

A Correlation Study of Accuplacer Math and Algebra Scores and Math Remediation on the  
Retention and Success of Students in the Clinical Laboratory Technology  
Program at Milwaukee Area Technical College

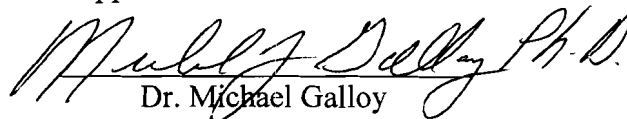
by

James Manto

A Research Paper  
Submitted in Partial Fulfillment of the  
Requirements for the  
Master of Science Degree  
in

Career and Technical Education

Approved: 2 Semester Credits

 Ph.D.  
Dr. Michael Galloy

The Graduate School  
University of Wisconsin-Stout

August, 2006

The Graduate School  
University of Wisconsin-Stout  
Menomonie, WI

Author: Manto, James C.  
Title: *A Correlation Study of ACCUPLACER Math and Algebra Scores and Math Remediation on the Retention and Success of Students in the Clinical Laboratory Technology Program at Milwaukee Area Technical College*

Graduate Degree/ Major: MS Career and Technical Education

Research Adviser: Michael Galloy, Ph.D.

Month/Year: August, 2006

Number of Pages: 46

Style Manual Used: American Psychological Association, 5<sup>th</sup> edition

ABSTRACT

The purpose of this study was to determine if there is a correlation between math and algebra scores on the ACCUPLACER placement test and the retention and success rates of the students in the Clinical Laboratory Technology (CLT) program at Milwaukee Area Technical College (MATC). This study also determined if there is a correlation between students who are placed directly into math remediation without taking the ACCUPLACER placement test and the retention and success rates of the students in the CLT program. Finally this study determined if there is a correlation between math scores in the CLT course QA/Lab Math and the success and retention rates of students in the program. Data was collected on students enrolled in the CLT program from August 2003 until May 2006.

The results showed that CLT students placed in math remediation had lower graduation rates when compared to the group as a whole. The study also showed that there was little, if any, relationship between ACCUPLACER math and algebra scores and the overall success of the students in the program. However, a mild positive relationship was found between math scores in the CLT course QA/Lab and the overall success of the students in the program.

The Graduate School  
University of Wisconsin Stout

Menomonie, WI

### Acknowledgments

I would to thank my advisor, Dr. Michael Galloy for his guidance, encouragement and support. I would also like to thank Dr. Amy Gillett whose passion for teaching inspired me. Finally, I would like to thank my co-workers and my family for their support, guidance, and patience.

## TABLE OF CONTENTS

	Page
ABSTRACT.....	ii
List of Tables.....	iv
Chapter I: Introduction.....	1
<i>Background Information</i> .....	1
<i>Statement of the Problem</i> .....	4
<i>Purpose of the Study</i> .....	4
<i>Research Questions</i> .....	5
<i>Importance of Topic</i> .....	6
<i>Limitations of the Study</i> .....	7
<i>Definition of Terms</i> .....	8
<i>Methodology</i> .....	9
Chapter II: Review of Literature.....	10
<i>Introduction</i> .....	10
<i>Retention and Student Success</i> .....	10
<i>Math</i> .....	12
<i>Purpose of Placement Testing</i> .....	14
<i>ACCUPLACER Placement Test</i> .....	15
<i>ACCUPLACER Math and Algebra Tests</i> .....	16
<i>ACCUPLACER Validity and Reliability</i> .....	18
Chapter III: Methodology.....	20
<i>Introduction</i> .....	20

<i>Instrumentation</i> .....	20
<i>Data Collection</i> .....	21
<i>Data Analysis</i> .....	21
<i>Limitations</i> .....	22
Chapter IV: Results.....	23
<i>Introduction</i> .....	23
<i>General Statistical Information</i> .....	23
<i>Research Questions</i> .....	24
Chapter V: Discussion, Conclusions, and Recommendations.....	33
<i>Introduction</i> .....	33
<i>Discussion</i> .....	33
<i>Conclusions and Recommendations</i> .....	34
References.....	41

## List of Tables

Table 1: Distribution of students in shared CLT program.....	24
Table 2: Number of CLT students placed into math remediation.....	25
Table 3: Success rates of CLT students who have taken math remediation.....	25
Table 4: Success rates of CLT students who have scored below the cut score of 64 on the math portion of the ACCUPLACER test.....	26
Table 5: Success rates of CLT students who have scored at or above the cut score of 64 on the math portion of the ACCUPLACER test.....	27
Table 6: Success rates of CLT students who have scored below the cut score of 40 on the algebra portion of the ACCUPLACER test.....	28
Table 7: Success rates of CLT students who have scored at or above the cut score of 40 on the algebra portion of the ACCUPLACER test.....	29
Table 8: Success rates of CLT students who have scored either at or above 77% or below 77% on math test in QA/Lab Math.....	30
Table 9: Correlations.....	32

## Chapter I: Introduction

### *Background Information*

Milwaukee Area Technical College (MATC) was founded in 1912 and has become one of the midwest's largest community-based technical colleges. It serves about 57,000 students and has four campuses located in the Milwaukee metropolitan area (MATC, 2005a). According to the MATC Graduation Employment Report (2003a), the MATC district includes Milwaukee County, portions of Washington and Waukesha Counties, and the southern two thirds of Ozaukee County. The college offers 170 associate degree and diploma programs, as well as certificate and apprentice programs, thousands of personal and professional courses, and has a Pre-College division that includes the adult high school and basic skills classes.

One of the associate degree programs at MATC is Clinical Laboratory Technology (CLT). The CLT program prepares students for employment as a Clinical Laboratory Technician (CLT) in hospitals, clinics, and doctors' offices. A prospective student must have a high school diploma, take a college placement assessment test, and have at least one year of high school level or one semester of college level algebra, chemistry, and biology. The program requires the student to complete 68 credits. The technical portion of the program includes the following courses: Phlebotomy, Basic Lab Skills, QA/Lab Math, Immunology, Urinalysis, Hematology, Coagulation, Chemistry, Immunohematology, Microbiology, and Clinical Experiences (MATC, 2005b).

Since 1999, the number of students registered in the CLT program has fluctuated from a low of 18 in February 2001 to a high of 58 in September 2002 (MATC, 2005c). The curriculum is based on a "one-plus-one" model. This allows the students to pursue the



program on a part-time or full-time basis. The first year consists of all general education and technical support courses, and the second year consists of the clinical technology didactic course work, laboratory sessions, and a 10-week clinical assignment (Heeman & Kilmer, 1992).

The majority of students who enroll in the Clinical Laboratory Technology Program at Milwaukee Area Technical College must take the ACCUPLACER placement test. The ACCUPLACER consists of subtests in mathematics, English, and reading (College Board, 2002; Hirschy & Mack, 2001). The information provided by the ACCUPLACER provides guidance, placement, and advisory information for students. The test is presented in a computer-adaptive mode that allows for the level of difficulty of additional questions to be subsequently increased depending on how the test taker has answered starter questions (College Board, 2002; Sireci, Patelis, Rizavi, Dillingham & Rodriguez, 2000). According to Ger Vang (counselor, personal communication, May 31, 2005), depending on the results of the various subtest scores from the ACCUPLACER and the cut scores developed for a particular program, a student may be placed into remediation. Many students can bypass taking the ACCUPLACER if they have completed 12 college credits.

