental to a student's success in the program, whether scoring high on the TABE or not. This may not be related to the math operations involved, but rather in the terminology.

Implications

- Where there is a low correlation with the job related math operations and the math operations tested by the TABE, it may hold that although a student's score reflects their grade level ability in basic math operations, it may not accurately reflect a student's ability to successfully complete the Practical Nursing program.
- The TABE may be considered to be a valid instrument for school or program entry, but should not be relied on as a predictor of student success.
- The question is raised as to whether the curriculum is also part of the problem. Are teachers of the program teaching the wrong math? Are they teaching more and different math than is required by the occupation?

Recommendations For Practice

- A recommendation for increasing the correlation between the TABE and job related math operations, might be to add the job math operations not included into the TABE.
- The Practical Nursing program could develop and administer its own mathematics exam utilizing those applications and operations as discovered in this study, or as determined by conducting their own research in soliciting data from their own advisory committees and local practitioners.

- The Practical Nursing program staff appears to be aware of the problem, which initiated this study, and should be prepared to put more emphasis on teaching their students the required math.
- Each TABE form comes with several different levels. The TABE Form 5, Level A was used for this study. If TABE Form 5, Level E or M were used, then different math operations such as adding and subtracting whole numbers would have been included. A review of all forms and the levels included in those forms should result in a relatively appropriate instrument. In addition, the TABE is also offered in a Health Form for Health Occupations. This should deserve some investigation.

Suggestions for Future Research

- Future research on this topic might be implemented in other geographical areas to determine if the math skills important to the Practical Nursing occupation are the same wherever it is found.
- A different mathematics assessment instrument other than the OMRA might be used to compare the differences in real world job related math operations required and those tested by the TABE.
- Investigate the correlation between TABE and other technical programs to see how accurately it predicts student success in those areas.
- Utilize each available version of the TABE in order to determine which would be most appropriate for a specific program area.

- Use the OMRA instrument to assess the math operations of the TABE, rather than utilizing the existing MALD.
- Utilize a different mathematics instrument other than the TABE to measure a student's ability to succeed in the program.

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Appendix A

Modular Analysis Of Learning Difficulties (MALD)
TABE Test Forms 5 and 6, Level A
Mathematics

LEVEL
A
MATHEMATICS

MODULAR ANALYSIS OF LEARNING DIFFICULTIES (MALD)

TEST 4 CONCEPTS AND APPLICATIONS

Priority	CATEGORY OBJECTIVE Subskill	FORM 5	Critical	FORM 6	Critical	Catalog
	NUMERATION *26*					
12a	Recognize Numbers	Required	R	4	1	12a
12c	Comparisons	22	1	30	1	12c
1	Expanded Notation	1	1	1	1	1
12b	Place Value	23	1	28	1	12b
12d	Rounding	21	1	23	1	12d
12e	Estimating	7	1	11	1	12e
12f	Number Lines	2	1	2 26	1	12f
12g	Exponential Notation	5 15	1	12	1	12g
12i	Roots, Radicals	39	1	Required	R	12i
12h	Scientific Notation	34	1	37	1	12h
	NUMBER SENTENCES *27*					
17a	Ratio and Proportion	3	1	25	1	17a
17b	Unknowns	35	1	13	1	17b
17c	Functions and Relations	29 40	1	33	1	17c
17d	Inequalities	Required	R	32	1	17d
17e	Equations	25	1	27	1	17e
	NUMBER THEORY *28*					
13a	Properties	31 37	1	22	1	13a
13b	Divisibility	4	1	Required	R	13b
13c	Multiples	Required	R	38	1	13c
13d	Factors	Required	R	29	1	13d
13e	Equivalent Forms	12	1	21	1	13e
	PROBLEM SOLVING *29*					
15a	Pre-solution	9 11 17	1	7 16 17	1	15a
15b	One-step	14 30	1	8 14	1	15b
15c	Multi-step	6 10 13	1	9 15 18	1	15c
15d	Percents	16	1	Required	R	15d
15e	Graphs	26 27	1	39 40	1	15e
15f	Probability, Statistics	24	1	5 6	1	15f
	MEASUREMENT *30*					
18a	Length	19	1	34	1	18a
18b	Temperature	32	1	36	1	18b
18c	Perimeter	8	1	Required	R	18c
18d	Volume	33	1	35	1	18d
18e	Surface Area	Required	R	31	1	18e
	GEOMETRY *31*					
19a	Points, Lines, Segments, Rays	Required	R	3	1	19a
19b	Angles	Required	R	10 19	1	19b
19c	Congruency	Required	R	20	1	19c
19d	Similarity	20	1	Required	R	19d
19e	Pythagorean Theorem, Coordinate Geometry	36	1	24	1	19e
19f	Planes	18	1	Required	R	19f
19g	Relationships Among Angles	28	1	Required	R	19g
19h	Triangles	38	1	Required	R	19h

Appendix A (Continued)

NAME ______________________ SSN ______________

VOCATIONAL GOAL ______________________ DATE __________

LEVEL

A

MATHEMATICS

MODULAR ANALYSIS OF LEARNING DIFFICULTIES (MALD)

TEST 3 COMPUTATION

Priority	CATEGORY OBJECTIVE Subskill	FORM 5	Critical	FORM 6	Critical	Catalog
	ADDITION					
8	Decimals *13*	4 8 10 12	1	6 8 12 23	1	8
4	Fractions *14*	13 17 19 21	1	16 19 21 38	1	4
	SUBTRACTION					
9	Decimals *16*	6 20 23 35	1	9 14 18 30	1	9
5	Fractions *17*	2 24 26 28	1	5 25 33 36	1	5
	MULTIPLICATION					
2	Whole Numbers *18*	1 3 7 11	1	1 3 10 13	1	2
10	Decimals *19*	5 14 22 29	1	15 17 20 26	1	10
6	Fractions *20*	16 25 32 38	1	22 24 28 40	1	6
	DIVISION					
3	Whole Numbers *21*	9 15 18 31	1	2 4 7 11	1	3
11	Decimals *22*	34 37 40 42	1	32 35 37 41	1	11
7	Fractions *23*	27 30 33 36	1	27 29 31 34	1	7
14	INTEGERS AND *24* PERCENTS	39 43 45 47	1	39 42 44 46	1	14
16	EXPONENTS AND *25* ALGEBRAIC EXPRESSIONS	41 44 46 48	1	43 45 47 48	1	16

Produced by Department of Technical & Vocational Studies (SAIL Project),
The University of West Florida, Pensacola

Appendix B

OMRA Instrument

PERFORMANCE-BASED

OCCUPATIONAL MATH REQUIREMENTS ASSESSMENT (OMRA)

OMRA Instrument

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PERFORMANCE-BASED OCCUPATIONAL MATH REQUIREMENTS ASSESSMENT (OMRA)

Introduction

The OMRA is designed to be completed by an analysis team composed of an occupational expert and a math expert knowledgeable about the occupation to be analyzed. The analysis will yield (1) a list of math operations required for performing successfully in the occupation and (2) a list of job applications requiring the math operations (a list which can be used as a context within which to teach the math operations). Follow the directions to complete the OMRA Inventory and the OMRA Applications Supplement.

