AN ANALYSIS OF THE VARIABLES INVOLVED IN MATHEMATICS PLACEMENT AT THE LETHBRIDGE COMMUNITY COLLEGE

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I. Introduction

"It isn't that they can't see the solution. It is that they can't see the problem."

by G.K.Chesterton, "The Point of a Pin",
in The Scandal of Father Brown

A. An Unsettling Impression

As an instructor of mathematics at the Lethbridge Community College (LCC), I have a keen interest in my students' success. I have taught in the College and University Prep Program for six years. I also taught for three years at the Junior High School Level and 4 years at the High School Level. I love teaching and, although I find it a challenge, I greatly enjoy the adult students in my classes at the College. However, there are times I feel I am "spinning my wheels" in trying to impart some small amount of mathematics knowledge into my students' minds. They are confused and frustrated by the solutions to the most basic arithmetic concepts, not realizing that herein lies the problem. Let me provide some typical examples of questions from students in Math 030 or Math 033 (Algebra and Trigonometry):

"How did you get $\frac{5}{6}$ from $(\frac{1}{3}+\frac{1}{2})$? Shouldn't it be $\frac{1}{5}$?"

"What happened to the negative when you multiplied (-42) times (-8)?"

"Why don't you just cancel the 5's in this example?" (e.g. $\frac{5x+2}{5xy}$)

"When you divided $20x$ by (-1/4), how did you get $(-80x)$?

"What is cosine?" or "What is perpendicular?"

"What is cosine?" or "What is perpendicular?"

On the surface one may feel that there is absolutely nothing wrong with the above questions and in fact, they are legitimate inquiries from students who simply do not understand the math material being taught. The frustration is that many of the students I teach do not have the basic mathematics skills needed to handle the material at the senior level of high school mathematics. With these skills lacking it is very hard for them to fully understand the new material being taught. These students are trying to upgrade their knowledge in math so as to qualify for a specific program at a college, attendance at a university, or simply to attain a High School Equivalency Diploma. They come with varying degrees of math knowledge and register at the level which supposedly most suits their own ability. As an instructor I expect students registered in Math 033 to have at least a "C" grade in Math 023 or an equivalent background. However, the fact that this has not been the case has made it difficult to cover all the material designated for Math 030 and Math 033 because precious class time has to be spent explaining basic math skills.

Another problem facing the students and instructors of math in the College and University Prep Program, also called upgrading, is a lack of time and poor retention. Some students may have been away from math for a year, while others may not have studied mathematics for five to ten years or more. For some students this may mean only a brief review to regain their knowledge base, while for others this may mean starting the process of learning math all over again. Unfortunately the time taken to teach basic skills eats away the time needed to the cover new material.

I feel that much of my class time is spent going over material that my students should already know. The time left for the new concepts is minimal and this causes more stress for those students who are not only struggling with prerequisite material they are supposed to know, but also trying to absorb this new material. Because of this lack of adequate preparation and knowledge, coupled with the simple fact that there is a great deal of work involved in learning the new material in these math courses, it is not surprising there is a high level of frustration and anxiety among the students in these classes. For students coming into a course of this kind without the knowledge base, failure and withdrawal rates can range from 30% up to 70% in the College Prep Program. These rates seem frustratingly high, yet they are not uncommon. It has been reported in Colleges in the United States that typical rates of attrition in remedial mathematics classes are from 25% to 65% (Cox, 1990, p. 5). It is also interesting to note that studies have shown that "32% of students entering a four-year college need help in remedial mathematics and 39% in two-year programs. In a 1977 study in El Paso Community College it was found that 98% of its students needed remedial mathematics" (Cox, 1990, p. 5). It is obvious that students do not have strong mathematics concepts. In terms of a thriving college program, we cannot be successful unless we are graduating a good percentage of our students, and our numbers do not reflect this. Present success rates are 48.8% for all math classes.

Quite a good number of students have low self-esteems because of their poor educational background. This can be further eroded by their poor performance in

mathematics. They will probably feel even more anxious and ambivalent toward their study of mathematics. It is apparent that generally "Mathematics" as a subject area is viewed negatively by the majority of students and even by some of the other course instructors. It is seen as inordinately difficult, abstract and without basis in the real world. However, if a person comes into a class and much of what the instructor is talking and writing about appears to be total *Greek* it is not hard to imagine why this person draws this conclusion.

It is my contention that in an average Math class with 25 students, only one-third to one-half of those registered should actually be in that class. That is, only one-third to one-half of a typical class have the necessary academic background and work habits to be able to take the level of math in which they are registered. The problem is not just inadequate math knowledge, but also lack of commitment, motivation and goals. In a class of 25 there is usually about one-third of the students who actually passes with a grade high enough to allow them to continue their studies in mathematics at either the college or university level. This is frustrating not just for the instructors. These students face many frustrating obstacles and the problems to be overcome are not simple.

B. The Problems

One area of concern is the correct placement of a student in a mathematics class. Presently, most mature students or those who have been out of school for more than two years are tested using the Computerized Placement Test (CPT) or the Canadian Achievement Test (CAT) in the Assessment Center of the Lethbridge Community College. The test used depends on the program to be entered. Students entering Upgrading or College Prep take the CAT. Students entering General Studies and some of the other programs at the College will write the CPT. These marks, along with transcripts where available, length of time since last being in school, and past performance in math, serve as the only criteria available to determine which math class the student should register in. As our assessment chairperson states: "Many times I have to judge intuitively beyond the test results and the student's math background to make a placement recommendation. There are many variables that affect whether the student will succeed. Many times I am making as best an educated guess as possible from the information I have" (personal communication with N. Baird-Duske - Assessment Center, 1995). It would seem that correct placement of a student is an art and not a science. But is this enough? Can we make placement more predictive of success?

Registration itself can present problems. The College wishes to have an open-door policy to allow anyone the opportunity to take classes and better their education. This is to be commended and is an honorable goal, but at the same time, this causes problems in controlling the prerequisite skills that are expected. Many students with up-to-date

transcripts and a pass mark (the equivalence of a grade of D) for a math class are allowed to register in the next level course at the College. This is not a situation unique to the LCC. As Ann Ferren and Jeff McCafferty (1992) reported:

> Students place themselves in courses beyond their abilities in an attempt to avoid taking non-credit remedial work. Faced with the option of taking finite mathematics, which fulfills the math requirement, or enrolling in non-credit algebra, which their placement test shows they need, students at our university often try the higher level course, with disastrous results. (p. 87)

If students have passed a math prerequisite with a grade of 'D', they are considered to have an inadequate or poor knowledge base in mathematics. Much grumbling is heard from students when the instructor seems to be covering material too quickly when in fact these students do not have adequate skills on entering the class. Often instructors simplify and cover only the simplest concepts in order to accommodate these poorly-prepared students because they are often the majority in a class. This has the overall effect of "watering down" the curriculum. It also has the effect of branding some instructors as "tougher" because they teach to the course objectives. Students with a 60% average mark coming into a course simply do not have the knowledge base necessary to carry on adequately in their mathematics learning. Poor technique and work habits can further affect performance negatively.

From the College's perspective, however, no student should be denied access to the education they desire and are able to pay for. Government funding is not granted

according to the successful completion of a mathematics course by a student, but simply by that student being in attendance and eventually completing a program. We are in a "Catch 22" situation. On the one hand we should allow all individuals access to further their knowledge and education. On the other hand, who are we benefiting by having such a high number of withdrawals and failures in math classes because of poor math competency? Is it wise to simplify and lower our standards of competence at specific course levels to accommodate lower quantitative competence? Are we not further embedding and reinforcing the attitude that math is difficult, confusing, useless and frustrating to learn?

Another problem facing students is the time that has passed since they were last in school. Their ages range from 18 to 57 years. Many have been away from school for years and their last academic efforts were neither productive nor beneficial. Many are frustrated that they would even have to repeat a mathematics course. They feel that they should be able to walk back into a math class with the same knowledge with which they left their last class years ago, or at least that they should immediately remember forgotten concepts. Many have a deep-seated anxiety of mathematics. They are unhappy and fearful of their performance and will bail out at the first sign of difficulty.

Personal problems encountered by these particular students can also greatly influence the successful completion of their math classes. These personal problems can dull their commitment and concentration. Drug addiction, single-parenting, physical and emotional abuse, poverty, poor self-concept, and poor life-skills can greatly affect their

ability to concentrate on their studies and their attendance. Attendance is extremely poor for at least one-third of the students, and we see a very high withdrawal rate from those with poor attendance.

"The level of a student's mathematics preparation and the length of time between mathematics classes also affect college success. Pre-collegiate preparation appears to be directly linked to retention and success in college" (Ferren & McCafferty, 1992, p. 88). In other words, successful students are often positive about being back at school upgrading their skills, and are motivated and committed to working hard. Only those students with these attributes seem to succeed. To be successful in the College Prep Program, students should, in my opinion, have a minimum of 70% on a previous math course, have completed this course in the last two years, and have clear goals in mind, not only for the math classes in which they are registered, but also in their career choices. This successful completion will lead to more self-confidence, more self-esteem, more positive drive, better quality math work, less memorization in solving math problems, and certainly less anxiety. Because the students in my math classes presently do not reflect these traits, I have the unsettling impression that something must be done to refine course placement in mathematics.

C. The Issue

Why do so many of our students register in math courses that are beyond their abilities or commitment at the time? What other variables are taken into account? How are the transcripts of these students figured into what they can and should register in? Are these predictions from the various factors involved as accurate as they could be? How good are the CPT and the CAT tests as predictors of successful completion of math courses?

These are the questions that this research project will address. The present situation of up to two-thirds of the class either withdrawing or failing is, in my mind, far too high. I realize that there will always be extenuating circumstances that may lead a student to withdrawal or failure. Death in the family, illness, personal and/or family problems, lack of funding, lack of support from family and friends, lack of true commitment, drug or alcohol abuse, or too heavy a schedule may all be factors in blocking or preventing success. Because a student is unable to move beyond the constraints of the classroom schedule, he or she may be unable to keep up the work necessary to complete a course by a specified time. All these unforeseen impediments may lead to failure but they are not indicative of poor ability. My impression is that students see withdrawal as the "way out" if the mathematics course becomes "too much" for them, instead of focusing harder and doing more work with the course material. Failure and withdrawal will happen no doubt, but the present high failure and dropout rates warrent attention.

The effectiveness of the CPT and the CAT tests as predictors of student success in math will be examined. Those other variables like age, sex, high school marks, years away from school, and long term goals that can be procured, will also be examined for their effect on students' outcomes in math. Finally, this project will look at other possible models for better placement of students in mathematics in the University and College Prep Program.

II. The Students

> "Midway in our life's journey, I went astray from the straight road and woke to find myself alone in a dark wood."
>
> Dante, *Inferno,* in *The Divine Comedy*

The adults who are registered in the College Prep Program are often individuals who have become lost in life's journey. There are segments of the population which, for reasons of unemployment, job upgrading, vocation changes, or job dissatisfaction simply want to change present working conditions. Many of the adult students lack a high school level education or they may have been away from school for some time and need to upgrade skills that have been forgotten. Some students are upgrading in order to go on to University or into a College program.

> Major reasons identified by adults in many programs include occupational advancement, content interest, compliance with external expectations, service to others, enjoyment of mental stimulation, and interaction with other participants. Knowing widespread reasons that adults generally participate in educational activities can enable you to more readily identify why individual adults do so and to adjust program offerings accordingly. (Knox, 1986, p. 33)

Other more personal influences such as gender, intelligence, social economic status, level of formal education, and role changes that produce a heightened readiness to

learn must be considered. The adult learner may be influenced by the awareness of opportunities, be encouraged by others, recognize the benefit of participating, and may have the financial opportunity to take advantage of more education. These influences must match the adult learner's motivations. If the only reason an adult learner is attending an educational program is to collect an unemployment cheque, satisfy a boss, or get a "meaningless" document, then the educational process means nothing and will more than likely be doomed to failure and further erode the self-concept of the adult learner.

Students taking math in the College Prep Program, attend 50 minute classes every day. My students are both challenging to teach and present a very mixed bag of backgrounds, problems and situations. This variety is best illustrated by a few examples of students I have taught. The names are fictitious but the individuals and their lives are not.