The cut scores or levels set for both the arithmetic and algebra sections of the ACCUPLACER require the student to achieve a minimum score that would relate to minimal algebra and arithmetic skills (College Board, 2002). According to Carol Wilson (health specialist, personal communication, May 31, 2005), scores that would fall below this threshold would require students to enroll in several remedial math courses, and they would be conditionally enrolled in the CLT program.

The preparation and retention of students in the CLT program at MATC is a very important issue for the faculty. Historically, recruiting a qualified pool of students and high attrition rates have been significant concerns (Heeman & Kilmer, 1992). Currently, the program retains about 75% of the students who enroll (MATC, 2005d). Karla Hartzheim (CLT clinical coordinator, personal communication, May 31, 2005), indicated that even though the program retains 75% of the students, it is important for the success of both the program and students that there be a mechanism in place to identify students who may potentially struggle in the program. Some of the students who struggle ultimately finish the program, but have to repeat certain courses, while others drop out.

Studies have shown that high school grade point averages (GPAs) as well as college admission scores are significant predictors of retention (Astin, Korn, & Green; Tross et al., cited in Reason, 2003). Many students struggle with college work and require remediation because they are coming to college under-prepared (Levine & Cureton, cited in Choate & Smith, 2003).

Another important predictor of student success appears to be math. According to Vaughn (cited in Perkins, 2005), “many students admitted to college also need to take remedial math classes, which can influence whether the student continues in college or not” (p. B. 08). Math is an important component of the various CLT courses, and one course in particular, QA/Lab math, focuses directly on the mathematical calculations used in laboratory settings (MATC, 2005e).

### *Statement of the Problem*

Most students interested in the CLT program at MATC must take the ACCUPLACER entrance exam before they are officially admitted to the program. Depending on how they scored on the various subtests, they may be placed in remedial courses. Currently 75% of the admitted students complete the program. The other 25% of the students drop out of the program due to various reasons. Some students repeat the CLT courses that they have not completed successfully, but these students sometimes drop out because they cannot pass the course a second time. The challenge facing the CLT program is to retain a higher percentage of students in the program and develop strategies to identify students who may have difficulty with the program.

### *Purpose of the Study*

The purpose of this study was to determine if there is a correlation between math and algebra scores on the ACCUPLACER placement test and the retention and success rates of the students in the CLT program at MATC. This study also determined if there is a correlation between students who are placed directly into math remediation without taking the ACCUPLACER placement test and the retention and success rates of the students in the CLT program. Finally this study determined if there is a correlation between math scores in the CLT course QA/Lab Math and the success and retention rates of students in the program. Data was collected during the summer of 2006 utilizing a spreadsheet. The data consisted of ACCUPLACER math and algebra scores, student placement in math remediation, scores in the course QA/Lab, and success rates in the CLT program from the fall of 2003 until the present.

### *Research Questions*

There are 11 research questions this study will attempt to answer. They are:

1. Of the number of students applying to the CLT program, how many fall below the cut scores for math and/or algebra on the ACCUPLACER placement test?
2. Of the number of students applying to the CLT program, how many have been placed in math remediation courses?
3. What are the success rates of CLT students in the program who have taken math remediation courses?
4. What are the success rates of CLT students in the program who scored below the cut score on the math subtest from the ACCUPLACER placement test?
5. What are the success rates of CLT students in the program who scored at or above the cut score on the math subtest from the ACCUPLACER placement test?
6. What are the success rates of CLT students in the program who scored below the cut score on the algebra subtest from the ACCUPLACER placement test?
7. What are the success rates of CLT students in the program who scored at or above the cut score on the algebra subtest from the ACCUPLACER placement test?
8. What are the success rates of CLT students in the program who scored either at or above or below the minimum passing score of 77% on the math test in the CLT course QA/Lab Math?
9. What is the correlation between ACCUPLACER math test scores and the overall scores of students in the CLT program?
10. What is the correlation between ACCUPLACER algebra test scores and the overall scores of students in the CLT program?

11. What is the correlation between math scores in the CLT course QA/Lab Math and the overall scores of students in the CLT program?

*Importance of Topic*

This research is important for the following reasons:

1. It is important to identify students through some type of indicator who may potentially struggle in the CLT program. If students who may potentially struggle are identified, they can be offered remediation that may contribute to their success in the program. Since the CLT program is part of a statewide curriculum, this indicator may have a potential for use in other CLT programs in the state.

2. Results of this study could contribute to a higher retention rate of students in the CLT program. It is important to the community that the CLT program remains viable and graduates enough students to keep up with job openings in southeastern Wisconsin.

3. It is important to develop strategies to help retain students in the CLT program. Once students have been identified as a potential risk, strategies must be in place to help retain those students. The strategies developed may have a benefit to the other CLT programs in the state.

4. It is important to better prepare students before they enter into the technical portion of the CLT program. If students enter into the program better prepared, they will potentially avoid retaking courses or dropping out. This is important in providing timely employment to the students and meeting the needs of employers in southeastern Wisconsin.

5. Part of the study will look at math scores in the CLT course QA/Lab Math. This course was implemented at MATC during Fall 2003 as part of the CLT statewide curriculum.

This study will provide a benchmark for potential future studies looking at the new curriculum.

### *Limitations of the Study*

The limitations of the study are as follows:

1. This study is limited only to the ACCUPLACER placement test and not other college placement tests such as Scholastic Aptitude Test (SAT) and American Counsel Testing (ACT).
2. This study did not address testing variables such as test anxiety, high school or college math courses, testing environment, learning disabilities of students, IQ, or preparation for the ACCUPLACER.
3. The study includes CLT students in the MATC district only and not students from other technical college districts in Wisconsin. Implications to other students in the Wisconsin Technical College system should not be made.
4. This study is limited to researching math and algebra ACCUPLACER scores and placement in math remediation as predictors of success in the CLT program and does not address other factors such as attendance, social-economic status, or personal problems of the students.
5. Part of this study will be limited to looking at data from the QA/Lab Math course that was generated after the implementation of the CLT statewide curriculum in Fall 2003. The testing tool used in this course is different than the testing tool used before Fall 2003, so data collected before Fall 2003 will not be used.
6. The study will look at data starting from the Fall of 2003. Any correlations or implications will be restricted to this time period.

### *Definition of Terms*

The following eleven terms need to be defined for clarity of understanding. These are:

ACCUPLACER - a computerized placement test for students entering two- or four-year colleges. Information from the test provides placement, advisement, and guidance information for the student (College Board, 2002).

Apprentice programs - combination of on-the-job training and classroom instruction. Various programs can be completed in two-to-five years (Wisconsin Technical College System, 2005a).

Associate Degree - a two-year program offered at technical colleges (Wisconsin Technical College System, 2005a).

Basic Skills - courses in reading, writing, math, and career education for adults at levels from grades one through twelve (Wisconsin Technical College System, 2005b).

Certificate programs - streamlined educational offerings focusing on enhancing job skills (Wisconsin Technical College System, 2005a).

Clinical laboratory statewide curriculum - all CLT programs in the Wisconsin Technical College System share the same course competencies (MATC, 2003b).

Clinical Laboratory Technician- a member of the health care team who performs general tests in the clinical laboratory. The Clinical Laboratory Technician has an associate degree from an accredited technical or community college. The Clinical Laboratory Technician is also referred to as a Medical Laboratory Technician (ASCP, 2004).

Clinical Laboratory Technology Program - a 68 credit associate degree program offered at MATC. The program includes 36 credits of technical courses related to Clinical

Laboratory Technology, and 32 credits of general education, support, and elective courses (MATC, 2005b).