Determining Math Operations Associated with Job Applications

1. Review the contents of the attached OMRA Inventory.

   - Categories of math are presented in bold letters.
   - Each numbered cell within a category contains a type of math operation.
   - Math operations in each category are arranged from simple to complex.

2. Review each of the job-related math materials included in the packet.

   - Review each page of each document.
   - Locate math applications in the materials. The math applications may actually be indicated by numerical calculations (2 + 2); they may be indicated verbally (e.g., "calculate the number of board feet necessary"); or they may be implied (e.g., "order the lumber needed"). Therefore, each page must be reviewed carefully for math calculations.

Sample job application: An aviation electronics manual requires the calculation of resistor wattage for selecting a replacement resistor. The application is as follows:

Calculate the wattage of a resistor. This is done using the following formula:

$$W = \frac{E^2}{R}$$

Example substitutions: $W = \frac{40 \times 40}{680}$

3. Analyze each job application in terms of the type of math operations it contains (e.g., addition of whole numbers, division of fractions, conversion of a decimal to a fraction). Many applications will require more than one math operation. If an application uses two or more operations, note each separately.

   Example: $\frac{40 \times 40}{680}$ uses "Multiply Whole Numbers" and "Divide Whole Numbers."

   Care must be taken to classify only the individual math operations used with a job application. For example, if an application contains an algebraic formula but the person does not have to manipulate the formula and only does simple addition and multiplication, the operations are entered under addition and multiplication and not under algebra. The operation would only be entered as an algebraic operation if a person has to reconfigure the formula using rules of algebra.

   Example: $W = \frac{E^2}{R}$ can be reconfigured to $E^2 = W \times R$.

4. After identifying each math operation, do the following.

   - Locate that operation by name or by example on the OMRA Inventory.
   - Rate the average number of times you would estimate a person would do the operation per month for that particular application.

     1 = 1 to 5 times per month
     2 = 6 to 10 times per month
     3 = 11 or more times per month

Appendix B (Continued)

- Place that rating in one of the small boxes in the shaded "tally block" to the right of that operation. Each box is used to record the rating for one operation.

  Example: If an electronics technician is required to multiply whole numbers (e.g., 40 × 40 = 1600) about eight times per month when calculating resistor wattage, enter a 2 in one of the "Multiply Whole Numbers" boxes.

  Multiply Whole Numbers

2			

5. As you find an application that requires math, also record that job application on the OMRA Applications Supplement for curriculum development. (See the sample at the end of the OMRA Instrument.)

   - List each math application by name (e.g., "calculate resistor wattage") on the attached OMRA Applications Supplement Sheet.
   - List the operation code (e.g., 1-5) from the OMRA Inventory for each operation which is used in the application.
   - Indicate the job-related material source for each application by source number and page number (e.g., 1.23 indicates page 23 of source 1).

6. Complete steps 3 through 5 for each job application you find that requires math in the job-related materials. If more than twelve applications are identified that require a particular operation, place an X over the entire tally block to indicate that the operation is used very often. After doing so, you no longer need to tally additional applications of that operation.

7. Operations that are identified from the job-related materials but that do not appear in the OMRA Inventory should be recorded on the back of the inventory.

Integers		
Words to Arabic Numbers Two hundred eighty = 280	1- 1	
Arabic Numbers to Words 152 = One hundred fifty two	1- 2	
Add Whole Numbers 830 + 94 + 12 = 936	1- 3	
Subtract Whole Numbers 364 − 158 = 206	1- 4	
Multiply Whole Numbers 303 × 97 = 29,391	1- 5	
Divide Whole Numbers 92⟌2024 = 22	1- 6	
Round Off To the nearest ten, hundred, etc. e.g., 162 → 160; 260 → 300	1- 7	
Add Signed Numbers −40 (+) −16 = −56	1- 8	
Subtract Signed Numbers +18 (−) −43 = +61	1- 9	
Multiply Signed Numbers +6 (×) −8 = −48	1-10	
Divide Signed Numbers +42⟌−420 = −10	1-11	

Fractions		
Order Fractions Arrange in ascending order $\frac{1}{8}, \frac{3}{8}, \frac{1}{2}, \frac{10}{16}, \frac{70}{80}$	2- 1	
Add Fractions $\frac{3}{11} + \frac{4}{11} + \frac{9}{11} = \frac{16}{11}$	2- 2	
Subtract Fractions $\frac{7}{16} - \frac{6}{16} = \frac{1}{16}$	2- 3	
Multiply Fractions $\frac{1}{3} \times \frac{1}{2} = \frac{1}{6}$	2- 4	
Divide Fractions $\frac{4}{9} \div \frac{2}{3} = \frac{2}{3}$	2- 5	
Least Common Denominator $\frac{1}{2}, \frac{1}{8}, \frac{1}{16}$ Answer = 16	2- 6	
Reduce Fractions $\frac{12}{16} = \frac{3}{4}$	2- 7	
Write as a Mixed Number (an improper fraction) $\frac{11}{8} = 1\frac{3}{8}$	2- 8	
Add Mixed Numbers $6\frac{9}{16} + 4\frac{1}{2} = 11\frac{1}{16}$	2- 9	
Subtract Mixed Numbers $12\frac{3}{8} - 9\frac{15}{16} = 2\frac{7}{16}$	2-10	
Multiply Mixed Numbers $5\frac{9}{16} \times 2\frac{3}{8} = 13\frac{27}{128}$	2-11	
Divide Mixed Numbers $\frac{3\frac{1}{8}}{\frac{5}{16}} = 10$	2-12	
Fraction of a Whole Number $\frac{2}{3}$ of 27 = 18	2-13	

OCCUPATIONAL MATHEMATICS REQUIREMENTS
ASSESSMENT INVENTORY

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Appendix B (Continued)