Let me begin with Jose, as I did most mornings. Jose was a cleanly dressed Hispanic man of about 35 years of age. In his broken English he would explain to me that he either was not ready to write a Math 033 exam, or that he needed help with some topic from previous classes. We spent much time grappling, not only with the obvious language problems, but with his math problems. He was from Mexico, had a wife and three children, and was determined to make a better life for himself. He worked three to four hours a night on Math. He was counseled to take a lower level algebra course first, but his determination was unalterable. He desperately wanted to pass this math course so he could get into Drafting. He did pass, but only with a minimal 50%.

Unfortunately, because there is a larger number of Spanish-speaking students, their English language does not develop as well as hoped because they spend all their own time together speaking Spanish. Many have come as refugees from war-torn countries; they are often dependent on the welfare system; they may be unhealthy, depressed and somewhat paranoid because of their histories. Otillia, a beautiful woman from Guatemala, had to flee her country with only what she could carry. She had been marked for death by one of the many militant factions of her country. She spoke English well and told me often of her worries about her family back at home. She found it very hard to concentrate. She was always wrapped in layers of clothes and found the climate here extremely cold. Her math skills were very weak. She tried to memorize everything which did not foster understanding in algebra and trigonometry. She had to repeat her math class to get her credits.

Because so many of the immigrant students have come from often poor, and oppressive conditions, they have the ability to keep all of us focused on what is important and how lucky we are. An example of this occurred one day when Bill, an 18 year old dropout from our Lethbridge school system arrived at the College and could not find a parking spot in any of the College lots. He just left and missed class. His effort in math class was minimal. He came in the next day, and complained that there were no parking spaces left at the College and there was no way that he was going to "walk clear from the Sportsplex parking lot" where extra parking was made available. He was then soundly chastised by an Hispanic woman, that he was very lucky he had a car, he had no children

to get off to school in the morning, and that he could sleep in until 10 AM. Bill blushed, grinned, we all had a little chuckle, and got on with class. Unfortunately there are too many "Bills" in our classes. Lack of ambition, motivation and interest make for poor performance. Many do eventually take responsibility for their learning but not before failing a number of courses.

Jack, 43 years old, was a laborer who was hurt on the job and had to find some other type of work because his leg was badly broken. He walked with a limp, was in constant pain, and sat in the back corner of the classroom. He was not comfortable nor was he happy about being in a math class. He did not know how to use a scientific calculator and had never taken any algebra. He was divorced, had two children in his ex-wife's custody, and was depressed and bitter towards his ex-wife and his circumstances. He gradually started to "unwind" over the semester, made eye contact with me more often, would ask questions occasionally, yet had no self-confidence. Jack found the math extremely difficult but when he could stay away from the painkillers and other drugs, he worked very hard. However, his attendance slipped now and again; eventually he simply dropped out.

Kathy, a single mom, had two very small children, was on welfare, and hated math. She remembered how much she had hated math in junior high school and brought that same feeling into class. She quite often missed class because one or the other of her children was sick. She could not afford a private baby-sitter and day-care centers would not take sick children. She did not like to read and spoke with a slight lisp so she rarely

spoke up in class. She felt overwhelmed by the responsibilities of raising two small children on her own, and complained bitterly in the hallways to her friends. She hated her lot in life, and this bitterness translated into blaming whomever she could for her tough times. Gradually, over the semester, she did gain more self-confidence in those parts of the course that she had been in attendance for and had done some work for. Unfortunately, her efforts were not consistent; her commitment was not strong enough to get her through.

Joanne was 19 years old, and pregnant with her second child. Toward the half-way mark of the semester when she was due any time, she still came every day determined not to miss any of her classes. She lived on a farm an hour out of town with her husband, little boy, father, mother and two brothers. She did extremely well in her work, was a very regular attendee, had her assignments done, and spoke up freely and unhesitatingly when she did not understand something I was doing in class. Unfortunately, I had a number of nightmares of her going into labor while in my class. She liked to remind all of us that her first labor was only 2 hours long, so I boned up on birthing procedures and notified our college nurse to be on the alert! Joanne came into upgrading with very low skills because she left school at a young age. She did marvelously well and was a real asset to have in class. It warms my heart to see individuals like her blossom intellectually before my eyes. By the way, she did have her baby mid semester. She went into labor at 5 PM and delivered about 6:30 PM a very healthy baby girl; she took one week off and came back to classes with her baby. Joanne was a natural and loving mother, but she was

also passionately devoted to her own education. Needless to say she did extremely well in her math class.

Zaid, a 21-year old from Jamaica, seemed to be well-off, as represented by his clothes and car; he was easily distracted in class especially by the good-looking women. It was a puzzle to me what his background was in school, but because he was not responsive to questions I did not press for information. He rarely came to class, and when he did he was usually late and looked like he had just gotten up. He did very poorly on his assignments and his exams. Yet occasionally, when he was paying attention he would answer questions and demonstrated a very deep understanding of the concept I was teaching. Many times he seemed to be bored or unhappy with being in class. He would sporadically ask me questions which were indicative of a better understanding of algebra than what he was showing in his work, yet he failed to do many assignments and missed exams. No, he did not pass, but not for lack of ability I believe.

Curtis, a native who lived in Standoff, was another puzzle. He had trouble getting rides into Lethbridge each day for his classes which meant his attendance was poor. He spoke very slowly and hesitantly, but did seem interested in learning the material. His writing was almost painful looking, and for the first three weeks of class I had to lend him a calculator because he could not afford one. He smiled at me, was certainly cordial and would sheepishly ask me questions when I was over by his desk. Some days he appeared to work very hard, other days he seemed distracted. On one chapter test he did well -

70% -on another he received 30%. It seemed to be a reflection of a life of ups and downs, or an education that worked well in some areas and not in others.

Sandra was another disturbing case. She was 32 at the time I taught her, a mother of three and was having problems in her marriage. I noticed bruises occasionally on her face and arms; she kept her eyes lowered and looked to be in pain when she moved. On some days she brought her children with her to class; more than once she notified me that she was staying for awhile at Harbor House, a local YWCA safe house for women. She desperately wanted to do well in her upgrading and passionately wanted out of her present life. She did very well, although her attendance was occasionally spotty. She did not hesitate to get extra help when she needed it, but she would get extremely upset with herself when she made mistakes and I had to remind her that mistakes were normal especially if a person was tired or distracted. Her math ability was poor but she worked extremely hard and received a 'B' in the class.

Cliff was a 26-year old single dad with three little girls at home. He was working in the coal mines in the Crowsnest Pass when he was laid off. His wife would not make the move to Lethbridge, for whatever reason so they were divorced. He found his role of single parent hard to cope, and making ends meet on unemployment insurance impossible. He was unable to concentrate on upgrading classes; his commitment and motivation were not there. I could see a great deal of frustration, fatigue, confusion and uncertainty in his eyes. Needless to say he did not stay in class for even half the course and I often wonder how he is doing.

Brent, another frustrating example, tried to work at his construction job and upgrade his math skills at the same time. This made for inconsistent attendance. He definitely had some real promise in his work, yet started to come to class smelling of booze. On those days he barely made it into his seat. Fortunately for me and the rest of the class, he was quiet so we were able to carry on with class, while Brent was in another world. Another failure for the record.

Brenda was one student I will probably never forget. She was a 38-year old single mom with 6 children and one on the way. She tried a two-week reconciliation with her husband, the reconciliation did not work, but she became pregnant anyway. Brenda came from a town in British Columbia where an offshoot group of Mormons practice polygamy to this day, apparently. She suffered a great deal of abuse as she grew up, and this carried on into her marriage. When she left this group in B.C., she was "blackballed" from ever coming back to see her family (her very extended family). When her own mother died, she was not allowed to attend the funeral. She had to work very hard at her math, and I felt, from helping her, that she had a very poor math education in her early childhood. Her spirit was indomitable however and she was determined to change her lot in life. Again, she passed with a 'C+', an example of how influential determination and commitment are to success. I would never have guessed at the beginning of the semester that she would do as well as she did.

Mark was an interesting and perplexing man. He was a 47-year old ex-rancher. He proudly showed his pictures of his prize bull to everyone who would listen to him brag

about it. For whatever reason, he had sold his ranch and was going back to school. He had a very hard time with algebra but poured through the material for two hours every day in the Computer Managed Learning Lab where there was tutoring help if he needed it. It was as if he was not going to be made to look bad by all the young people in the class. I knew his algebra background was weak if it even existed at all. These more mature students certainly reinforce the saying, "Where there is a will, there is a way!" Mark did very well, rarely scoring below a 90% all term.

These are only a few examples. Many of the individuals we teach have simply gone astray for whatever reason. For every student there is another story--many are heart-wrenching. I have learned that just when I think I have heard it all, there will be someone else in a class who has some even stranger background or circumstances, and who is trying to cope and learn new math skills. The older students for the most part are tested to ascertain their skill levels in mathematics and reading. Most are very weak in mathematics and reading, but are unwilling to accept that they probably should start at a lower math course in order to gain and establish their base skills. I am not involved in the placement procedure, and do not have much influence in persuading students who register in my class without the necessary math background to take a lower level class first. Many have the false sense that if they "really work hard they can get it", yet their idea of working hard in math consists of doing some spotty questions from the text on weekends. There are varying degrees of maturity, varying degrees of preparedness, and varying degrees of determination. While there are many who are interested in learning, are positive

about being in school, are enjoying the process of learning and using their minds, there are also many who seem to be wandering aimlessly through life. Some are alone and afraid of failure or appearing "stupid", and some are blinded by bitterness; some have been unlucky; some have simply wasted their earlier years. Many are carrying a great deal of "baggage" when they come to my class, but there is also a spark of hope; there is hope that they can get their grade 12 standing, and that they might just improve their chances for a better job; there is hope that they can be accepted into a program at a college; and hope that they can find some sense of sanity and calmness in their lives.

For me, it is hard not to become involved in the problems of these individuals. There is a great deal of life experience among these adult learners, and although most that has happened to them is negative in their eyes, some of their experiences can be viewed as positive because they may lead to better insight and change. The instructor can benefit from these insights and use them to help the adults learn and to enhance instructional methods and proficiencies. However, my primary task is to teach mathematics to my students in the hope of helping them to experience the sweet taste of success. I can be a listener and show some compassion and caring, but in the end, these people must deal with their own problems and the effects of these problems on their schooling. The responsibility for their success in the end will be that of the students; but I hope that I can help facilitate the process to make it as beneficial and meaningful as possible.

The inner feelings and motivations of the student must be addressed for successful completion to become a reality. However, it is imperative that students not be thrown

for their success in the end will be that of the students; but I hope that I can help facilitate the process to make it as beneficial and meaningful as possible.

The inner feelings and motivations of the student must be addressed for successful completion to become a reality. However, it is imperative that students not be thrown into the deep end of the pool if they cannot swim. The students' success can be enhanced by having them work from their own knowledge level and build on a solid base. Math knowledge will be of little value if the student simply memorizes techniques without a complete understanding of why the technique is used and how it works. It would be similar to asking a person who has taken piano lessons for only a short time, to play a deeply involved study by one of the great musical masters. The task would be awesome, if not impossible. The abstract timing, the confusing fingering, the multitude of notes played in unfamiliar patterns would make for confusion and frustration in the student. The person may even find the task so difficult that he/she simply gives up and so wastes what could potentially be, with proper training and guidance, a great pianist. The would-be performer simply does not have an adequate understanding of the notes, timing and expression of an overwhelmingly complicated piece. Is it not naturally assumed to be better to gradually introduce harder and more challenging music to the student as he/she improves? As the pianist learns and gradually becomes accomplished in more difficult music, so he or she will also gain a greater appreciation of music itself, and his or her ability at it.