Cut scores - a predetermined level that is set subjectively for tests used to categorize scores. The score set may be a differentiation point to separate passing scores from failing, or there may be multiple scores set to separate student's scores into categories (Horn et al., 2000).

Diploma programs - one- and two- year programs that focus on hands-on learning (Wisconsin Technical College System, 2005a).

Remedial math courses - courses students are placed in if they fall below the cut scores on the ACCUPLACER or if the required math prerequisites are not met (G. Vang, personal communication, May 31, 2005).

### *Methodology*

Algebra and math scores from the ACCUPLACER placement test were correlated with retention rates and math scores of students in the CLT program. Chapter Two will review literature related to the problem presented in this study. Chapter Three will discuss a step-by-step description of how the research was carried out. Chapter Four will provide an analysis and discussion of the research. Chapter Five will provide a summary of the study, conclusions, and recommendations related to the study.



## Chapter II: Review of Literature

### *Introduction*

This chapter will include a discussion on retention and student success in post secondary education. It will also look at student issues concerning math and how mathematical aptitude affects a student's success in school. Finally, there will be a discussion on the general purpose of college placement tests followed by a more detailed analysis of the ACCUPLACER placement test focusing on the math and algebra portions of the test.

### *Retention and Student Success*

Many students who enroll in technical or community colleges never finish a program. The research indicates that 36% of full-time students who enroll in technical colleges leave by the end of their first year and do not return within a 3-year period (Seppanen, 1995). Often times students who enroll in technical and community colleges are under-prepared for their studies. Remedial education was needed by 41% of community college freshman in 1995 (U.S. Department of Education, 1996). According to Hoyt (1999), community colleges often provide a second chance for the under-prepared college student. Because of this, student retention rates at community colleges tend to be low.

Many students who enroll in postsecondary education never obtain their goals. In a study performed by Berkner, He, and Forrest (2003), a student group enrolled in postsecondary education in 1995 was followed for six years. The study found, of the students who initially enrolled in a public 2-year institution and intended to complete either an associate degree and/or a bachelor degree, only 36% obtained their goal.

There are many studies and theories as to why students do not complete their course work or programs. One study listed factors such as students' pre-entry abilities, goals, and academic and social integration as influences in their ability to complete their studies successfully (Tint, cited in Hoyt, 1999). Adult learners who enroll in postsecondary education may face financial challenges because they are often the sole household earner and also may face logistical problems such as daycare that could interfere with their ability to succeed (Golfin et al., 2005).

To get at the source of the problem, one needs to look at the demographics of the students attending a particular institution. Two-year colleges typically have a large number of working adults and minority students enrolled. It has been shown that these groups tend to have high dropout rates (Hoyt, 1999). Older adult students have to juggle commitments such as family and work with academic activities. This could be a factor influencing student drop out rates. Conversely, Naretto (1995) has remarked that older adults who have a strong supportive social network tend to be successful in their college endeavors. There are numerous factors that affect the rate of attrition for minority students. Academic stress and the stress associated with minority status could be factors in poor retention rates of these students (Smedley, Hector, & Harrell, 1993). The minority student is an important sector when looking at student retention in community colleges. Szelenyi (2001) reported that ethnic minorities made up approximately 30% of student enrollments in community colleges, but received only 23% of all associate degrees awarded.

Besides factors such as demographics, race, finance, and pre-college preparation, Moore (1995) and Windham (1994) have looked at attendance on a full-time versus part-time basis as a reason for poor retention rates. Their studies have shown that full-time

attendance at a college was the most predictive factor in determining whether students stayed in school. Or stated another way, they found that part-time attendance was the most prevalent characteristic of students who dropped out of college.

As shown, there are many factors that affect student retention. It is important that community and technical colleges devise strategies to improve student retention. It is also important to identify the reasons why there may be problems in retention. The first problem is to admit there is a problem. Some faculty members will deny that there is a problem and fear that increasing student retention will decrease educational standards of their institution. They even feel that weeding out the less successful students will help the remaining students will perform much better (McLaughlin, Brozovsky, & McLaughlin, 1997).

To understand student retention, one must look at indicators that may predict student success. In a study performed by Maggio, White, Molstad, & Kher (2005), certain variables were examined to determine the success and retention of students enrolled in college. They determined that high school GPA and the length and size of college programs had an effect on the students' college GPA.

### *Math*

Math skills are a very important component to success in college and beyond. Some postsecondary education is needed in more than two-thirds of new jobs. Success in college requires developing skills in college level reading, writing, and math. (American Diploma Project, cited in Jobs for the Future, 2005). Unfortunately, two out of every five 18 to 64 year-olds lack the basic math skills needed to succeed in postsecondary education (Jobs for the Future, 2005). Of those students graduating in 2005, about half are entering

postsecondary education with inadequate college level skills in reading, math, and science (ACT, cited in Jobs for the Future, 2005).

Attitude and anxiety about math may have a correlation on how well a student succeeds in postsecondary education. In a study performed on students at Chippewa Valley Technical College in northwestern Wisconsin by Truttschel (2002), it was determined that there was a negative correlation between school GPA and math anxiety levels. He also determined that there was a positive correlation between the dislike of math and anxiety levels. This general anxiety and dislike of math has a negative effect on the career options of college students (Hembree, cited in MacKenzie, 2002).

Preparing students in math skills is an important key to both individual student success and the overall health of the economy in the United States. The Hamilton School District in Wisconsin initiated a program to identify students who are struggling in math and developed strategies to help these students improve their skills (Hetzner, 2006). Better preparing students in math and the sciences is so important that President Bush is proposing an increase of over \$50 billion dollars in federal spending on critical research programs in the physical sciences over the next 10 years. He is also advocating training an additional 70,000 teachers over the next five years to teach advanced math and science courses in high schools (Bush calls for more math, science funding, 2006).

It is important to identify students who may struggle in postsecondary education due to poor math skills and offer remediation to help those students improve their skills. In a study performed at Columbus State Community College, it was determined that 21% of students who failed to graduate were withdrawn for not completing or failing a math course (Neutzling, 2003). In a study conducted in 15 community colleges, it was found that through

the use of learning assistance centers and special skill labs focusing on basic skills such as math, students' academic preparedness increased (Perin, 2004). An important tool used to identify students who may have difficulty with postsecondary education is through the use of placement and assessment tests. Students who are enrolled in remedial or developmental courses based on their scores on mandatory placement tests have more success in college courses than similar students who did not take any remediation (Young, cited in Golfin, Jordan, Hull, & Ruffin 2005).

### *Purpose of Placement Testing*

It is important that students be adequately prepared to succeed in college. According to Overstreet (2004), it is important to ensure initial academic success for students in college. Students must be placed into courses based on their abilities. Initial academic success will equate to students meeting their educational goals. Overstreet (2004) felt an institution must select a student assessment device that meets the institution's needs as well as matching students with courses best aligned to their abilities.

It is important not to misinterpret the purpose of an assessment test. The college assessment test should not be used to predict a students' college success. It should be used to measure the student's skill level relative to skills needed in specific courses (Gordon, 2001). Gordon (2001) felt that without accessing academic skills of students, they may start in a course that is above their abilities. Many students start to accumulate a skills deficit that will affect their ability to develop advanced skills needed in future courses.

### *ACCUPLACER Placement Test*

There are various assessment tests that are used by colleges to place students in appropriate courses. According to Overstreet (2004), the ACCUPLACER placement test can

be used to effectively place students into courses based on their skill levels and capabilities. The ACCUPLACER test can also determine if remedial course placement is needed and can be used to monitor student course progress (College Board, 2003).