Decimals

Add Decimals
.724 + .101 = .825 — 3-1

Subtract Decimals
.729 − .397 = .332 — 3-2

Decimal to a Fraction
$.833 = \frac{833}{1000}$ — 3-3

Fraction to a Decimal
$\frac{5}{16} = .3125$ — 3-4

Multiply a Decimal by a Decimal
0.077 × 0.023 = 0.001771 — 3-5

Divide a Decimal by a Decimal
$0.311 \overline{)0.933} = 3.0$ — 3-6

Percents

Convert Percents to Fractions
$25\% = \frac{8}{32}$ — 4-1

Convert Percents to Decimals
$3\frac{1}{2}\% = .035$ — 4-2

Convert Fractions to Percents
$\frac{11}{32} = 34.375\%$ — 4-3

Convert Decimals to Percents
.32 = 32% — 4-4

Take the Percent
10% of 45 = ??
Answer: 4.5 — 4-5

Determine the Percent
?? of 48 = 12
Answer: 25% — 4-6

Ratios

Ratio in Lowest Terms:
12 : 3
Answer: 4 : 1 — 5-1

Solve the Proportion:
?? : 6 = 14 : 4
Answer: 21 — 5-2

Conversion of Units
$3\ ins. \times \frac{1\ ft.}{12\ ins.} = 0.25\ ft.$ — 5-3

Algebra

Add Monomials
$7xy + 9xy = 16xy$ — 6-1

Subtract Monomials
$(5x-2y) - (8x+12y) = -3x-14y$ — 6-2

Multiply Monomials
$(x^4)(x^7) = x^{11}$
$(x^{\frac{1}{2}})(x^{\frac{1}{4}}) = x^{\frac{7}{8}}$ — 6-3

Divide Monomials
$6xy^2 \div 2xy = 3y$
$x^{\frac{3}{4}} \div x^{\frac{1}{8}} = x^{\frac{1}{4}}$ — 6-4

Transpose Formulas: Solve for r.
$t = \frac{d}{r}$ Answer: $r = \frac{d}{t}$
$P = IR^2$ Answer: $R = \sqrt{\frac{P}{I}}$ — 6-5

Solve Equations for x.
$x - 6 = 0$
Answer: $x = 6$ — 6-6

Solve Equations with Fractions for x.
$\frac{5x}{3} = 20$
Answer: $x = 12$ — 6-7

Solve Equations: Graphically.
$3x - 4y = 5$
$5x + y = 16$
Answer: $x = 3;\ y = 1$ — 6-8

Solve Equations: Algebraically.
$5x - 6y = 2$
$3x - 7y = 9$
Answer: $x = \frac{-40}{17};\ y = \frac{-39}{17}$ — 6-9

Find the Root
$\sqrt{169} = 13$
$\sqrt{x^6} = x^3$ — 6-10

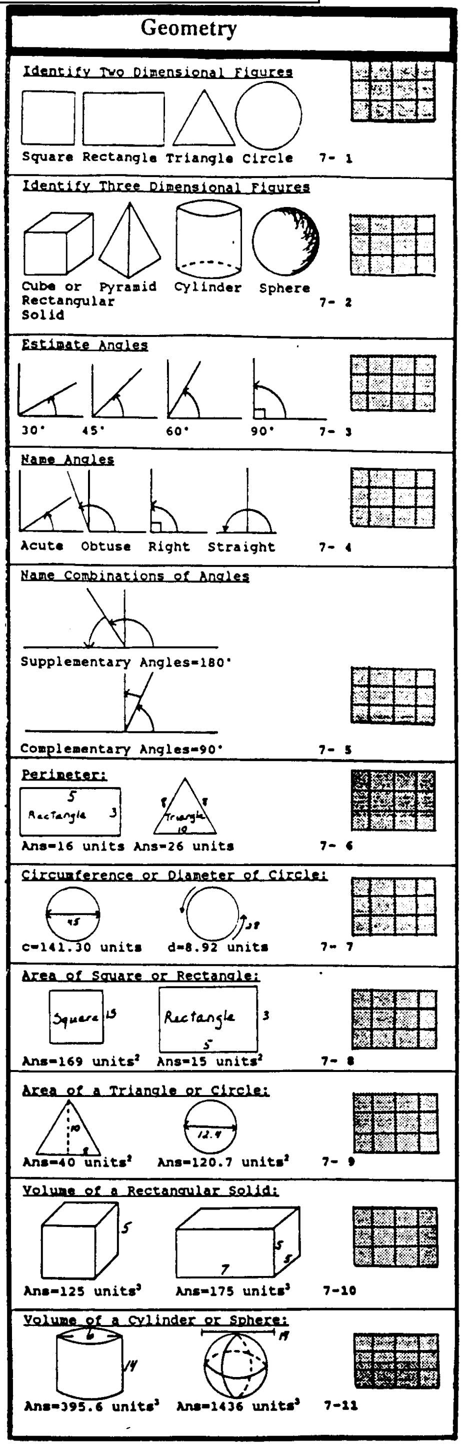
Factor Quadratic Equation
$x^2 - 5x + 6 = 0$
Answer: $x = 2;\ x = 3$ — 6-11

Quadratic Equation - Complete the Square.
$x^2 - 6x - 7 = 0$
Answer: $x = 7;\ x = -1$ — 6-12

Quadratic Equation - Use Quadratic Formula.
$3x^2 + 7x + 2 = 0$
Answer: $x = -\frac{1}{3};\ x = -2$
Quadratic Formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ — 6-13

I-5

Appendix B (Continued)



Appendix B (Continued)

OMRA Applications Supplement Sheet

Name ______________________ Occupation ____________________

	Description of Application	Operation Code	Source#.p#
e.g.	Calculate resistor wattage	1-5, 1-6	1.23, 4.5
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Appendix C

OMRA Coordinator Manuel

PERFORMANCE-BASED

OCCUPATIONAL MATH REQUIREMENTS ASSESSMENT (OMRA)

Coordinator Manual

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PERFORMANCE-BASED OCCUPATIONAL MATH REQUIREMENTS ASSESSMENT (OMRA)

OMRA COORDINATOR MANUAL

Introduction

Purpose

The Occupational Math Requirements Assessment (OMRA) is designed to determine the mathematics operations (skills) required for success in an occupation. The results of OMRA can be used as a basis for curriculum development and/or for judging an individual's occupational math preparation. OMRA was designed for use with occupations requiring less than baccalaureate degree preparation; therefore, the range of mathematics operations presented includes skills typically used in such occupations. It was also designed as a tool for local curriculum and training program development. Consequently, results are not necessarily generalizable beyond a local setting. If more generalizable results are desired, the sampling procedures must be expanded to include a broader sample of job-related materials and a broader base of experts.

OMRA includes the OMRA Inventory (for recording the required math operations) and the OMRA Applications Supplement (for recording sample job applications for which each operation is used). These applications are useful in developing contexts for occupationally relevant math instruction. [Note: A glossary of terms is presented at the end of the Coordinator Manual.]