Surely, much of our learning occurs in this same gradual fashion. Can we possibly understand fractions before simply counting, working with whole numbers, breaking them

into parts and eventually dividing them? How can a student possibly understand the "roots" of an involved polynomial function if they have not a firm grasp of factoring, graphing and working with polynomials? Can complicated trigonometric proofs be accomplished without a basic understanding of the trigonometric functions, sine, cosine and tangent, and the identities applied to them? How can a student be expected to understand graphing principles, or to graph complex functions without an ability to graph a simple line or ordered pair? It is imperative that the students experience success by working from their own knowledge level in math and be placed accordingly. With perseverance success will follow. Possibly, even an enjoyment and appreciation of math could be fostered. This small first step of better placing students in mathematics upgrading classes is the focus of this project.

III. Literature Review

A. The Need for Change in Attitudes

Some studies center on the attitudes of those students who are successful and unsuccessful in math. It is felt that if student attitudes can be analyzed and those "at risk" identified, measures can then be taken to help those whose attitudes do not measure up to success. Many authors (Ferren & McCafferty, 1992; Jenkins, 1991; Pierce & Henry, 1993; Sutarso, 1992) agree that the attitudes of students toward their own abilities, past performances, and the study of math in general have a profound effect on the ability of the students to be successful in math.

Attitudes toward the study of mathematics need to change. Our population generally has a dim view of mathematics and the learning of algebra. Students will take any steps they can to avoid registering in a math course specified as the pre-requisite for a particular program. Their basic abilities in arithmetic and algebra are often poor, and many feel negatively toward the study of mathematics. This may not have changed substantially from the past; however, what seems frighteningly apparent is the attitude that mathematics is no longer necessary or applicable in the real world.

Students registered in math courses that are beyond their abilities are predestined to a frustrating and agonizing time. Math courses in general are viewed with distrust and fear; the ability to do math is seen as something akin to genius, or, for lack of a better term, akin to insanity. Even more worrisome are the negative attitudes toward the study of math which are held by instructors in other subject areas. Being unable to read, that is, being illiterate, is viewed as unacceptable in today's society; but to be illiterate in basic

math skills is viewed as quite normal. In fact, those who enjoy mathematics and do well at it are often ridiculed or labeled as "math nerds". This generally negative view of mathematics is pervasive and does nothing to foster students' competency or confidence in math. It is clear there is a need to change and enhance positive attitudes toward mathematics and how it relates to other subject areas.

Ferren and McCafferty (1992) surveyed thirteen institutions and focused on placement, course requirements, and attitudes of students in mathematics. They felt that if the math material being taught was relevant to the students' major or interest area, the students may be more comfortable and better equipped to handle the math material. In their survey some institutions were linking mathematics to science, political science, and music to establish a greater commitment by the students to their learning of math. Many math instructors understand intuitively that a poor or negative attitude can have a negative impact on the successful learning of mathematics. Sutarso (1992) felt that Students' Attitudes Toward Statistics is directly related to student achievement and, in fact, the higher the Statistical Test Anxiety score the lower the course grade. While the Sutarso study focused on college level students taking statistics, it has applicability to math courses at the college level in general. Sutarso's (1992) results clearly show that pre-knowledge in a course subject, in this case statistics, does lower anxiety.

Pierce and Henry (1993) also concluded that the "at risk" students, those with negative attitudes toward the study of mathematics, had poor records of success in any math course. Their "Learned Helplessness Model" stated that :

> Those who attribute failure to internal-stable-global causes have a pessimistic attributional style and are more likely to display symptoms associated with learned helplessness such as not trying when faced with failure. Those who attribute failure to external-unstable-specific causes have an optimistic attributional style and are expected to continue to work in the face of failure. (p. 8)

Two questionnaires were used in the Pierce and Henry (1993) study; the Attributional Style Questionnaire (ASQ) was given at the beginning of the term (n = 806), and the End of Term Questionnaire (ETQ) two weeks prior to the end of term (n = 742). The first questionnaire dealt with the positive-negative approach to situations, and the second questionnaire dealt with the frustration and effort levels of the students themselves and their perceptions of these. These two measures were then compared to the final grade in the algebra class. Their final results were not only interesting, but also valuable in their application at colleges. Students with an optimistic attributional style showed less frustration and were able to focus their attention on the course and make better grades. They found that those with a positive approach to life, who did not blame themselves or internalize their poor performance, who were not as easily frustrated, did much better in their math courses. Those students who had a negative attributional style were more easily frustrated and unsure of their ability to do well. That is, the students who saw negative grades as the norm, who viewed themselves as the problem, who saw themselves as always failing math, and who felt that their negative performance would always take place, were at risk for poor grades. In fact, a circular effect begins as negative students may feel

frustration when they perform poorly on an exam, which further erodes their perception of their ability, which leads to more frustration and so on.

The ETQ showed correlation between frustration (.560), and ability perception (.364) to the final grade. The student's own attribution to ability was the most important of the specific attributions in determining performance. From the Pierce and Henry (1993) study it could be concluded that if an "at risk" student could be identified, steps could be taken to reduce the negative effect of a student's poor attitude of his or her own ability and, in turn, enhance the student's success in the mathematics course. At risk students could be identified at the beginning of term or even on entrance to a college, and possibly helped to deal with their negativism and frustration. This could have a major impact on success and failure results in college mathematics courses.

Pierce and Henry's (1993) findings support a study carried out at Redlands Community College by Jenkins (1991), who identified four kinds of students in the college system and their diverse needs. The first type of student was well-prepared and highly motivated; the second type had high expectations yet lacked academic preparation; the third kind of student had reasonable preparation while lacking motivation or experience, while the fourth kind of student was under-prepared with low expectation and low self-concepts (Jenkins, 1991).

To meet the diverse needs of these students, accurate entry level assessment is necessary. It is clear that students with math anxiety, and who are negative in attitude are poor candidates for success in math. These internalized feelings will have an effect on their ability to study and do well in math. Knowing the attitudes and feelings towards

math can provide us with one more tool with which to help and enhance students' success in math.

Attitude did not play a role in the successful student in math according to a study done by Cox (1990). Students were given a math attitude inventory. "This was the Aiken-Dreger 'Mathematics Attitude Test' with a 5 option Likert-type scale with ten reversals on twenty questions" (Cox, 1990, p. 9). The attitude inventory seemingly showed no effect on grades. However, the inventory was given to the students available (49) in a class in November of the semester they were taking math. By November, any students that were withdrawing would have done so thereby eliminating potential "unsuccessful attitude" students. As well, the 49 tested was a small ratio to the total (287) and did not accurately reflect the attitudes of the whole. Because those 49 students were actually in class on the day chosen for this study may in itself mean that these 49 were the most dedicated and automatically had a "successful attitude".

What is of significance from the Cox (1990) study was that students indicated they were comfortable and relaxed in the math lab as opposed to a classroom situation. While the students indicated that they did not enjoy taking the math course, they did seem much more comfortable working individually on the computer (Cox, 1990). This preference for a computerized setting was further supported in the survey conducted by Ferren and McCafferty (1992). In their survey, there was a general consensus among the institutions surveyed that teaching methods of faculty need to change. Faculty themselves helped cope with poor attitudes affecting student's performance in math, yet tended to be slow to change their approach to teaching math. Strategies that employed realistic and

positive self-concepts were believed to reduce math anxiety by Ferren and McCafferty (1992). The 1991 National Research Council Report "strongly encouraged computer-assisted teaching, interactive teaching, and group problem solving" (Ferren and McCafferty, 1992, p. 90). Full-time faculty must be willing to participate in teaching innovations and to be committed to reaching those students who most need their math knowledge enhanced.

Another reform suggested by Ferren and McCafferty (1992) was that of committed support to tutoring and math labs in which students are able to get the personal, one-on-one help that they may need. This requires fully staffed and trained personnel, full-time faculty, computer assistance and flexible hours which, while expensive to run, may greatly enhance a student's understanding and success potential. This is a key element for success for our students at the LCC.

One further reform mentioned by Ferren and McCafferty (1992) relates to registration practices at some institutions. Presently students will register beyond their level of ability hoping that they can "scrape" through. Because they do poorly there is a negative impact on the student, the instructor, the class and the institution. Students generally want to register in only those courses that are part of their program. A remedial math course is felt to be a detriment to their grade point average (GPA) and a waste of time. Taking a math course will, in many students' minds, bring on more anxiety, frustration and take time away from the area they wish to study. Ferren and McCafferty (1992) found that although more institutions were requiring at least one mathematics course over what was required in the past, students were finding loopholes to avoid taking

the required mathematics course. At some institutions, foreign languages, linguistics, computer science, or an extra core course could be taken in lieu of mathematics. "These concessions may reduce students' anxiety, but they also diminish the number of students who achieve quantitative competency." (Ferren & McCafferty, 1992, p. 87)

When calculating the success rates of students taking math courses, the question of whether to include withdrawal students or not in the totals can greatly affect the overall percentages and averages. Ang and Noble (1993) felt that including withdrawal (W) grades as unsuccessful completion will usually result in lower probabilities of success, higher cutoff scores, and higher accuracy rates, but felt that how the "W" grade was interpreted depended on the institution's policy or philosophy on this grade (Ang and Noble, 1993). At the LCC an 'I' grade is given to a student who for reasons of illness or death in the family, is unable to complete a course or write the final exam. A time extension is given and a date set for another exam. If this deadline is not met, or a specified time period passes without any work from the student, the grade is changed to an 'F'. In the study done by Ang and Noble (1993), two definitions of unsuccessful completion of a math course were used, one being all grades, including 'W' and 'I', below the successful score of 'C', and the other excluding the 'W' and 'I' grades. Their accuracy rate was the sum of the number of students who were placed correctly over all students considered. "The value of the AR depends on the cutoff score, the distribution of scores, and the statistical relationship between the test score and the success criterion" (Ang & Noble, 1993, p. 8).

B. The Need to Change Total Reliance on Nationally -Normed Tests

Several authors of studies on math placement feel there is far too much emphasis placed on nationally normed tests (Ferren & McCafferty, 1992; Gougeon, 1985; Jenkins, 1991; Keely, Hurst & House, 1994). The LCC uses the CAT and the CPT as indicators of student potential and abilities. Many American institutions base placement upon the math portion of the Scholastic Aptitude Test (SAT) results and scores on the American University's Finite Math Equivalency Exam. It is interesting that of the institutes surveyed by Ferren and McCafferty (1992), the placement exam most often used by institutions were those distributed by the Mathematics Association of America, and those institutions using their own placement tests were the most unsatisfied with their results. However, those institutes "that used multiple indicators of preparation, including SAT scores, placement exams, and high school GPA, are the most satisfied with the results." (Ferren & McCafferty, 1992, p. 89)

Gougeon (1985) felt far less emphasis should be placed on the SAT and American College Test (ACT) scores for placement of students in college mathematics. The change needed, according to Gougeon's study, was for colleges and universities to use a student's high school grade point average as it was more indicative of the student's ability than college entrance exams such as the SAT and the ACT. Gougeon (1985) theorized that a number of reasons had brought about the need for institutions to use high-school grade point average (HSGPA) as a better predictor of success in college mathematics. One of the reasons for this is that the population attending colleges is higher, which means there will be a broader spectrum of abilities.

> The pressure placed on students to attend college, along with the revolutionary period of history that they had experienced, were considered to be major factors in the decrease of the SAT scores. Almost half of all high school students went to college in 1977 as compared to one-third in 1964. The decline in scores continued, and from 1970 to 1978 the decline moved at an accelerated pace. For the past four years this decline has reversed (Gougeon, 1985, p. 9).

The overemphasis on tests and coaching for tests has changed. Teacher confidence in the results of these tests and changing characteristics of the test-taking population has lead to a drop in the confidence placed in these tests and a drop in SAT and ACT scores.

Jenkins (1991), in agreement with Gougeon (1985), felt that using one standardized test would not identify all the factors that may put a student at risk in the college setting. While continuing to use the nationally-normed test, the American College Testing Program's Assessment of Skills for Successful Entry and Transfer (ASSET), Jenkins (1991) felt that this test was one first step to objective math placement. Additional measures could be found to identify students with low self-esteem, low expectations, and low motivation. Looking at correlations between math course success rates and the ASSET score, Jenkins (1991) did not list the correlations because they were too low; but, during the semester the specific data was collected, the sample sizes for each class were extremely low so as to make the statistics invalid. Jenkins did feel that the nationally-normed test was much more accurate for the lower level math courses as opposed to intermediate algebra and higher.