Milwaukee Area Technical College (MATC) has been using the ACCUPLACER placement test since 1997. Prior to 1997, MATC utilized an assessment device called the ASSET that was initially designed as a screening test. In a study performed by O'Brien (1995), MATC was unhappy with the ability of ASSET test to assess the students' capabilities. The study cited concerns that the test was not meeting the community's multi-cultural population and questioned the logic of using a screening test as a placement device. The ASSET test also uses a scaling procedure that is based on Normative Population characteristics. Inherent in this type of scaling are bias and measurement errors evident especially with low or high performing students and with minority students. According to O'Brien (1995), the test construction of the ACCUPLACER is logarithm-based and the scores are dependent on content difficulty rather than norm performance. The study showed that the ACCUPLACER placement test was a reliable predictor of course placement at MATC and recommended that the school start using the test.

The ACCUPLACER is an online placement test that uses a computerized adaptive testing system. The computer selects appropriate questions for the examinee based on his/her performance and picks the next question based on how they answered the previous one. Because of this, the computer adapts the exam to each individual examinee. A student's score is determined by how many questions that are answered correctly and the difficulty level of the questions that are answered correctly (College Board, 2003).

The ACCUPLACER was introduced in 1985 and consisted of four tests: reading comprehension, sentence skills, arithmetic, and elementary algebra. In 1990 the college level mathematics test (CLM) was introduced, followed by the addition of tests in English proficiency and writing skills (College Board, 2003). This literature review will focus only on the math and algebra test subsets and their validity and reliability.

According to the College Board (2003), ACCUPLACER scores are reported on a scale ranging from 0 to 120. This total score provides a criterion-referenced interpretation of a student's performance and is independent of the various skill levels of all the students taking the test. The total score should be used to help the college make placement decisions for the student. The College Board (2003) has developed proficiency statements for each subset of the ACCUPLACER that describe the knowledge and skills associated with each specific score. The College Board (2003) recommends that each college develop its own cut scores to determine when a student should be placed into remediation.

#### *ACCUPLACER Math and Algebra Tests*

According to the College Board (2003), the arithmetic test consists of content in whole numbers and fractions, decimals and percents, and applications. The test-takers receive questions in all three content areas, and the number and difficulty of the questions depends on how they answer particular problems. There are four proficiency statements describing the knowledge and skills of the test-takers based on their total score. Students who score around 31 have minimal arithmetic skills, those who score around 57 have basic arithmetic skills, those who score around 90 have adequate arithmetic skills, and those who score around 112 have substantial arithmetic skills.

The elementary algebra test consists of content in the following three areas: integers and rationals; algebraic expressions; and equations, inequalities, and word problems. As with the arithmetic test, the type of questions administered depends on how the test-taker answers each question. Students who score around 25 have minimal pre-algebra skills, those who score around 57 have minimal elementary algebra skills, those who score around 76 have sufficient elementary algebra skills, and those who score around 108 have substantial elementary algebra skills (College Board, 2003).

According to the College Board (2003), the college-level mathematics test consists of content in algebraic operations, solutions of equations and inequalities, coordinate geometry, functions, trigonometry, applications, and other topics. This test is useful in placing students into college intermediate algebra through introductory calculus courses. Students who score around 40 or less are required to take the elementary algebra test before any placement decisions are made. Students who score around 40 should also take the elementary algebra test and should be considered for placement into intermediate algebra. Students who score around 63 should be considered for placement into college algebra, those who score around 86 should be considered for placement in a pre-calculus course, and those who score around 103 should be considered for placement into calculus.

As previously discussed, each college should set cut scores that determine what courses the student should be placed into based on their total scores relative to the proficiency statements established by the College Board. For example, students who are eligible to enroll in the Clinical Laboratory Program (CLT) at MATC must score 64 or above on the arithmetic test and 40 or above on the elementary algebra test. If they do not meet one



or both requirements, they will be conditionally admitted to the program and will be required to take math and/or algebra remediation (MATC, n.d.).

### *ACCUPLACER Validity and Reliability*

In order for the ACCUPLACER placement test to be useful, it must show evidence of content validity. The quality of the test development process reflects on the quality of the exam. The ACCUPLACER undergoes numerous quality control steps relating to the development of item pools, score reporting, and the selection of questions for examinees. Content specialists have verified that ACCUPLACER test items represent the intended subject domain (College Board, 2003).

A placement test should also demonstrate evidence of predictive validity. The test should be predictive of a student's performance in courses in which he/she is placed. Between 1990 and 1992, the College Board performed a large scale study of the predictive validity of the ACCUPLACER. Thirty-eight two-year colleges and 12 four-year colleges participated in the study. The students' ACCUPLACER scores were correlated with the grade received in the appropriate college course. ACCUPLACER arithmetic test scores showed overall correlations between .31 and .38 with grades in college level math and algebra courses. This shows there exists a mild positive relationship between ACCUPLACER math scores and grades in college level math and algebra courses. ACCUPLACER elementary algebra test scores showed overall correlations between .19 and .38 with grades in college level math courses ranging from elementary algebra to calculus. This shows there exists a low to mild positive relationship between ACCUPLACER algebra scores and grades in college level algebra and calculus courses. According to the College Board (2003), there is no perfect measure of predictive validity concerning course placement.

Student-level factors that have effects on course grades but are not measured by the ACCULACER include attendance, motivation, and perseverance.

In a study conducted by O'Brien (1995) at MATC, the predictive validity of the ACCUPLACER was determined. Instead of comparing ACCUPLACER scores with appropriate course grades, a student rating instrument was developed. The rating instrument, filled out by the student's instructor, included questions concerning the participation of the student in the class, the student's academic skills necessary to succeed in the class, and the overall rating of the student in the class. ACCUPLACER scores in reading and sentence structure were correlated with the student rating instrument in appropriate English and reading courses. The study determined there were a number of statistically significant correlations between the ACCUPLACER scores and the skills necessary to succeed in class. Based on the results of this study, MATC started using the ACCUPLACER test for placement decisions in 1997.

Aside from demonstrating validity, a placement test must also yield reliable or consistent scores. According to the College Board (2003), the ACCUPLACER showed good test-retest performance with correlations ranging from .73 to .96. These results must be interpreted cautiously, due to the small sample sized used for study conducted. In the study performed by O'Brien (1995) at MATC, no measures of reliability were conducted.

### CHAPTER III: Methodology

#### *Introduction*

This chapter will include information on how the subjects were selected and a description of the instrument being used. In addition, information about data collection and data analysis procedures will be given. The last section of the chapter will include a discussion on methodological limitations.

#### *Subject Selection and Description*

The population used for this study was students enrolled at Milwaukee Area Technical College (MATC). The sample chosen consisted of students enrolled in the Clinical Laboratory Technology (CLT) program at MATC starting from August of 2003 until May 2006. August 2003 was chosen as a beginning date for the study because a new state-wide curriculum for the CLT program was instituted during the Fall semester of 2003 (MATC, 2003a). Demographic data was not collected as it fell outside of the scope and purpose of this study.

#### *Instrumentation*

The instrument used to collect data for this study was a spreadsheet grid developed by the researcher. It was created using the computer program Microsoft Excel. Since the instrument was created for the purposes of this study, there are no measures of validity or reliability. Grades in 14 technical courses of the CLT program, as well as a math test grade in the course QA/Lab Math were collected, along with ACCUPLACER math and algebra scores of the sample group. If applicable, grades in any math remediation courses were collected.