OMRA Uses

OMRA can be used to do the following:

1. Determine the math operations required in an occupation.

2. Determine, as a basis for curriculum development, job applications which require the math operations.

Resources Required

1. Project coordinator (the person who will manage the assessment)

2. Occupational practitioners (individuals who actually engage in or supervise an occupation and can furnish samples of on-the-job materials which contain applications requiring math)

3. An occupational expert (e.g., an occupational instructor)

4. A math expert (e.g., a math instructor)

5. Sample job-related materials which include applications requiring math

Process for Coordinating the Assessment

1. Define the occupation to be analyzed.

2. Identify occupational experts and math experts.

3. Identify occupational practitioners (e.g., members of advisory committees).

4. Obtain from occupational practitioners samples of job-related materials that include applications requiring math. (These materials will later be compiled and become the job-related material source used by occupational experts and math experts when completing their part of OMRA.)

5. Provide the occupational experts and math experts with job-related materials and OMRA—including the OMRA Inventory, OMRA Applications Supplement, and directions. [Note: The OMRA Inventory contained in the OMRA Directions has been printed as three separate pages for easy duplication of this manual. However, it is recommended that the three pages be placed side by side and duplicated on one 11" by 17" sheet for distribution.]

6. After receiving the results for each of the expert teams, develop a prioritized list of math operations required for the occupation.

7. Assemble the list of sample job applications which require math.

Defining the Occupation To Be Analyzed

In order to conduct the analysis, the occupation which will be the focus of the analysis must be clearly defined. An occupational title which clearly communicates the occupation to be analyzed (e.g., machinist, secretary, electronics technician) and a description of the occupation are required. If the occupation has been in existence for some time, a beginning point for obtaining both the title and a description is the *Dictionary of Occupational Titles* (*DOT*). This *DOT* definition may need to be modified to suit local needs. If the occupation is newly emerging and a formal definition has not been developed, it is recommended that a *DOT*-like definition be developed by interviewing people employed in the occupation.

Identifying Occupational and Math Experts

One or more teams—each of which includes an occupational expert proficient in the occupation to be analyzed and a math expert who has had experience with students preparing for the occupation—should be assembled. The more teams that are assembled, the more valid the analysis will be. Three teams are recommended so that differences among teams' analyses can later be reviewed.

[Note: If the procedure is to be used with vocational education programs, the following process is recommended for identifying the occupational and math experts and the occupational practitioners. First, identify instructors of vocational programs which prepare people for the occupation to be analyzed. Ask the instructors to recommend members of their advisory committees who have access to materials actually used on the job. Those advisory committee members can then provide the materials or can ask others in their organizations to do so. The occupational instructors can also recommend math experts.]

Identifying Occupational Practitioners

Each of the occupational experts should be asked to recommend two or more people who have direct contact with job-related materials used by people in the occupation (e.g., members of their advisory committees). People selected should include those individuals who actually engage in or supervise an occupation and who can furnish samples of on-the-job math requirements.

Obtaining Samples of Job-Related Materials

OMRA is designed for use with samples of job-related materials which include job applications requiring math. Job-related math materials include any materials that contain references to the use of math and which are used by a worker on the job. They include, but are not limited to, materials containing charts, manuals, job aids, and tables used on the job. They can also include verbal references to job activities requiring math.

The examples may contain actual math calculations (number calculations), or they may verbally call for a job application which requires math. For example, a carpenter may be required to calculate the board feet needed to cover a hardwood floor. The job manual on the installation of the hardwood floor may just assume a carpenter can do such a calculation and may merely indicate "order the hardwood flooring." The actual calculations might be performed with a calculator or written on a piece of board. Such an application requires math and, therefore, needs to be included in the assessment. The accuracy of the math assessment generated by OMRA is enhanced when the job-related math materials are up-to-date and when they accurately represent the entire range of occupational skills.

The materials can be gathered entirely by mail or through a combination of mail and interviews. The following procedure is suggested.

1. Call or write to each practitioner selected. Invite her or him to participate in the project. The invitation should include (1) an explanation of the intent of the project, (2) an explanation of why a sample covering the *range* of job-related materials requiring math calculations is important, (3) an explanation of which types of materials and/or examples of math applications should be provided, (4) two samples of related math materials as examples, and (5) a telephone number which

they can call to have questions answered. (Even if the initial invitation is by phone, a follow-up letter summarizing the information should be sent.)

2. Collect the related math materials and examples.

   Option 1: Ask the occupational practitioners to send you copies of the job-related math materials within one week.

   Option 2: Arrange an interview with each practitioner after one week and collect the job-related math materials. (Interviews provide an opportunity to speak with each practitioner to obtain further clarification of the materials and to ensure that the full range of occupationally relevant math materials has been collected.)

3. From the materials collected, collate the packet of job-related materials to be included in the analysis. All teams performing an analysis must receive the same packet of materials. Select materials which sample the full range of materials that are used in the specific occupation. If the materials collected do not represent a full range, obtain additional materials.

4. Assign a number to each of the pieces of material for use as a common reference by participating experts.

Administering OMRA to Teams of Occupational and Math Experts

Contact the teams of occupational and math experts and inform them that you will be sending them a packet of materials including a sample of job-related materials and OMRA. Ask them to analyze the job-related materials and to return their results within one week. If a fee will be paid for their participation, clearly indicate what the fee will be and when it will be paid. (Even if the initial invitation is by phone, include a follow-up letter summarizing the information when you send the assessment packet.)

The packet should include the following:

1. A cover letter

2. The job-related materials

3. OMRA (including the OMRA Inventory and OMRA Applications Supplement)

4. A stamped envelope with return address

All teams should receive exactly the same packet unless special contractual arrangements have been made and are indicated in the cover letter.

Developing a Prioritized List of Math Operations

After the results have been gathered from all expert teams, do the following:

1. Total the ratings in each of the cells within each separate tally block for each team (e.g., four cells with 1, 3, 2, and 1 total 7).

2. Add the number for a given operation for all teams. Tally blocks which were crossed with an X, indicating 12 or more applications, should be considered to have a total of 36 (12 × 3).

3. Develop a prioritized list of math operations used in the occupation. Do this by placing the operation which was selected by all teams and which has the largest total first, the one used by all teams and has the next largest total second, and so on. After all of the operations selected by all teams have been placed in order, then place those selected by the next largest number of teams in order. This procedure gives those operations selected by all teams higher priority than those selected by fewer teams. (See Table C-1 for a sample prioritized list.)

Assembling the List of Sample Job Applications

The lists of applications obtained from the different teams should be synthesized and placed in order by operation number. (See Table C-2 for a sample of a synthesized list of applications.)