A study by Keeley, Hurst and House (1994) also supported Jenkins' (1991) findings as it also indicated that the nationally-normed SAT and ACT scores did not correlate well with success in math courses at the college level. While the overall correlations between math grades and the ACT-Math and the SAT-Math were 0.764 (both were virtually the same) the results indicated correlation depending on the level of the math course. The higher ranked courses (those with more rigor and prerequisites) were not as closely correlated to the nationally-normed tests as were the lower, less rigorous courses with fewer prerequisites. High School Class Rank and ACT scores together tended to be better predictors of course grades at the higher ranked courses, whereas in the lower-ranked courses with fewer prerequisites, the ACT was a better predictor of grades. The SAT generally did not predict as well as the ACT scores. Many instructors are becoming disenchanted with and distrustful of the nationally-normed test results as indicators or predictors of success in college-level math courses.

The Keely, Hurst and House (1994) study found that predictive ability varied widely depending on the course under consideration. The higher ranked courses were closer to the high school percentile rank than to the nationally-normed test scores. As the course became less rigorous with fewer prerequisites, the nationally-normed test scores become more important. Gender was not a significant predictor, whereas ethnicity could be more significant in some cases than the ACT or SAT (Keeley, Hurst, and House, 1994). It is interesting to note that they also felt that non-cognitive measures such as a student's own perception of his or her math ability or the expectancy of success would be a valuable measure in combination with rank and test scores.

Golden West College (Isonio, 1992) was the site of another study to try to use a better exam for placement of students in math. At the time of this study, Golden West College was using a combination of the Stanford Test of Academic Skills and the Mathematics Association of America Algebra test. Isonio (1992) felt that the major shortcoming of these two tests was that they tested only a limited range of skills from arithmetic through elementary algebra. Students who tested beyond the scale of these two tests could not be provided with accurate information as to their course placement.

C. Studies Which Looked at Better Placement Techniques

There is a need for better placement of students in math courses. Dependence on a single score from a nationally-normed test is simply not adequate to predict a student's success in a math course, nor can it be used to establish the level of remedial math deemed necessary. The problems of students' attitudes, study skills, preparation, and anxiety are interrelated. Ferren and McCafferty (1992) found that students' effort and commitment were strongly related to success, and no placement would be beneficial or accurate if these factors were not taken into consideration. They commented that "placing students into courses tailored to their abilities is essential to improving success rates." (p. 88). Their survey revealed that placement procedures varied among the colleges, and that generally the less structured and refined the placement procedures were, the less successful the students. Unfortunately, as is the case at the LCC, the placement recommendations are not enforceable and students continue to have the right to choose courses for which they think

they are best suited. It is clear we must look at other variables to establish better prediction for math.

A new tool for better placement of students in math is the Math Diagnostic Testing Project (MDTP). This test measures mathematics skills ranging from Pre-Algebra through to Pre-Calculus and is the most widely used placement instrument in the California Community Colleges (Isonio, 1992). Isonio reported that not only the MDTP tests can provide a wider assessment of higher level math skills but it can also identify deficits in focused areas. This is a key advantage to the MDTP test as students' recommendations can be made not only on the overall score, but also on their areas of weakness. This test, which covers from basic work with integers and fractions through elementary algebra, intermediate algebra to precalculus, logarithmic and exponential functions, makes it a test with a wide and useful range of application to the college level. Predictive validity for Algebra Readiness, to predict whether the student has the necessary foundation of knowledge to succeed at Algebra, has been at a range from the mid .30s to the high .40s. In Pre-Calculus, the validity coefficients range from .33 to .61 (Isonio, 1992). The validity coefficients here are not high; however, they do provide more information about the students' abilities beyond elementary algebra which was felt to be the shortcoming of the TASK-Math and the MAA-Algebra tests that had been in use prior to 1991.

The correlations between the MDTP recommendation for student placement and the math grade (below a 'C' grade was considered 'unsuccessful') including the withdrawals as fails ranged from .36 to .45 for the lower end Math courses (Math 010, 020, 030) and where the withdrawals were deleted, the correlations ranged from .34 to .72

(Isonio, 1992). Including the withdrawal grade did make a significant difference. Data regarding the student's last math grade and the grade expected in the current course was felt to be an important indicator warranting particular attention. "Prediction based upon multiple indicators, each at least moderately correlated with the criterion, is typically superior to prediction based upon a single indicator" (Isonio, 1992, p. 23).

This need for better math placement was demonstrated at Cottey College and is described in Callahan's (1993) study. This study is informative because it establishes specific criterion beyond the use of ACT test scores for accurate mathematics course placement. Cottey College offers a liberal-arts curriculum for transfer to a four-year school. The college's population averages 350 female students. In 1980, placement into mathematics courses was solely based upon the ACT math scores and the number of years of high school math. However, there was a large number of students dropping classes or failing. This concern spawned a study to better place students in math classes. Callahan (1993) analyzed the records of the math students so as to establish a better criterion on which to base math placement. They adopted the use of the Basic Algebra and Calculus Readiness tests of the Mathematics Association of America's Placement Testing Program. Withdrawals were included in this study as unsuccessful completion. She found that those with more years in high school did better and were more successful.

A number of studies indicated that high school performance and math courses taken provide significant information in predicting success in upgrading math at colleges (Callahan, 1993; Gougeon, 1985; Hietala, 1994; Keeley, Hurst & House, 1994; Hsu & Shermis, 1989). Gougeon (1985) studied the student records from 1978-1979 at two

two-year colleges in Northern Pennsylvania, one using the SAT as criterion for admission and the other using the ACT score. Sample size was approximately 2000. The dependent variable was college mathematics achievement, while SAT and ACT test scores, high school GPA, high school mathematics taken, and high school attended were the independent variables. The results showed, in order of the amount of correlation accounted for, that the ACT mathematics score correlated better with high school mathematics average (.566) followed by sex (specific correlation not given), mathematics units taken (.25), ACT score (.363), course program (specific correlation not given), and high school attended (specific correlation not given), (Gougeon, 1985). For those students taking the SAT, the ranked ordering of the independent variables for predicting college mathematics achievement was: high school mathematics average (.577), followed by the SAT score (.355) , then sex (specific correlation not given), mathematics units taken (.291), course programs (specific correlation not given), and high school attended (specific correlation not given), (Gougeon, 1985). The high school mathematics marks and units taken were clearly better correlated to college math achievement and would be better predictors of success in college math. Gougeon recommended that the combination of both the high school mathematics averages and the standardized test score should be used as the predictor for college success in math. Nationally-normed test scores should be valued less than the high school mark and units taken. It was not clear in Gougeon's study what the average age of the students was.

A study was done by P. W. Hietala (1994) at Seneca College in Ontario in the fall of 1991 to assess the mathematics skills of students in the Faculty of Applied Science and

Engineering Technology. Following his presentation to the Annual Conference of the Metro Colleges Mathematics Association in 1992 to a meeting of mathematics chairs and coordinators of mathematics at fifteen Ontario Colleges, twenty individuals from eleven colleges in Ontario agreed to do a province-wide collaboration to develop a common approach to assessment. Students who have deficient mathematics skills will not do well in many technical programs at the college level. However, if a student's shortcomings in math skills can be identified and addressed, the chance for successful completion is enhanced.

The purpose of Hietala's (1994) study was to develop an assessment process which would identify students who are "at risk". The sample consisted of 2727 students from five Ontario colleges in the fall of 1992, and 3948 students from eleven colleges in the fall of 1993. Potential predictors of success were grouped in three categories. Background variables such as the "highest level of education previously attained, the highest level of mathematics successfully completed, the number of years since either of the previous, the highest level of English successfully completed" (Hietala, 1994, p. 6) was the first predictive category. The second category consisted of personal data such as first language, language spoken at home, years at full-time employment, and present employment hours. The third category comprised the mathematics and English pretest scores. The pretest used focused on the prerequisite skills deemed necessary by the Ontario Colleges of Applied Arts and Technology programs. This pretest consisted of 40 multiple-choice and 35 open-format questions and were taken from previous tests used at Seneca College. Because this test yielded a good linear correlation between the multiple-

choice and open-format questions (r^2 =0.78) it was felt to be an accurate representation of student skills and was edited to a 45 multiple-choice format with 17 numerical, 18 algebraic, and 10 geometric and trigonometric questions. As well, a questionnaire to collect the student's educational background was designed to be given at the same time as the pretest (Hietala, 1994).

It is noted that no attitudinal surveys were considered by Hietala (1994) in his study. While there is no mention of student age, it is clear that the math courses under consideration for placement were not at the remedial level, but were possibly from intermediate algebra and up.

The Hietala (1994) study was able to develop a model for identifying students who were at risk in the initial mathematics course in a technology program. While not trying to predict final grades, this study did sort students into two categories: those needing remedial help in math and those not. The most important predictor variable was the algebra subscore of the pretest. This was followed by the highest level mathematics course previously taken and passed. In 4 out of 11 colleges in Ontario, the number of years since the last mathematics course taken was a significant predictor, and in 9 out of 11 colleges, the difficulty of a particular introductory mathematics course in relation to others was a significant predictor (Hietala, 1994). This analysis was done college to college and, because there were differing philosophies, standards and definitions of success, an equation for predicting correct math placement was developed for each location. The multivariable model was an improvement over past practices. "Overall accuracy rates for the 11 composite models of this study range from 72% to 84%,

compared with 64% to 77% for models based on pretest subscores only" (Hietala, 1994, p. 42).

This particular study is valuable and indicative that it is possible to develop a test which closely mirrors the expectations of specific programs, and is enhanced by including other predictors such as previous courses taken and passed, the number of years since taking math, and the level of difficulty of a previous math course in the final placement. Because this was a Canadian study it was more valuable to the considerations of this project.

Another study to improve math placement was that done by Hsu and Shermis (1989) who collaborated to develop a microcomputerized adaptive placement test. They recognized as well that placement of students into introductory level mathematics courses was a problem encountered especially where colleges had programs designed specifically for working people who attended the institution on a part-time basis. This study looked at developing a better testing mechanism for placement of students into college math, algebra, trigonometry and pre-calculus. The 120 item testbank was developed through collaboration with the faculty teaching the material and based on the course content listed from the college syllabus.

What is unique to this test was the requested information on the examinee's previous math background. This information was not only used to rate the overall level of the examinee, but was also used to select the starting cluster of questions from the testbank. Most students "expressed a preference for taking computer tests over paper-and-pencil tests" (Hsu & Shermis, 1989, p. 483) and were less anxious writing an exam on

a computer. The placement decisions were felt to be accurate by both students and advisors. However, there was no correlation coefficient of the test cut-score placement recommendations to successful completion of math classes.

In a study to identify variables such as gender, time of attendance (day or evening) and attitude which might account for successful and unsuccessful performance in remedial basic math courses, Cox (1990) explored a model of academic achievement. It was hoped that potentially unsuccessful students could be identified and intervention might help them. The variables used included pretest scores from the series Basic Mathematics: An Individualized Approach by Burris (1981), the Assessment of Skills for Successful Entry and Transfer (ASSET) scores, the Aiken-Dreger "Mathematics Attitude Test" and the time spent in the classroom. Successful completion was considered a grade of 'A', 'B', or 'C' and unsuccessful completion was a grade of 'D', 'E', or 'W' (Cox, 1990, p. 7). Students were 17 and older, and were non-traditional students who would not have considered attending college a few years earlier. Like the LCC, the students were "generally weak in reading, writing and mathematics skills and these students have not retained the needed skills for college" (Cox, 1990, p. 8).

In Cox's study (1980) gender did not prove to be a factor on grades received, although there were twice as many women taking the course as there were men. The average age was 24 in 1987 and 25.4 in 1988. The average grade point average for the two different semesters was 2.00 in 1987 and 1.98 in 1988. The multiple regression model developed had an R-square of approximately .31 indicating that 69% of the variance in grades was unexplained (Cox, 1990, p. 19).