The ACCUPLACER test has been used by MATC to make student placement decisions since 1997. According to the College Board (2003), test-retest reliability is high for the math and algebra subtests with correlations ranging from .78 to .89. The predictive validity of the math subtest of the ACCUPLACER shows a mild positive correlation with correlations ranging from .31 to .38, and the predictive validity of the algebra subtest shows a low to mild positive correlation with correlations ranging from .19 to .38.

#### *Data Collection*

Permission was received from the Institutional Review Boards of MATC and the University of Wisconsin-Stout to perform this study. The data was collected during the Spring of 2006. ACCUPLACER scores, math remediation grades, math test scores in the course QA/Lab Math, as well as the individual grades of the 14 technical courses in the CLT program were obtained from a database. Only data from students enrolled in the CLT program from Fall 2003 to Spring 2006 was used. Once the data was collected, it was entered into the data collection spreadsheet. Student names were replaced with numerical data to ensure student confidentiality.

#### *Data analysis*

All appropriate descriptive statistics were run on the data. Pearson R correlation coefficient was performed to determine the relationship of students ACCUPLACER math and algebra scores as well as math test scores in the course QA/LAB math with their overall scores in the CLT program.

*Limitations*

One limitation to the data collection instrument was that it had no measures of validity or reliability. Only data from students enrolled in the CLT program from August 2003 to the Spring of 2006 was collected due to the change in the program curriculum that occurred in August 2003. Not all students who entered the program had to take the ACCUPLACER placement test, and some of the students who did take the test, took it in a district other than MATC. Since the sample for this study was concentrated to the students in the MATC district, generalizations concerning the results of this study may not be applicable to other districts or colleges.

## Chapter IV: Results

### *Introduction*

The purpose of this study was to determine if there is a correlation between math and algebra scores on the ACCUPLACER placement test and the retention and success rates of the students in the CLT program at MATC. This study also determined if there is a correlation between students who are placed directly into math remediation without taking the ACCUPLACER placement test and the retention and success rates of the students in the CLT program. Finally, this study determined if there is a correlation between math scores in the CLT course QA/Lab Math and the success and retention rates of students in the program. This chapter will include the results of the study. General statistical information will be addressed as well as the results from the research questions.

### *General Statistical Information*

This study used data from 80 students enrolled in the Clinical Laboratory Technology (CLT) program from August 2003 until June 2006. Of that total, 23 (29%) of the students took the ACCUPLACER math and/or algebra test, and 57 (71%) took another college entrance exam. The reason for the low number of students taking the ACCUPLACER is varied. Two other technical colleges, Gateway Technical College (GTC) and Waukesha Technical College (WTC), share the CLT program with MATC. These colleges do not use the ACCUPLACER placement test. According to Ger Vang (counselor, personal communication, May 31, 2005), a student who has 12 college credits from another institution other than GTC, WTC, or MATC may also not have to take the ACCUPLACER placement test. Refer to table 1 for the distribution of CLT students from the 3 technical colleges.

Table 1

*Distribution of students in shared CLT program*

Technical college	Frequency	Percent
Gateway	23	28.8
MATC	50	62.5
Waukesha	7	8.8
Total	80	

*Research Questions*

Research Question #1 - Of the number of students applying to the CLT program, how many fall below the cut scores for math and/or algebra on the ACCUPLACER placement test?

Of the 23 students who took the ACCUPLACER, 9 (39.1%) scored below the cut score of 64 on the math test, and 8 (34.8%) scored below the cut score of 40 on the algebra test.

Research Question #2 - Of the number of students applying to the CLT program, how many have been placed in math remediation courses?

Based on ACCUPLACER test scores or the lack of high school algebra, a student may be placed into math remediation. Table 2 lists this data. A total of 29 students (44.6%) were placed in a math course. Out of the 80 CLT students, complete records could not be found on 15 of the students.

Table 2

*Number of CLT students placed into math remediation*

	Frequency	Percent	Valid Percent
Number of students placed in math remediation	29	36.3	44.6
Total	65	81.3	100.0
Missing	15	18.8	
Total	80	100.0	

Research Question # 3 - What are the success rates of CLT students in the program who have taken math remediation courses?

Table 3 shows the success rates of students who have taken math remediation. Of the 15 students who have taken math remediation and are not currently enrolled in the program as of July 2006, 10 (66.7%) have graduated and 5 (33.3%) have either failed or dropped out of the program.

Table 3

*Success rates of CLT students who have taken math remediation*

	Frequency	Percent	Valid Percent
Graduated	10	34.5	66.7
Failed/dropped	5	17.2	33.3
Total	15	51.2	100.0
Currently enrolled	14	48.2	
Total	29	100.0	



Research Question # 4 - What are the success rates of CLT students in the program who scored below the cut score on the math subtest from the ACCUPLACER placement test?

Table 4 shows data concerning the success rates of CLT students who have scored below the cut score of 64 on the math portion of the ACCUPLACER test. Of the 8 students who are not currently in the program, 4 (50.0 %) have graduated and 4 (50.0%) have either failed or dropped out of the program.

---

Table 4

*Success rates of CLT students who have scored below the cut score of 64 on the math portion of the ACCUPLACER test*

---

	Frequency	Percent	Valid Percent
Graduated	4	44.4	50.0
Dropped/failed	4	44.4	50.0
Total	8	88.9	100.0
Currently in program	1	11.1	
Total	9	100.0	

---

Research Question # 5 - What are the success rates of CLT students in the program who scored at or above the cut score on the math subtest from the ACCUPLACER placement test?

Table 5 shows data concerning the success rates of CLT students who have scored at or above the cut score of 64 on the math portion of the ACCUPLACER test. Of the 3 students who are not currently in the program, 2 (66.7%) have graduated and 1 (33.3 %) has

either failed or dropped out of the program. A total of 8 (72.7%) students are still enrolled in the program.

---

Table 5

*Success rates of CLT students who have scored at or above the cut score of 64 on the math portion of the ACCUPLACER test*

---

	Frequency	Percent	Valid Percent
Graduated	2	18.2	66.7
Dropped/failed	1	9.1	33.3
Total	3	27.3	100.0
Currently in program	8	72.7	
Total	11	100.0	

---

Research Question # 6 - What are the success rates of CLT students in the program who scored below the cut score on the algebra subtest from the ACCUPLACER placement test?

A total of 8 students scored below the cut score of 40 on the algebra portion of the ACCUPLACER test. The data presented in Table 6 shows that of the 4 students who are not currently enrolled in the program, 1 (25.0%) has graduated and 3 (75.0%) have either failed or dropped out of the program.

Table 6

*Success rates of CLT students who have scored below the cut score of 40 on the algebra portion of the ACCUPLACER test*

	Frequency	Percent	Valid Percent
Graduated	1	12.5	25.0
Dropped/failed	3	37.5	75.0
Total	4	50.0	100.0
Currently in program	4	50.0	
Total	8	100.0	

Research Question # 7 - What are the success rates of CLT students in the program who scored at or above the cut score on the algebra subtest from the ACCUPLACER placement test?

Table 7 shows that out of the 3 students who are not currently enrolled in the program, 2 (66.7 %) have graduated and 1 (33.3%) has either failed or dropped out of the program.

Table 7

*Success rates of CLT students who have scored at or above the cut score of 40 on the algebra portion of the ACCUPLACER test*

	Frequency	Percent	Valid Percent
Graduated	2	20.0	66.7
Dropped/failed	1	10.0	33.3
Total	3	30.0	100.0
Currently in program	7	70.0	
Total	10	100.0	

Research Question # 8 - What are the success rates of CLT students in the program who scored either at or above or below the minimum passing score of 77% on the math test in the CLT course QA/Lab Math?