Appendix C (Continued)

Table C-1
Sample of Secretary—Occupational Math
(Ordered by Frequency Ratings Across Teams)

Cell No.		Grp 1	Grp 2	Grp 3	Avg. Freq.	Priority
	Three Teams Selected the Operation					
1- 3	Add Whole Numbers	30	14	32	25.3	1
3- 5	Multiply a Decimal by a Decimal	26	10	24	20.0	2
3- 1	Add Decimals	20	20	17	19.0	3
4- 5	Take the Percent	15	11	12	12.7	4
3- 2	Subtract Decimals	15	6	11	10.7	5
1- 5	Multiply Whole Numbers	19	3	5	9.0	6
1- 4	Subtract Whole Numbers	20	3	3	8.7	7
3- 6	Divide a Decimal by a Decimal	4	5	3	4.0	8
1- 8	Add Signed Numbers	2	2	7	3.7	9
4- 6	Determine the Percent	4	5	1	3.3	10
	Two Teams Selected the Operation					
4- 2	Convert Percents to Decimals	14	0	14	9.3	11
4- 4	Convert Decimals to Percents	7	7	0	4.7	12
1- 7	Round Off	3	2	0	1.7	13
	One Team Selected the Operation					
5- 3	Conversion	20	0	0	6.7	14
1- 6	Divide Whole Numbers	0	2	0	0.7	15
1- 1	Convert Words to Arabic Numbers	1	0	0	0.3	16
1- 2	Convert Arabic Numbers to Words	0	1	0	0.3	17

Appendix C (Continued)

Table C-2
Sample of Electronics Applications

	Operation Code	Description of Application	Source #p. #
1	1-3 Add Whole Numbers	Calculate Base Current of BJT	2.170
		Calculate Current in a Two Branch Circuit	1.158
		Calculate for a Voltage across a Component when Two Supplies Are Used	1.241
		Calculate Input Impedance of an Amplifier	2.213
		Expense Report Calculations	3.15
		Fill Out Requisitions & Invoices	3.51
		Pay Calculations	3.67
		Work Order Calculations	3.73
2	1-4 Subtract Whole Numbers	Calculate Drain Current of a Junction Field Effect Transistor	2.392
		Reduce Total Resistance of Parallel Circuit	1.119

Occupational Mathematics Requirements Assessment (OMRA) Applications Supplement

The section of OMRA used for recording sample job applications of various math operations.

Occupational Mathematics Requirements Assessment (OMRA) Inventory

The section of OMRA which contains a taxonomy for classifying the math operations used in an occupation.

Occupational Practitioner

A person who actually engages in or supervises an occupation and can furnish samples of on-the-job materials which contain applications requiring math.

Operation

The most elemental manipulation of numbers and symbols in math. Each cell of the OMRA Inventory represents a math operation. The operations are arranged from simple to complex.

Tally Block

The shaded, twelve-section cell following each math operation on the OMRA Inventory. The cell is used to indicate the estimated monthly frequency of use for each job application.

Appendix D

Pilot OMRA Application Calculation

OMRA Project Participants,

Prior to commencing our study of occupational math requirements for the Practical Nursing program, it is advisable for us to try a sample situation to make sure that we are all on the same wavelength as to what the procedures in using the OMRA instrument are understood to be. This simple exercise will only take a minute of your time, but will hopefully save confusion when we begin the actual data analysis in a couple of weeks. Please follow the directions, and return the OMRA inventory sheets to me as soon as you have completed this exercise.

The following problem is a representation of a typical TABE mathematics concept and application question, and could relate to the type of mathematics applications used in a number of occupations.

Using the information provided, and the OMRA inventory sheets attached, please calculate the solution to the problem, and identify each mathematics operation used .

Locate that operation by name or example on the OMRA inventory

Rate the number of times that operation was used in the calculation.

Place that number in one of the small boxes in the shaded "tally block" to the right of the operation.

The perimeter of a shape is 275 feet.

Four of its six sides add up to 195 feet. The remaining two sides are equal.

What is the length of each remaining side.

Integers

Words to Arabic Numbers	*Two hundred eighty* = 280	1- 1
Arabic Numbers to Words	152 = *One hundred fifty two*	1- 2
Add Whole Numbers	830 + 94 + 12 = 936	1- 3
Subtract Whole Numbers	364 − 158 = 206	1- 4
Multiply Whole Numbers	303 × 97 = 29,391	1- 5
Divide Whole Numbers	92⟌2024 = 22	1- 6
Round Off	To the nearest ten, hundred, etc. e.g., 162 → 160; 260 → 300	1- 7
Add Signed Numbers	−40 (+) −16 = −56	1- 8
Subtract Signed Numbers	+18 (−) −43 = +61	1- 9
Multiply Signed Numbers	+6 (x) −8 = −48	1-10
Divide Signed Numbers	+42⟌−420 = −10	1-11

Fractions

Order Fractions	Arrange in ascending order $\frac{1}{8}, \frac{3}{8}, \frac{1}{2}, \frac{10}{16}, \frac{70}{80}$	2- 1
Add Fractions	$\frac{3}{11} + \frac{4}{11} + \frac{9}{11} = \frac{16}{11}$	2- 2
Subtract Fractions	$\frac{7}{16} - \frac{6}{16} = \frac{1}{16}$	2- 3
Multiply Fractions	$\frac{1}{3} \times \frac{1}{2} = \frac{1}{6}$	2- 4
Divide Fractions	$\frac{4}{9} \div \frac{2}{3} = \frac{2}{3}$	2- 5
Least Common Denominator	$\frac{1}{2}, \frac{1}{8}, \frac{1}{16}$ *Answer* = 16	2- 6
Reduce Fractions	$\frac{12}{16} = \frac{3}{4}$	2- 7
Write as a Mixed Number (an improper fraction)	$\frac{11}{8} = 1\frac{3}{8}$	2- 8
Add Mixed Numbers	$6\frac{9}{16} + 4\frac{1}{2} = 11\frac{1}{16}$	2- 9
Subtract Mixed Numbers	$12\frac{3}{8} - 9\frac{15}{16} = 2\frac{7}{16}$	2-10
Multiply Mixed Numbers	$5\frac{9}{16} \times 2\frac{3}{8} = 13\frac{27}{128}$	2-11
Divide Mixed Numbers	$\frac{3\frac{1}{8}}{\frac{5}{16}} = 10$	2-12
Fraction of a Whole Number	$\frac{2}{3}$ *of* 27 = 18	2-13

OCCUPATIONAL MATHEMATICS REQUIREMENTS
ASSESSMENT INVENTORY

David J. Pucel, Principal Investigator
Joan Feickert, Research Assistant
Mark Lewis, Research Assistant
National Center for Research in Vocational Education
University of Minnesota