A number of models exist to better place students in math courses. However, most studies believe the high school history, that is; the math taken, marks received and grade point average in high school, is most important. Some have developed complete new placement testing procedures (Hietala, 1994; Hsu & Shermis, 1989; Isonio, 1992), but others continue to use nationally-normed tests in combination with other identifiable variables (Callahan, 1993; Cox, 1990; Ferren & McCafferty, 1992; Gougeon, 1985; Keely, Hurst & House, 1994).

D. Summary

"Correct course placement decisions promote student success and foster persistence among students. Incorrect course placement decisions, however, waste students' time in school and educational expenses, as well as institutions' personal allocations and costs." (Ang & Noble, 1993, p. 6) Having students completing courses and programs are becoming fiscally imperative and having a high failure and withdrawal rate does not bode well for institutions such as the LCC. These students cost not only the taxpayers and sponsoring agencies who often support or subsidize them, but also cost the institution in reputation and amounts of government dollar transfer based on the number of students successfully completing their programs. It would seem that research has not only supported the need for better placement into college mathematics, but also for more data to be used in making these placement decisions than a nationally-normed test like the ACT or the SAT. It seems that the high school mathematics history, that is the courses taken, the marks received and the high school grade point average, all can be used to

better place students into college math. In fact, high school performance is more indicative in some studies than the SAT or ACT scores for a student's successful completion of College Mathematics courses (Keely, Hurst & House, 1994). There are a number of placement tests such as the Assessment of Skills for Successful Entry (ASSET) (Cox, 1992), the Mathematics Association of America's Placement Testing Program Basic Algebra and Calculus Readiness tests (Callahan, 1993), the Math Diagnostic Testing Project (MDTP) (Isonio, 1992) that have also provided better prediction for placement of students in College Math.

Age has not been referred to as a predictor of success. Yet in the College Prep Program at the LCC it clearly seems to be an indicator that deserves some consideration. It is my impression that the older students who generally are more mature in attitude also have a greater degree of responsibility and motivation. While it can be argued that some adults never achieve these traits, it can be generally stated with confidence that the older adult learners are more committed and more willing to make an effort in their learning.

Students' attitudes clearly are a major indicator of success or failure in college mathematics (Callahan, 1993; Cox, 1990; Jenkins, 1991; Pierce & Henry, 1993; Sutarso, 1992). Those students exhibiting negative attitudes toward their own ability in math, toward the study of math, or toward their need for math may need intervention to achieve success. These "at risk" students need to be identified and intervention needs to be taken to help them improve their chances of success. Tutoring availability, relating the material to other areas of interest, access to computer-assisted instruction, and close attention to anxiety levels all will help the performance of students in college mathematics. The age-

old problems of attendance and time on the task of learning mathematics are still problems, and while they may not be a cause of failure, they are certainly detrimental to the overall performance of a student. "We are faced with the challenges of overcoming negative attitudes, properly placing students in courses, developing supportive instruction, motivating students for the more demanding requirement, and creating appropriate mathematics courses for a liberal arts education." (Ferren & McCafferty, 1992, p. 87) The "bottom line" is discovering what attributes and history are necessary for students to be successful in their study of math. Math must be seen as something more user-friendly, more necessary, and more enjoyable. What factors improve students' success in math? It is clear that correct placement is a necessary first step.

IV. The Purpose of this Study

"All things have their place, knew we how to place them."
Proverbs

A. The Study

Students will indeed have a place if educators can learn how to correctly place them into math courses so that their chances for success are better. Currently, students with recent high school transcripts are enrolled in General Studies or College Prep at the LCC using these records for placement into math courses. Most students who have been out of school for more than two years are tested to determine their level of reading, vocabulary and math knowledge. The tests used are the Canadian Achievement Test (CAT) and the Computerized Placement Test (CPT). Recommendations as to placement into appropriate classes are made from these test scores. Generally, those students going into the College Prep Program write the CAT while those students going into General Studies take the CPT. This study will seek to determine how well the CAT scores and the CPT scores work to predict successful outcomes in specific math courses in the College and University Prep Program at the LCC. Other independent variables, including previous high school math history, program, age and gender, will also be examined for their relationship to a successful grade in a College Prep math course. It was hoped that from this quantitative analysis the important or essential predictors could be identified to better place students in upgrading mathematics.

B. The CPT and the CAT Tests

No study of the predictive validity of a test can be undertaken without an analysis of the test under scrutiny. Since this particular study will be evaluating the predictive performance of the Canadian Achievement Test and the Computerized Placement Test, an examination of each test is necessary.

The **Canadian Achievement Tests, Second Edition** (1992) were developed from the input of a panel of teachers and subject specialists across Canada. Close adherence to provincial standards was monitored, and care was taken to avoid questions with ethnic, age and gender biases by not only following the guideline given in the 1982 publication of *Guidelines for Bias-Free Publishing* by McGraw-Hill Book Company, but also by having men, women, and ethnic groups in the educational community review all the material. The CAT was given to 5000 students across Canada in May 1991 and the data was analyzed by the *Evaluation, Measurement and Research Group of the University of British Columbia* (CAT booklet, 1992, p. 2).

The CAT test series is designed to measure math competency at eight overlapping levels. Items for the CAT/2 are categorized to reflect the objective levels commonly found in the provincial curriculum guides for mathematics. Levels 17, 18 and 19 are roughly comparable to grades 7-13 and are used by the Assessment Center at the LCC. Students are not allowed to use calculators. Test 7, Mathematics Concepts and Applications and Test 8 Mathematics Computation are each given with 45 minutes for completion. Test 7 Mathematics Concepts and Applications covers a student's ability to apply mathematical concepts "related to numeration, number theory, data interpretation,

algebra, measurement, and geometry" (CAT Booklet, p. 2). Test 8, Mathematics Computation covers the student's ability in computation skills with whole numbers, decimals, fractions, integers and elementary algebraic expressions, exponents and percentage (CAT Booklet, p. 2).

The **ACCUPLACER COMPUTERIZED PLACEMENT TESTS**, (CPT) was designed for students entering college. This test was developed jointly by the College Board and Educational Testing Service in 1993. The levels of math ability of entering students into colleges differ markedly and identifying the appropriate level of ability for each entering student is imperative. "The primary function of the Computerized Placement Tests is to determine which course placements are appropriate for students and whether or not remedial work is needed" (CPT Test Technical Data Supplement, 1993, p. 1).

In the CPT, each examinee is initially given a randomly selected item of middle difficulty. If the examinee's response is wrong, the test then branches to a randomly selected item from extremely easy items. On the other hand, if the response is correct the test then branches to randomly selected extremely difficult questions. These items stay at this level until there is at least one right or wrong answer. The response vector will be analyzed by the computer so that the next item will be the best item for the examinee at the ability level estimated by the CPT program. The advantage is that students do not become bored with questions that are too easy or frustrated by difficult questions which they cannot do. "The difficulty of the questions is quickly and automatically adapted to the capability of the individual student. Thus, challenging tests corresponding to each

student's skill level are always provided" (CPT Technical Data Supplement, 1993, p. 2). Also, this test is untimed, so students can work at their own pace. The test results are available immediately. There are three methods of presenting this test. The first method is based on administration choice where the examiner initially chooses the test which the student will then take. The second method of administration is based on the background of the student. Three questions are asked about background information as to the number of years of high-school mathematics taken, the study of algebra in high-school, and the years since last studying mathematics. From the answers to these questions, the system will choose questions suitable from pre-established rules. The third method of administration is based on the student's own choice. That is, the student is asked what test they wish to take from a list of Arithmetic, Elementary Algebra, and College-Level Mathematics. The choice the student makes will then be administered first. The Assessment Center is presently using the first method of examiner-choice exams.

The Arithmetic Test is a 16-question test drawn from three categories; the first category is basic operations on whole numbers and fractions; the second category consists of operations with decimals, percentage, and estimating; and the third category contains applications and problems using these basic numbers. The number of items from each area depends on the student's response level. An examinee with low skills will receive 7 questions from category one, 7 questions from category two and 2 application questions; an examinee with higher skills will receive progressively fewer from categories one and two and more in category three.

The Elementary Algebra Test has 12 questions drawn from three categories. The first category consists of operations with integers, rationales, ordering and absolute value. The second category contains operations on algebraic expressions, simple formulas, operations on polynomials, exponents, rational roots, factoring and simplifying algebraic fractions. The final category for the Elementary Algebra Test is comprised of solution of equation, inequalities and word problems. These questions provide the most challenge for examinees who are competent in Elementary Algebra, and may cover linear equations, quadratic equations by factoring, graphing, geometric reasoning, and verbal problems. The Assessment Center at the LCC uses the CPT Arithmetic and Elementary Algebra tests and makes math placement decisions based on the scores from these two tests.

The item pool for these tests was developed from the existing New Jersey College Basic Skills Placement Test combined with new test questions. These questions were tested on 199 high schools and 86 colleges in 1983. The initial screening of the items done by a faculty committee was accomplished by categorizing items into three levels; Intermediate Algebra, College Algebra and PreCalculus. These items were subjected to standard item analysis procedures, and the final pools of 120 questions in each level were then selected. Reliability of test scores was indicated by students taking the same test several times during a short period of time. In this method, it was hoped that students would obtain essentially the same scores. "A reliability index is established which demonstrates the consistency of placement decisions based on a CPT score" (CPT Technical Data Supplement, 1993, p. 31). The reliability coefficient was .92 for arithmetic, .92 for elementary algebra, and .86 number for College-Level Mathematics"

(CPT Technical Data Supplement, 1993, p. 32). "All of the reliability of classification indices are at or above .90, indicating substantial agreement between classifications based on CPT scores and classifications that would be based on true scores, were they known" (CPT Technical Data Supplement, 1993, p. 42).

The predictive validity of the CPT test was determined in 1990 with 50 colleges and universities using this test. Students' scores on the CPT test, their placement and course grade were compared. Arithmetic test scores had an overall correlation between .31 and .38 with grades in General Mathematics, Arithmetic, Elementary Algebra, and Intermediate Algebra courses. The Elementary Algebra test scores correlated from .19 to .38 with Intermediate Algebra, College Algebra, Precalculus and Calculus. The correlation between the College-Level Mathematics test and the Intermediate Algebra, College Algebra, Precalculus, and Calculus was between .32 and .49 (CPT Technical Data Supplement, 1993, pps. 58-59).

The correlations given for the CPT Arithmetic Test and the Elementary Algebra Test are very low if they are to be used for prediction of success. The CPT Arithmetic test r-square would be between .096 and .144. This means that the CPT Arithmetic Test can account for only 10% to 14% of the variation in the final score of General Mathematics, Elementary Algebra and Intermediate Algebra. The CPT Elementary Algebra Test would have r-square values of .036 to .144 which means that this test can only account for between 4% and 14% of the final score of the three same math courses. The CPT College-Level Mathematics test is slightly better with r-square values from .102 to .240, which translate to 10% to 24% of the variation in the final scores in Intermediate

Algebra, College Algebra, Precalculus and Calculus. However, the CPT College-Level Mathematics test is not used by the Assessment Centre for the upgrading mathematics at the LCC.

V. Methodology

A. Sample

The sample included 606 final grades of students taking Introductory (Math 010 AND 013) and Intermediate Algebra (Math 020 and 023), and Senior Level Algebra and Trigonometry (Math 030 and 033). These courses were offered in the fall, winter and spring terms of 1994 in the College Prep Program at the LCC. Not all students would have been tested using the CAT or the CPT just prior to their 1994 math course. Some may simply be working gradually and progressively through the College Prep math course sequence in which case their assessment score was applicable only to the first and original math course taken. Some students came straight out of high school to College Prep and had not been tested for placement because they had high school transcripts; while others may have single-mindedly decided not only the math course they wanted to take, but also that they did not want to be tested for placement. The decision to test a student for placement is not "cast in stone" at this time. For these reasons, it was necessary to consider more than one math course so as to acquire an adequate sample of both CAT and CPT scores.

The content of each math course is agreed to by each math instructor and the texts used are consistent among the same sections of a course. It is assumed that instructor variations in grading and rigor would be minimal, as all math instructors agree to the course's general framework and content. These particular courses were being analyzed because at the intermediate and upper levels of algebra there is a general impression among the instructors that the failure rates are higher and more students are withdrawing.