Of the 78 students who took the math test in the course QA/Lab Math, 22 (28.2%) scored below the minimum passing score of 77% and 56 (71.8%) scored at or above. Two students dropped out of the program before taking the test. Table 8 shows that 27 (56.3%) of students who scored above 77% on the math test graduated while 6 (12.5%) either dropped out or failed the program. Conversely, 9 (18.8%) of the students who scored below 77% on the math test graduated, while 6 (12.5%) either dropped out or failed the program. Of the 15 students who are not currently in the program and scored below the minimum passing grade, 40% of them dropped out or failed the program. It should be noted that of the 30 students currently in the program, close to 77% of them received a passing grade on the math test,

while only about 69% of the 48 students who either graduated or dropped out or failed the program received a passing grade.

---

Table 8

*Success rates of CLT students who have scored either at or above 77% or below 77% on math test in QA/Lab Math*

---

	Frequency	Percent	Valid Percent
Graduated and scored at or above 77%	27	34.5	56.3
Graduated and scored below 77%	9	11.5	18.8
Dropped out or failed and scored at or above 77%	6	7.7	12.5
Dropped out or failed and scored below 77%	6	7.7	12.5
Total (students who graduated and dropped out or failed)	48	65.5	100.0
Currently in program and scored at or above 77%	23	29.5	76.7
Currently in program and scored below 77%	7	9.0	23.3
Total (current students)	30	38.5	100.0
Total	78	100.0	

---

Research Question # 9 - What is the correlation between ACCUPLACER math test scores and the overall scores of students in the CLT program?

Pearson r was performed to answer research question 9. Table 9 shows the data was found not to be statistically significant at the .05 level ( $r = .291$ ;  $p = .213$ ). Of the 20 students who took the ACCUPLACER math test, little if any relationship was found between the overall scores of the students in the program and ACCUPLACER math test grades.

Research Question # 10 - What is the correlation between ACCUPLACER algebra test scores and the overall scores of students in the CLT program?

Pearson r was performed to answer research question 10. Out of the 18 students who took the ACCUPLACER algebra test, how students performed on the test did not seem to have an affect on their overall grade in the program. Table 9 shows the data was found not to be statistically significant at the .05 level ( $r = .007$ ;  $p = .978$ ).

Research Question # 11 - What is the correlation between math scores in the CLT course QA/Lab Math and the overall scores of students in the CLT program?

Pearson r was performed to answer research question 11. Table 9 shows that a mild positive relationship was found between math scores and overall scores of students in the CLT program and was found to be statistically significant at the .05 level ( $r = .315$ ;  $p = .001$ ).

Table 9

*Correlations*

		CLT Program Scores
ACCUPLACER Math Scores	Pearson	.291
	Correlation	.213
	Sig (2-tailed)	
	N	20
ACCUPLACER Algebra Scores	Pearson	.007
	Correlation	.978
	Sig (2-tailed)	
	N	18
QA Lab Math Scores	Pearson	.315
	Correlation	.005
	Sig (2-tailed)	
	N	78

## Chapter V: Discussion, Conclusions, and Recommendations

### *Introduction*

This chapter will include a general discussion of the study as well as conclusions and recommendations derived from the study.

### *Discussion*

The purpose of this study was to determine if there is a correlation between math and algebra scores on the ACCUPLACER placement exam and the overall success of students in the Clinical Laboratory Technology (CLT) program at Milwaukee Area Technical College (MATC). The study also looked at the success rates of the CLT students and if there is a correlation between math scores in the CLT course QA/Lab Math and the success rates of the students in the program. The study included data from 80 students enrolled in the CLT program from August 2003 until June 2006.

The literature review focused on issues concerning student retention and success in post secondary education. The overall findings of these issues showed that there are many factors that contribute to student success and retention. Some of these factors included demographics, social-issues, pre-college preparation, and math skills. The literature review also included information on college entrance exams with an emphasis on the ACCUPLACER entrance exam. The findings from this section revealed that college entrance exams are a good tool for placing students in the appropriated courses based on their academic skills and abilities. It was also found that the placement test should not be used as a predictor of student success in college.



Instrumentation used in this study included: a) ACCUPLACER math and algebra scores, b) success rates of the CLT students in the CLT program, c) student math scores in the course QA/Lab Math, and d) spreadsheet designed by the researcher to record the data.

### *Conclusions and Recommendations*

Research question #1 asked how many CLT students applying to the CLT program fell below the cut scores for the math and/or algebra subtests on the ACCUPLACER placement test. About 39% of the students fell below the cut score for the math subtest and about 35% of the students fell below the cut score for the algebra subtest. Based on this data it can be concluded that over a third of the prospective CLT students had inadequate math and/or algebra skills. According to the literature review of this study, students with inadequate math skills tend to struggle in post secondary education. This data, however, should be looked at cautiously since the number of students used to compile the data was only 23. Based on this conclusion, it is recommended that the CLT department at MATC look at students who score below the math and/or algebra cut scores as potential at risk students. It is also recommended that more data be collected and reanalyzed in the future to determine the significance of this issue since math is an important component of the CLT profession. Since not all students take the ACCUPLACER placement test, future research should include data from other placement tests.

Research question #2 asked how many students applying to the CLT program were placed in math remediation. About 45% of the students entering into the program had to take some type of math remediation. Based on this data, it can be concluded that a significant number of prospective CLT students needed to upgrade their math skills based on program requirements. Since math is an important component of the CLT profession, it is critical that

students obtain the proper math skills before they enter into the program. Based on this conclusion, it is recommended that there should be no change to the process used to assess the math skills of prospective CLT students. Future research should look at the content of the various math remediation options to determine if they are meeting the needs of the program.

Research question #3 asked what the success rates of CLT students were who were placed in math remediation. Close to 67% of the students who took math remediation completed the program successfully. The goal of the CLT program is to retain 80% of the students and currently the program is retaining about 75% (MATC, 2005d). Based on the data it can be concluded that math remediation did not have an effect in increasing graduation rates for this group of student. This data should be viewed with caution since this study only contained data on 15 students. Based on this conclusion, it is recommended that data continue to be collected and reanalyzed in the future to determine the impact of math remediation on the success rates of students in the program. Future research should determine if the various math remediation options are meeting the needs of the CLT program.

Research question #4 asked what the success rates of CLT students were who scored below the cut score on the math subtest from the ACCUPLACER placement test. The data showed that only half the student who scored below the cut score completed the program. From this data it can be concluded that having inadequate math skills has an impact on the success of students in the program. This conclusion should be looked at carefully, since the numbers of students used to compile the data were only 8. Based on this conclusion, it is recommended that data continue to be collected and reanalyzed in the future to determine the

impact of low math ACCUPLACER scores on the success rates of the students in the CLT program. Since not all students take the ACCUPLACER, future research should include data from other placement tests.

Research question #5 asked what the success rates of the CLT students were who scored at or above the cut scores on the math subtest from the ACCUPLACER placement test. The data showed that about 67% of the students who scored at or above the cut score successfully completed the program. This number falls below the 80% student retention goal for the program. From the data it can be concluded that scoring at or above the cut score on the math subtest did not have a significant effect on the success rates of students in the program. This data needs to be looked at with concern, since only 3 students were used to compile this data. Based on this conclusion, it is recommended that data continue to be collected and reanalyzed in the future to determine the impact of math ACCUPLACER scores on the success rates of the students in the CLT program. Since not all students take the ACCUPLACER, data from other placement tests should also be looked at for future research.