Decimals

Add Decimals
$.724 + .101 = .825$ — 3-1

Subtract Decimals
$.729 - .397 = .332$ — 3-2

Decimal to a Fraction
$.833 = \frac{833}{1000}$ — 3-3

Fraction to a Decimal
$\frac{5}{16} = .3125$ — 3-4

Multiply a Decimal by a Decimal
$0.077 \times 0.023 = 0.001771$ — 3-5

Divide a Decimal by a Decimal
$0.311 \overline{)0.933} = 3.0$ — 3-6

Percents

Convert Percents to Fractions
$25\% = \frac{8}{32}$ — 4-1

Convert Percents to Decimals
$3\frac{1}{2}\% = .035$ — 4-2

Convert Fractions to Percents
$\frac{11}{32} = 34.375\%$ — 4-3

Convert Decimals to Percents
$.32 = 32\%$ — 4-4

Take the Percent
10% of 45 = ??
Answer: 4.5 — 4-5

Determine the Percent
?? of 48 = 12
Answer: 25% — 4-6

Ratios

Ratio in Lowest Terms:
12 : 3
Answer: 4 : 1 — 5-1

Solve the Proportion:
?? : 6 = 14 : 4
Answer: 21 — 5-2

Conversion of Units
$3 \text{ ins.} \times \frac{1 \text{ ft.}}{12 \text{ ins.}} = 0.25 \text{ ft.}$ — 5-3

Algebra

Add Monomials
$7xy + 9xy = 16xy$ — 6-1

Subtract Monomials
$(5x - 2y) - (8x + 12y) = -3x - 14y$ — 6-2

Multiply Monomials
$(x^4)(x^7) = x^{11}$
$(x^{\frac{1}{2}})(x^{\frac{3}{8}}) = x^{\frac{7}{8}}$ — 6-3

Divide Monomials
$6xy^2 \div 2xy = 3y$
$x^{\frac{3}{8}} \div x^{\frac{1}{8}} = x^{\frac{1}{4}}$ — 6-4

Transpose Formulas: Solve for r.
$t = \frac{d}{r}$ $P = IR^2$
Answer: $r = \frac{d}{t}$ Answer: $R = \sqrt{\frac{P}{I}}$ — 6-5

Solve Equations for x.
$x - 6 = 0$
Answer: $x = 6$ — 6-6

Solve Equations with Fractions for x.
$\frac{5x}{3} = 20$
Answer: $x = 12$ — 6-7

Solve Equations: Graphically.
$3x - 4y = 5$
$5x + y = 16$
Answer: $x = 3; y = 1$ — 6-8

Solve Equations: Algebraically.
$5x - 6y = 2$
$3x - 7y = 9$
Answer: $x = \frac{-40}{17}; y = \frac{-39}{17}$ — 6-9

Find the Root
$\sqrt{169} = 13$
$\sqrt{x^6} = x^3$ — 6-10

Factor Quadratic Equation
$x^2 - 5x + 6 = 0$
Answer: $x = 2; x = 3$ — 6-11

Quadratic Equation - Complete the Square.
$x^2 - 6x - 7 = 0$
Answer: $x = 7; x = -1$ — 6-12

Quadratic Equation - Use Quadratic Formula.
$3x^2 + 7x + 2 = 0$
Answer: $x = -\frac{1}{3}; x = -2$

Quadratic Formula
$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ — 6-13

Appendix E

Job Related Math Applications for Practical Nursing

Conversions	
1	Household 3 tsp = _______gtt teaspoons : drops :: teaspoons : drops 1 : 60 :: 3 : x x = 180 gtt = 3 tsp
2	Apothecary 3 oz = ____dr ounces : drams :: teaspoons : drops 1 : 8 :: 3 : x x = 24dr = 3 oz
3	Metric 250 mg = ____ g milligram : gram :: milligram : gram 1000 : 1 :: 250 : x 1000x = 250 x = 0.25 g = 250 mg
4	Conversion Between Systems Gr 1/6 = ______mg grains : milligrams :: grains : milligrams 1 : 60 :: 1/6 : x lx = 60 x 1/6 x = 10 mg = gr 1/6
5	Centigrade to Fahrenheit 20° C x 1.8 + 32° = Appendix E (Continued
6	Fahrenheit to Centigrade 68°F – 32° x .5556 = 20°C

Dosage Calculations	
7	Give 500 mg of tetracycline using capsules containing 250 mg. $\frac{500 \text{ mg}}{250 \text{ mg}} \times 1$ capsule = 2 capsules
8	Physician orders Demerol 35 mg. IM. You have on hand 50 mg/cc. How much do you give? $\frac{35}{50} \times 1 = .7$ cc
IV Drip Calculations	
9	Administer 1000 ml of dextrose 5% in water over 8 hr using an infusion set that delivers 10 gtt per minute. $\frac{1000\text{ml}}{8 \text{ hr}} = 125$ ml/hr $\frac{125 \text{ ml/hr}}{60 \text{ min/hr}} = 2.1$ ml/min 2.1 ml/min x 10 gtt/ml = 21 gtt/min
10	Physician has ordered 2500 ml to be delivered in 24 hours. After 12 hours, 1500 ml have been delivered. The solution must run at ______ ml/hr to deliver the remaining solution. 2500 ml – 1500 ml = 1000 ml remaining solution to be delivered 24 hrs – 12 hrs = 12 hrs remaining time to complete delivery $\frac{1000 \text{ ml}}{12 \text{ hr}} = 83$ m
11	Using 10 gtt tubing, give 125 ml/hr. Flow rate in gtts/min = _____ $\frac{125 \text{ ml} \times 10 \text{ gtts/ml}}{1 \text{ hr} \times 60 \text{ min/hr}} = \frac{1250}{60} = \frac{21 \text{ gtts}}{\text{min}}$

Appendix E (Continued)

Calculate Infection Control Statistics	
12	If there are 1534 patient days for the month of August If there were 17 nosocomial urine infections The % rate for total nosocomial urine infections for the month is __ (17 – 1534) x 100 = 1.10821
Blood	
13	Determine the percent RBC recovery. $\frac{\text{mls RBC post}}{\text{mls RBC pre}}$ x 100 = % RBC recover
14	Calculate Platelets/Unit and record results. Raw Count x 10^3 x volume = Plt/Unit x 10^{10}
15	Calculate the amount of blood to draw from a donor who weighs 90 pounds. 450 x (donor weight / 110) = ml to draw 450 x (90 / 110) = 450 x o.81 = 365 ml

Appendix F

Assortment of Job Related Mathematics Samples Collected

MEDICATION RECORD

SARASOTA MEMORIAL HOSPITAL
SARASOTA, FLA.