Intermediate Algebra (Math 020 and Math 033) are accepted in a number of programs at the LCC as the prerequisite math level required. Math 010, 020 and 030 would be considered the academic route for students who want the higher level theoretical approach and who are headed for University. Many programs do require Math 030 as a prerequisite. Math 013, 023 and 033 are the less strenuous math courses. Topics are covered at a much less intense level, there are fewer covered and therefore more time is spent on each. Students who have chosen the Math 013, 023, 033 route tend to have a poor math history and feel anxiety with math study. The Math 010, 020, 030 route is considered more rigorous; however, it is hoped that by the time students reach Math 033 they will have established better work habits and have less anxiety. All of these courses reflect generally what is in the Alberta curriculum for high school Math 10, 20, and 30, and Math 13, 23, and 33. The course descriptions from the LCC Calendar (1995, p. 146) as well as the prerequisites follow on the next page:

Math 013 - MTH013 (5 credits)

Prerequisite: "C" in MTH009 or equivalent. Topics include numbers systems, polynomials and factoring, coordinate geometry, graphing, relations, statistics and geometry.

Math 023 - MTH023 (5 credits)

Prerequisite: MTH010 or MTH013 or equivalent. MTH023 is a course in Algebra and Geometry at the Grade Eleven level. Topics to be covered include power and radicals, algebra, linear equations, systems of equations, probability, geometry and trigonometry.

Math 033 - MTH033 (5 credits)

Prerequisite: MTH020 or MTH023 or equivalent. Topics to be covered include radicals and exponents, annuities, statistics, trigonometry, polynomials and functions, and relations.

Math 010 - MTH010 (5 credits)

Prerequisite: "A" in MTH009 or MTH013 or equivalent. A first course in the basic techniques of algebra from operations on rational numbers through equations and inequalities, factoring and algebraic fractions.

Math 020 - MTH020 (5 credits)

Prerequisite: MTH010 or MTH023 or equivalent. A continuation of algebra and geometry from MTH010 includes factoring, systems of equations and operations with radicals, functions and variables, quadratic equation in one and two unknowns, rational exponents and logarithms, quadrilaterals, ratio and proportion circles.

Math 030 - MTH030 (5 credits)

Prerequisite: MTH020 or equivalent or "C+" in MTH033. Linear Relations, second degree equations, conic sections, induction, binomial theorem, sequences and series, circular and trigonometric functions, trigonometric analysis, theory of polynomials, permutations, combinations and probability, and analytic geometry. This course is 80% equivalent to the Alberta Education Math 30 course.

B. Data Collection

Because this study was looking at math class placement for the 1994 school term, only those students grades from math courses in the fall, winter or spring semester of 1994 were used. Data collected for these specific math students was taken from the transcript records and the individual student files maintained by the Registrar's Office in Student Services at the LCC. Once the student lists were established, as much information as was available from each student file was recorded. The data obtained included the specific math course(s) taken, the semester, the final grade, age, gender, the program in which the student was registered, the marital status, long term goal, the last high school math course taken, the grade and the year this was completed, the number of years away from math study, and finally the CAT and/or the CPT scores.

The long term goal was the educational goal written by the student on his or her original application to the LCC. Some students stated in their applications that they wanted to obtain an official High School Equivalency Diploma while others needed to attain their high school equivalent courses to gain entry into specific programs. Their goals were many and varied, and included University, Nursing, Drafting, Electronics, Science Programs, Business and Industry Programs, General Studies, and College Upgrading to name but a few. Some students did not indicate any goal or were undecided.

The information on high school performance, the last high school math course taken and the year this was taken, was obtained from high school transcripts. However,

many students, particularly the older students, did not have high school transcripts in their files.

The Assessment Test Scores of either CAT scores or the CPT scores and the date they were taken were usually recorded in the student files. This date was vital in determining whether the CAT or the CPT was taken just prior to the math class of 1994. In this study, only those CAT or the CPT scores were used when no math course was taken between the assessment test and the 1994 math course. While CAT scores were both in raw and percentile form, the CPT scores were in percentiles only. In this study only the percentile scores were used. In some cases students had not written all four specific tests encompassed by the CAT or by the CPT. These cases, although recorded for future reference, were not included in the analysis as they were considered incomplete.

The final grade was a letter grade representing the student's comprehensive knowledge of the math course in question. The final letter grades and comparable percentages are given in Table 1.

Table 1 Letter Grades and the Percentage Equivalents

Letter Grade	Percentage Equivalents
A+	95-100%
A	89-94%
B+	83-88%
B	76-82%
C+	70-75%
C	63-69%
D+	57-62%
D	50-56%
F	0-49%
W	Student Withdrawal
RW	Administrative Withdrawal

The "RW" grade is given by the instructor when a student simply disappears or stops coming to class and does not withdraw on his/her own. Each instructor has his/her own method of arriving at a comprehensive grade for students in a specific math class so there will be discrepancies amongst the evaluation standards of instructors in the College Prep Program. Generally, it is agreed that any math course should have a number of unit exams, plus a comprehensive final exam which itself should be worth 20% to 50%. The following breakdown of evaluation in Math 030 is an example of how all final grades might be arrived at:

4 Unit Exam @ 15% each.....60%

Assignments and Quizzes.....10%

Final Comprehensive Exam.....30%

The final percentage is calculated and recorded, however it is the equivalent letter grade that is submitted to the Registrar's Office. No student may receive a pass mark if they have not written the instructor's final exam. Differences in evaluation standards of instructors does make for an added variable to the prediction of successful completion of a course. It is hoped that by combining all six levels of math courses offered at the LCC, and encompassing all six instructors and their assigned grades, a more general conclusion can be reached with application to all the included math courses.

C. Variables Used in the Study

The specific long term goals listed by students were dichotomized for analysis on the basis of having a goal or not having a goal. Because these long term goals simply represented what the student had written on their application to the LCC, and because some students had, from their file, changed their minds a number of times as to their actual goal, the long term goal statistics may not be as valid as hoped. Goals change, circumstances change and this study has no way of checking the reality of the goal statement on the student's application.

The ages of the students were recoded and grouped so as to allow analysis of specific age groups. The programs in which students were registered were grouped into General Studies, Upgrading, Specific Program (to include all other program areas), and finally Occasional (for the student taking just one course on his or her own).

Final Grades were recoded using numbers from 0 to 9 to represent the grades from RW to A+. Table 2 outlines these comparison scores.

Table 2 Letter Grade and Comparable Coded Value

LETTER GRADE	CODED VALUE USED FOR ANALYSIS
A+	9
A	8
B+	7
B	6
C+	5
C	4
D+	3
D	2
F	1
W and RW	0

Because of the large number of "RW" and "W" students, and the problematic effect these students have on the overall final score averages, a final adjusted average was also developed by not including the "W" and "RW" grades. In this way only the students who actually completed the semester were included in the final adjusted score.

The success rate (SR) was obtained by dichotomizing the final score mark. If the score was greater than or equal to 4 (D+) it was considered a successful outcome (1), and if less than 4, an unsuccessful outcome (0). Some of the studies reviewed considered "C" and above as a successful outcome. "D+" has been set by the LCC Registrar's Office as the grade necessary to go on in math study at the LCC; therefore, this study treated "D+" and better as a successful outcome. The success rate in each course was developed as well.

Descriptive frequencies were generated for the FS and the FAS of specific groups according to age, gender, and program. The grouping of students into specified ages was done as follows:

group 1 - ages 16-22
group 2 - ages 23-29
group 3 - ages 30-36
group 4 - ages 37 +

After selecting a specific age group descriptive statistics were done on the FS and the FAS. This same process was done for males and females, and Upgrading and General Studies students.

The FS were selected only for those students who had written a CAT or CPT just prior to their taking a math class in the 1994 term. Pearson Correlation Coefficients were computed to examine the correlation between the predictive variables and the final grades

of those students who had also written the CAT prior to taking the math course in question. Predictive Variables included not only the CAT Vocabulary, Reading, Mathematical Computation and Mathematical Concepts and Application Tests percentile scores, but also the students' age, sex, high school math score, whether there was a long-term goal in place, and the number of years away from studying mathematics. The Pearson Correlation Coefficients were also examined to determine if there were any strong correlations between any of the predictive variables themselves.

Similarly, correlation coefficients were obtained from the group of students who had taken the CPT just prior to taking the 1994 term math course. Predictive variables were the same as those used in the CAT analysis but substituting for the CAT scores were the CPT Percentile Scores for the CPT Reading Comprehension, Sentence Skills, Arithmetic Test, and Elementary Algebra tests.

The next step of the data analysis involved a multiple regression analysis of both the CAT group and the CPT group to determine if there was a regression equation with predictive ability for math performance. Other predictive variables used in the regression analysis were: age, sex, long term goal, the number of years away from math study, and the high school math score.

D. Attitudinal Analysis

The attitudinal measurement of students is missing from the data available at this time. Self-confidence, motivation, commitment, and goals are necessary ingredients of a successful outcome. A negative or positive attitude toward math study, toward their ability in math, and toward life in general have been proven to have a significant impact on math performance. Math anxiety, poor work habits and poor attendance can be devastating for students' performances. These key elements cannot be included because they are simply unavailable from the student records.

VI. Results

A. Frequency and Summary Statistics

1) General

There were 606 final mathematics grade scores during the 1994 term. This sample consisted of 295 (48.7%) males and 311 (51.3%) females, aged 16 to 52 years of age (the average age was 26.5 years). 450 students indicated some kind of long term goal on their application forms, while 156 were undecided or left blank. Only 15.7% of our students had grade 12 math from high school, 22.1% had grade 11 math, 24.3% had grade 10 math, 22.8% had grade 6 to 9 math, while 15.2% were unknown (this information was not available in their files). 97 students were registered in General Studies, 468 in the College Prep Program, 34 were occasional students and 7 were in a specific program here at the LCC during the 1994 term. The average number of years that students had been away from math study in 1994 was 1.919 years. Many had taken a math course in the previous year at the LCC, however, some students had been away from math study for up to 28 years.

2) The CAT and CPT Scores

Many of the 606 students had not written an assessment test just prior to their 1994 math course. The total valid CAT scores that could be used for this study was 62, while there were 104 valid CPT scores. Summary statistics on the CAT scores are found in Table 3. Summary statistics on CPT scores are found in Table 4

Table 3

Summary Statistics of CAT scores.

SPECIFIC CAT TEST	TOTAL NUMBER WRITTEN	MEAN (PERCENTILE)	SD	RANGE (PERCENTILE)
Reading Comprehension	179	47.2	27.9	2 - 97
Vocabulary	175	57.1	28.0	2 - 97
Mathematics Computation	182	29.5	21.4	1 - 96
Mathematical Concepts and Applications	186	35.5	22.4	1 - 94

Table 4

Summary Statistics of CPT scores.

SPECIFIC CPT TEST	TOTAL NUMBER WRITTEN	MEAN (PERCENTILE)	SD	RANGE (PERCENTILE)
Reading Comprehension	169	56.4	26.8	2 - 96
Sentence Skills and Vocabulary	169	62.5	26.0	2 - 97
Arithmetic	172	60.8	25.3	5 - 94
Elementary Algebra	169	66.1	22.1	0 - 98

The CAT and the CPT math tests results differed markedly. The CAT Mathematics Computation mean percentile was 29.5 while the comparable CPT Arithmetic mean percentile was 60.8. The CAT Mathematical Concepts and Applications mean percentile was

35.5 while the CPT Elementary Algebra mean percentile was 66.1. While the former two tests would contain much the same basic mathematical skills questions, the latter two are somewhat different in their focus.

3. The Math Classes

When considering each math class separately, the are listed in Table 5. Math 020 had the highest final average at 5.565 while Math 030 had the lowest at 4.227.