Research question #6 asked what the success rates of CLT students were who scored below the cut score on the algebra subtest from the ACCUPLACER placement test. The data showed that 75% of the students who scored below the cut score did not complete the program successfully. Based on this data, it can be concluded that having poor algebra skills has an impact on the success of students in the program. However, since this data only included 4 students, this conclusion should be looked at with caution. Based on this conclusion, it is recommended that data continue to be collected and reanalyzed in the future to determine the impact of low algebra ACCUPLACER scores on the success rates of the

students in the CLT program. Since not all students take the ACCUPLACER, data from other placement tests should also be looked at for future research.

Research question #7 asked what the success rates of CLT students were who scored at or above the cut score on the algebra subtest from the ACCUPLACER placement test. The data showed that about 67% of the students who scored at or above the cut score successfully completed the program. Since the CLT program goal for student retention is 80%, it can be concluded that having adequate algebra skills did not have an impact on meeting this goal. However, since only 3 students were used to compile this data, the conclusion should be looked at with concern. Based on this conclusion, it is recommended that data continue to be collected and reanalyzed in the future to determine the impact of algebra ACCUPLACER scores on the success rates of the students in the CLT program. Since not all students take the ACCUPLACER, future research should include data from other placement tests.

Research question #8 asked what the success rates of CLT students were who scored either at or above, or below the minimum passing score on the math test in the CLT course QA/Lab Math. The course QA/Lab Math includes math content that is very specific to what a CLT needs to know in order to perform as a competent technician in the field. Based on the data, about 56% of the students who scored above the minimum passing score graduated, whereas only about 19% of the students who scored below the minimum passing grade graduated. It can be concluded that passing the math test increased a student's chance of graduating from the CLT program. The data also shows that 25% of the students either dropped out or failed the program. Of this group half scored at or above the minimum passing grade, while half scored below the minimum passing grade. Based on this data it can be concluded that other factors beside performance on the math test influenced the success or

lack of success of this group of students. However, the data also shows that 40% of the students who scored below the minimum passing grade on the math test dropped out or failed the program. Based on this data, it can be concluded that poor performance on the math test affected the success of these students. Since QA/Lab Math is one of the first courses the students take in the program, it is recommended that students who score below the minimum passing grade on the math test receive counseling to determine the factors for their poor performance. Through this recommendation, potential at risk students could be identified and offered options to help increase their overall success in the program. Future research should look at other possible indicators to determine at risk students in the program.

Research question #9 asked if there is a correlation between ACCUPLACER math scores and the overall scores (grades) of students in the CLT program. The data showed a slight positive correlation ( $r = .291$ ;  $p = .213$ ), but was found not to be statistically significant at the .05 level. Based on this data, it can be concluded that little if any relationship exists between ACCUPLACER math scores and overall grades of students in the program. Only 20 students took the ACCUPLACER math test, so this data must be looked at with caution. Based on this conclusion, it is recommended that data continue to be collected and looked at in the future to determine if there is a relationship between ACCUPLACER math scores and the overall program scores of CLT students. Since not all students take the ACCUPLACER placement test, future research should include data from other placement tests.

Research question #10 asked if there is a correlation between ACCUPLACER algebra scores and the overall scores (grades) of students in the CLT program. The data did not show any relationship between ACCUPLACER algebra scores and the overall grades of students in the program ( $r = .007$ ;  $p = .978$ ). Based on this data, it can be concluded that how

a student performed on the ACCUPLACER algebra test had no impact on his/her overall grade in the program. Only 18 students took the ACCUPLACER algebra test, so this data must be looked at with concern. Based on this conclusion, it is recommended that data continue to be collected and looked at in the future to determine if there is a relationship between ACCUPLACER algebra scores and the overall program scores of CLT students. Since not all students take the ACCUPLACER placement test, future research should include data from other placement tests.

Research question #11 asked if there is a correlation between math scores in the CLT course QA/Lab Math and the overall scores (grades) of students in the CLT program. The data showed that a mildly positive relationship exists between math scores and the overall grades of students in the program ( $r = .315; .001$ ). Based on this data it can be concluded that the better a student scored on the math test in the course QA/Lab Math, the better his/her overall grade in the program was. It can also be concluded that the lower a student scored on the math test, the lower his/her overall grade was. Having competent math skills not only is important for student success in the course QA/Lab Math, but is also important for student success in other courses in the CLT program. Based on this conclusion, it is recommended that the CLT program use math scores from QA/Lab Math as a possible indicator of potential at risk students. Since this course is one of the first courses in the program, a student could receive appropriate counseling that might increase his/her chances of finishing the program successfully. Future research should look at other potential indicators that may identify at risk students in the CLT program.

College placement tests such as the ACCUPLACER test are useful in placing students in classes that match their skill level. This study focused on student's math and

algebra skills and how it affected their success in the CLT program at MATC. The results showed that a significant number of prospective CLT students needed some type of math remediation based on their college entrance exam scores. The study also showed that this group of students tended to have a lower graduation rate when compared to all CLT students. Because of this conclusion, it was recommended that the CLT faculty continue to collect data and reanalyze it in the future. It was also recommended that the content of the various math remediation courses be reviewed to determine if these courses are meeting the needs of the program.

A major portion of this study used data based on results of the ACCUPLACER placement test. Because not all students in this study took the ACCUPLACER, it was hard to determine the impact of this test on the success of the students in the program. Based on this conclusion it was recommended that any future studies include results on other placement tests that the students might take.

The literature review stressed the importance of math skills to the success of students in college. This study showed that CLT students who scored higher on a math test in the CLT course QA/Lab Math tended to have a higher overall program grade than students who scored lower on this test.

Finally it is hoped that this study showed the importance of math and/or algebra skills to the success of CLT students. Through continued research it is hoped that indicators be developed to identify at risk students in the program and options be developed to help improve with the retention and success of the students in the program.

## References

- American Society of Clinical Pathologists. (2004). *The medical laboratory technician*. Retrieved June 7, 2005, from: <http://www.ascp.org/bor/medlab/careers/page3.asp>
- Berkner, L., He, S., & Forrest, E. (2003). *Descriptive summary of 1995-1996, beginning postsecondary students: Six years later*. U.S. Department of Education. National Center for Educational Statistics. Retrieved February 6, 2005, from: <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2003151>
- Bush calls for more math, science funding. (2006, February 1). *The Milwaukee Journal Sentinel*, A6.
- Choate, L., & Smith, S. (2003, Fall). Enhancing development in 1<sup>st</sup>-year college student success courses: A holistic approach. *Journal Humanistic Counseling, Education & Development*, 42 (2), 178-193. (ERIC Document Reproduction Service No. EJ 677 833) Retrieved June 7, 2005, from: EBSCOhost Academic Search Elite.
- College Board. (2003, January). *Accuplacer online technical manual*. New York, NY: Author.
- College Board. (2002, December). *Accuplacer online coordinator's guide*. New York, NY: Author.
- Golfin, P., Jordan, W., Hull, D., & Ruffin, M. (2005). *Strengthening mathematics skills at the post secondary level: Literature review and analysis*. U.S. Department of Education Office of Adult Education and Literacy. Retrieved February 6, 2006, from: <http://www.ed.gov/about/offices/list/ovae/pi/hs/factsh/litreview905.doc>