INJECTION SITE: A-LEFT DELTOID 40, B-RIGHT DELTOID, C-LEFT THIGH, D-RIGHT THIGH, E-LEFT GLUTEUS, F-RIGHT GLUTEUS

01/31/90 00:05 — 01/31/9 0700

START DATE & TIME TO STOP DATE & TIME	GENERIC NAME, STRENGTH, UNIT OF MEASUREMENT, FORM / TRADE NAME / COMMENTS	DOSE	ROUTE	FREQ.	1ST 0700-1459	2ND 1500-2259	3RD 2300-0659
01/29 #0032	HEPARIN LOCK FLUSH SOLN 100U INJ 1ML FLUSH AS PER PROCEDURE	DOSE 200. UNIT	IV	NSF	N S F	N S F	N S F
01/29 #0031	HEPARIN LOCK FLUSH SOLN 100U INJ 1ML FLUSH AS PER PROCEDURE	DOSE 100. UNIT	IV	NSF	N S F	N S F	N S F
01/30 1000 #0019	ATENOLOL 50MG TAB TENORMIN	DOSE 50.0 MG	PO	QD	10		
01/29 #0047	ACETAMINOPHEN 325MG TABS TYLENOL 1-2 TABS	DOSE 325. MG	PO	PRN Q4H			
01/29 #0046	TRIMETHOBENZAMIDE 200MG SUPPOSITORY TIGAN	DOSE 200. MG	RECT	PRN Q6H			
01/29 #0045	METOCLOPRAMIDE 10MG INJ REGLAN GIVE 5-10MG	DOSE 5.00 MG	IV	PRN Q6H			
01/29 #0044	PROCHLORPERAZINE 25MG SUPPOSITORY COMPAZINE	DOSE 25.0 MG	RECT	PRN Q6H			
01/29 #0043	ATROPINE 1MG/10ML SYR PRN SYMPTOMATIC BRADYCARDIA <40/MIN	DOSE .400 MG	IV	PRN			
01/29 #0042 *	NITROGLYCERIN 0.15MG TAB (25'S) IF SBP BETWEEN 90-120 OR PATIENT DEVELOPS HEADACHE	DOSE .150 MG	SL	PRN			
01/29 #0041 *	NITROGLYCERIN 0.4MG SL TAB (25'S) IF SBP > 120	DOSE .400 MG	SL	PRN			
01/29 #0040 *	LAXATIVE OF CHOICE			PRN			

IV OR PRN ADAPTER					
INITIAL / TIME					
GUAGE / SITE					
TYPE OF FLUID					
UNSUCC. SITES					

[illegible] 01/31/9[illegible]

[illegible] [redacted] (C393221) 416369A [redacted] PG1 CON

YOUR ORDERS ... WRITE OR PRINT LEGIBLY USING FIRM PRESSURE. USE BALL POINT PEN ONLY.

ADDRESSOGRAPH

REV. 5/86

PHSICIAN'S ORDERS

ORDERS	K	MAR	MC	S	TIME AND NURSES NAME
DATE: 6-17-94 TIME:					
Admit as inpatient 10 Wold					
DX: Retinal Detachment OD					
VS c shift					1
NKA					
Activity: Up ad lib					
Position: Ad lib					
Diet: NPO on adm.					
Lab: CBC, U/A, SMAC, PT, PTT,					
CXR, EKG					
Consent: Scleral buckle right eye					
Meds Dalmane 30mg po of hs prn sleep					
Valium 2mg po tid prn restlessness, anxiety					
DATE: TIME:					
Tobrex ii gtts surgical eye on admit					
and qid					2
Preadmit meds:					
Cardizem CD 300mg qd					
Dilate surgical eye 1½ hrs preop c					
Atropine 1% 2 gtts q 15min x4					
Phenylephrine 2.5% ii gtts q 15 min x4					
Ocufen ii gtts q 30min x3					
PhisoHex face wash preop					
Anesthesia IV local c sedation					
Procardia 10mg SL q 1hr prn diastolic BP > 90					
DATE: TIME:					
IV of D5LR @ 100cc/hr on admit (1000cc)					3
t.o [redacted]					
SAV A Life, MD					

PHYSICIAN'S ORDERS

INSTRUCTION SHEET **NO. 1 - CALCULATING ML/HOUR**

In order to calculate ml/hour, you need to know:

1. Quantity of solution ordered by the physician.
2. The time period for administration.

EXAMPLE

1. Problem: Administer 1000 ml/D5W over 8 hours.

$$\frac{\text{amount of solution}}{\text{delivery time (hrs)}} = \frac{1000 \text{ ml}}{8 \text{ hrs}} = 125 \text{ ml/hr}$$

2. Often the physician orders fluids for a 24-hour period.

EXAMPLE

Problem: Give 2500 ml NS over 24 hours.

$$\frac{\text{amount of solution}}{\text{delivery time (hrs)}} = \frac{2500 \text{ ml}}{24 \text{ hrs}} = 104 \text{ ml/hr}$$

3. For normal fluid replacement in adult, 3000 ml are delivered over 24 hours. The rate should never be increased more than 1/4.

EXAMPLE

Problem: The physician has ordered 2500 ml to be delivered in 24 hours. After 12 hours, 1500 ml have been delivered. The solution must run at ______ ml/hr to deliver the remaining solution.

2500 ml - 1500 ml = 1000 ml - remaining solution to be delivered

24 hrs - 12 hrs = 12 hrs - remaining time to complete delivery

$$\frac{1000 \text{ ml}}{12 \text{ hr}} = 83 \text{ ml/hr}$$

Formula for Calculating medication dosages

$$\frac{\text{Desired}}{\text{Available}} \times \text{amount available is in} = \text{amount to be administered}$$

#1 Example Physician orders Demerol 35 mq. IM. You have on hand 50 mg/cc. How much would you give?

$$\frac{35}{50} \times 1cc = 50 \overline{)35.0} = .7$$

35 0

Ans: .7cc of Demerol

#2 Example Physician orders Lanoxin 0.375 mg orally. You have on hand Lanoxin 0.25 mg per tablet. How much would you give?

$$\frac{.375}{.250} \times 1 = 250 \overline{)375.0} = 1.5$$

250

125 0

125 0

Ans: 1½ tablet

Formula for calculation of IV dosages

$$\frac{\text{cc's/hr.} \times \text{drop factor}}{60} = \text{drops/minute}$$

#1 Example Physician orders 1,000 cc D5½ NS with 20 KCL to infuse over 10 hours. Drop factor of Abbott Venoset tubing is 15 drops = 1 ml.

$$\frac{1{,}000 \text{ cc}}{10 \text{ hrs.}} = 100 \text{ cc/hr.}$$

$$\frac{100 \text{ cc/hr} \times 15}{60} = 25 \text{ drops/min.}$$

PRACTICE QUESTIONS IV AND MEDS

NOTE: Under calculation section: please come to class with these practice problems completed! (since you are expected to be able to do these and pass a medication, IV test with 80% proficiency.

MEDICATION QUESTIONS

1. You have a vial of heparin labeled 1,000 u/cc. The doctor orders 5,000 u q 6° IV push. Every 6 hours you should give ____ cc.