Table 5

Final Adjusted Scores for each Math Class

CLASS	FINAL ADJUSTED SCORE (letter grade)	SD
Math 010	3.519 (C)	2.210
Math 013	3.988 (C)	2.639
Math 020	4.565 (C+)	2.526
Math 023	3.571 (C)	2.184
Math 030	3.227 (D+)	2.321
Math 033	4.095 (C)	2.191

The differences between instructors and course level work can be seen in these statistics as some classes have somewhat higher averages than others. Math 030 historically has a lower average because the content is difficult for many of our College Prep students. As well, those instructors teaching Math 030 must meet 80% of the provincial guidelines for this course, so the content must be completed every semester it is taught. This can make the course fast-paced and stressful for the students. Math 013, 023, and 033 are the less

academic routes for learning mathematics and are considered to be the "easier" math courses by many of the College Prep students.

4) Final Scores and Final Adjusted Scores

Figure 1 depicts the distribution of the FS in all math courses taken in 1994 in the College Prep Program. Figure 2 shows the distribution of grades with the "W" and "RW" grades removed.

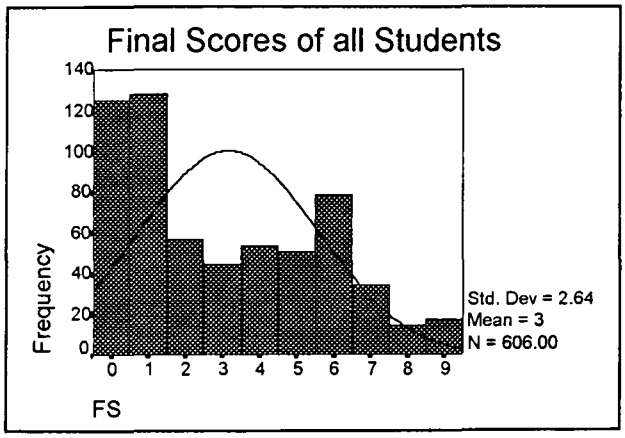

Figure 1 Distribution of Final Scores

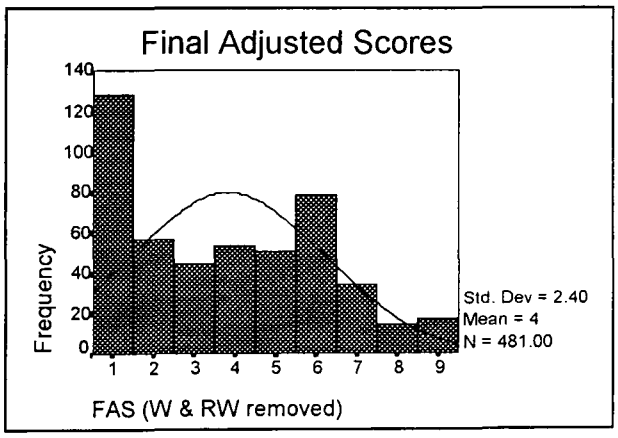

Figure 2 Distribution of Final Adjusted Scores

The difference between counting in the "W" and "RW" grades and not counting them has an effect not only on the average, but also the sample size (606 down to 481). The average for all FS was 3.040 (SD = 2.679) as compared to the FAS of 3.830 (SD = 2.404) when the "W" and the "RW" grades were removed. The FS distribution is somewhat positively skewed (.458) and flat (-.959 kurtosis) as compared to a normal distribution. While the FAS distribution is positive skewed (.343) , the distribution is flatter having a kurtosis of -1.026.

5) Success Rates

Fundamental to developing a better placement system into math courses at the LCC, is the understanding of the need for higher success rates in these courses. The success rate for all students taking a math course in 1994 was 48.8%. That is, a total of 296 (n = 606) students taking a math upgrading course in 1994 attained D+ or better for a grade. The adjusted success rate (eliminating the 'W' and 'RW' grades) was somewhat better at 61.5% (n = 481). The success and adjusted success rates of each course is listed in Table 6.

Table 6

The Success Rates of Math Upgrading Courses

	MATH 010	MATH 013	MATH 020	MATH 023	MATH 030	MATH 033
TOTAL N	68	100	114	96	141	87
SUCCESS RATE (%)	47.1	51.0	58.8	41.7	37.6	60.9
TOTAL NUMBER OF WITHDRAWALS (%)	16 (23.4)	17 (17.0)	22 (19.2)	26 (27.0)	31 (22.0)	13 (14.9)

Success = D+ or better as a final grade

6) High School Scores

High school math history was not readily available in the student files. Only 264 student files contained information on the course taken in high school, the mark achieved and the year. The mean score for the last high school math course taken was 58.462% (which translates to a D+), SD = 13.834, and the range being 16% to 81%. The average year in

which this math course was completed was 1987, SD = 6.896, with a range from 1958 - 1994.

7) Programs

There seemed to be no difference between the FS of Upgrading students (mean = 3.086, SD = 2.620) and the FS of General Studies students (mean = 3.052, SD = 2.744). However, when "W" and "RW" scores were removed the difference became more pronounced. Of the 481 Upgrading students, 87 students were removed with a "W" or "RW" grade (18.1%) and the mean score became 3.769 (SD = 2.406). The General Studies sample dropped by 26 students (26.8%) showing a higher dropout rate but had a higher mean score of 4.169 (SD = 2.366). The 41 other students who were either occasional students or in a specific program had a very low average FS of 2.683 (SD = 2.715) which would translate to a "D" letter grade. These occasional and specific program students had the highest withdrawal rate of 29%; that is, 12 of these students were deleted in the FAS. However, the average score for the remaining students became higher at 3.793 (SD = 2.484) an equivalent of a full letter grade increase (C). The success rates for Upgrading Students was 49.1% and 49.5%for General Studies students.

8) Gender

Females did somewhat better in the College Prep Program math as indicated by their mean scores. The FS average for the 311 female students was 3.151 (SD = 2.657) while the average for the 295 male students was 2.922 (SD = 2.630). The withdrawal rate shows only a slight difference between males and females. 20.3% (63) of the females had withdrawal

grades and 21.0% (62) of the males withdrew from their math course. When looking at the average FAS, the female average was 3.952 (SD = 2.384) as opposed to the male average of 3.7 (SD = 2.424. The differences and similarities are shown in Figures 3 and 4.

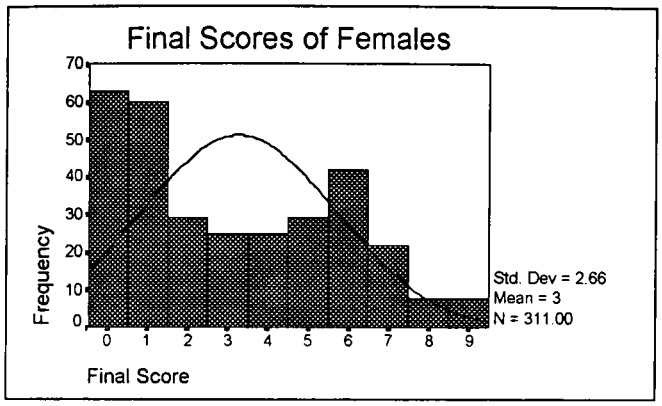

Figure 3 Distribution of the Females Final Scores

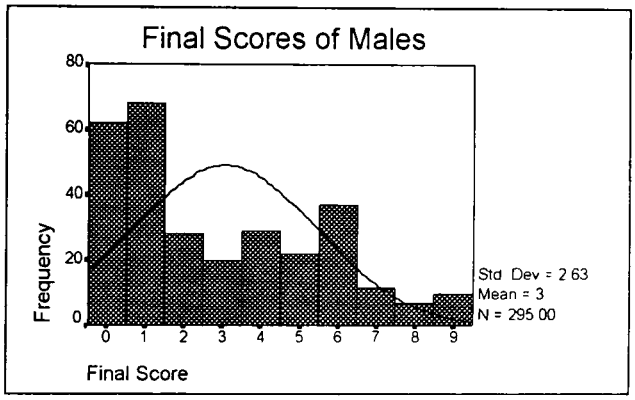

Figure 4 Distribution of the Males Final Scores

9) Age

When comparing the four age groups distinct differences were apparent. The 258 younger students aged 16 to 22 years which represented 42.6% of the sample size, clearly showed a lower average score of 2.756 (SD = 2.420) in comparison to the other three age groups. Students in their thirties seemed to perform much better. Their mean FS was 3.590 (SD = 2.857) and had the lowest withdrawal rate (13.9%). Table 7 illustrates the similarities and differences between the average scores of the four age groups.

Table 7

Summary Statistics of the Final Score and Adjusted Final Score for Four Age Groups

Age Group	Total	Final Score Average	SD	Withdrawals (%)
16 - 22	258	2.756	2.4	53 (20.5%)
23 - 29	157	3.066	2.7	39 (24.8%)
30 - 36	122	3.590	2.9	17 (13.9%)
37 +	69	3.116	2.7	16 (23.2%)

B. Correlations

The sample was divided into two groups; one group representing the scores of those students who had completed a CAT test just prior to their 1994 math course, and the other group consisted of those students who had completed a CPT just prior to their 1994 math course. The sample size for scores with CAT was reduced to 62 while the sample size for scores with CPT was somewhat better at 104.

The correlation matrix containing the FS, the four CAT scores, age, sex, years away from school, high school math score, and the dichotomous variable long term goal, is given in Appendix A. The highest correlation of the CAT test to the FS was the CAT Vocabulary Test at .288 which, based on r^2, would account for 8.2% of the variation in the FS. Age had the highest correlation of .344 which means 11.8% of the variation in the FS could be predicted by age. The correlation of the FS with: number of years away was .289, and having a long term goal in place was .214. The sample size for the variable "high school math scores" was only 29 and subsequently was removed as a predictive variable from the analysis as was the variable "years away from school" which had a sample size of 48. The correlation coefficients of the other variables with the FS were: the CAT Math Application at .099, the CAT Reading Comprehension at .075, the CAT Math Computation test at .0473 and finally Sex at .0295. The four CAT tests did not correlate highly among themselves. The CAT Mathematical Concepts and Applications had a correlation of .5893 with the CAT Math Computation and .3682 with the CAT Reading Comprehension. The CAT Vocabulary test had a correlation of .6895 with the CAT Reading Comprehension test.

The correlation matrix of the four CPT tests and the other predictive variables, age, high school math score, sex, years away from school, long term goal, and the FS can be found in Appendix B. These correlations were all very low. The CPT Arithmetic test had a correlation of .2255 with the FS which means that this test could only account for 5.1% of the FS of students. The other correlations with the FS which were greater than 0.1 were: long term goal (.1757), and CPT Elementary Algebra (.1562),

C. Regression Analysis

The independent variables used for the regression analysis were: the four CAT test scores or the four CPT test scores, age, sex, and long term goal. The dependent variable was the FS. One analysis was generated for CAT scores, age, sex and long term goal, and a separate one generated for CPT scores, age, sex and long term goal. The variables "years away from school" and "high school math score" were eliminated as their sample sizes were too small. Eliminating those two variables made for a ratio of 8.3 cases to variable.

The stepwise regression yielded age as the only predictor variable ($p < .001$) with an r-value of .4216 and an r-square of .1778. The regression equation would be:

Final Score = 0.167 * age - 1.423

Based on this information, the age of the student can be used to predict 17% of the variability in the FS.

The Stepwise regression using CPT scores yielded the dichotomous variable "long term goal" as the only predictor variable with an r-value of .203 and an r-square of .041. What this means is if a student has a long term goal in place, 4.4% of the variation in the FS can be predicted. The equation was:

Final Score = 1.117 * long term goal in place + 2.667

D. Discussion

Placing students in their correct level math course is not an easy process. This study has not clarified that process other than to make it clear that we need to look beyond the CAT and the CPT scores. Even with a seemingly large sample (606), once the data was documented, and the appropriate CAT and CPT dates analyzed, the sample left was dismally small. Not all students were tested when they applied to the LCC. The decision as to whether a student is to be assessed is not clear.

As indicated earlier, the mean scores of the CPT math tests and the CAT math tests were quite different. Why would two assessment tools for use in establishing the math ability of the student differ by about 30%? If the CAT and the CPT test for different abilities and knowledge, then are they useful by themselves as placement tools? Neither of the assessment tests correlated well with the final grades of students in math in the College Prep Program. Possibly the skills necessary really are not being addressed in the CAT or CPT.