- Gordon, R. (2001). *Accuplacer and a foundation of learning*. Accuplacer Users Conference, Jun 28-20, 2001. Chicago, IL.
- Heeman, R.A., & Kilmer, J. (1992). Linking program costs, recruitment, retention, and graduation to the medical laboratory technology curriculum. *Laboratory Medicine*, 23(4), 227-228.
- Hetzner, A. (2006, February 7). Strength in numbers. *The Milwaukee Journal Sentinel*, A1.
- Hirschy, P., & Mack, Q. (2001). *Comparison of student success among Asnnuntuck Community College elementary algebra students placed by Accuplacer score, scholastic aptitude test score, or prerequisite course*. Institutional Research: Leadership through Excellence. North East Association for Institutional Research Annual Conference Proceedings 28<sup>th</sup>, Cambridge, Massachusetts, November 17-20, 2001. (ERIC Document Reproduction Service No. ED 465 362) Retrieved June 7, 2005, from: EBSCOhost Academic Search Elite.
- Horn, C., Ramos, M., Blumer, I., Madaus, G., Lynch, P., & Lynch, C. (2000, April). Cut scores: Results may vary. *The National Board on Educational Testing and Public Policy: Monographs*, 1(1). Retrieved June 7, 2005, from: <http://www.bc.edu/research/nbetpp/statements/M1N1.pdf#search='cut%20scores'>
- Hoyt, J.E. (1999). Remedial education and student attrition. *Community College Review*, 27(2), 51-73.
- Jobs for the Future. (2005). Education and skills for the 21<sup>st</sup> century: An agenda for action. (ERIC Document Reproduction Service No. ED 486 155) Retrieved February 17, 2006, from: EBSCOhost Academic Search Elite.

- MacKenzie, S. (2002, May). Can we make math count at HE? *Journal of Further & Higher Education*, 26(2), 159-171.
- Maggio, J.C., White, W.G., Molstad, S., & Kher, N. (2005, Winter). Prefreshman summer programs; Impact on student achievement and retention. *Journal of Developmental Education*, 29(2), 2-33.
- McLaughlin, G., Brozovsky, P., & McLaughlin, J. (1997). *Strategies in retention research*. Retrieved February 19, 2002, from:  
<http://fbox.vt.edu/admin/ir/papers/sture.html>.
- Milwaukee Area Technical College. (2005a). *The story of MATC*. Retrieved June 6, 2005, from: [www.matc.edu/mate\\_news/StoryOfMATC.html](http://www.matc.edu/mate_news/StoryOfMATC.html)
- Milwaukee Area Technical College. (2005b). *Clinical laboratory technician*. Retrieved June 6, 2005, from: [www.matc.edu/documents/catalog/Clinical\\_Laboratory\\_Technician\\_AAADegree.html](http://www.matc.edu/documents/catalog/Clinical_Laboratory_Technician_AAADegree.html)
- Milwaukee Area Technical College. (2005c). *Clinical laboratory advisory committee meeting from May 4, 2005*. (Available from: Health Occupations Division, Milwaukee Area Technical College-Milwaukee, WI)
- Milwaukee Area Technical College. (2005d). *Quality review process scorecard*.  
Prepared by strategic planning and research. (Available from: Health Occupations Division, Milwaukee Area Technical College-Milwaukee, WI)
- Milwaukee Area Technical College. (2005e). *Clabt-113; QA/Lab Math*. Retrieved June 6, 2005, from:  
[http://oncampus.matc.edu/catalog/course\\_results.asp?TITLE=QA%2FLab+Math](http://oncampus.matc.edu/catalog/course_results.asp?TITLE=QA%2FLab+Math)

- Milwaukee Area Technical College. (2003a). *2003 graduation report*. Retrieved June 6, 2005, from: [www.matc.edu/documents/GradReport3.pdf](http://www.matc.edu/documents/GradReport3.pdf)
- Milwaukee Area Technical College. (2003b). *Self-study document of the clinical laboratory technician program for consideration by the National Accrediting Agency for Clinical Laboratory Sciences*. (Available from: Health Occupations Division, Milwaukee Area Technical College - Milwaukee, WI)
- Milwaukee Area Technical College. (n.d.). *Admissions process*. (Available from: Counseling Department, Milwaukee Area Technical College - Milwaukee, WI)
- Moore, N. (1995). *Persistence and attrition at San Juan College*. (ERIC Document Reproduction Service No. ED 380 159) Retrieved February 17, 2002, from: EBSCOhost Academic Search Elite.
- Naretto, J.A. (1995). Adult student retention: The influence of internal and external communities. *NASPA Journal*, 32(2), 90-100.
- Neutzling, E. (2003). Crossing the finish line: A strategic approach designed to help community college students persist and graduate. (ERIC Document Reproduction Service No. ED 474 579) Retrieved February 17, 2006, from: EBSCOhost Academic Search Elite.
- O'Brien, M. (1995, August 15). *Executive summary: Selected MATC students performance on the Accu-placer*. (Available from: Student Services, Milwaukee Area Technical College - Milwaukee, WI)
- Overstreet, M. (2004, November, 8). Assessment + retention = student success. Community College Week, p. 3.

- Perin, D. (2004, August). Remediation beyond developmental education: The use of learning assistance centers to increase academic preparedness in community colleges. *Community College Journal of Research & Practice*, 28(7), 559-582.
- Perkins, N. (2005, April 22). Higher education needs more mentors. *Deseret News*. Retrieved May 31, 2005, from: ProQuest database.
- Reason, R. (2003). Student variables that predict retention: Recent research and new developments. *The NASPA Journal*, 40 (4), 172-191. Retrieved May 31, 2005, from: <http://publications.naspa.org/naspajournal.vo40/iss4/art10>
- Seppanen, L. (1995). *Implications for retention strategies of differential student progress rates and the literature on student retention*. (ERIC Document Reproduction Service No. ED 387 165) Retrieved February 17, 2002, from: EBSCOhost Academic Search Elite.
- Sireci, S., Patelis, T., Rizavi, S., Dillingham, A., & Rodriguez, G. (2000). *Setting standards on a computerized-adaptive placement examination*. (ERIC Document Reproduction Service No. 443 869) Retrieved June 7, 2005, from: EBSCOhost Academic Search Elite.
- Smedley, B.D., Hector F.M., & Harrell, S.P. (1993). Minority-status stresses and the college adjustment of ethnic minority freshmen. *Journal of Higher Education*, 64(4), 434-452.
- Szelenyi, K. (2001). *Minority student retention and academic achievement in community colleges*. (ERIC Document Reproduction Service No. ED 451 859) Retrieved April 3, 2002, from: EBSCOhost Academic Search Elite.

Truttschel, W. (2002). *Mathematics anxiety at Chippewa Valley Technical College*.

Unpublished master's thesis, University of Wisconsin - Stout, Menomonie, WI.

U.S. Department of Education. (1996). *Remedial education at higher education*

*institutions in fall 1995*. National Center for Education Statistics. Retrieved April 4,

2002, from: <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=97584>

Windham, P. (1994). *The relative importance of selected factors to attrition at public*

*community colleges*. (Eric Document Reproduction Service No. ED 373 833)

Wisconsin Technical College System. (2005a). *Areas of study*. Retrieved June 7, 2005, from:

[www.witechcolleges.com/areas\\_study.htm](http://www.witechcolleges.com/areas_study.htm)

Wisconsin Technical College System. (2005b). *Adult basic education*. Retrieved June 7,

2005, from: [www.witechcolleges.com/abe.htm](http://www.witechcolleges.com/abe.htm)