2. Your patient is to receive Digoxin .125 mg q day. You would give ____ tabs. Each tablet = .25 mg.

3. Your patient is to receive 50 mg Lasix IM. You have a vial labeled 40 mg per 2 cc. Your patient would receive _____ cc.

4. Your patient is to receive Keflin 750 mg IVPB q 6°. A 1 gm vial of Keflin is diluted with 10cc sterile of water. How many cc = 750 mg? _____ cc.

5. You have morphine 15 mg/2 cc. The order is to give 10 mg IV. How many cc_______ would you give?

6. An order is to give atropine .30 mg. The ampule reads .4 mg/cc. How many cc's would you give? _______cc.

7. Administer 1,000 D5W q 8° with blood set tubing. Calculate gtt rate (gtt factor = 10). _________gtt/min.

8. The doctor orders digoxin .0625 mg IV Push. The drug comes mixed in a 2 ml ampule with .5 mg digoxin. How much solution must be drawn up. ______cc

IV QUESTIONS FOR RNs and LPNs

9. Give 500 cc NS over 8°. Use drop factor of 15. Calculate the drops/min. to regulate the IV. ________

10. Administer 500cc D5W over 24°. Use 60 gtt factor (minigtt). Calculate the drops/min. rate. _______

11. You are to give 2 gm Ampicillin over 30 min. Ampicillin is mixed in 100 cc D5W. Use a drop factor of 15 and indicate gtts/min. _________

12. IV rate is ordered: 75cc/hr. Calculate gtt/min for minidrip set ____gtts/min. a)
for blood set ____gtt/min. b)
(10 gtts=1 ml)
for Abbott Venoset ____gtts/min. c
(15 gtts = 1 ml)

13. Your patient return from surgery with 750 cc credit on his IV D5½NS with 20 KCL. The doctor orders to finish present IV over next 2 hrs. The tubing is a blood set (drop factor - 10). At how many gtts/min. would you regulate the IV? ________

Dear R.H. Clay

Re: Math Requirements of the LPN
Usage in ALF of Sarasota Facility

Our LPN's utilize Math skills for:

1) All Med administration (IV, P.O, Enteral, etc.)
2) Calorie & Diet Requirements (P.O., PEG feedings, G Tube)
3) All IV parenteral fluids, TPN,
4) I+O
5) Weight Conversion
6) Most Apoth, Household, Metric Conversions
7) Insulin Requirements.
8) Calibration of Syringes, Meds to Match
9) Vital Signs - Conversion of C to F etc.

Hope this helps.

Good luck.

[illegible]

September, 12, 1997

G.H. Clary:

We are a 60 bed Rehabilitation hospital. The nurses which work on the unit are exposed to math daily in the following aspects of their jobs:

* Intake and output measurements (basic addition)
* Medication administration (algebra)
  ie: If the pharmacy sends digoxin .25mg and the pt. is to receive .125mg, how many tablets would you give?
  .25mg/1 as .125mg/x , x =.5 (1/2 tablet)

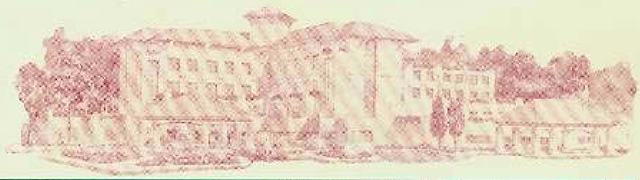
  similar equations would be used to calculate IV rates
  ie: pharmacy sends 1000cc of D5W, the IV is to infuse at 125cc per hour, how many hours will it take (bag is to be marked hourly). 1000 - 125 = 8 hours.
* In other areas of the hospital, such as mine, I do infection control statistics and graphs. This I learned through our risk management and APIC as far as the equations and formulas to use to arrive at percentages. This is not something I learned in school. It would have been helpful to have had a statistics course in nursing school addressing tracking and trending for the healthcare setting.
  ie: if there are 1534 patient days for month of August
  if there were 12 nosocomial urine infections and 5 other infections (such as wound, blood, etc.)
  To get % rate take number of UTI's - number of patient days then multiply by 100
  (12 - 1534) x 100 = .78226
  To get % rate for total nosocomial infections for the month take total number - number of pt. days then multiply by 100
  (17 - 1534) x 100 = 1.10821.
  % can be figured by specific programs (spinal cord, brain injury, etc. on infection rates in these areas.

I hope this has been helpful to you and your research study.

Sincerely,

Appendix F (Continued)

Doctors Hospital
OF SARASOTA



COLUMBIA/HCA
Healthcare Corporation

A New Commitment To Healthcare...Together

9/22/97

Dear Mr Chang,

I received your inquiry regarding Math skills required of the Practical Nurse, on the job. I can answer for the the LPN in an Acute Care Setting. The LPN in the Acute Care Setting is required to be able to:

- Perform Drip Rate Calculations:
  - cc per hour
  - gtts per minute
- Conversions ie lb to kg:
  - pt weighs 175 lb – how many kg?
  - 0.1 grams = how many mg?
  - 60 cc = how many ounces?
- Medication dosages:
  - give Demerol 35mg. 50mg/cc How many cc do you give?
  - give 10 meq KCL. Bottle labeled 20meq/15ml. How many ml. do you give?

5731 Bee Ridge Rd., Sarasota, Florida 34233 Telephone 813-342-1100 Fax 813-371-1029

SARASOTA COMMUNITY BLOOD BANK, INC. SARASOTA, FLORIDA

APPENDIX A: LOW VOLUME/ANTICOAGULANT REDUCTION PROCEDURE

EXAMPLE 1: Calculate amount of blood to draw from a donor who weighs 90 lbs.
450 x (donor weight/110) = amount to draw
450 x (90/110) =
450 x 0.81 = 365 ml.

NOTE: Anticoagulant reduction is <u>NOT</u> needed for this collection because the final unit volume is not less than 300 ml.

EXAMPLE 2: Calculate amount of blood to draw from a donor who weighs 65 lbs.
450 x (donor weight/110) = amount to draw
450 x (65/110) =
450 x 0.59 = 265 ml.

NOTE: Anticoagulant reduction <u>IS</u> needed for this collection because the final unit volume is less than 300 ml.

EXAMPLE 3. Calculate amount of anticoagulant needed for collection of 265 ml whole blood.

0.14 x volume to collect = anticoagulant needed
0.14 x 265 = 37 ml

EXAMPLE 4. Calculate the amount of anticoagulant to remove for collection of 265 ml whole blood.

63 - anticoagulant needed = amount to remove
63 - 37 = 26 ml.

FIGURE 1. PLACEMENT OF "LOW VOLUME FROM XXX ML WHOLE BLOOD" STICKER FOR UNITS WHERE ANTICOAGULANT HAS <u>NOT</u> BEEN REDUCED.