The success rate of 48.8% is cause for great concern and so is the large withdrawal numbers. Students might have reasons other than his/her math ability to withdraw from the math class, but we all know within our own classrooms that the vast majority of students who withdrew would have gotten a "F" grade in the class had he or she stayed.

The program students are already in the program of their choice, and may want to get on with the program courses. The material in the math upgrading courses, even though deemed necessary for their program, may seem to have little relevance or application to what they may be learning in their program courses. Many times the students are simply taking a mathematics upgrading class to satisfy the concerns of the program chairperson or the Dean.

taking a mathematics upgrading class to satisfy the concerns of the program chairperson or the Dean. Their own motivation and commitment may not be internalized and withdrawal becomes a common occurrence.

Age does play a key role in how well a student will do in a math class. Overall, the students who are more mature may have more motivation and determination to get through their upgrading and get into a new program. Often the younger students lack goals, have poor work habits, may not like school and may have a poorer attitude toward learning. All of these factors tend to undermine any attempt to learn mathematics.

It was confirming to my own personal biases to see no remarkable differences between College Prep Program students and General Studies students, and between male and female students. If anything the female student may be more motivated and focused on what she wants, and more committed to doing well in College Prep mathematics.

The math history from high school should certainly play a role in future math course placement especially among the younger students just coming from high school. The data may need to be more carefully monitored by the Registrar's Office and math instructors in the future.

It was surprising to identify so few predictors to the final score in this study. As a math instructor I have felt that age, high school math scores, a firm goal, a requisite math skill level, and a positive attitude should correlate strongly with the final score. However, it is obvious from this data analysis, that other psychological and social variables need to be considered. That is, there is more complexity to a successful completion equation than a purely quantitative approach allows. The measure of motivation, commitment, support

(both financial and family), general attitude, and work habits all must be considered but were beyond the scope of this study. Variables other than age, long term goals and assessment test scores have a substantial bearing on the performance of the students in math class.

VII. Conclusion

The purpose of this study was to quantifiably analyze such variables as: the CPT test scores, the CAT test scores, age, gender, high school math history, having long term goals in place and the number of years away from school, to determine whether any of these variables had predictive ability on the successful completion of a math course in the College Prep Program. If better predictors of math performance could be identified, the LCC would be able to better place its' students. This could have consequences throughout the college as more students are able to qualify for programs, because of their increased math ability and confidence. This will then have a "domino effect" on our community as a whole because more students will join the work force as knowledgeable and capable participants.

It is clear after delving into the literature on math placement, and on the basis of the results of this study, there is a need to change our attitudes about math study and the students taking math. With governments looking closer and basing our college funding on the number of students who graduate, we must become more involved in developing a more successful placement procedure for mathematics.

Age appears to be a key factor in the successful completion of a math upgrading course. Younger students do not do as well in their math courses. Lack of maturity, focus, and commitment to their education may all play a part and, although difficult to measure, are necessary factors in considering placement. The older students may have clearer goals, and be generally more motivated. However, we have all had young students that have done very well in a math class. While age is an important variable, it may be directly linked to the students' attitudes and how they view their study of math. The negative student who is

easily frustrated has been shown to perform more poorly in math. (Pierce & Henry, 1993). This area of attitude assessment is necessary in future research if we are going to truly increase success rates among math upgrading students. We need to establish those qualities of success for young and old in order to better understand the parameters necessary for students to be successful at mathematics.

Having a long term goal in place was the one predictive variable that was of some value in determining the variability of the final score in an upgrading math class. What would seem imperative is the commitment to a program, occupation, certificate, or standard, which the student has not only internalized, but also has clearly stated on paper.

The correlations found in this study, while interesting, are of limited use beyond the scope of this project. The regression equations would have little application and would be questionable as placement tools. The CAT and the CPT test scores, taken alone, would seem to be of little predictive value in determining the academic abilities of the math student. However, this is not to say that they should be thrown out as one assessment tool in math placement, and could still play a role in identifying areas of weakness for a student. It is this role that must be further researched. Is there a better tool for establishing math ability?

It becomes apparent that the prediction of successful outcomes among math students is not a clear-cut quantifiable issue. There are many factors involved (both academic and non-academic), and it may well be the non-academic factors which play the most important part in the success or failure of a student. Much more research and change is needed to foster confidence and success in our students. This study was a small first step.

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APPENDIX A: Correlations of Final Scores to the CAT and other Predictive Variables

- - Correlation Coefficients - -

	SCORECAT	CATAP	CATMP	CATRP	CATVP	AGE
SCORECAT	1.0000	.0994	.0473	.0753	.2871	.3436
	(62)	(61)	(61)	(58)	(58)	(62)
	P= .	P= .446	P= .717	P= .574	P= .029	P= .006
CATAP	.0994	1.0000	.5893	.3682	.2016	-.1470
	(61)	(186)	(182)	(179)	(175)	(186)
	P= .446	P= .	P= .000	P= .000	P= .007	P= .045
CATMP	.0473	.5893	1.0000	.0699	-.0867	-.0580
	(61)	(182)	(182)	(176)	(175)	(182)
	P= .717	P= .000	P= .	P= .356	P= .254	P= .437
CATRP	.0753	.3682	.0699	1.0000	.6895	-.1126
	(58)	(179)	(176)	(179)	(175)	(179)
	P= .574	P= .000	P= .356	P= .	P= .000	P= .133
CATVP	.2871	.2016	-.0867	.6895	1.0000	.1810
	(58)	(175)	(175)	(175)	(175)	(175)
	P= .029	P= .007	P= .254	P= .000	P= .	P= .017
AGE	.3436	-.1470	-.0580	-.1126	.1810	1.0000
	(62)	(186)	(182)	(179)	(175)	(606)
	P= .006	P= .045	P= .437	P= .133	P= .017	P= .
HSMSCORE	.1948	-.1762	-.1503	-.2446	.0006	.0170
	(29)	(74)	(72)	(71)	(69)	(264)
	P= .311	P= .133	P= .208	P= .040	P= .996	P= .784
LTGOAL	.2141	.0841	.1497	.1541	.1557	.0691
	(62)	(186)	(182)	(179)	(175)	(606)
	P= .095	P= .254	P= .044	P= .039	P= .040	P= .089
SEX	.0295	.0722	.0606	.0684	-.0736	-.0277
	(62)	(186)	(182)	(179)	(175)	(606)
	P= .820	P= .328	P= .416	P= .363	P= .333	P= .497
YRSAWAY	.2894	.1358	.1272	.2159	.2295	.1704
	(48)	(168)	(164)	(164)	(160)	(543)
	P= .046	P= .079	P= .105	P= .005	P= .004	P= .000

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

APPENDIX A CONTINUED:

- - Correlation Coefficients - -

	HSMSCORE	LTGOAL	SEX	YRSAWAY
SCORECAT	.1948	.2141	.0295	.2894
	(29)	(62)	(62)	(48)
	P= .311	P= .095	P= .820	P= .046
CATAP	-.1762	.0841	.0722	.1358
	(74)	(186)	(186)	(168)
	P= .133	P= .254	P= .328	P= .079
CATMP	-.1503	.1497	.0606	.1272
	(72)	(182)	(182)	(164)
	P= .208	P= .044	P= .416	P= .105
CATRP	-.2446	.1541	.0684	.2159
	(71)	(179)	(179)	(164)
	P= .040	P= .039	P= .363	P= .005
CATVP	.0006	.1557	-.0736	.2295
	(69)	(175)	(175)	(160)
	P= .996	P= .040	P= .333	P= .004
AGE	.0170	.0691	-.0277	.1704
	(264)	(606)	(606)	(543)
	P= .784	P= .089	P= .497	P= .000
HSMSCORE	1.0000	-.0377	-.0348	-.0128
	(264)	(264)	(264)	(260)
	P= .	P= .542	P= .574	P= .837
LTGOAL	-.0377	1.0000	.0607	.0698
	(264)	(606)	(606)	(543)
	P= .542	P= .	P= .136	P= .104
SEX	-.0348	.0607	1.0000	.0395
	(264)	(606)	(606)	(543)
	P= .574	P= .136	P= .	P= .359
YRSAWAY	-.0128	.0698	.0395	1.0000
	(260)	(543)	(543)	(543)
	P= .837	P= .104	P= .359	P= .

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

APPENDIX B: Correlations of Final Scores to the CPT and other Predictive Variables

- - Correlation Coefficients CPT- -

	SCORECPT	CPTA	CPTM	CPTR	CPTV	AGE
SCORECPT	1.0000	.1562	.2255	.0702	-.0264	-.0001
	(104)	(102)	(104)	(102)	(102)	(104)
	P= .	P= .117	P= .021	P= .483	P= .792	P= .999
CPTA	.1562	1.0000	.5543	.3279	.3024	-.2434
	(102)	(169)	(169)	(163)	(163)	(169)
	P= .117	P= .	P= .000	P= .000	P= .000	P= .001
CPTM	.2255	.5543	1.0000	.3577	.3737	-.0312
	(104)	(169)	(172)	(166)	(166)	(172)
	P= .021	P= .000	P= .	P= .000	P= .000	P= .685
CPTR	.0702	.3279	.3577	1.0000	.6997	-.0414
	(102)	(163)	(166)	(169)	(169)	(169)
	P= .483	P= .000	P= .000	P= .	P= .000	P= .593
CPTV	-.0264	.3024	.3737	.6997	1.0000	-.0940
	(102)	(163)	(166)	(169)	(169)	(169)
	P= .792	P= .000	P= .000	P= .000	P= .	P= .224
AGE	-.0001	-.2434	-.0312	-.0414	-.0940	1.0000
	(104)	(169)	(172)	(169)	(169)	(606)
	P= .999	P= .001	P= .685	P= .593	P= .224	P= .
HSMSCORE	.0403	-.0083	.0354	.0177	-.0950	.0170
	(75)	(109)	(111)	(111)	(111)	(264)
	P= .731	P= .931	P= .712	P= .854	P= .321	P= .784
LTGOAL	.1757	.0142	.1138	.0253	.0116	.0691
	(104)	(169)	(172)	(169)	(169)	(606)
	P= .074	P= .854	P= .137	P= .744	P= .881	P= .089
SEX	.0106	.0866	.2593	-.0314	.0555	-.0277
	(104)	(169)	(172)	(169)	(169)	(606)
	P= .915	P= .263	P= .001	P= .685	P= .474	P= .497
YRSAWAY	-.0347	-.1992	-.0115	.0821	.0838	.1704
	(102)	(161)	(164)	(162)	(162)	(543)
	P= .729	P= .011	P= .884	P= .299	P= .289	P= .000

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

APPENDIX B CONTINUED:

- - Correlation Coefficients - -

	HSMSCORE	LTGOAL	SEX	YRSAWAY
SCORECPT	.0403	.1757	.0106	-.0347
	(75)	(104)	(104)	(102)
	P= .731	P= .074	P= .915	P= .729
CPTA	-.0083	.0142	.0866	-.1992
	(109)	(169)	(169)	(161)
	P= .931	P= .854	P= .263	P= .011
CPTM	.0354	.1138	.2593	-.0115
	(111)	(172)	(172)	(164)
	P= .712	P= .137	P= .001	P= .884
CPTR	.0177	.0253	-.0314	.0821
	(111)	(169)	(169)	(162)
	P= .854	P= .744	P= .685	P= .299
CPTV	-.0950	.0116	.0555	.0838
	(111)	(169)	(169)	(162)
	P= .321	P= .881	P= .474	P= .289
AGE	.0170	.0691	-.0277	.1704
	(264)	(606)	(606)	(543)
	P= .784	P= .089	P= .497	P= .000
HSMSCORE	1.0000	-.0377	-.0348	-.0128
	(264)	(264)	(264)	(260)
	P= .	P= .542	P= .574	P= .837
LTGOAL	-.0377	1.0000	.0607	.0698
	(264)	(606)	(606)	(543)
	P= .542	P= .	P= .136	P= .104
SEX	-.0348	.0607	1.0000	.0395
	(264)	(606)	(606)	(543)
	P= .574	P= .136	P= .	P= .359
YRSAWAY	-.0128	.0698	.0395	1.0000
	(260)	(543)	(543)	(543)
	P= .837	P= .104	P= .359	P= .

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed